

ForWarn Aids Forest Resource Managers

Eastern Forest Environmental Threat Assessment Center

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Stateline Meeting

Louisiana and Mississippi

April 15 -16, 2014

Natchez, MS

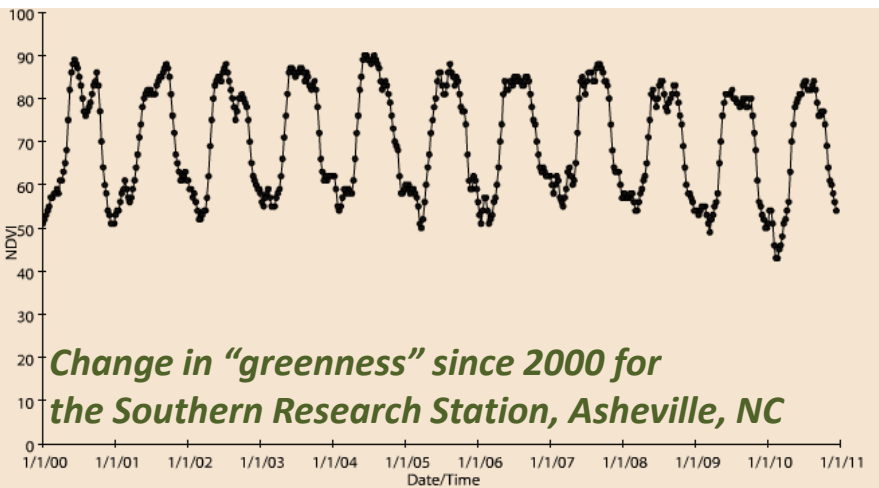
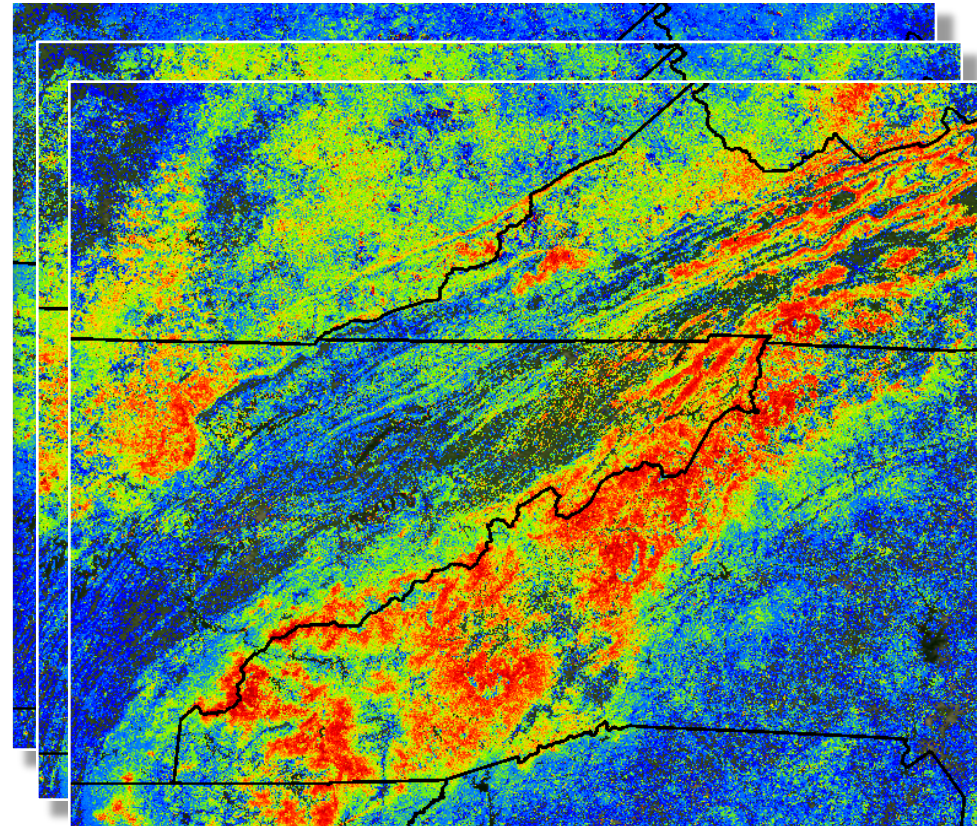




USDA FS Threat Assessment Centers' remotely monitored forest change initiative

<http://forwarn.forestthreats.org>

- MODIS-based
- Moderate resolution (~240m; 14ac)
- 2000 – present
- Conterminous US
- 24-day window; every 8-days
- Normalized Difference Vegetation Index (NDVI) – **GREENNESS INDEX**



- Maps of change in NDVI from multiple baselines (1, 3, all year, +3 new)

How Does *ForWarn* Work?

Based on a Simple Comparison between historical and current greenness

We find potential disturbance by comparing current greenness with the "normal," historically observed greenness that would be expected for healthy, undisturbed vegetation growing at this location during this time

- We develop this expected greenness from the 11-year historical MODIS satellite record
- Locations that are currently less-green than we expect are marked as potentially disturbed
- Locations having more actual greenness than we expected may represent vigorous or recovering vegetation, and will become the new expected value for next year

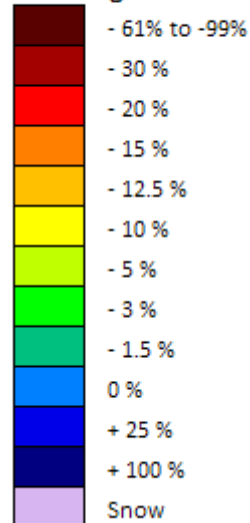
Only forested areas are shown, but *ForWarn* detects disturbances in all vegetation, including agricultural crops and rangeland forage

Compare actual greenness **as a percentage** of **expected greenness**

- Less than 100% of expected greenness = **Potential Disturbances** -- shown as **Greens, Yellows, and Reds**
- Greater than 100% of expected greenness = **Vegetation Recovery** -- shown as **Blues**

TACs-NASA Products

% Change in NDVI



Age of Disturbances and Length of Reference Baselines

We are producing **3 slightly different national disturbance maps** at every 8-day interval

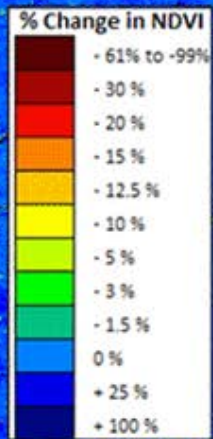
Differences relate to **the age of the disturbances that are mapped**

Three reference baselines of different length historical periods are used to calculate the normal, expected NDVI values:

- A short-term history baseline (**the prior year only**) shows **only recent disturbances**
- A mid-term history baseline (**the previous 3 years**) shows **intermediate-age disturbances**
- A long-term history baseline (**the entire available baseline period**) shows **all disturbances since MODIS**

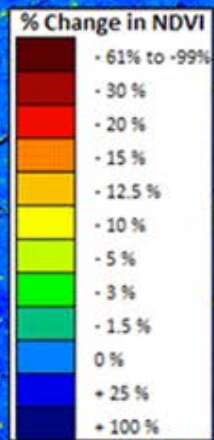
ForWarn: May 23, 2012
Change since 2011

Twin tornado tracks
from March 2, 2012

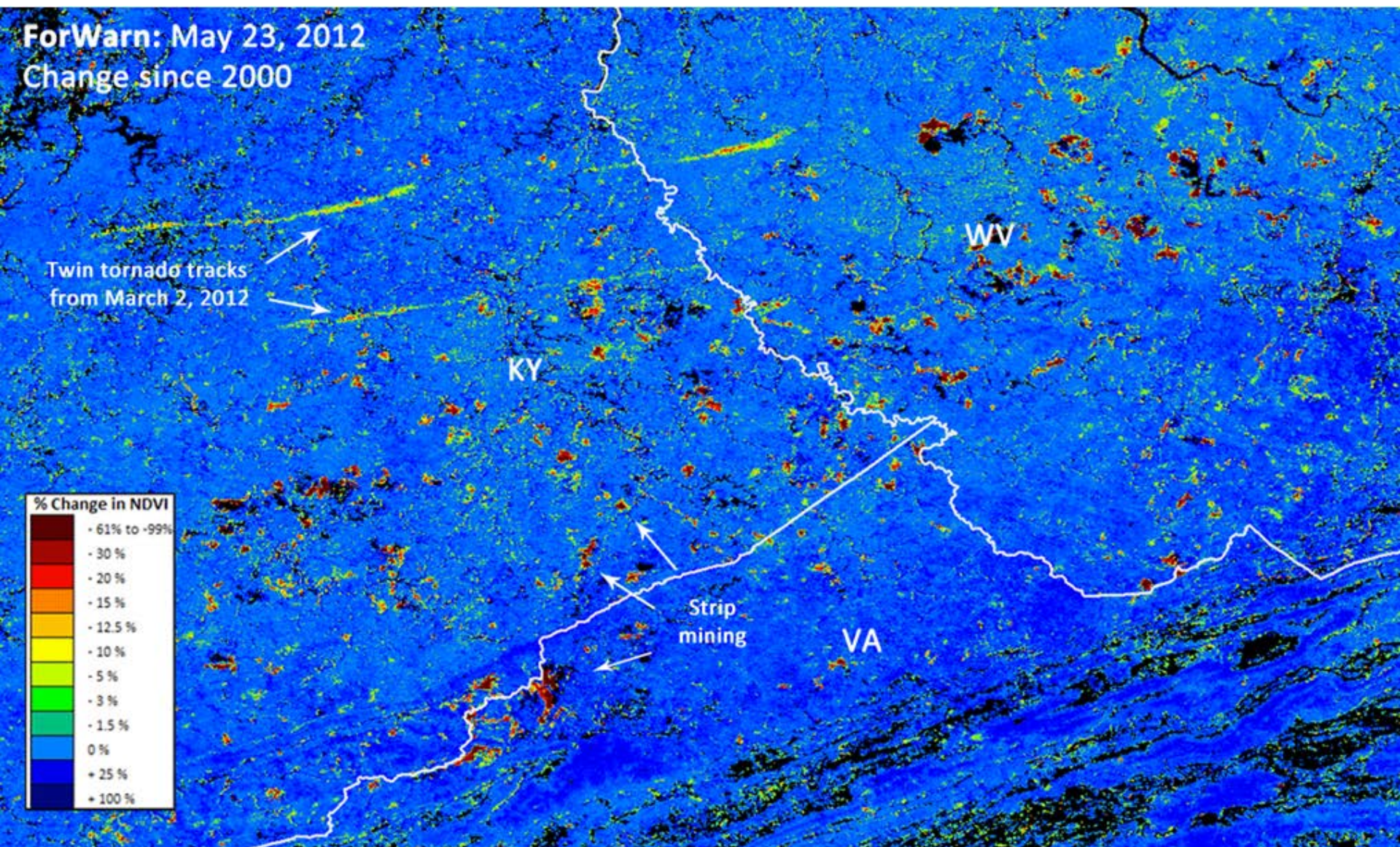


ForWarn: May 23, 2012
Change since 2000

Twin tornado tracks
from March 2, 2012



Strip
mining



Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

Natural disturbances causing a decline in NDVI value

- Tornados and hurricane events
- Wind, hail and ice storm damage
- Drought and flood conditions
- Insect and disease outbreaks
- Fall season brown-up
- Snow pack extent
- Wildfire events

Human-Induced disturbances causing a decline in NDVI value

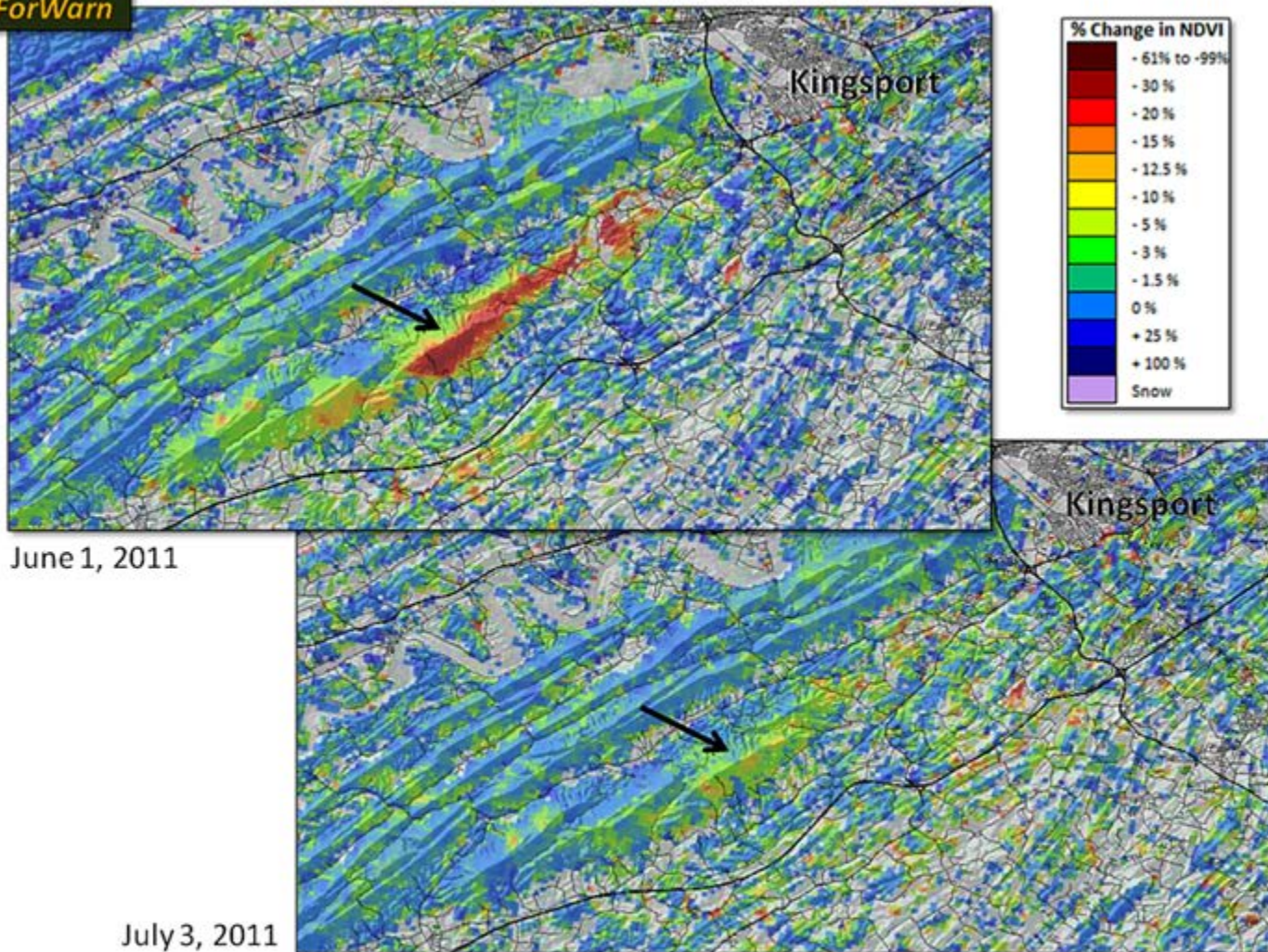
- Forest fragmentation, conversion and urban sprawl
- Forest clear-cutting and stand thinning
- Mining, oil and natural gas activities
- Non-native plant species invasions
- Climate variability and change
- Prescribed fire
- Arson wildfire

Events that can increase NDVI values

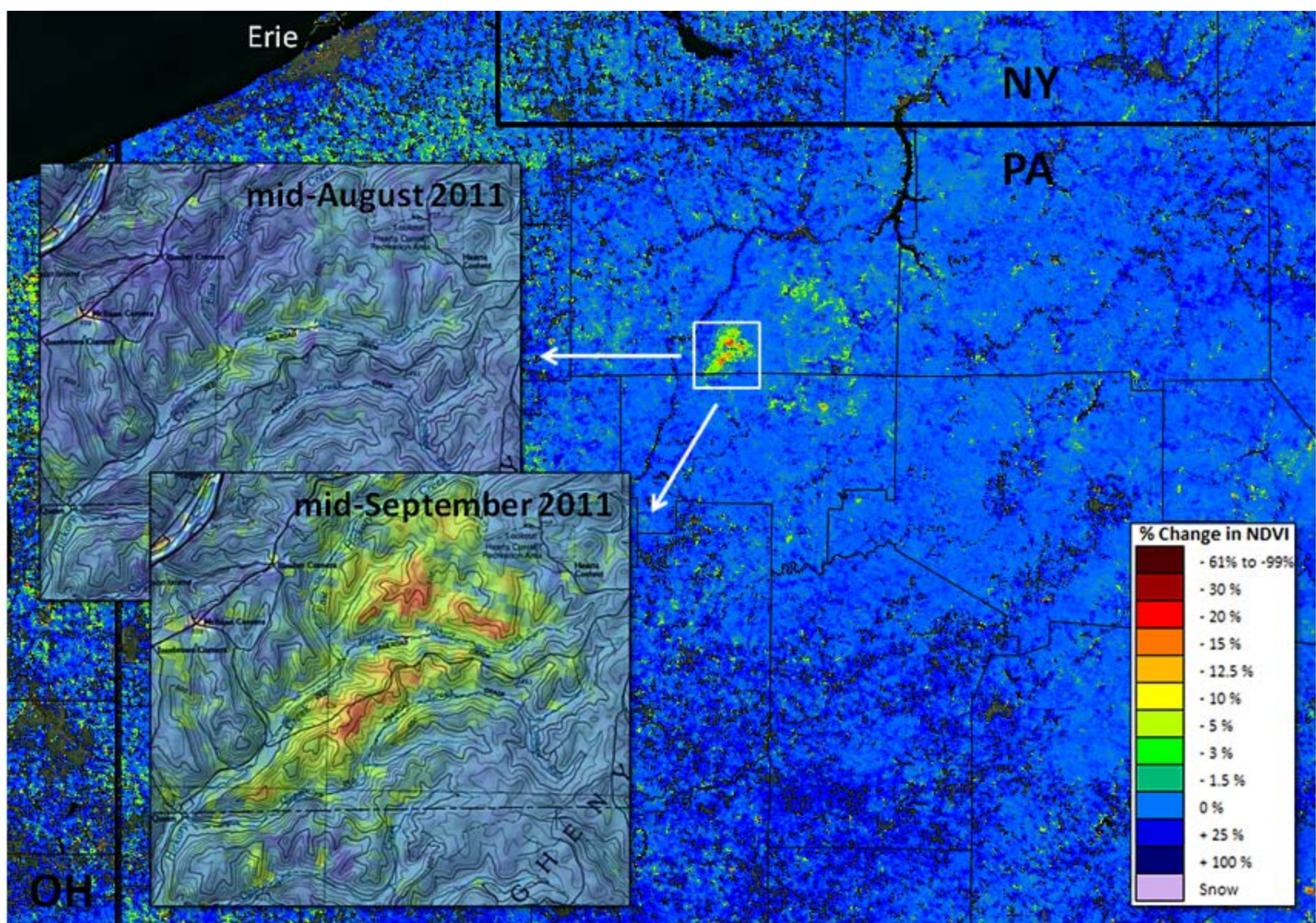
- Vegetative recovery from disturbance
- Non-native plant species invasions
- Precipitation events in arid locales
- Forest canopy closure
- Forest plantings
- Spring leaf-out

*Forest disturbance events often display degrees of severity.
Variation in rates of recovery can relate to ecological, or vegetative resilience.*

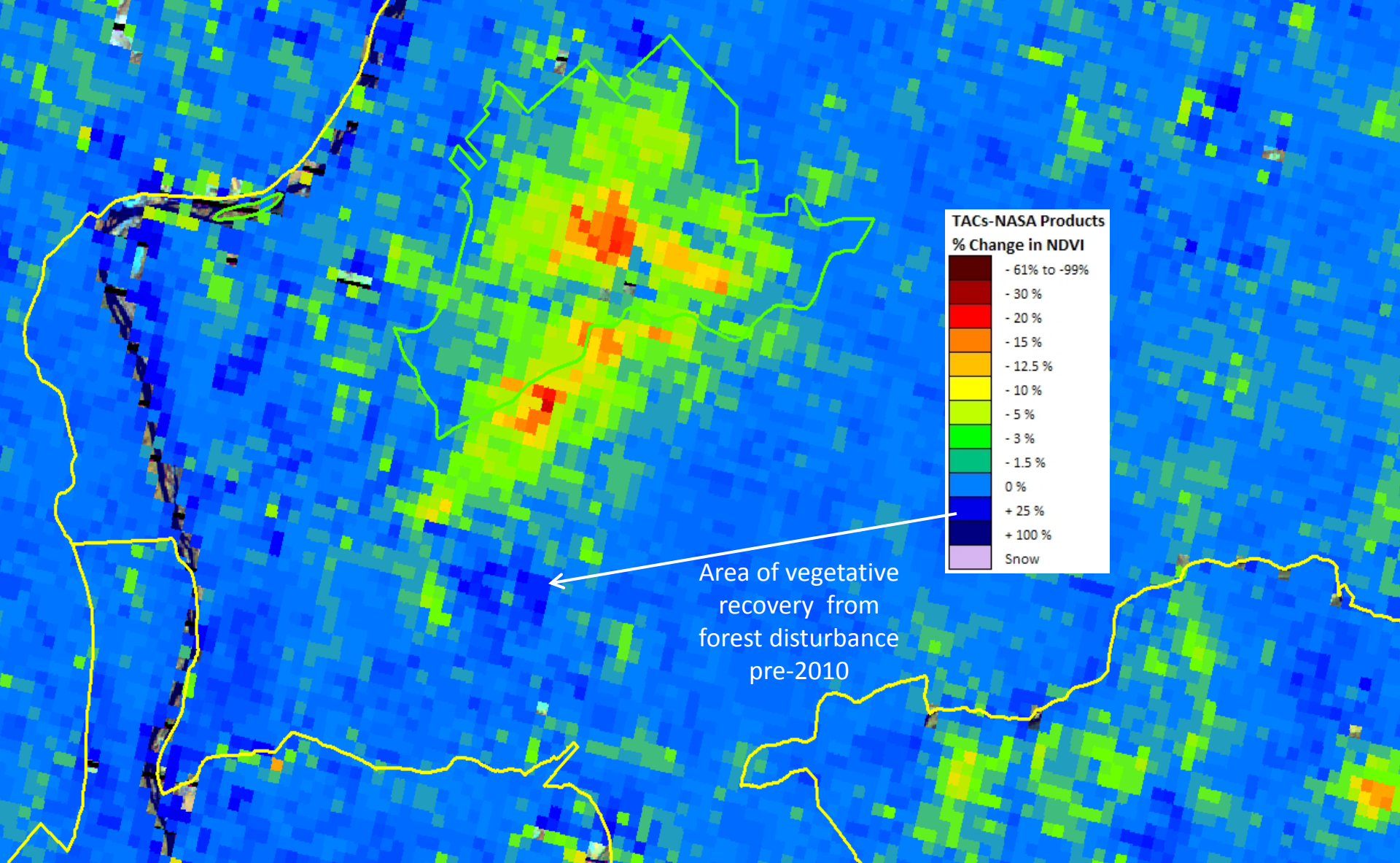
ForWarn



One month after the April 2011 tornado outbreak (top), *ForWarn* mapped a localized linear windstorm event on a ridgeline forest southwest of Kingsport, TN. Two months later (bottom), the vegetation had almost completely recovered. Regular observations are needed to spot such ephemeral forest damage.



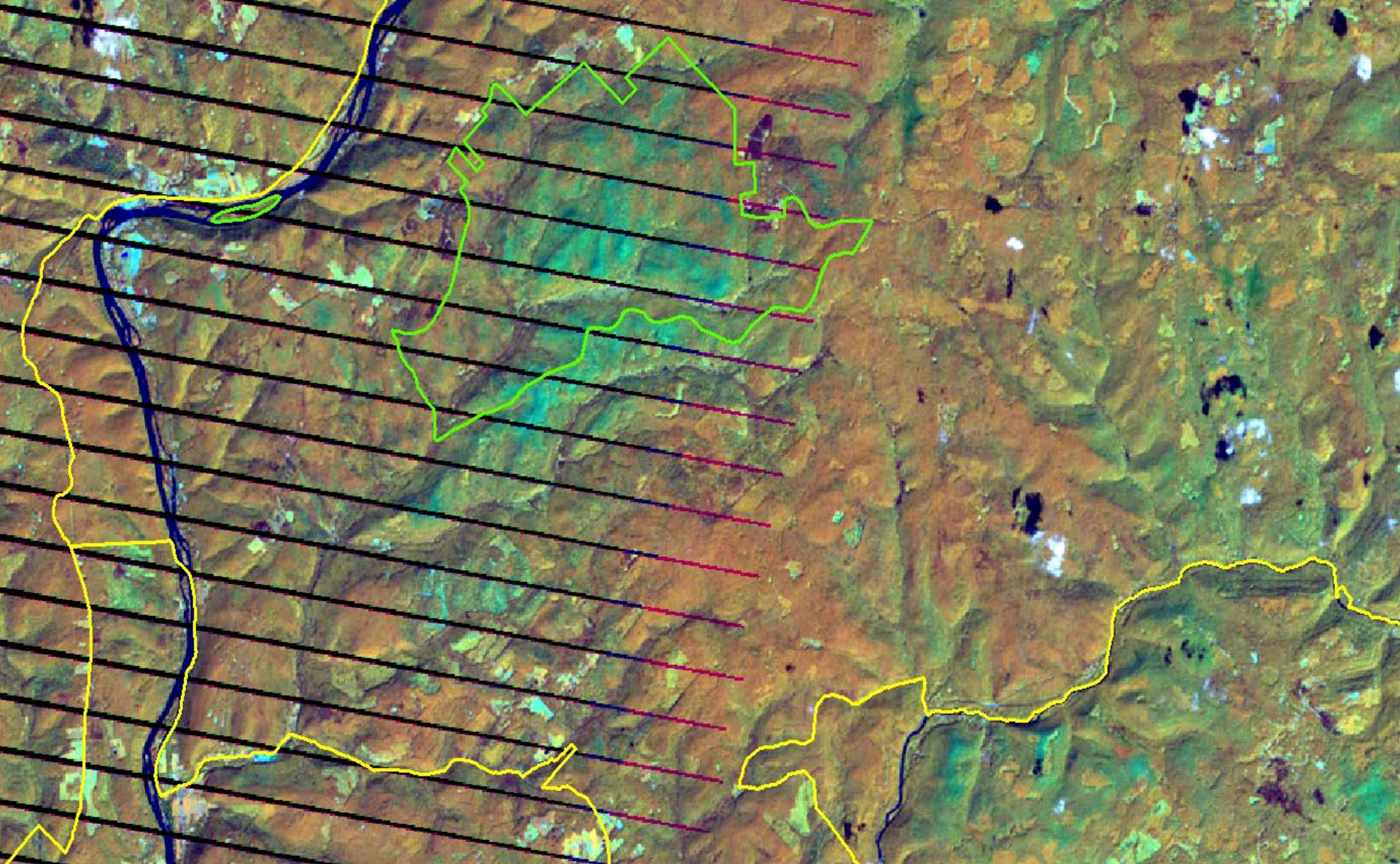
Fall webworms in the Hickory Creek Wilderness Area. Minimal indications of defoliation in mid-August, 2011, but clear patterns by mid-September, until leaf loss. In 2012, this area experienced an even more severe and widespread outbreak of fall webworms, detected by *ForWarn*.



<http://ews.forestthreats.org>

Allegheny National Forest
Hickory Creek Wilderness area
Forest Change Assessment Viewer (FCAV)
09/13/2011 1-yr baseline

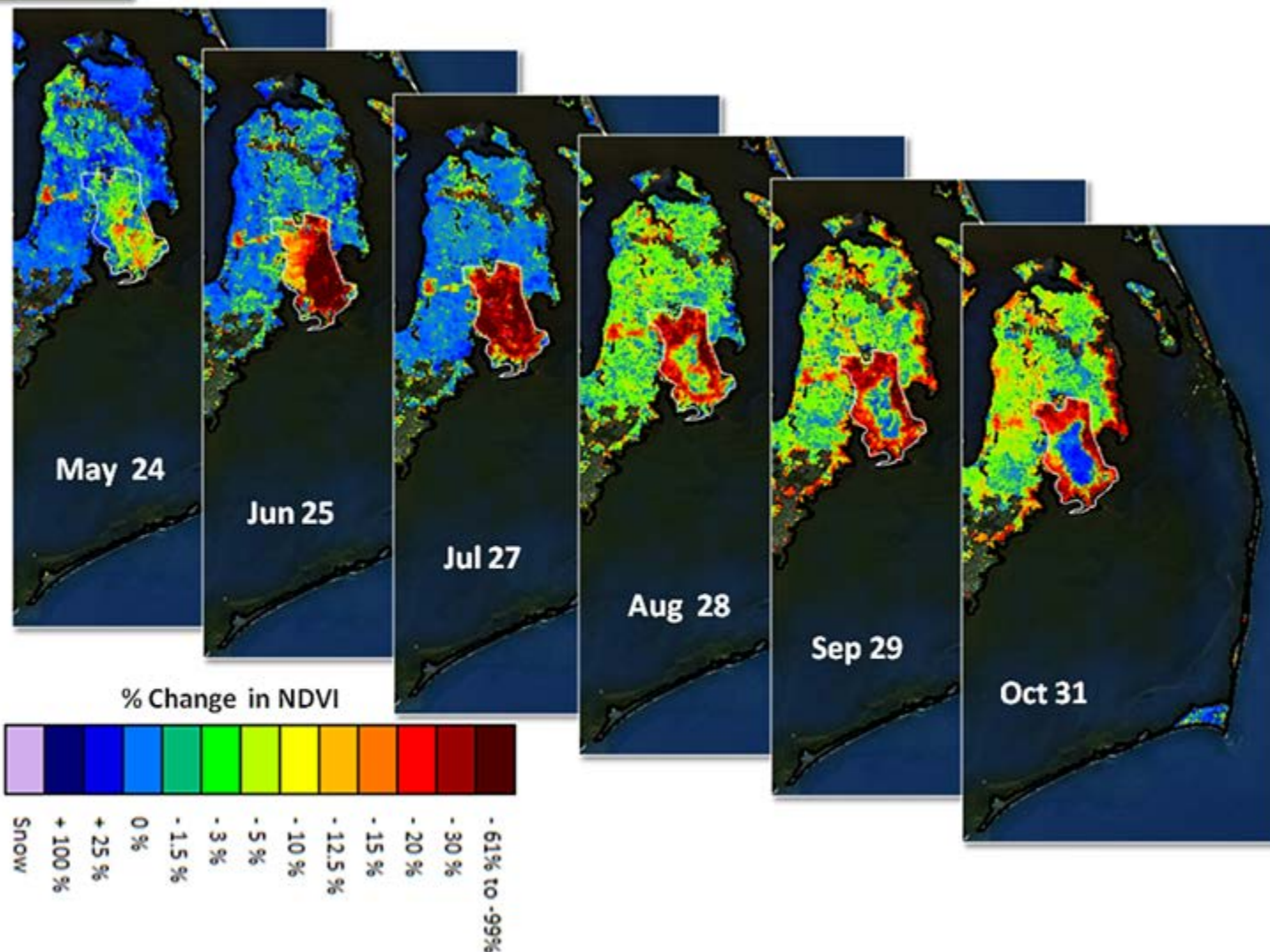




<http://ews.forestthreats.org>

Allegheny National Forest
Hickory Creek Wilderness area
Landsat 7TM on **09/13/2011** , 453 RGB





The center of the Pains Bay fire burned lightly, with low severity, allowing amazingly rapid recovery of herbs, ferns, and sprouting woody species by August. But an outer ring of the burn scar shows a longer lasting departure from prior years.

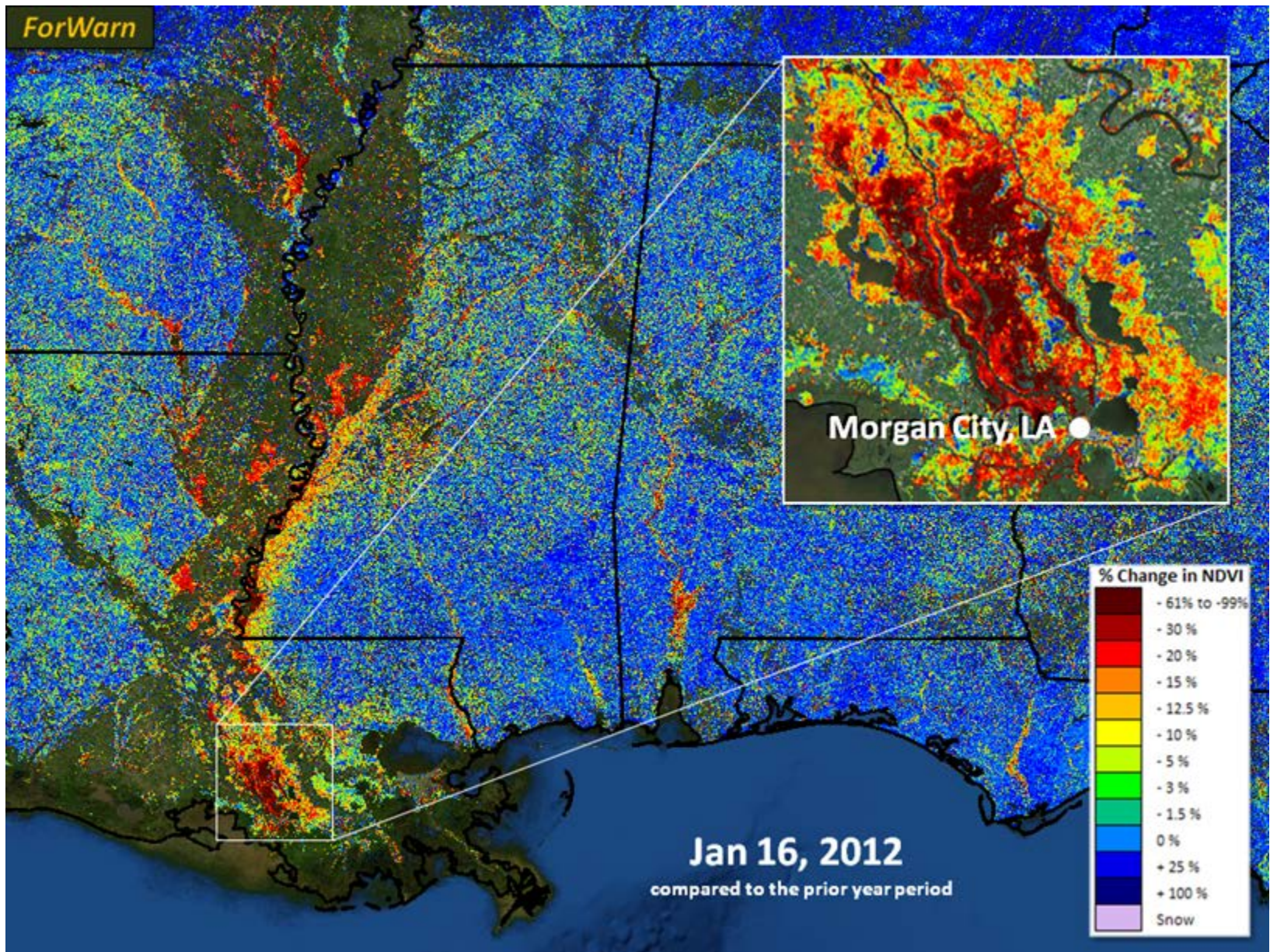
The *ForWarn* System is:

**Not Measuring *Disturbance* in a Strict Sense,
but instead *Departure from Normal* Phenological Timing**

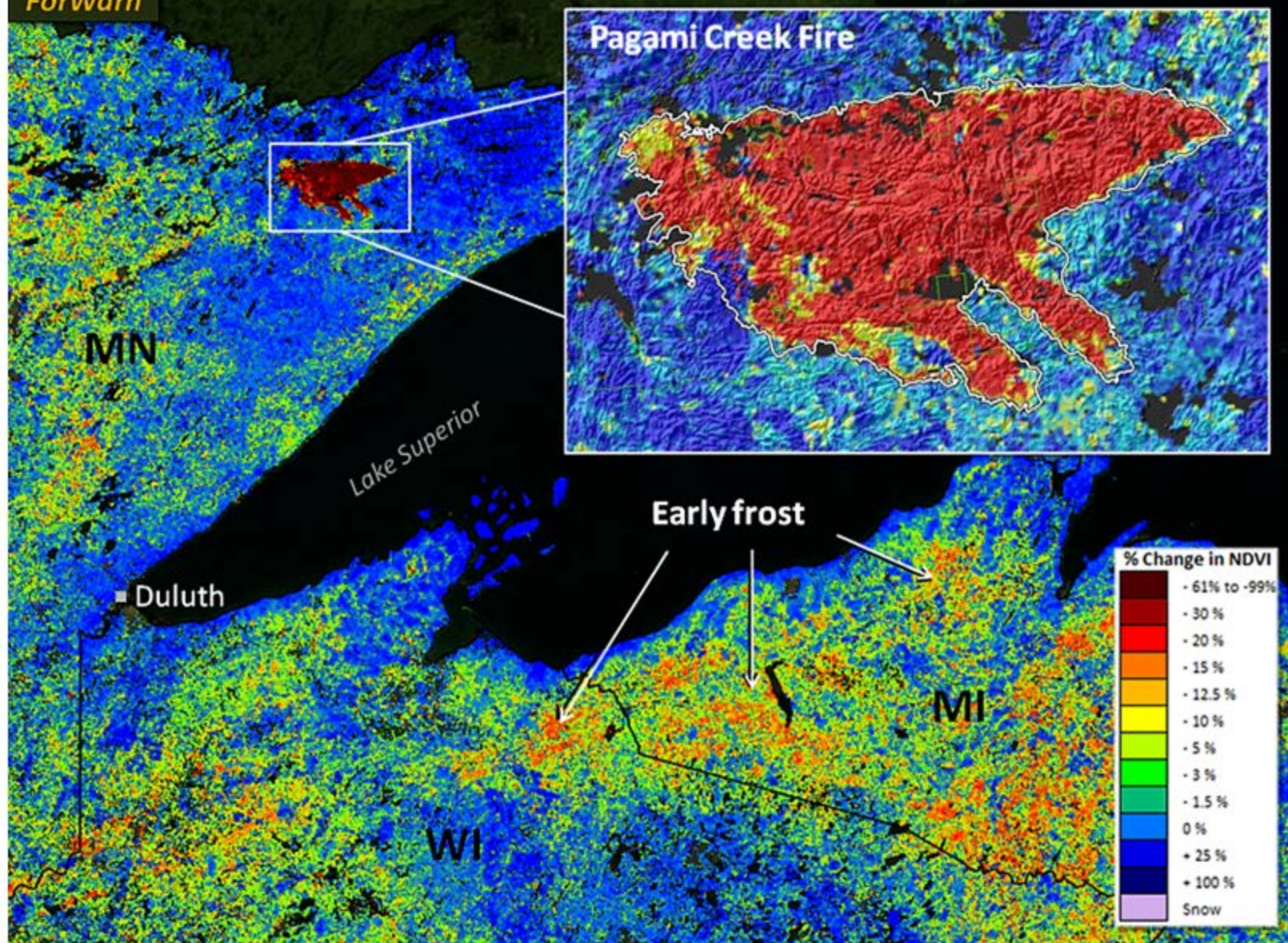
Not just detecting insects, diseases, invasives, storms, wildfire

**Also detecting *weather departures* caused by precipitation and temperature
deviations: extremes of hot and cold, or wet and dry periods**

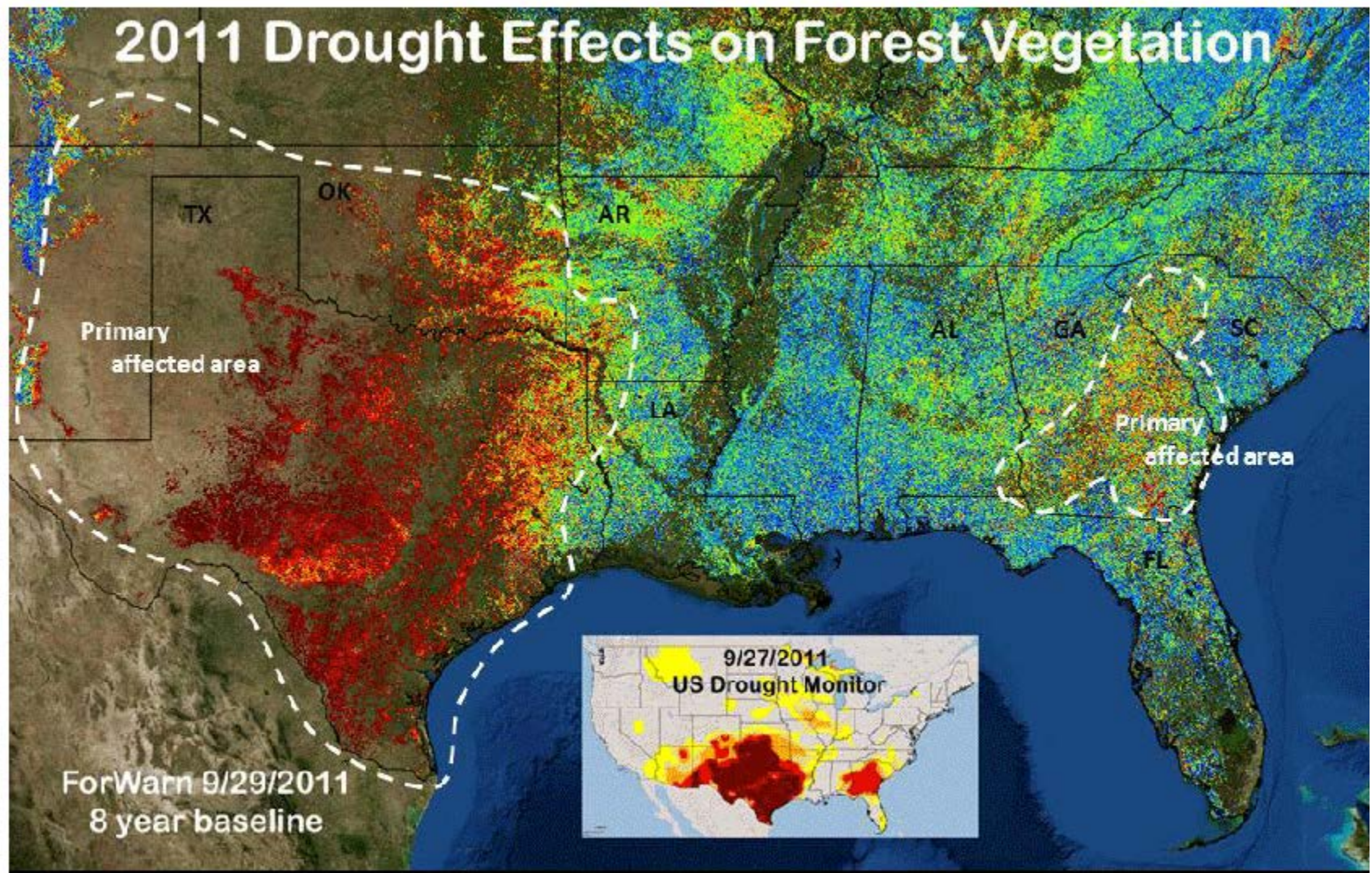
***ForWarn* has proven to be sensitive to drought, warm/cold periods, shifts in timing of
leaf greenup and senescence**



The Atchafalaya basin's forests thrive with seasonal flooding, yet high water is normally a spring phenomenon there. During the past month, unusually high water levels have inundated wetlands and forests along and near the Mississippi River basin. From space, floodwaters appear to decrease existing vegetation, as water masks low lying plant cover. According to the USGS, river discharge at Morgan City, Louisiana was 145,000 ft³/sec on January 16, 2012 compared to 84,000 ft³/sec the prior year. (See <http://waterdata.usgs.gov>.)



A single October, 2011 *ForWarn* image shows the final high-severity Pagami Creek Fire (92 thousand acres), as well as forest disturbance resulting from an early hard frost that hastened the end of the growing season in northern Wisconsin and Michigan.



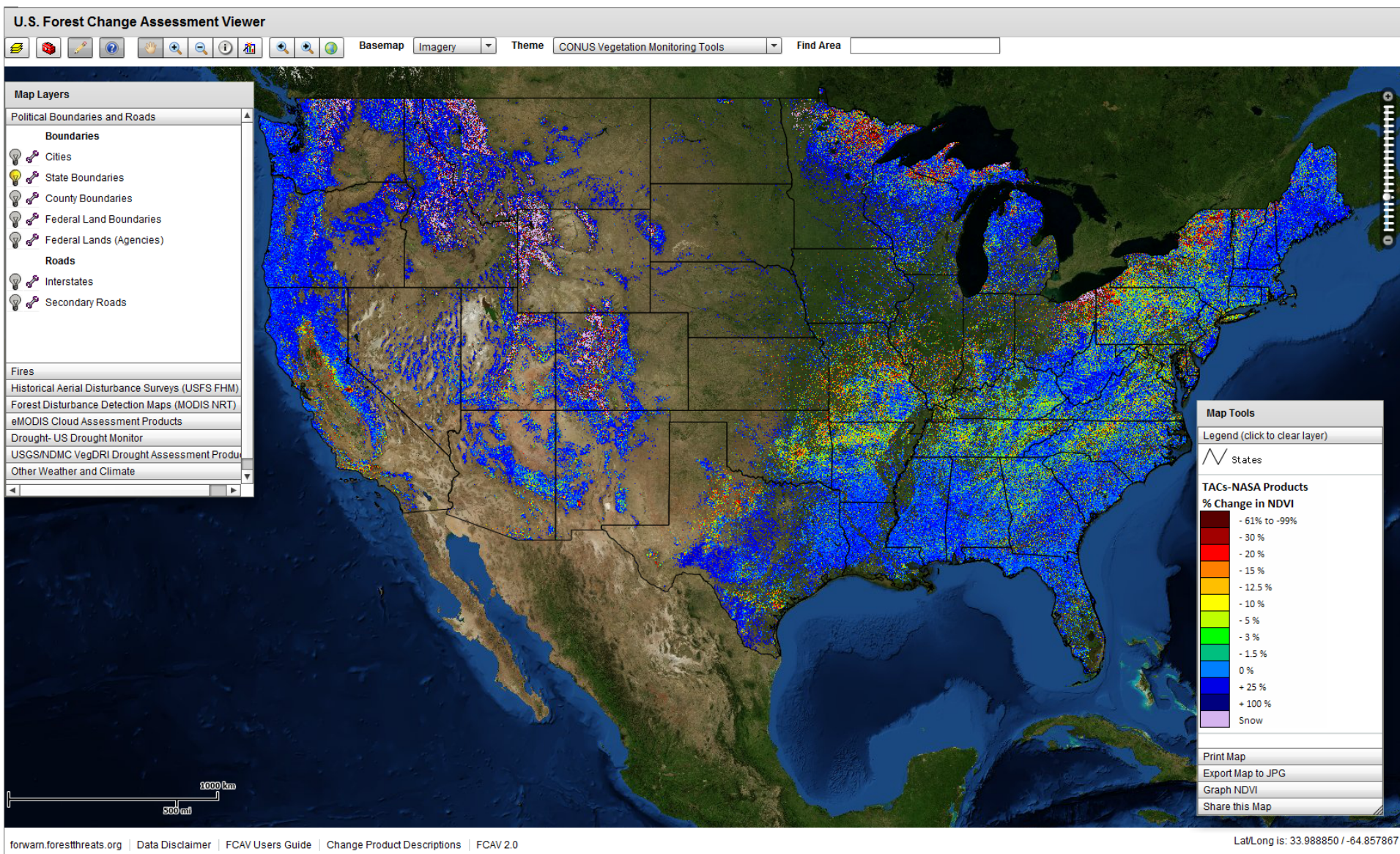
**The *ForWarn* system is a sensitive indicator of drought,
which is a precursor to regional wildfire**

The Forest Change Assessment Viewer is the main delivery vehicle for output from *ForWarn*

Developed by the University of North Carolina Asheville National Environmental Modeling and Analysis Center (NEMAC)

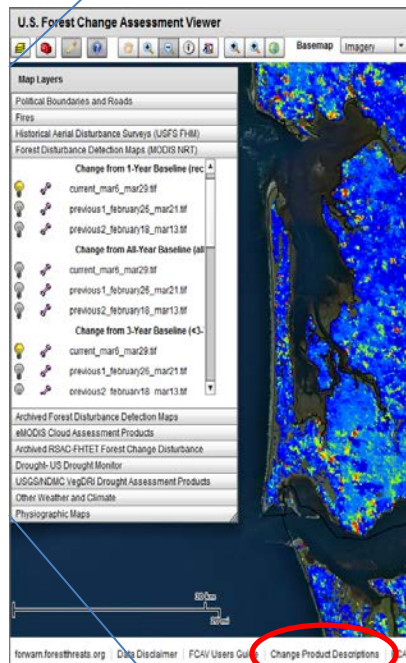
- The Assessment Viewer is totally open to anyone, no userid, no password is required
- Runs on almost any computer using any browser; nothing is downloaded
- Intuitive and easy to use, similar to the Google Maps interface
- Shows the three most-recent national *ForWarn* disturbance maps, as well as all historical *ForWarn* products since Jan 2010
- Shows other relevant maps in the same spatial context
- Assess likely causes of potential disturbances based on past disturbance history using a "weight-of-evidence" approach

Resource managers (and anyone else!) can see the newest national disturbance maps at the same time the Threat Centers do

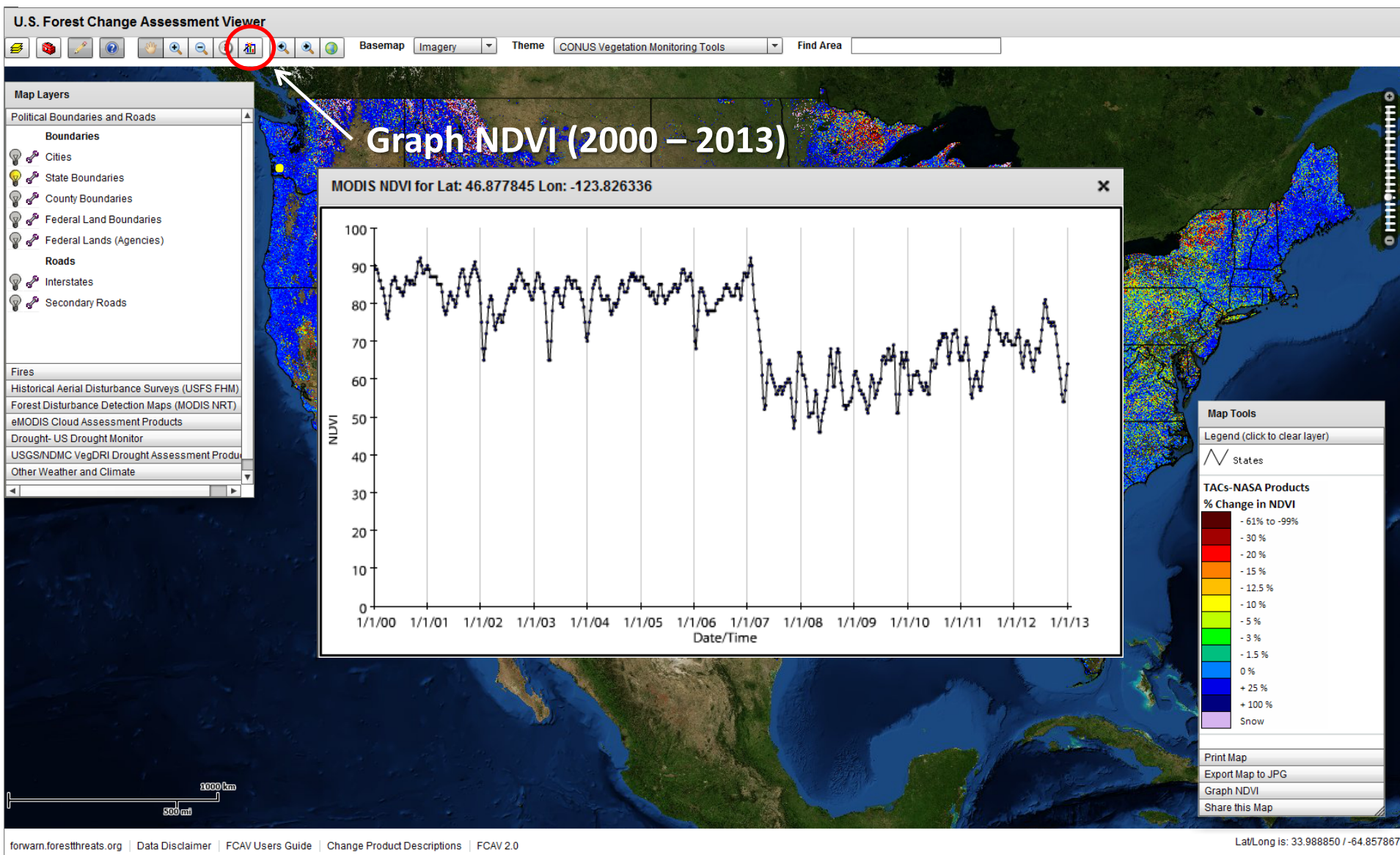


ForWarn Quick Start Guide

1. Open this URL in a web browser
<http://forwarn.forestthreats.org/fcav>
2. **By default**, the most recent “1-Year” baseline forest change image is displayed at CONUS scale with streets base map.
3. Use the zoom control, or the **Find Area** tool to jump to a NF or County.
4. To access other baselines and change products, **Map Layers / Forest Disturbance Detection Maps**, click heading to expand (NRT – near real time).
5. To investigate a potential disturbance, switch to the **“Imagery”** base map and toggle on and off the change image, or make transparent the change image with wrench icon beside the layer toggle to allow you to see the land cover type displaying the disturbance.
6. Other **Map Layer TABS** contain layers that can assist in vetting a potential disturbance.

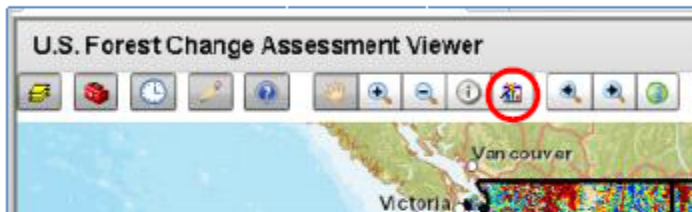


Map Layers	
Political Boundaries and Roads	
Fires	
Historical Aerial Disturbance Surveys (USFS FHM)	
Forest Disturbance Detection Maps (MODIS NRT)	
Forest NDVI Change (USFS TACS-NASA)	
Change from 1-Year Baseline (recent disturbances)	
	current_mar6_mar29.tif
	previous1_february26_mar21.tif
	previous2_february18_mar13.tif
Change from All-Year Baseline (all disturbances)	
	current_mar6_mar29.tif
	previous1_february26_mar21.tif
	previous2_february18_mar13.tif
Change from 3-Year Baseline (<3-Yr old disturbances)	
	current_mar6_mar29.tif
	previous1_february26_mar21.tif
	previous2_february18_mar13.tif
Early Detect (ALC) Change from previous year	
	current_mar6_mar29.tif
	previous1_february26_mar21.tif
	previous2_february18_mar13.tif
Seasonally-Adjusted Change from All-Year pheno-cluster max (MUC)	
	current_mar6_mar29.tif
	previous1_february26_mar21.tif
	previous2_february18_mar13.tif
Seasonally-Adjusted Change from All-Year mean of maximums (MMAX)	
	current_mar6_mar29.tif
	previous1_february26_mar21.tif
	previous2_february18_mar13.tif
RSAC-FHTET Forest Change	
Change from 3-Year Baseline	
	current_mar14_mar29.tif
	previous1_nov9_nov24.tif
eMODIS Cloud Assessment Products	
Drought- US Drought Monitor	
USGS/NDMC VegDRI Drought Assessment Products	
Other Weather and Climate	
Physiographic Maps	



Portion of Viewer detailed is shown in red

Using the Graph NDVI feature

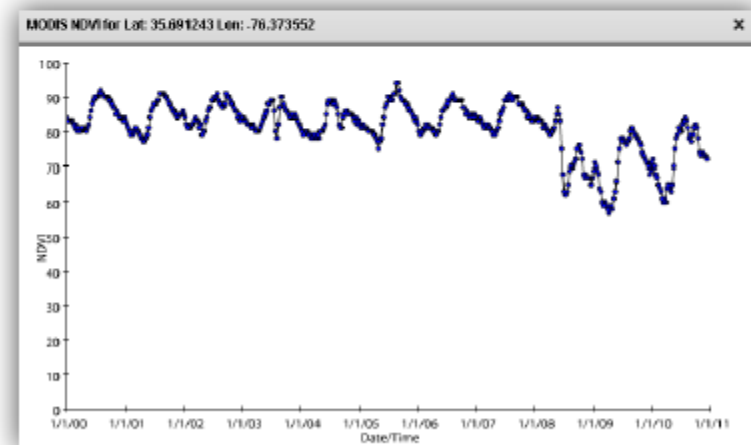


Large scale best use:

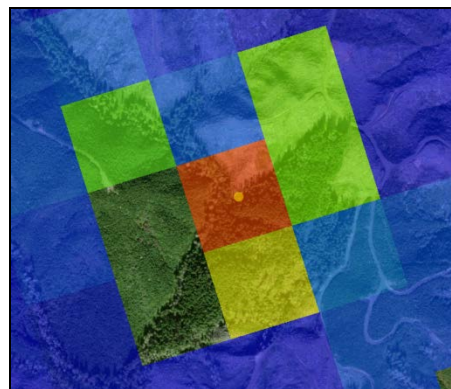
- zoom into your area of interest and choose the imagery basemap
- make active one of the forest change images and apply a transparency so you can see through to the aerial photography underneath (use the 'wrench' icon next to the layers 'light bulb')
- use the transparent pixels of the forest change image as a guide to select a specific pixels' land cover composition for which the NDVI history will be returned
- by using the transparent forest change images' pixels as a template, one can photo-interpret a pixels land cover composition before selection to better understand the character of that pixels' NDVI history
- different land covers, land uses and mixed pixel compositions create unique phenological signatures



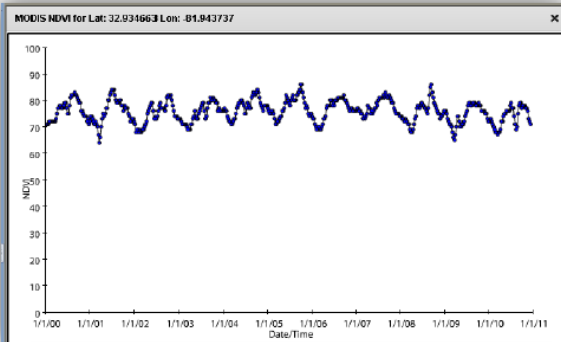
“Graph NDVI” shows a locations’ change in NDVI value over an 11-years history, measured every 8-days



The “Graph NDVI” database covers the entire U.S. and is not restricted to the forest mask, as are the forest change images



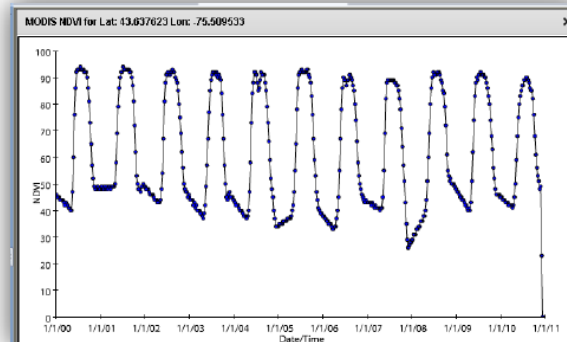
Interpreting NDVI Pheno-signatures



Pine Plantation

(*Pinus sp.*, GA)

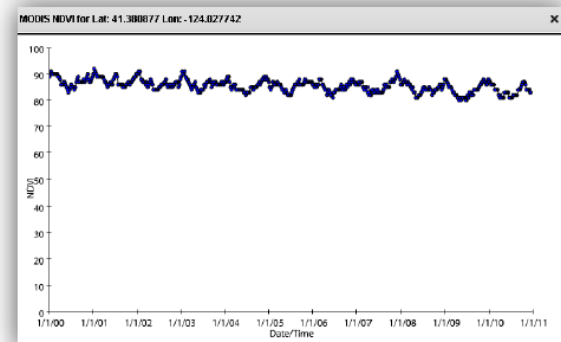
- relatively high average-NDVI values
- amplitude relatively narrow
- annual NDVI value increase and decrease due to photosynthetic response to annual phenology



Mixed Hardwood Forest

(Adirondack Park, NY)

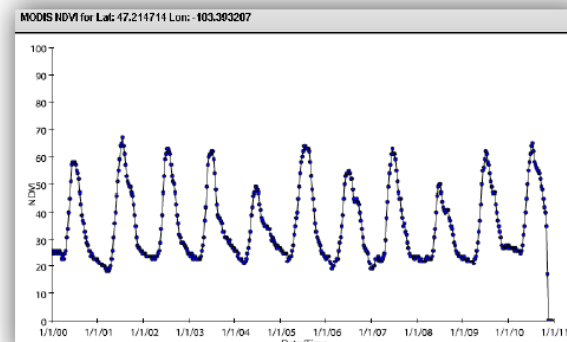
- high maximum-NDVI values
- data range relatively high
- NDVI increase and decrease due to annual phenology
- NDVI-minimum variability may be due to snow events masking the shrub layer



Coastal Redwoods

(*Sequoia sempervirens*, CA)

- relatively high and constant NDVI values
- amplitude of change very narrow
- slight phenological variation across time

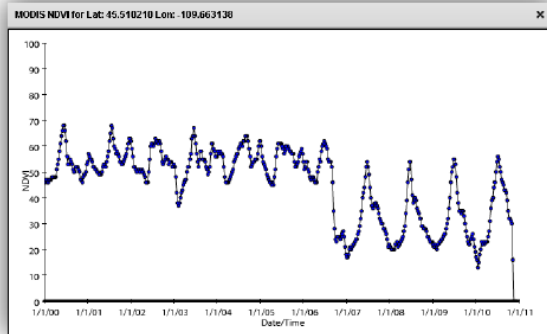


Prairie Grasslands

(National Grasslands, ND)

- relatively low average-NDVI values and range large
- sharp NDVI increase and decrease due to annual phenology
- variability in yearly maximums due to variations in seasonal precipitation

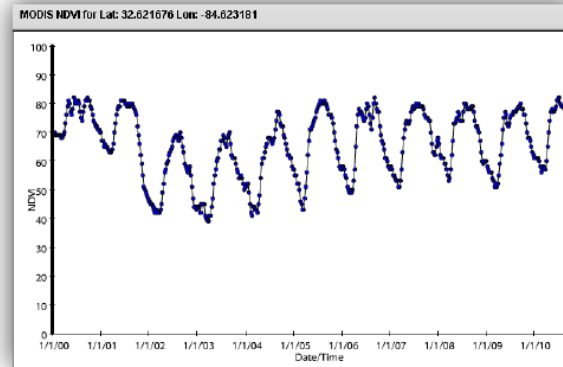
Interpreting NDVI Pheno-signatures



2006 Derby Wildfire

(southern Montana)

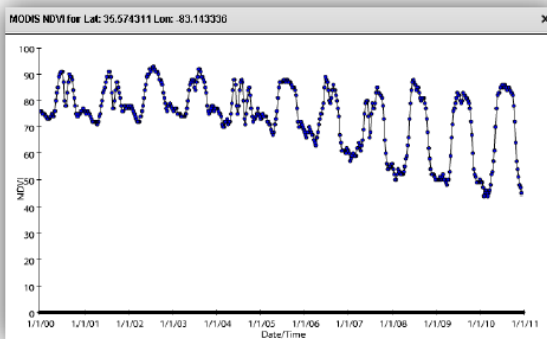
- Pre-fire, dominated by low density Ponderosa Pine
- Post-fire, tree killing event led to grass dominated landscape
- observe greater peakedness and lower winter minimums



Timber Harvest and Recovery

(central Georgia)

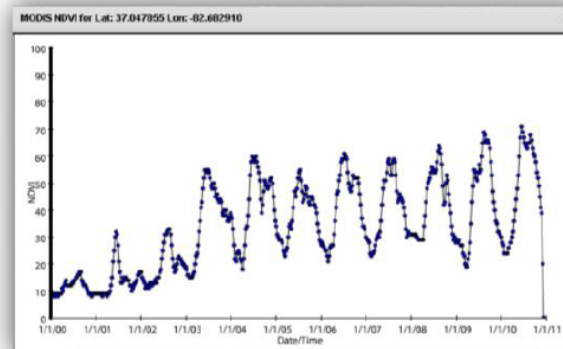
- drop in NDVI due to plantation clear-cut in 2001
- crown closure of the pine plantation reduces the amplitude of the annual phenological signal
- note the trend in increased minimum NDVI values over time



Non-native Invasive Species

(Hemlock Woolly Adelgid, TN)

- declining Hemlock composition causes a drop in the winter minimum
- defoliation began during the 2005 growing season
- this tool can be used to monitor the rate of decline for this area and for new sites

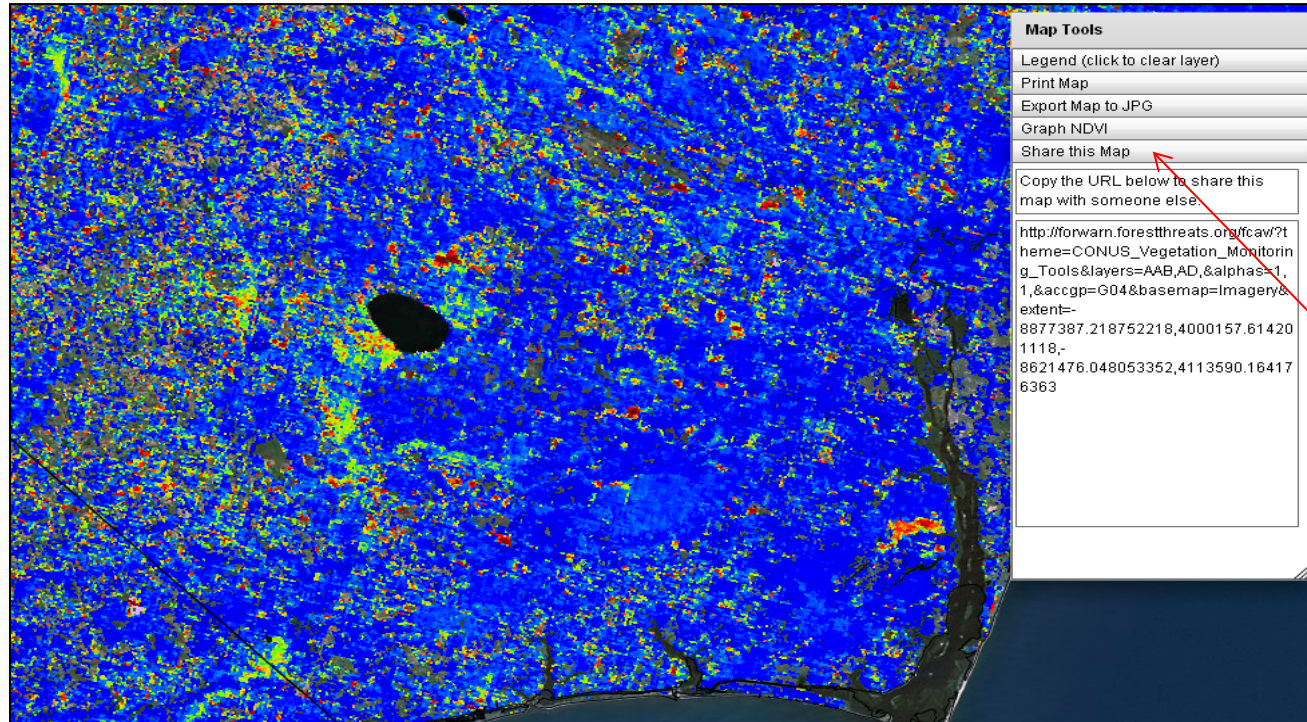


Strip-Mining Reclamation

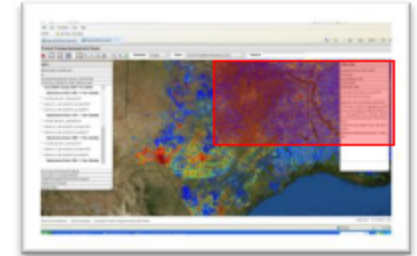
(western Virginia)

- NDVI increase due to the mined area being replanted
- has not achieved maximum greenness of original forest cover
- this tool can provide insights into the ability of reclaimed land to recover its productivity within a specified time frame

Share Disturbance Events with Colleagues



Portion of Viewer detailed is shown in red



- The “Map Tools” box in the upper right portion of the Viewer offers the capability to send a URL of a view via your email client to a colleague.
- Click the “Share this Map” tab, then highlight and copy the URL, and paste the link into your email program. Your colleague can open the Viewer to the same extent and data layers you were using to explore a disturbance event.

Application Limitation

- Detection delay due to compositing method -

Detection Delays are caused by the fixed-length 24-day Maximum Compositing currently used to get rid of Clouds in the Current View

Unfortunately, clouds act to lower NDVI, just like true forest disturbances -
Can cause false positives - Cloud contamination is continuous, not binary

We currently use the **MAXIMUM NDVI** seen over a 24-day compositing period to generate the Current view as cloud-free as possible

BUT

Taking the maximum NDVI seen over the period guarantees that the newly-lowered NDVI from a new forest disturbance **WILL NOT BE DETECTED** until after the 24-day compositing period has passed

This creates a delay in detection of new disturbances

Three additional change products now available:

- (1) derived from an 'Adaptive Length Compositing' method, and*
- (2) called Seasonally Adjusted, which mitigates annual seasonal variations in the timing of spring and fall*

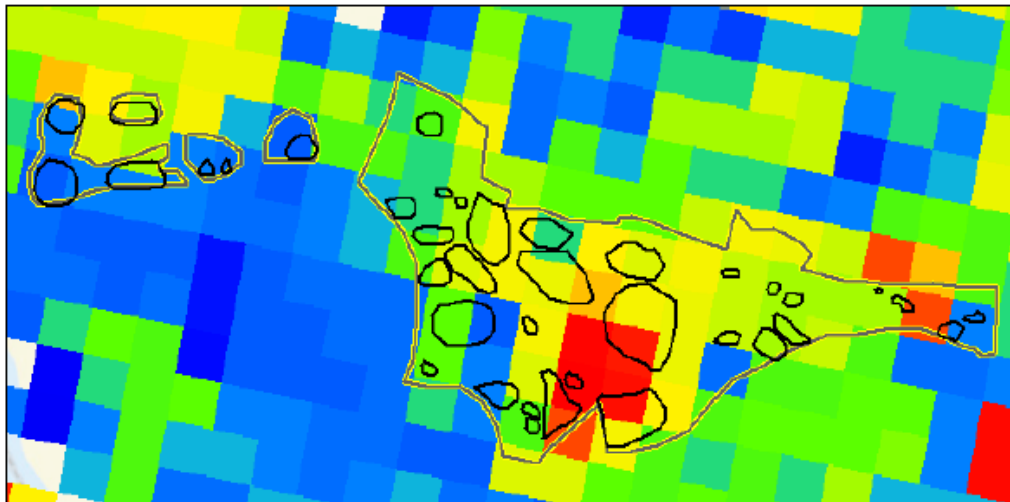
Application Limitation

- *Spatial resolution* -

08/14/2012
Landsat 453

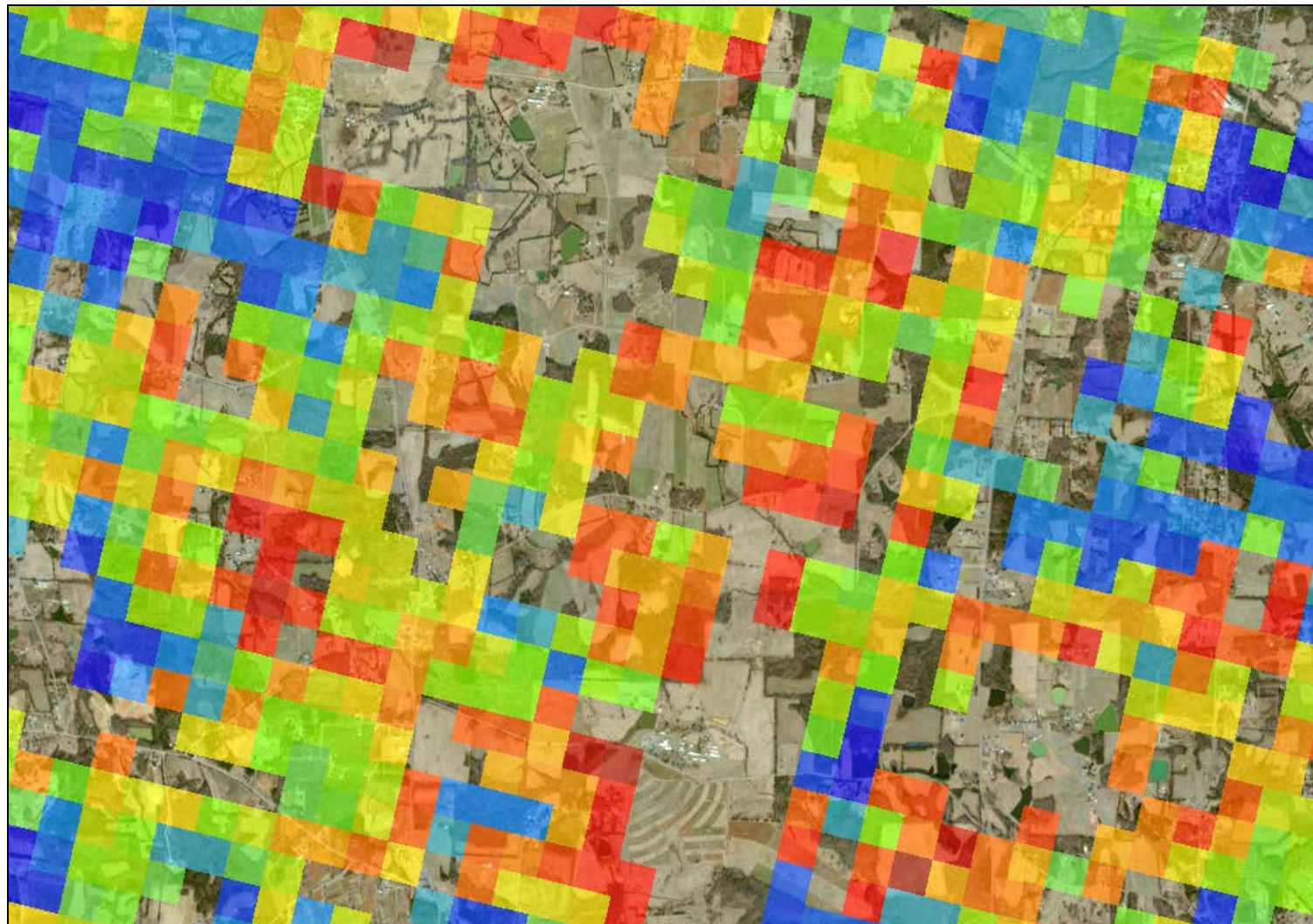


08/19/2012
ForWarn 11yr



Application ~~Limitation~~ Awareness

- *“Edge-of-the-mask” mixed pixels* -

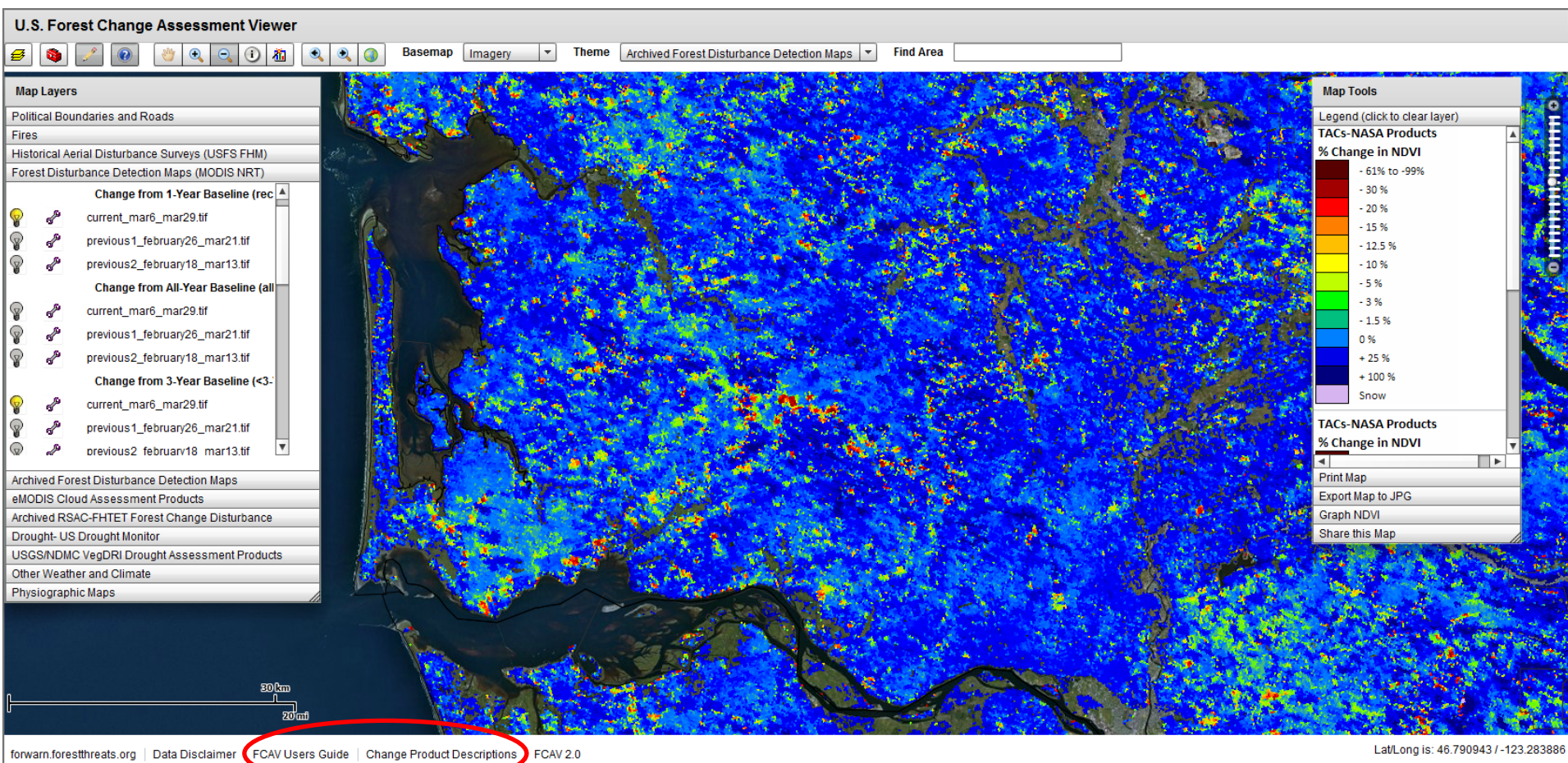


Drought Sensitivity at the ‘edge-of-the-mask’



Next Steps to Develop Additional Future *ForWarn* Capacities

- ✓ NLCD-based “Masks”
- ✓ New Open-Source “FCAV Viewer v2”
- Clip, Zip and Ship functionality
- Download data by point/line/polygon
- User-shapefile upload
- Disturbance auto-detect
- Disturbance auto-notify via any social media format



ForWarn

Satellite-Based Change Recognition and Tracking



Home

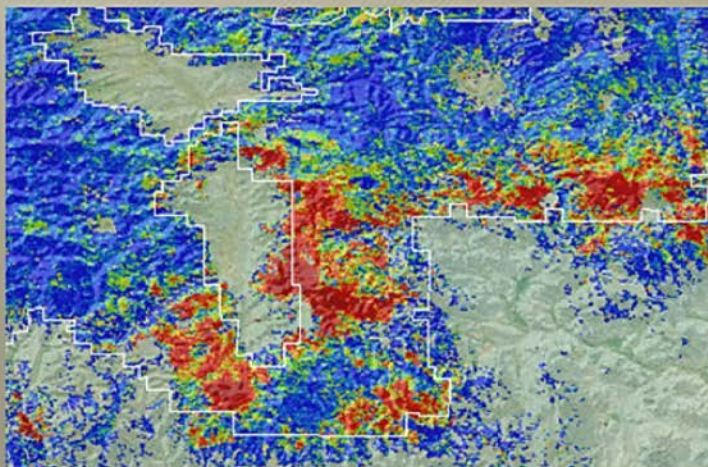
Overview

News

Highlights

Data

Support



A rare outbreak of pine butterflies

Outbreaks of the defoliating pine white butterfly are rare. In eastern Oregon, outbreaks occurred in 1908-11, 1940-43, 1982 and 2008 to the present. Sometimes defoliations can lead to mass mortality of ponderosa pine—the primary host—but not...

[read more »](#)

What is ForWarn?

ForWarn is a satellite-based forest disturbance monitoring system for the conterminous United States. It delivers new forest change products every eight days and provides tools for attributing abnormalities to insects, disease, wildfire, storms, human development or unusual weather. Archived data provide disturbance tracking across all lands since 2000. Interactive maps are accessible via the [Forest Change Assessment Viewer](#). Read more about ForWarn [here](#).



Recent News

[ForWarn award featured in Compass Magazine](#)

01/10/2013 - 15:25 Click [here](#) to read an article in *Compass Magazine*...

[USDA Forest Service Article in National Woodlands Magazine](#)

01/07/2013 - 15:08 Click below to download an informative article, featuring ForWarn and written by EFETAC's Stephanie Worley Firley for the National Woodlands magazine.

[NATIONALWOODLANDS_FALL2012_EFETAC.PDF](#)

[more news »](#)

For More Information...

- *ForWarn Home Page:*
<http://forwarn.forestthreats.org>
- *Forest Change Assessment Viewer
for the ForWarn System:*
<http://forwarn.forestthreats.org/fcav>

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Many persons at many agencies and institutions
have contributed to this work