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EASTERN FOREST ENVIRONMENTAL THREAT ASSESSMENT CENTER

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The Eastern Threat Center hosts First Friday All Climate Change Talks, monthly information sharing forums featuring presentations about research activities focused on climate change impacts to eastern forest ecosystems.

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Family forest owners may use consulting foresters or state extension foresters for advice on the technical details of land management, but many owners shy away from seeking help with how best to pass their forest land on to the next generation.

Sunlight vs. Hemlock Woolly Adelgids

Scientists have identified a potential new strategy for protecting hemlocks from the miniscule insect that plagues them.

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- Potential and limitations of inferring ecosystem photosynthetic capacity from leaf functional traits pdf
- A remotely sensed pigment index reveals photosynthetic phenology in evergreen conifers pdf

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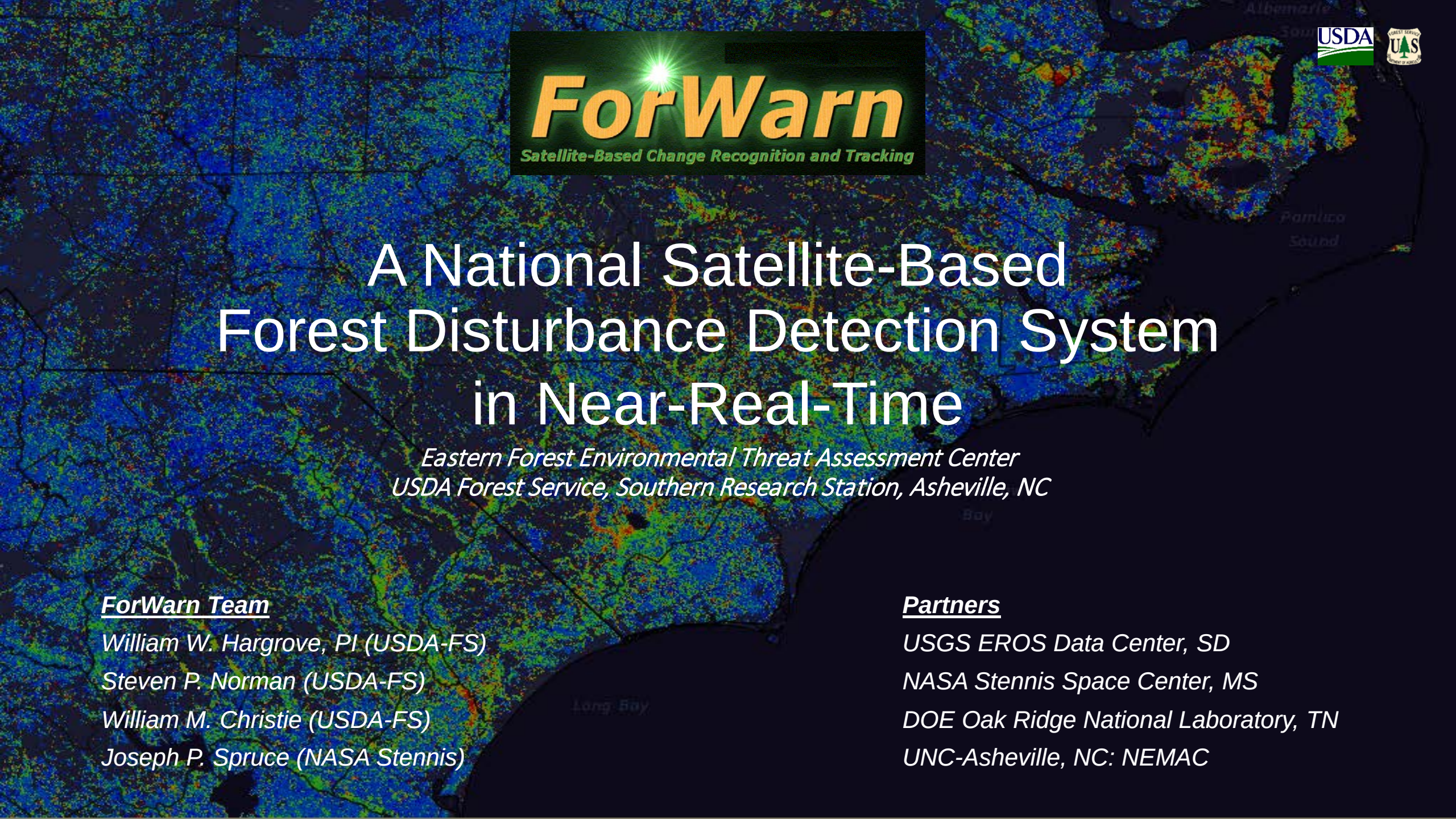
SITE MAP CONTACT ACCESSIBILITY PRIVACY POLICY IMPORTANT NOTICES POWERED BY SREF LOG IN

Updated 02/07/2017 09:08 AM



A National Satellite-Based Forest Disturbance Detection System in Near-Real-Time

Eastern Forest Environmental Threat Assessment Center
USDA Forest Service, Southern Research Station, Asheville, NC

ForWarn Team

William W. Hargrove, PI (USDA-FS)
Steven P. Norman (USDA-FS)
William M. Christie (USDA-FS)
Joseph P. Spruce (NASA Stennis)

Partners

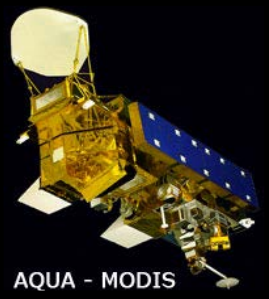
USGS EROS Data Center, SD
NASA Stennis Space Center, MS
DOE Oak Ridge National Laboratory, TN
UNC-Asheville, NC: NEMAC

ForWarn

Satellite-Based Change Recognition and Tracking

- What is ***ForWarn*** and how does it work?
- The ***Forest Change Assessment Viewer***
- Website - https://forwarn.forestthreats.org
- Questions?

2017 NASF Annual Meeting
Forest Science & Health Committee
March 29-30, 2017 Zachary, LA



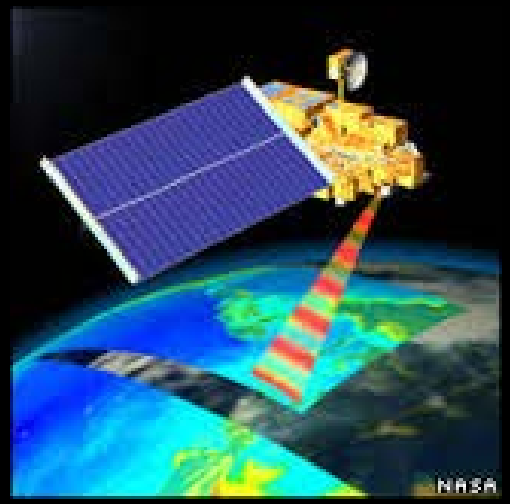
ForWarn

Satellite-Based Change Recognition and Tracking

- A **national-scale near real-time** satellite-based recognition and tracking system for all land cover disturbances
- "Officially" rolled-out in 2012, but has actually been operating since January 2010
- ***ForWarn*** covers the entire lower 48 United States
- Generates new potential **disturbance maps every 8 days**, even throughout the winter
- Detects most types of regional and local land cover disturbances
    - insects, diseases, wildfires, ice and frost damage, tornadoes, hurricanes, blowdowns, harvest, urbanization, seasonal timing and drought. and landslides
- 231 meter native resolution map cells (**13-acre minimum mapping unit**)
    - It is not necessary for an entire forested pixel to be disturbed for disturbance to be detected

Application Context

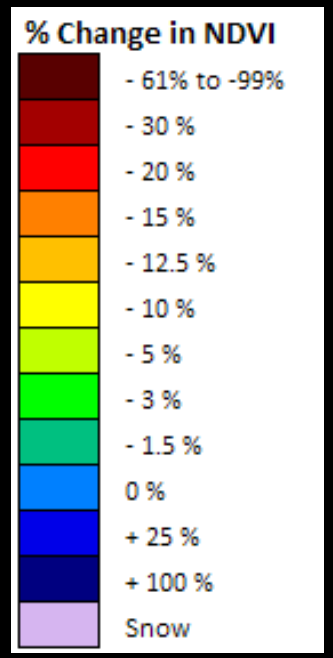
strategic



tactical

- The ***ForWarn*** System covers essentially 100% of the forests within the lower 48 United States **every 8 days**
- In 2011, airborne observers from the Aerial Disturbance Survey (ADS) program covered about 70% of forests within the lower 48 United States once with visual observations from light aircraft
- **The two tiers are complementary:**
  - ***ForWarn*** is coarse-scaled, automated and extensive, and has a very high repeat rate
  - Aerial surveys are finer-scaled, but require experienced observers, are labor-intensive and expensive, are a safety risk, are limited in extent and are completed once-a-year
- The two different systems can support each other well

How Does *ForWarn* Work?



- Based on a simple comparison between current greenness vs. historical greenness
- We develop this historical greenness from the 16-year historical MODIS satellite record
- The comparison is both spatially and temporally explicit – compares during the same 24-day period and for the same MODIS pixel
- **If the current NDVI value is less than 100% of the baseline used** = Potential Disturbances
  - ✓ shown as Greens, Yellows, and Reds
- **If the current NDVI value is greater than 100% of baseline greenness** = Vegetation Regrowth or Recovery
  - ✓ shown as Blues
- Only shows a Disturbance if it affects the plants - and to the degree that it affects the plants
- When first opening the 'Forest Change Assessment Viewer', only forested areas are shown by default, but ***ForWarn*** detects disturbances in all NLCD-based land use and land cover classes, including agricultural crops and rangeland forage (see the new "Masking" tool)

ForWarn produces seven annually-based disturbance maps every 8 days, each emphasizing the age of disturbances that are displayed

Added in 2016, are four intra-annual disturbance maps produced for three timeframes during the growing season, each emphasizing the persistence of disturbance

Standard Products

1. **Early Detect 1yr baseline (by most recent cloud-free)**
2. **1yr baseline (by NDVI max)**
3. 3yr baseline "
4. 5yr baseline "
5. All year baseline "

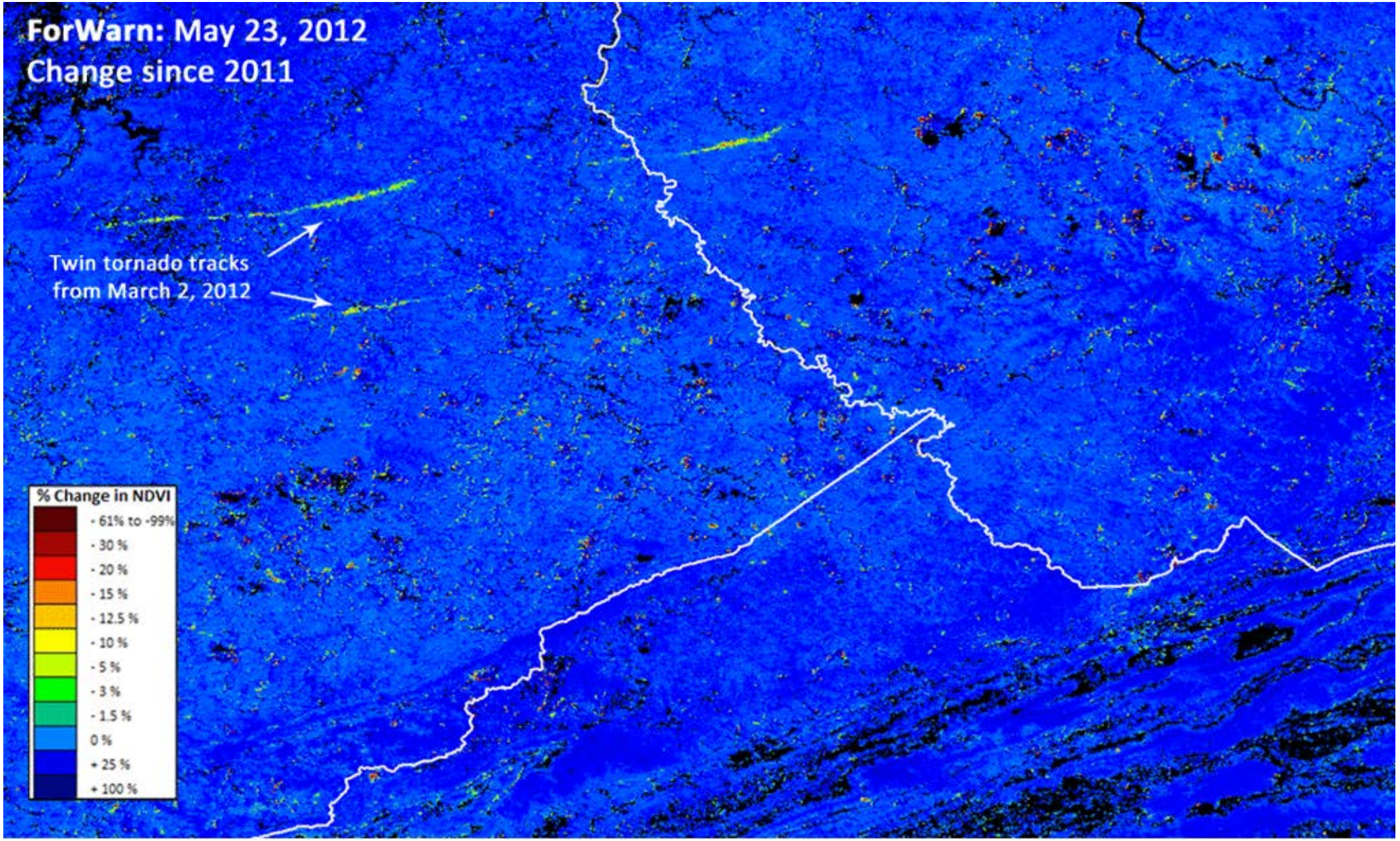
Seasonally Adjusted (for early/late - spring/fall)

6. All year, based on Mean-of-the-Max NDVI
7. All year, based on Phenotype Mean NDVI

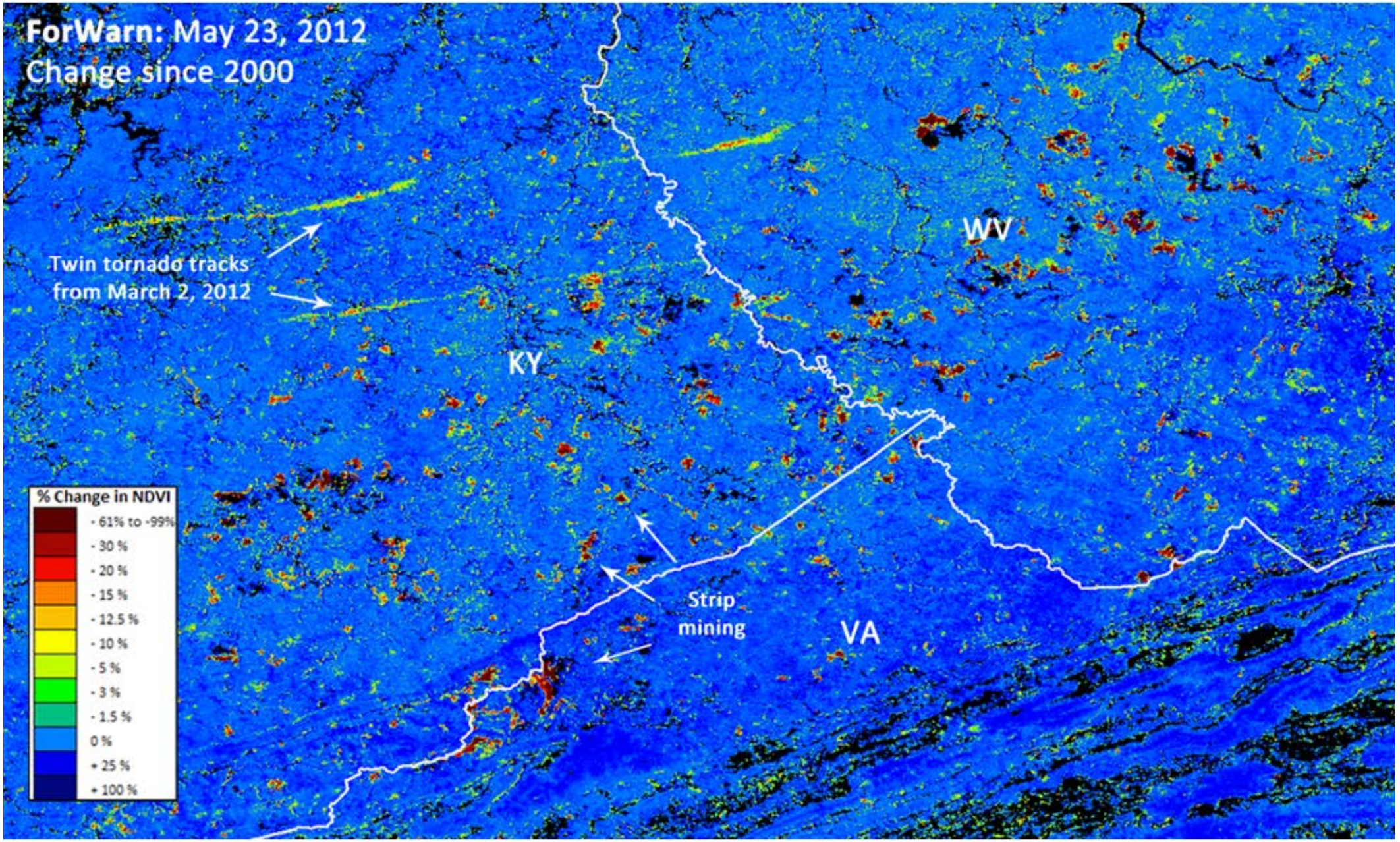
Intra-Annual Duration

1. 6-period Duration, May 8 – June 17 (for western U.S.)
2. 6-period Duration, June 24 – Aug 4
3. 6-period Duration, Aug 12 – Sept 21
4. 12-period Duration, June 24 – Sept 21

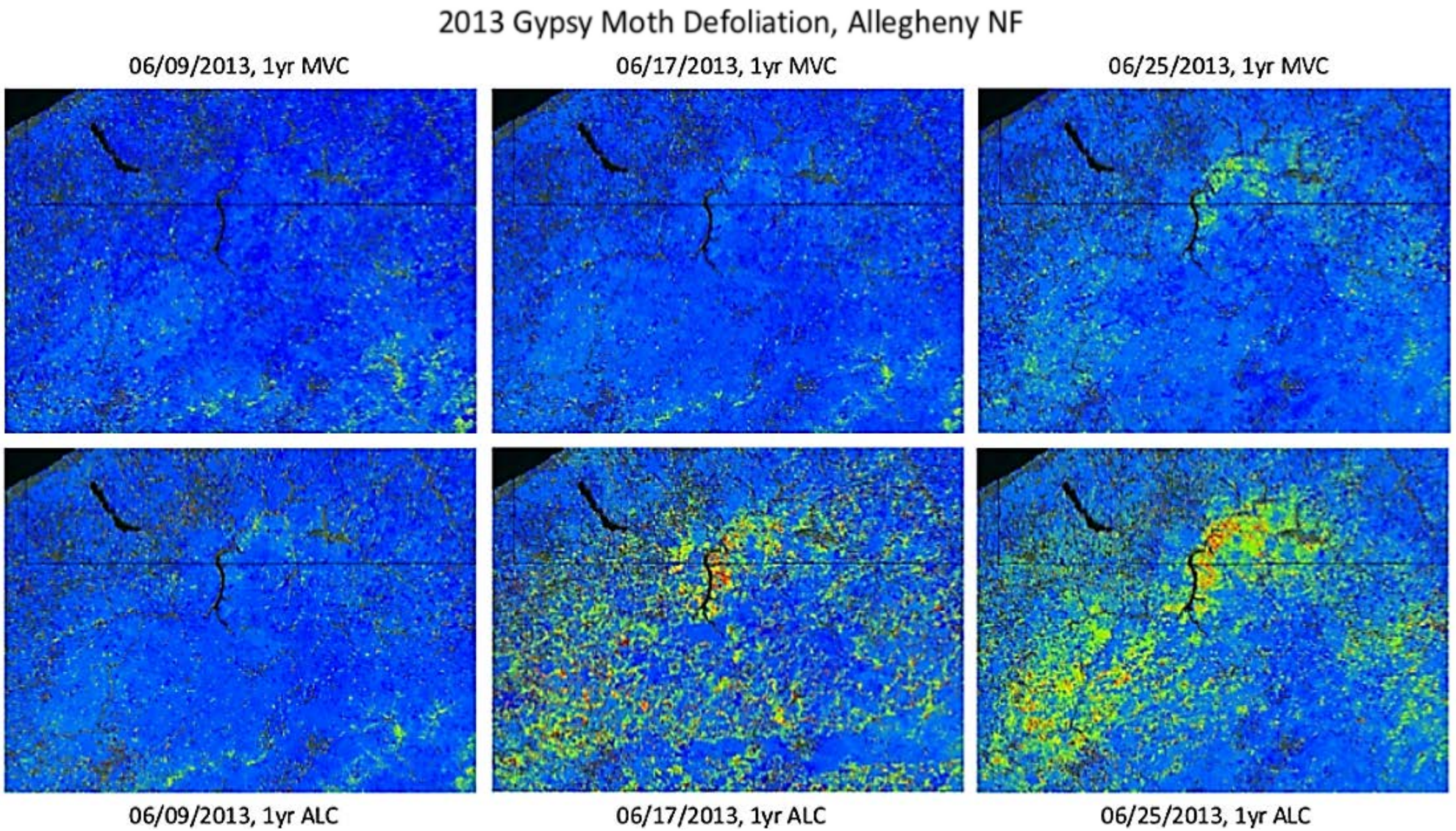
ForWarn 1 year baseline vs. All-year baseline



ForWarn 1 year baseline vs. All-year baseline

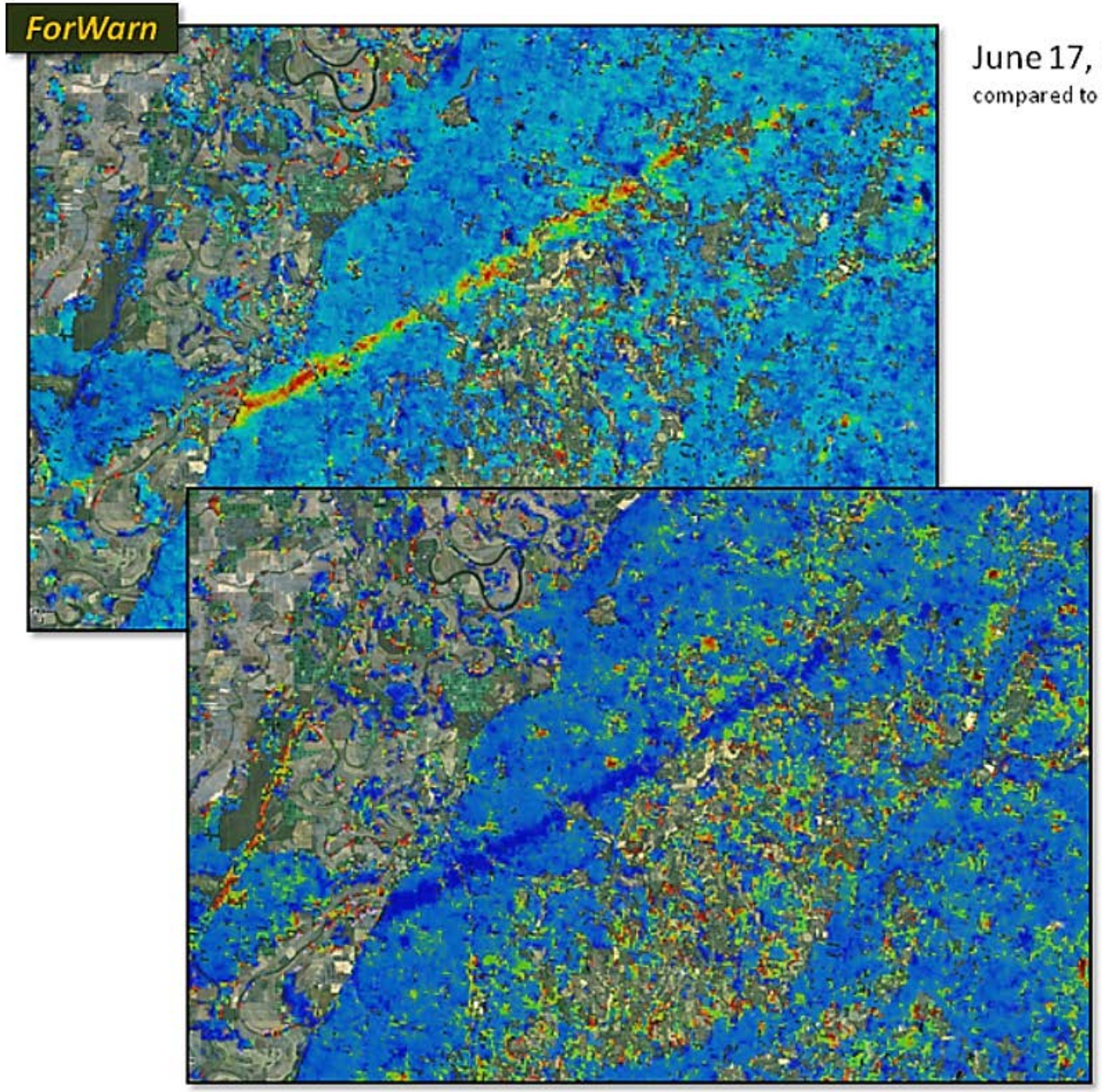


ForWarn 1yr Baseline '<u>Standard</u>' Product <u>vs.</u> 1yr Baseline '<u>Early Detect</u>' Product



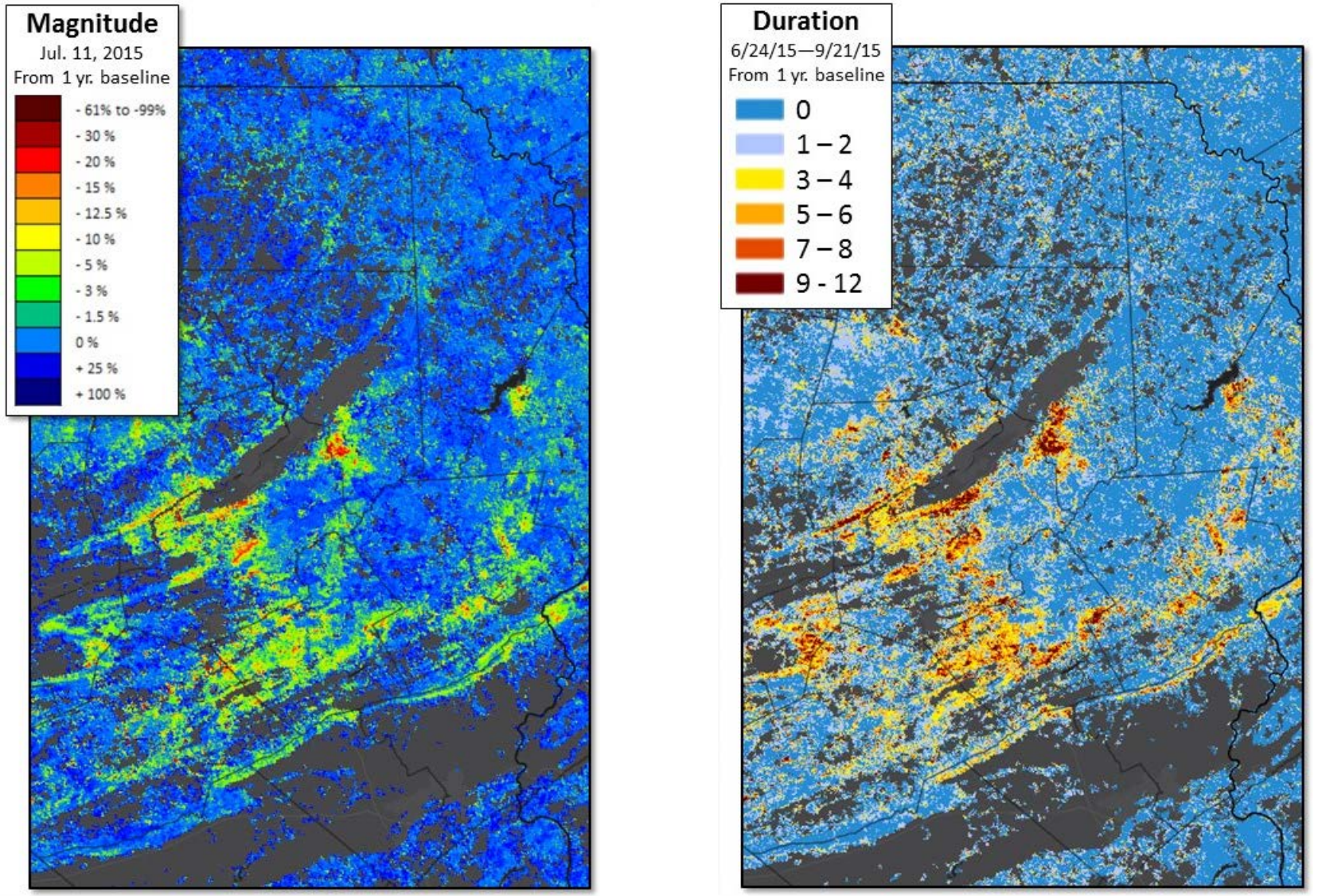
*The 'Early Detect' product dramatically reduces **ForWarn** detection speeds, allowing the detection of disturbances in as few as one 8-day period*

Positive NDVI Departure = Vegetative Recovery / Re-Growth



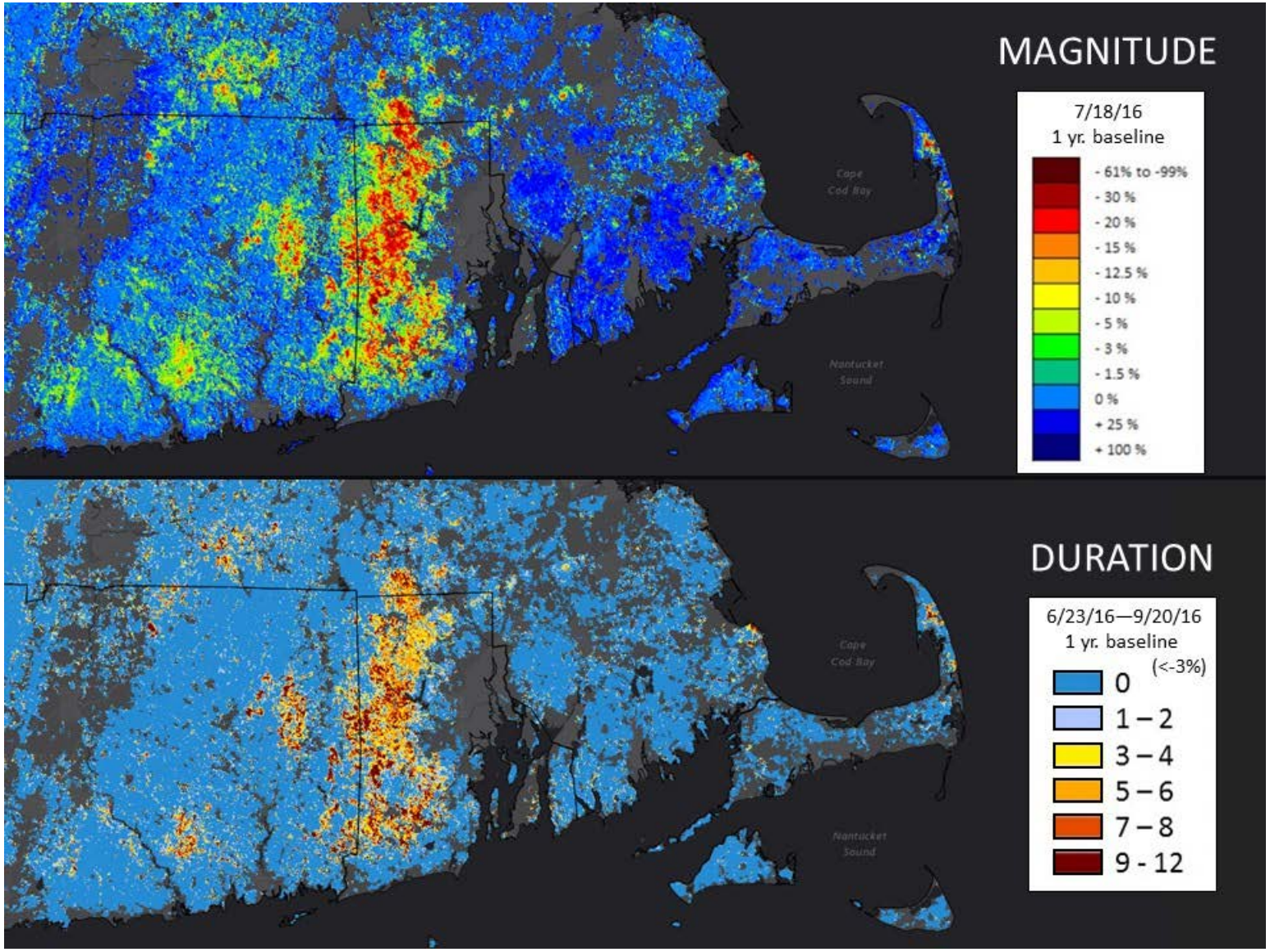
Relative to a 1-year baseline, forest vegetation is re-growing within the Yazoo, MS tornado track. ***ForWarn*** can easily track such recovery, and the rate of recovery is highly variable.

Tracking Gypsy Moth emergence and severity with magnitude and duration (PA, 2016)



ForWarn's Seasonal Duration products help discriminate ephemeral from persistent impacts

Gypsy Moth defoliation in the state of Rhode Island (2016)



Single period observations can underestimate impacts because peak defoliations may not coincide.

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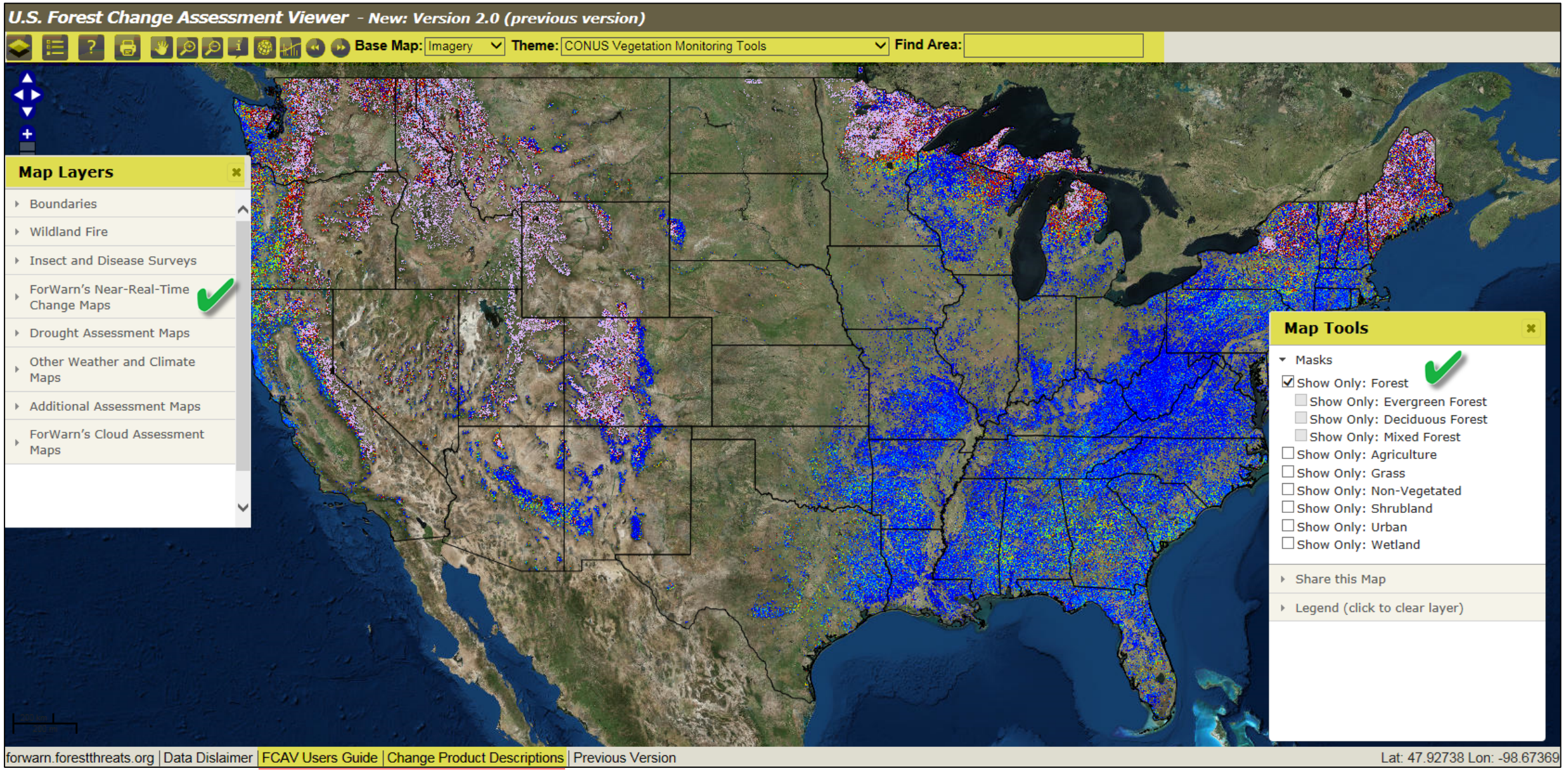
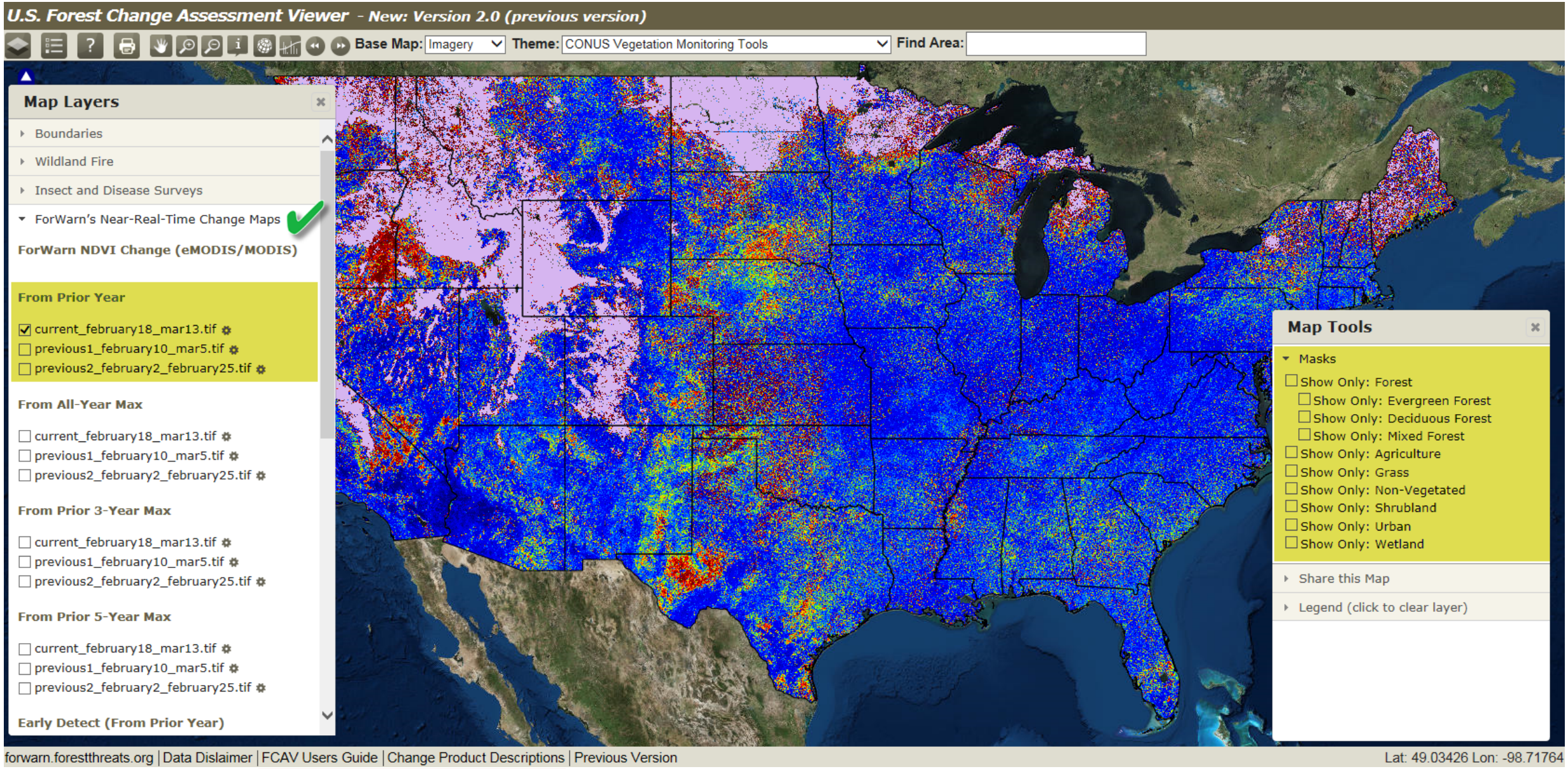
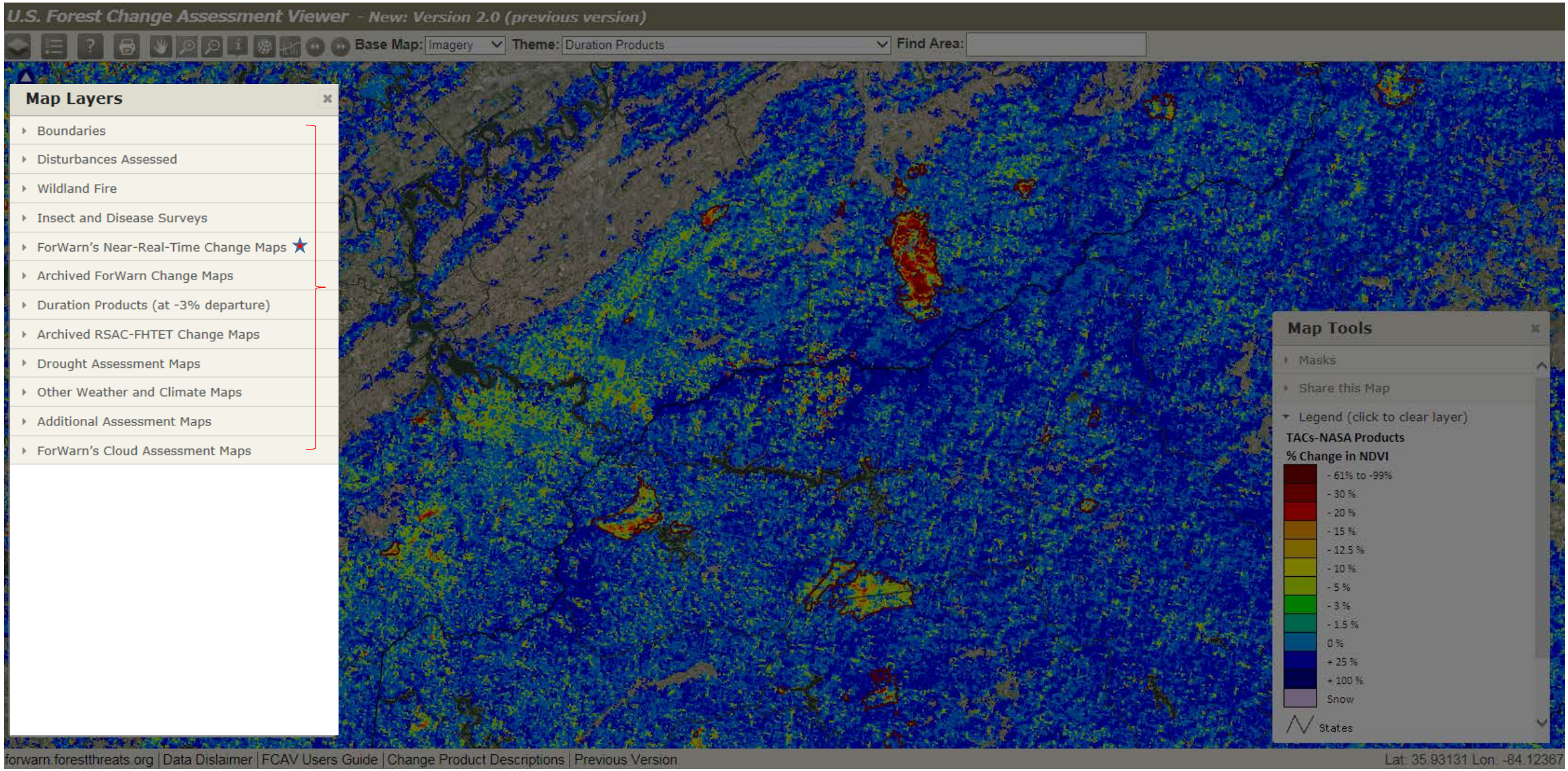
ForWarn's Forest Change Assessment Viewer



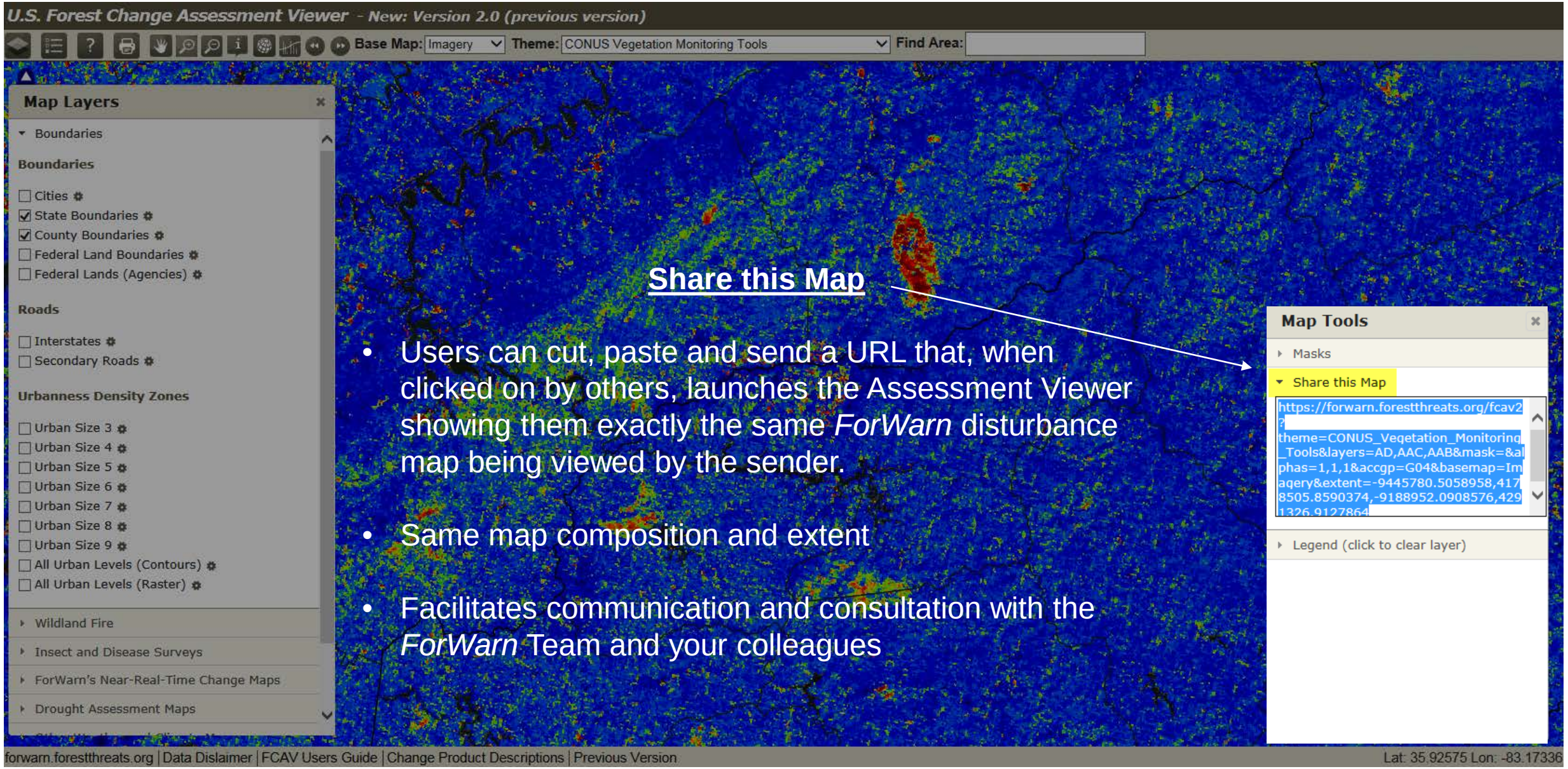
Forest Change Assessment Viewer (FCAV): **Current 1yr, 'All-Lands'** *(no mask)*



Forest Change **Assessment** Viewer (FCAV): **Map Layers Window**



FCAV Feature: **“Share this Map”***(share potential disturbances with your colleagues)*

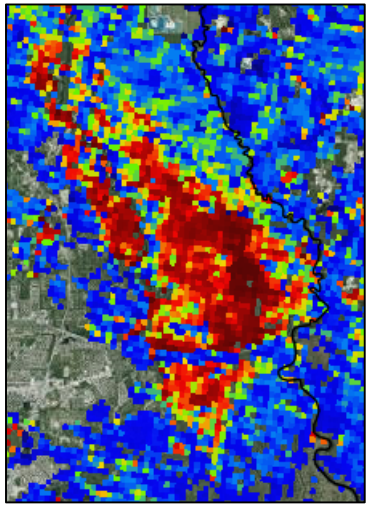


Share this Map

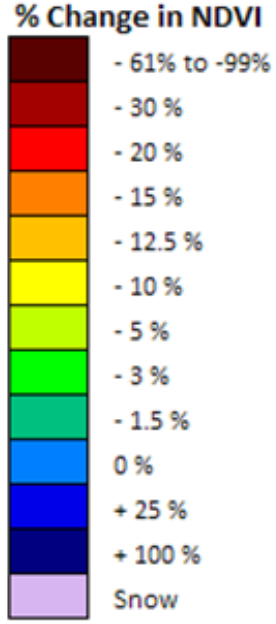
- Users can cut, paste and send a URL that, when clicked on by others, launches the Assessment Viewer showing them exactly the same *ForWarn* disturbance map being viewed by the sender.
- Same map composition and extent
- Facilitates communication and consultation with the *ForWarn* Team and your colleagues

Identifying and Interpreting Forest Disturbance

(locate, characterize and assess)



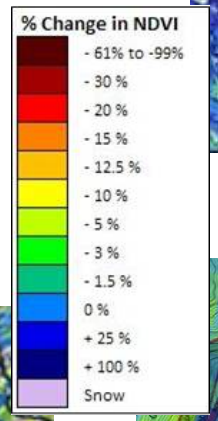
- *Where is the Disturbance Located?* *(geographic site and situation)*
  - ✓ **Land cover / Land Use** (image basemap, NLCD masks, FS/GAP veg maps)
  - ✓ **Topographic position** (elevation, slope and aspect, USGS topo's are available in Viewer under 'Base maps', wet/dry – USGS Stream Gauges, amount of mix?)
- *What is the character of the NDVI departure?*
  - ✓ **Progression speed** (use the 3 most recent, fast vs. slow, on in 1/off in next = clouds)
  - ✓ **Severity, percent NDVI change** (pos./neg., low/high departure, climate affects?)
  - ✓ **Spatial extent** (large area or localized)
  - ✓ **Pattern and shape** (spotty/scattered, bulls-eye, target-like, linearity)
  - ✓ **Edges** (hard/well defined or bulls-eye – trails-off showing less departure)
  - ✓ **Seasonality** (spring, fall, snow: local and regional variation in annual phenology can causes NDVI departure (+/-); two new forest change products attempt to mitigate the effects in the variability of the start and stop of spring and fall from year to year)

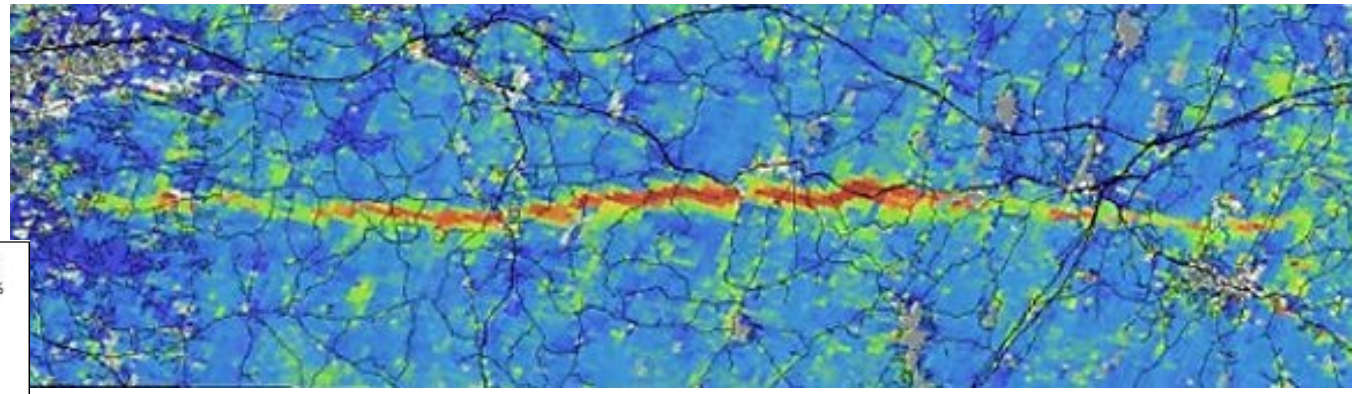


Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

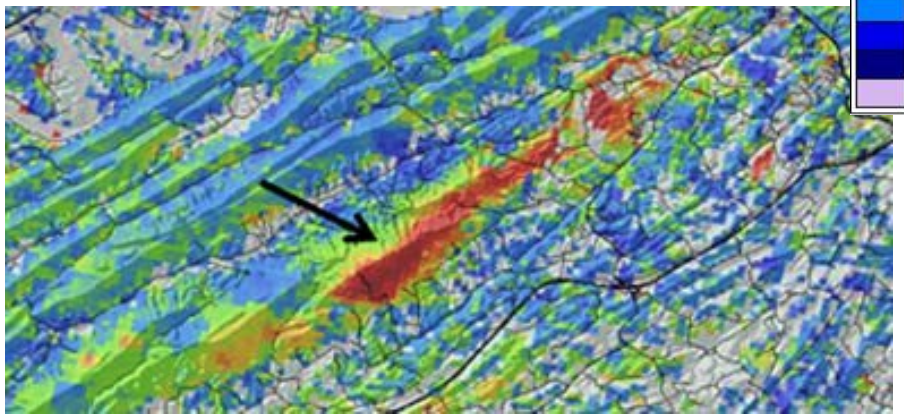
Natural disturbances causing a decline in NDVI value

- 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

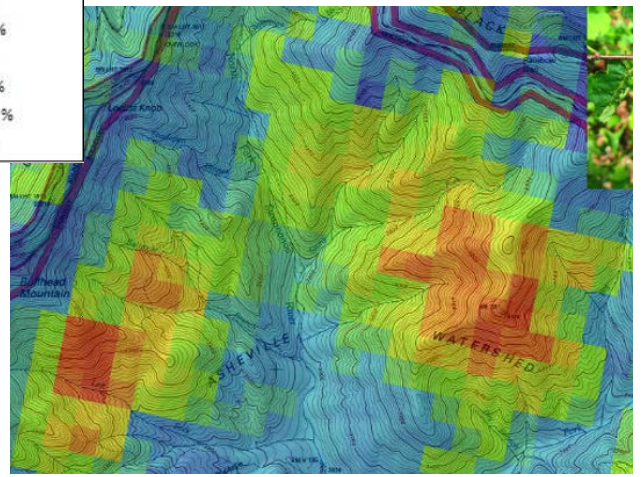




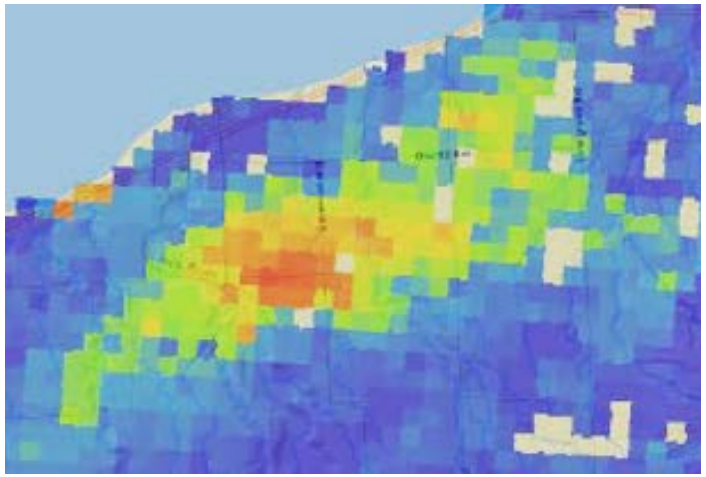
Tornado (MA)



Severe Wind, Leaf Stripping (TN)



Hail Damage (NC)



Severe Weather (MI)

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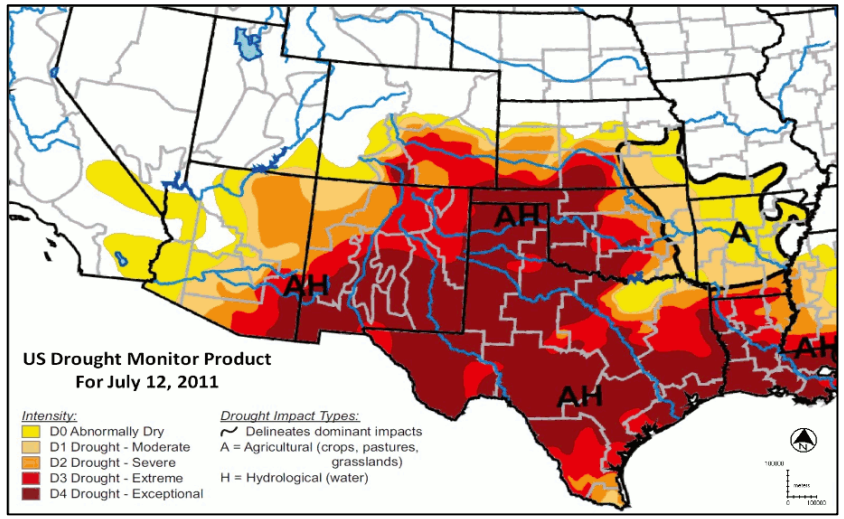
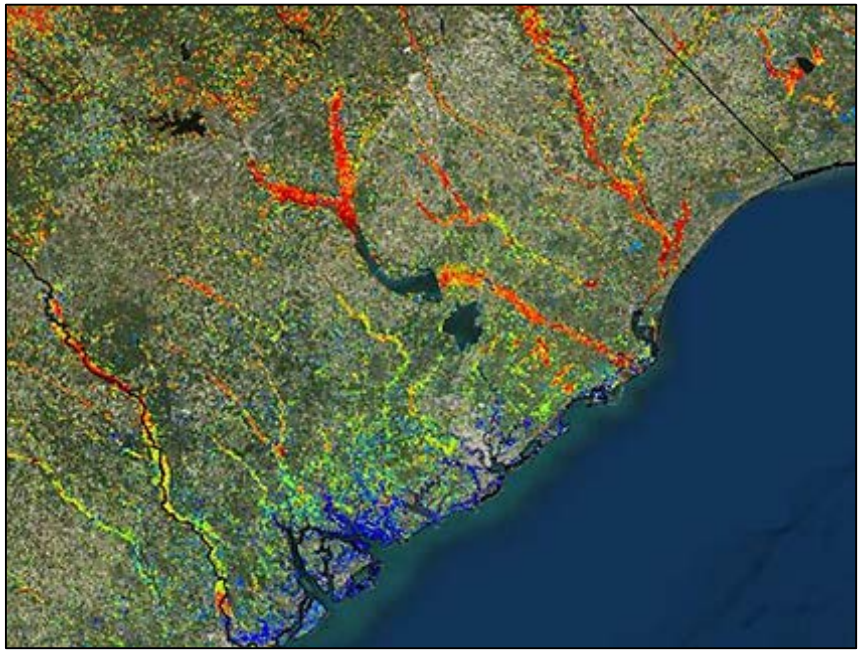
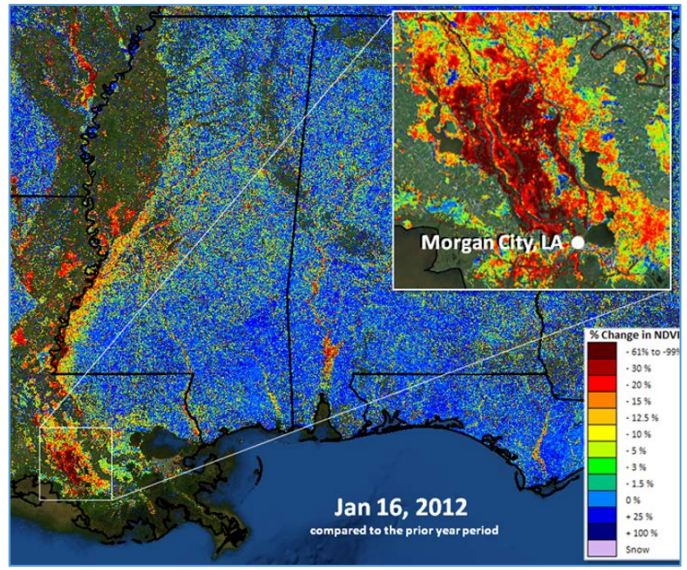


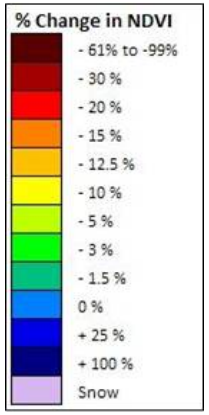
Texas Drought Monitor Comparison, 2011



Bottomland Hardwood Flooding (SC)



Flooding (Atchafalaya Basin, LA)



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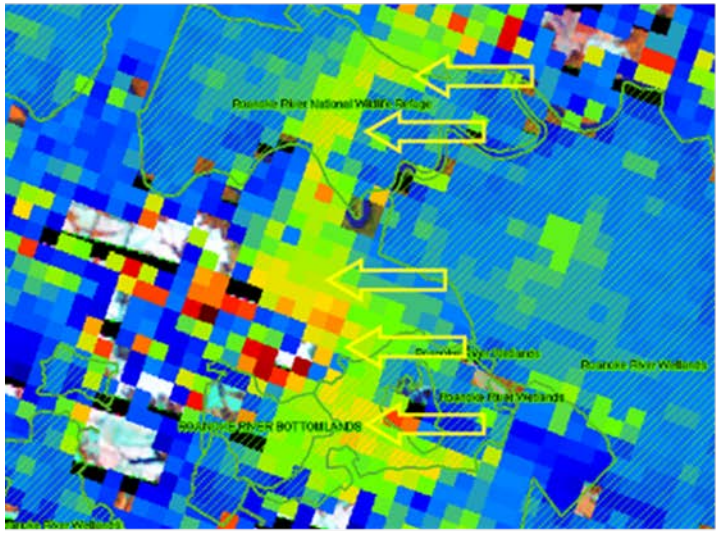
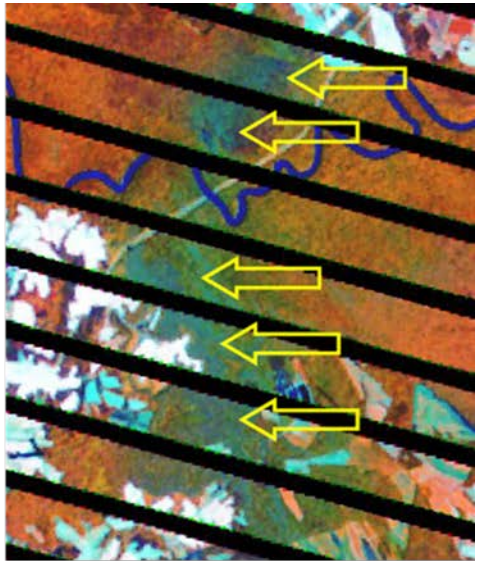
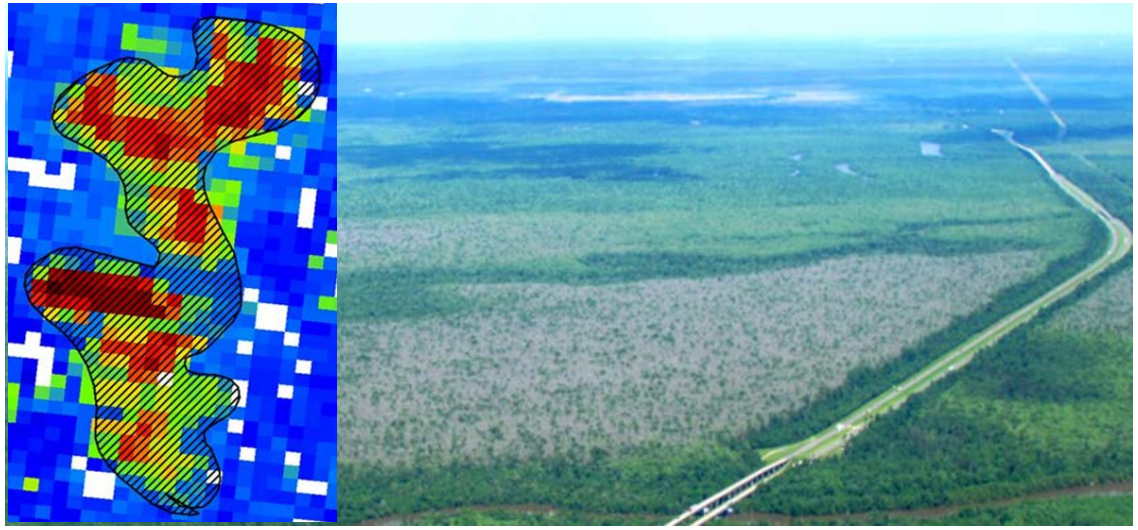


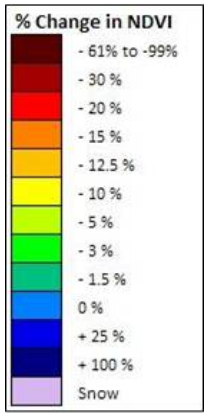
Forest Tent Caterpillar (NC)

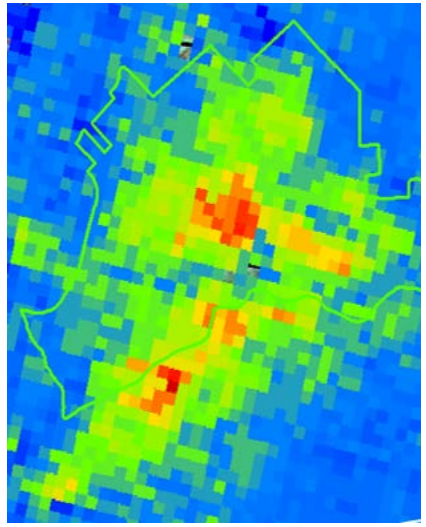


Landsat

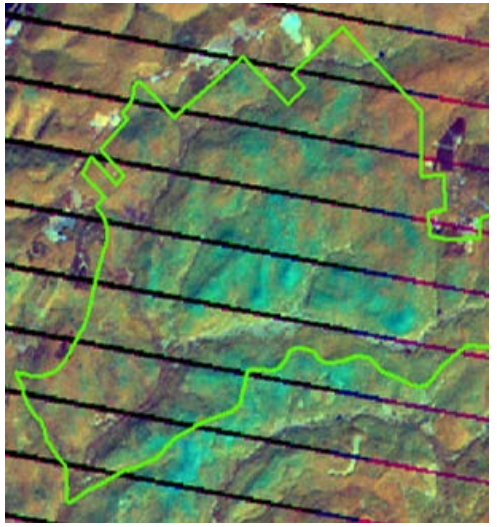


Forest Tent Caterpillar (MS)





Fall Webworm (PA)



Landsat

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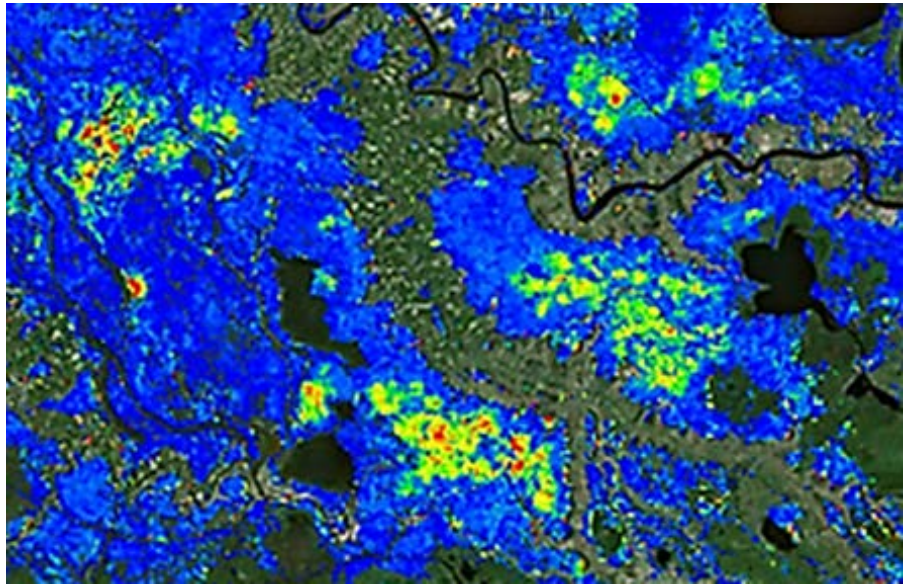
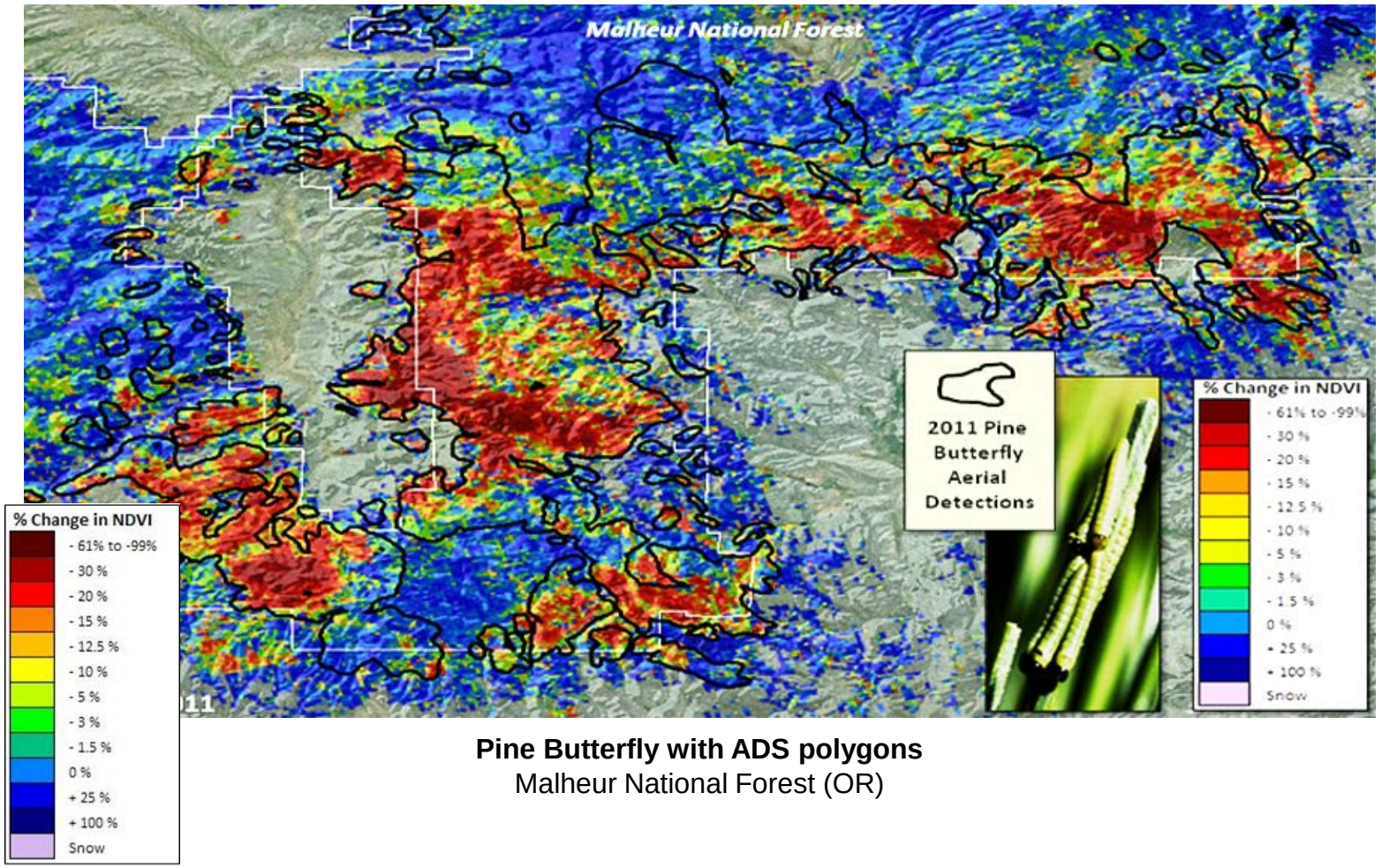
Wildfire events



Cypress Leaf roller – Forest Tent Caterpillar (LA)



Pine Butterfly with ADS polygons
Malheur National Forest (OR)

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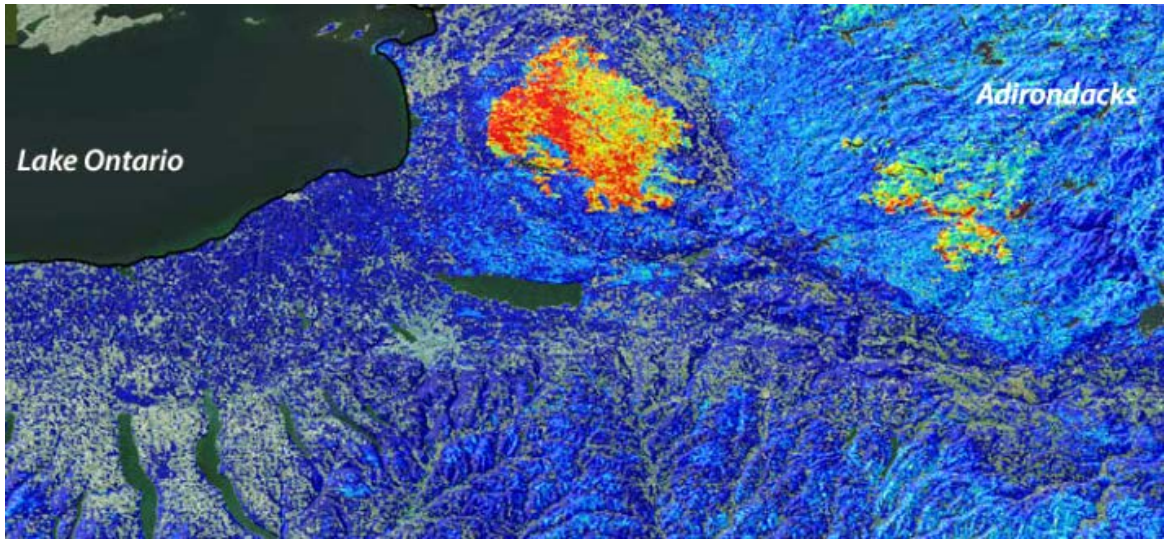

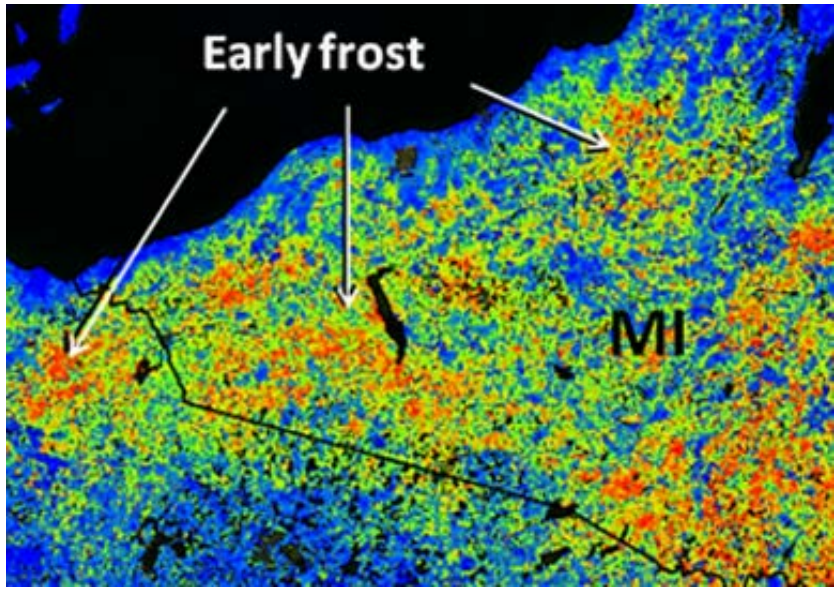

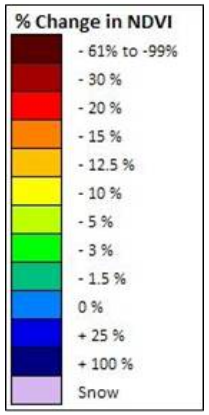

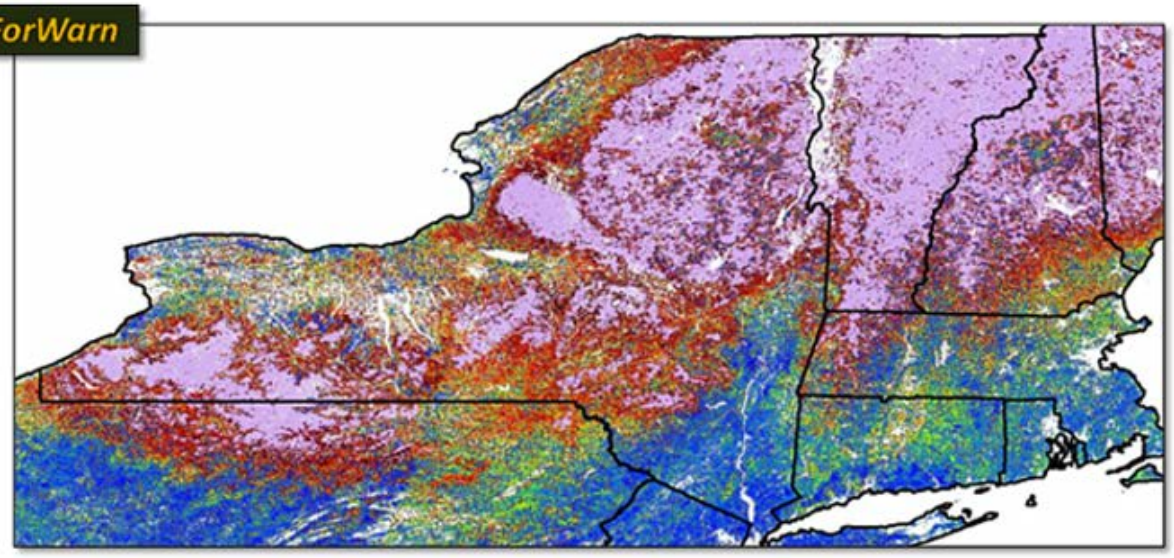

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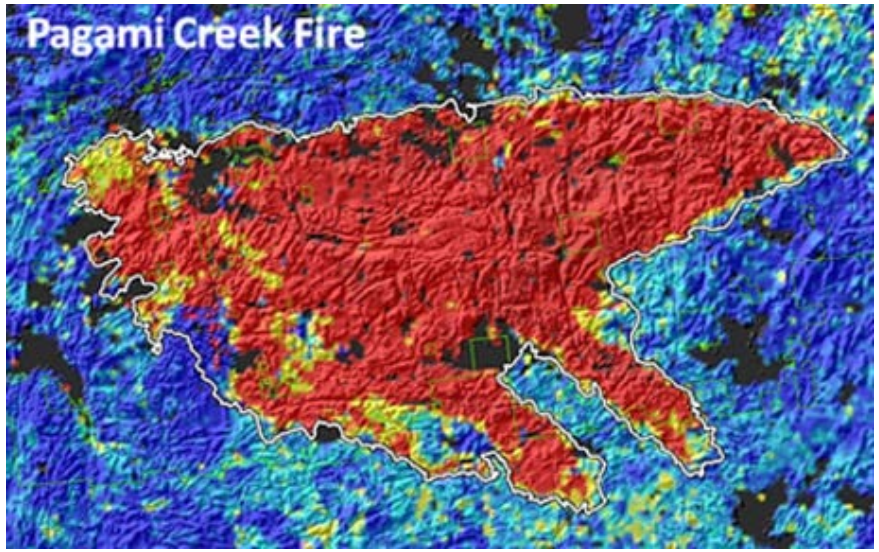
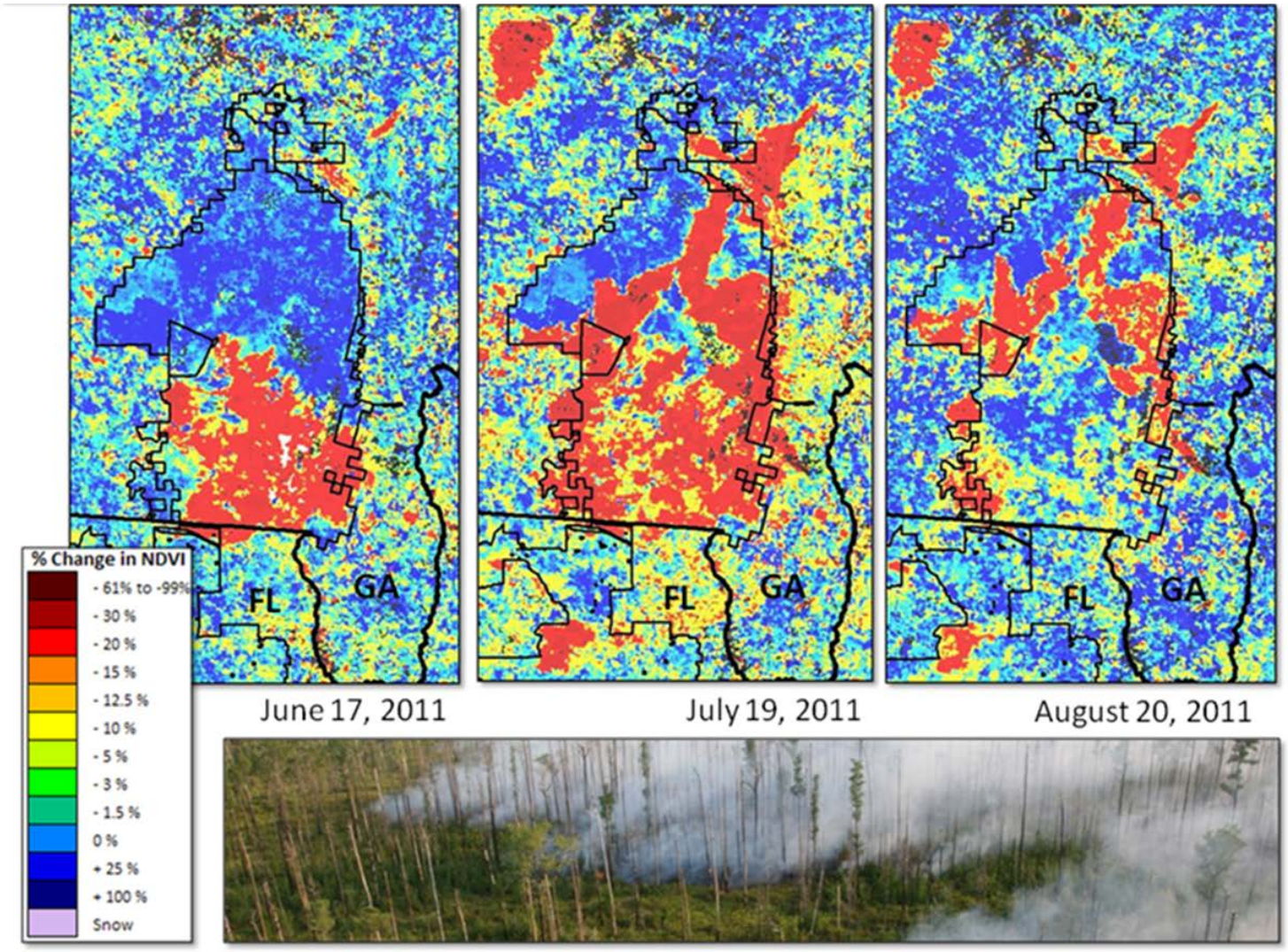


Okefenokee Swamp (GA)



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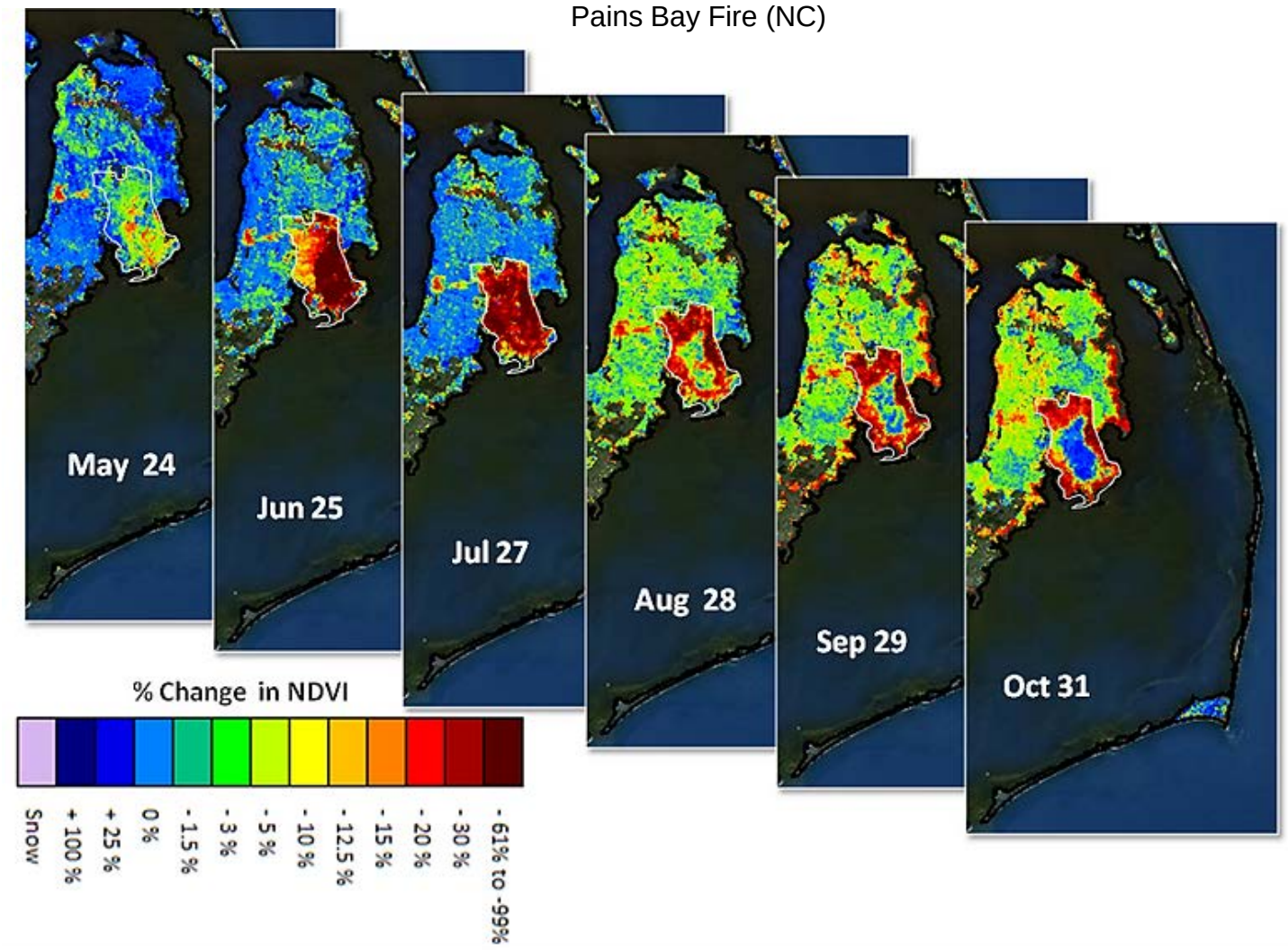
Wildfire events

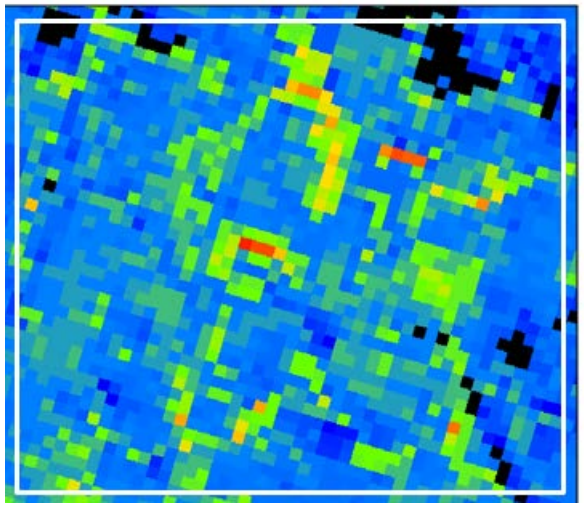
Forest disturbance events often display degrees of severity. Variation in rates of recovery can relate to ecological, or vegetative resilience.



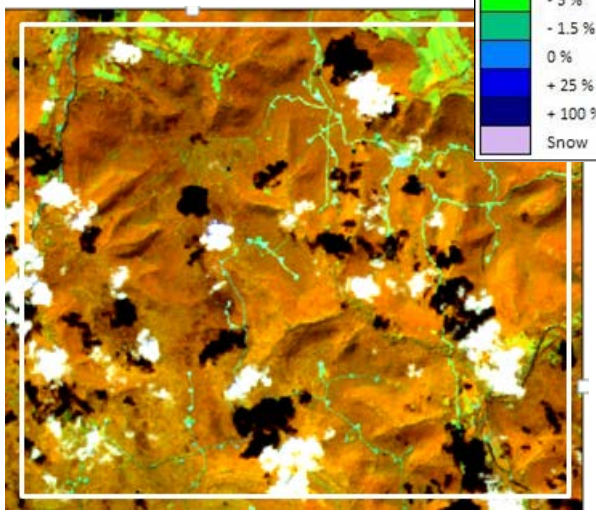
Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

Human-Induced disturbances causing a decline in NDVI value

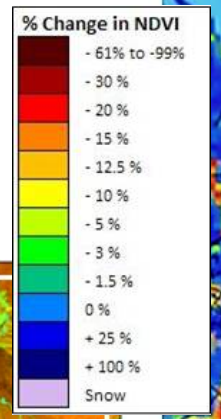
Forest fragmentation, conversion and urban sprawl
Forest clear-cutting and stand thinning
Mining, oil and natural gas activities
Non-native plant species invasions
Climate variability and change
Prescribed fire
Arson wildfire

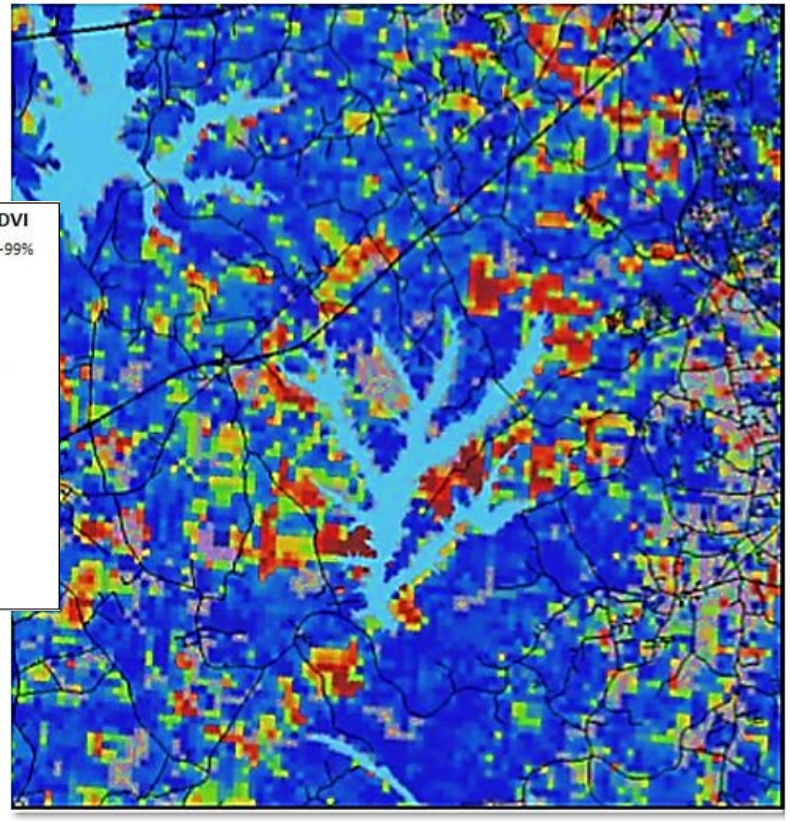


Oil and gas well construction (PA)

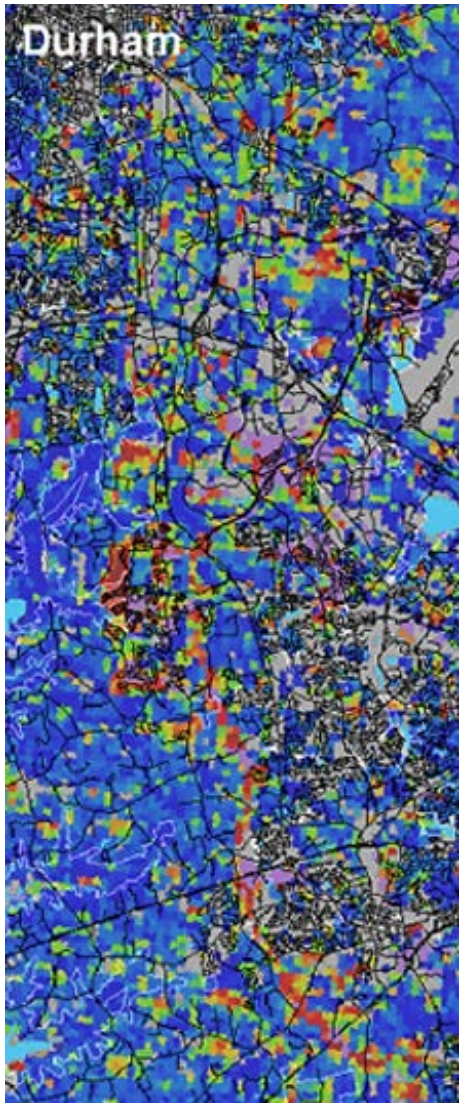


Landsat





Forest management, above, and
Road construction, right (NC)



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Satellite-Based Change Recognition and Tracking

- What is ***ForWarn*** and how does it work?
- The ***Forest Change Assessment Viewer***
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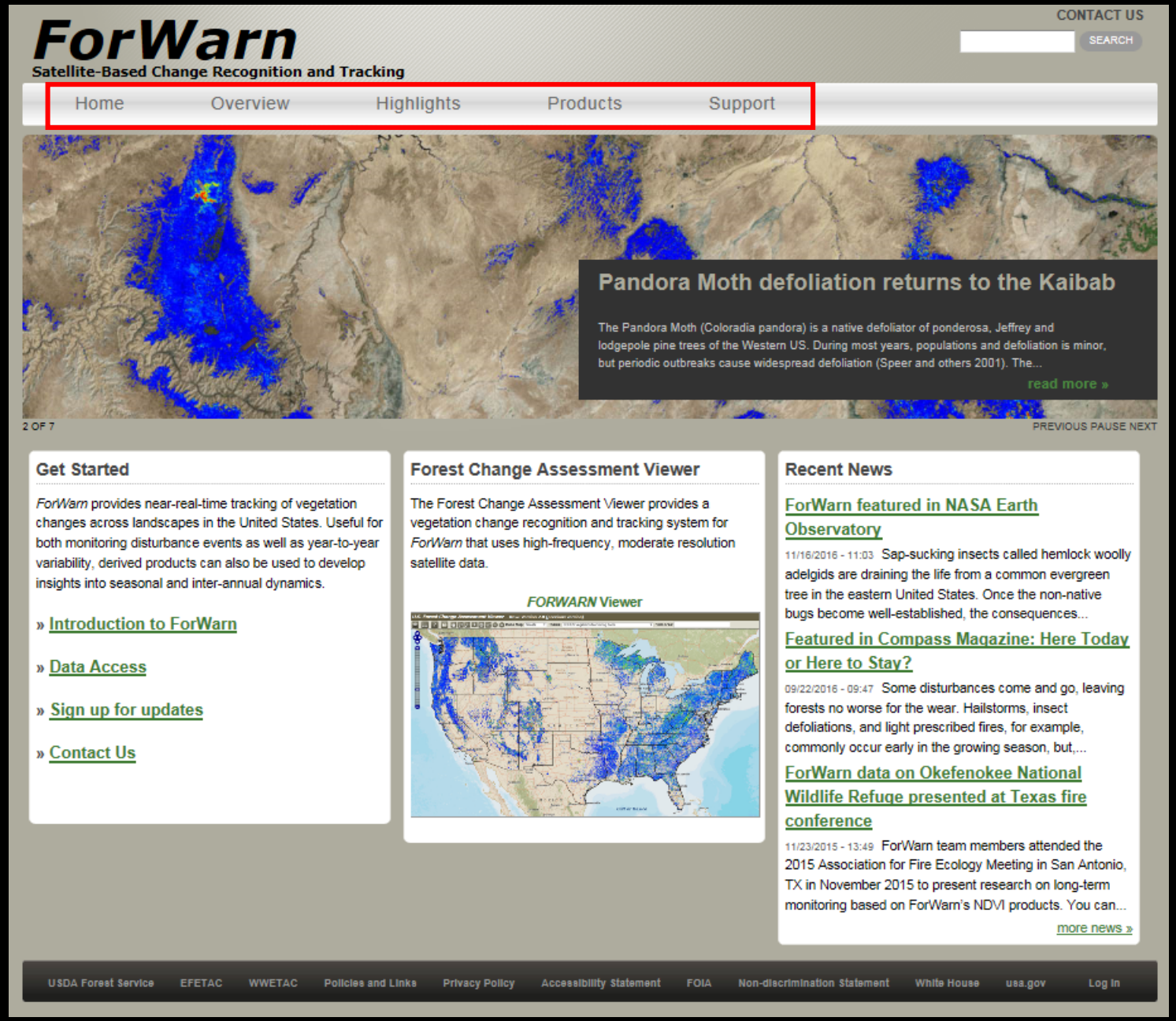

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Satellite-Based Change Recognition and Tracking

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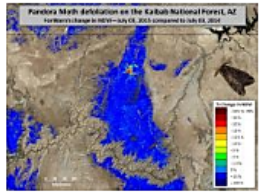
Keyword

Disturbance Type

- Any - APPLY

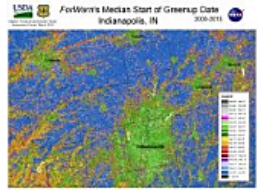
Highlights



Pandora Moth defoliation returns to the Kaibab

07/14/2015 - 14:45 The Pandora Moth (Coloradia pandora) is a native defoliator of ponderosa, Jeffrey and lodgepole pine trees of the Western US. During most years, populations and defoliation is minor, but periodic outbreaks cause widespread defoliation (Speer and others 2001). The outbreak shown here in Arizona's Kaibab National Forest first caused significant defoliation in June-July of 2013 and defoliating caterpillars have now returned in 2015.

One of the more peculiar aspects of outbreaks is that... *(read more)*



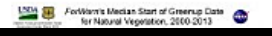
Mapping the urban phenological footprint

03/18/2015 - 21:44 Urban areas are renowned for their admixture of species and vegetation types that can change from one parcel to the next. Yards and woodland parks intermix with road medians--all of which may be dominated by an irregular mix of native and exotic trees, shrubs, herbs and grasses. In cities, the vegetation of nearly every block is compositionally complex.

These species green up at different times and at different rates. Because of this, it can be difficult to decide when spring occurs... *(read more)*

The typical start of greenup on agricultural lands

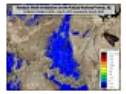
03/18/2015 - 09:56 Understanding the normal start of greenup for croplands is important because it provides a baseline to compare year to year conditions. The date of greenup for agricultural lands varies based on year-to-year climate factors, the unique responses of the specific crop or vegetation type planted, and farmers' management practices. For areas that need to be planted in the spring, wet late winters can delay planting. Cool springs can delay growth. Either can potentially influence seasonal growth... *(read more)*



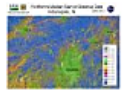
The typical start of greenup in natural vegetation

Highlights

Pandora Moth defoliation returns to the Kaibab



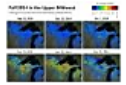
Mapping the urban phenological footprint



The typical start of greenup on agricultural lands

The typical start of greenup in natural vegetation

Autumnal Hail and Early Browndown in the Upper Midwest



Coastal pocosins respond to hurricanes and fire

more highlights »

*If you need a quick shapefile of a forest disturbance, you can load **ForWarn** imagery to your desktop GIS and screen-digitize the extent, and if present, depict zones of severity.*

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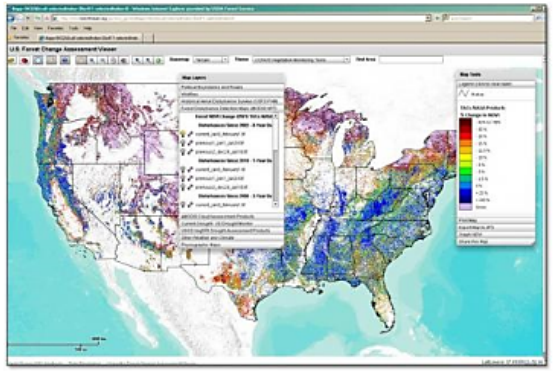
Products

- Near-Real-Time Products
- Long-Term Monitoring Products
- Data Access

Data Access

ForWarn data are readily accessed through the project's Forest Change Assessment Viewer using a standard internet browser. To learn more about the functions and features of the Assessment Viewer, please read the Forest Change Assessment Viewer Users Guide



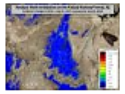
Web Map Service (WMS) Access

WMS allows access to the ForWarn vegetation change images using your desktop GIS or mobile mapping application software. The advantages of viewing the forest change images locally are: (1) to overlay with your GIS layers, (2) to screen-digitize disturbance extent and severity, (3) the increased use and functionality of a desktop GIS, and (4) to view the change images via mobile devices (such as using OruxMaps with Droid-based handhelds). Use the following WMS connection strings to access the ForWarn data products:

WMS Dataset	Contents	Connection URL (ArcGIS users denote version 1.0.0)
All-Year baseline forest change images (Web Mercator)	Begins 01/08/2010 for all-year baseline-only; current, previous 1 and previous 2 available for all baseline periods, disregard 16-day composite products	http://wms.forwarn.forestthreats.org/ews [GetCapabilities]
All-Year baseline forest change images (WGS84)	Begins 01/08/2010 for all-year baseline-only; current, previous 1 and previous 2 available for all baseline periods, disregard 16-day composite products	http://wms.forwarn.forestthreats.org/ewswgs84 [GetCapabilities]
1-year baseline forest change images	Begins 01/08/2010 through current for 1-year baseline-only	http://wms.forwarn.forestthreats.org/ews1year [GetCapabilities]
3-year baseline forest change images	Begins 01/08/2010 through current for 3-year baseline only	http://wms.forwarn.forestthreats.org/ews3year [GetCapabilities]
Cloud Product, MODIS True Color Composites	Begins 01/08/2010 through current	http://wms.forwarn.forestthreats.org/ewstruecolor [GetCapabilities]

Highlights

Pandora Moth defoliation returns to the Kaibab



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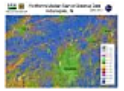

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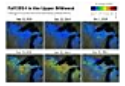

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Resources

Selected Publications

- Toward a national early warning system for forest distances using remotely sensed canopy phenology, *Photogrammetric Engineering and Remote Sensing*, October 2009.
- Highlights of satellite-based forest change recognition and tracking using the ForWarn System (Steve Norman, 2013)

Presentations

- Toward a national Early Warning System for forest disturbances using remotely sensed land-surface phenology (Bill Hargrove, et al. 2012)
- Using land surface phenology for national mapping of the occurrence and health of evergreen and deciduous forests (evergreen/deciduous thrive/decline) (Bill Hargrove et al., International Association for Landscape Ecology Meeting, Apr. 2013)
- Predicting long-term wildfire effects across complex landscapes (Steve Norman, et al. USDA Forest Service Landscape Science Webinar, Oct. 2013)
- Detecting and tracking forest change in the Blue Mountains of Oregon and Washington using the *ForWarn* system (Steve Norman et al., Blue Mountains Forest Vegetation Workshop, Apr. 2014)
- Tracking forest and landscape change from space using the ForWarn system (Steve Norman et al., Southern Regional Forestry Extension Webinar, Oct. 2014) View this archived webinar at any time through forestrywebinars.net.
- Five applications of the *ForWarn* System for wildland fire management (Steve Norman et al., USDA Forest Service Rocky Mountain Research Station Webinar, May 2014)
- Recognizing gradual loss of forest resilience using continuous satellite-based monitoring (Steve Norman et al., Appalachian Society of American Foresters Meeting, Jan. 2015)
- The use of phenological completion milestones for determining day-of-year of Start-of-Greenup and Start-of-Senescence (Bill Hargrove, et al., Blue Ridge Parkway Science Meeting, Apr. 2015)
- Satellite-based monitoring of seasonal, successional and event fuels for fire planning (Steve Norman et al., Southern Blue Ridge Fire Learning Network Workshop, May 2015)

Posters

- High Frequency Monitoring of Fire Regimes and Ecological Resilience across the Okefenokee National Wildlife Refuge, 2015
- The tornado outbreak of April, 2011 recorded by the USDA Forest Service's "Forest Change Assessment Viewer"
- A framework for predicting post-wildfire trajectories with desired conditions using NDVI time series
- Mapping hemlock decline in the Southern Appalachians using high and moderate resolution imagery

Highlights

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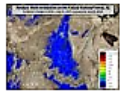

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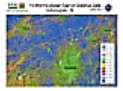

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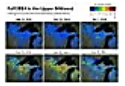

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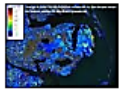

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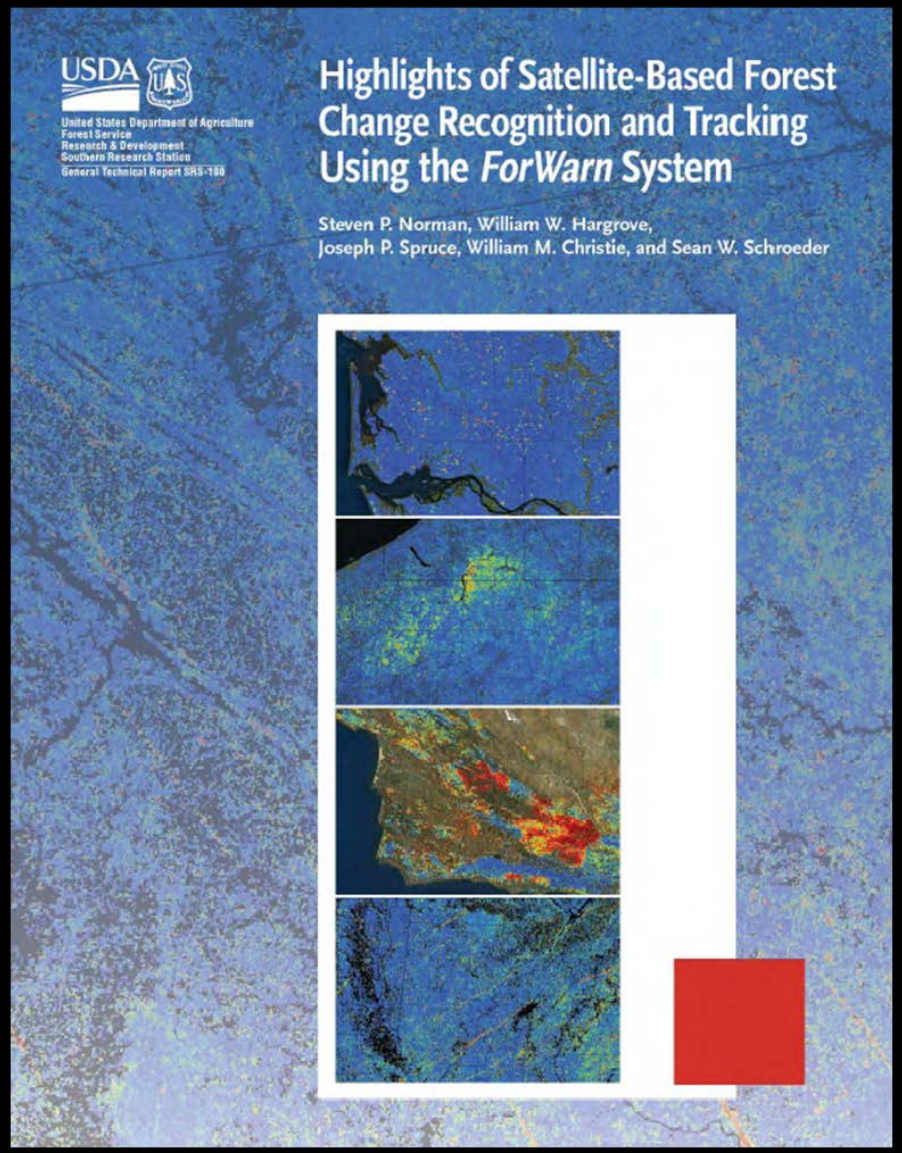
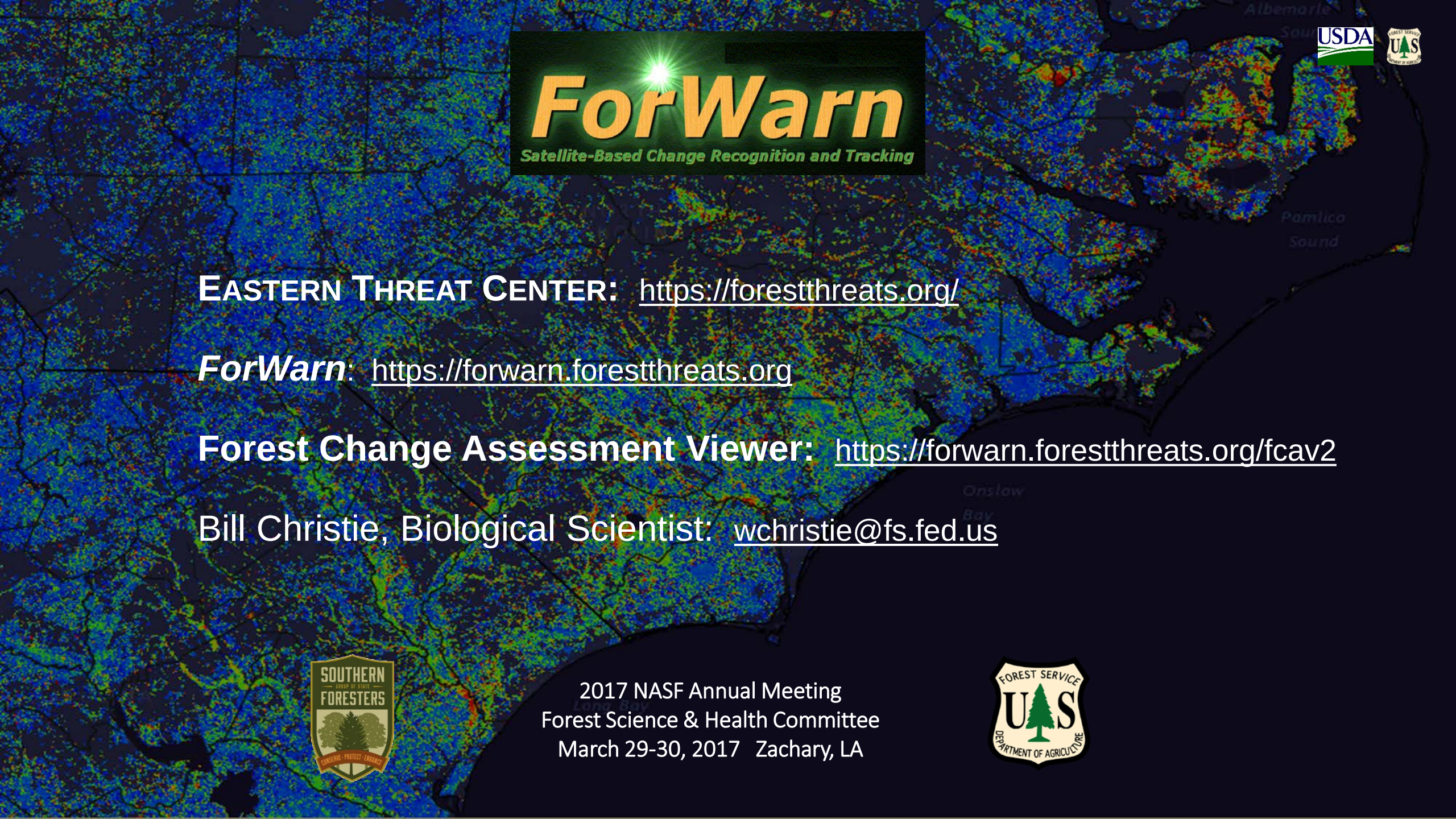
ForWarn General Technical Report



http://www.srs.fs.fed.us/pubs/gtr/gtr_srs180.pdf

Google *'forwarn gtr'*, first listing *(paper copies are also available)*



EASTERN THREAT CENTER: https://forestthreats.org/

ForWarn: https://forwarn.forestthreats.org

Forest Change Assessment Viewer: https://forwarn.forestthreats.org/fcav2

Bill Christie, Biological Scientist: wchristie@fs.fed.us

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