

# Using Google Earth Engine to map and track silvicultural activity

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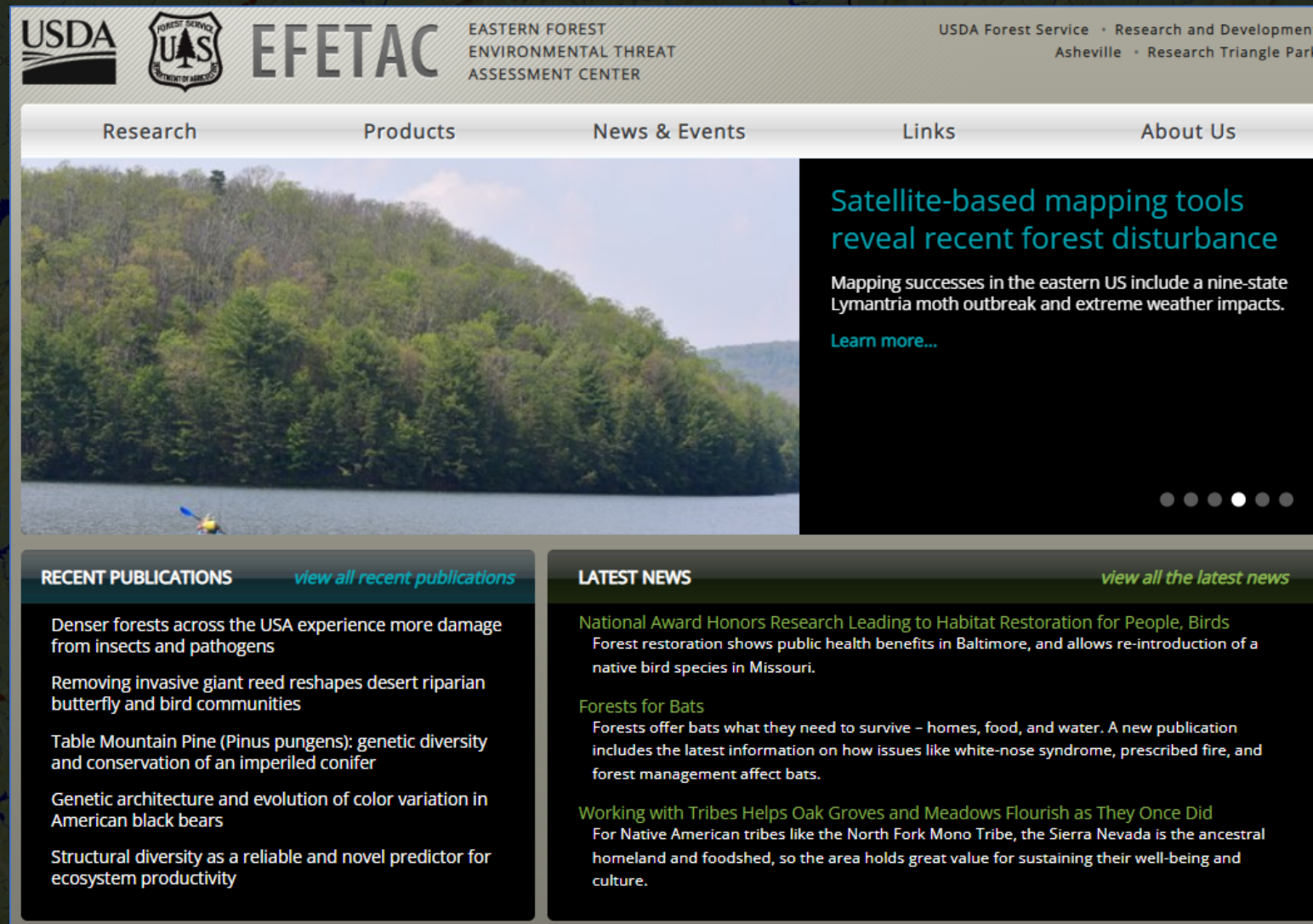
USDA Forest Service, Southern Research Station  
Eastern Forest Environmental Threat Assessment Center (EFETAC)




Water Resources and GIS Committees  
Southern Group of State Foresters  
June 20, 2023  
- virtual -



The mission of the Eastern Forest Environmental Threat Assessment Center is to generate knowledge and tools needed to anticipate and respond to environmental threats



The screenshot shows the EFETAC website homepage. At the top left are the USDA and U.S. Forest Service logos, followed by the EFETAC logo and the text "EASTERN FOREST ENVIRONMENTAL THREAT ASSESSMENT CENTER". On the top right, it says "USDA Forest Service · Research and Development Asheville · Research Triangle Park". Below this is a navigation bar with "Research", "Products", "News & Events", "Links", and "About Us". The main content area features a large image of a forested hillside with a person kayaking in a lake in the foreground. To the right of the image is a dark box with the headline "Satellite-based mapping tools reveal recent forest disturbance" and a sub-headline "Mapping successes in the eastern US include a nine-state Lymantria moth outbreak and extreme weather impacts." with a "Learn more..." link. Below the main image are two columns: "RECENT PUBLICATIONS" with a link to "view all recent publications" and "LATEST NEWS" with a link to "view all the latest news".

**USDA**  **EFETAC** EASTERN FOREST ENVIRONMENTAL THREAT ASSESSMENT CENTER

USDA Forest Service · Research and Development  
Asheville · Research Triangle Park

Research Products News & Events Links About Us

**Satellite-based mapping tools reveal recent forest disturbance**

Mapping successes in the eastern US include a nine-state Lymantria moth outbreak and extreme weather impacts.

[Learn more...](#)

**RECENT PUBLICATIONS** [view all recent publications](#)

- Denser forests across the USA experience more damage from insects and pathogens
- Removing invasive giant reed reshapes desert riparian butterfly and bird communities
- Table Mountain Pine (*Pinus pungens*): genetic diversity and conservation of an imperiled conifer
- Genetic architecture and evolution of color variation in American black bears
- Structural diversity as a reliable and novel predictor for ecosystem productivity

**LATEST NEWS** [view all the latest news](#)

- National Award Honors Research Leading to Habitat Restoration for People, Birds**  
Forest restoration shows public health benefits in Baltimore, and allows re-introduction of a native bird species in Missouri.
- Forests for Bats**  
Forests offer bats what they need to survive – homes, food, and water. A new publication includes the latest information on how issues like white-nose syndrome, prescribed fire, and forest management affect bats.
- Working with Tribes Helps Oak Groves and Meadows Flourish as They Once Did**  
For Native American tribes like the North Fork Mono Tribe, the Sierra Nevada is the ancestral homeland and foodshed, so the area holds great value for sustaining their well-being and culture.

# Terminology



'High-resolution Forest mapping'



HiForm Timber Harvest BMP Tool

**HiForm.org Change Script**

**1. Choose Satellite**

Satellite: Sentinel 2 TOA

Start Date: 2015

**2. Set Dates**

Pre-Disturbance Image dates

2019-06-01

2020-07-15

Post-Disturbance Image dates

2021-06-15

2021-06-30

**3. Actions**

Do the change analysis

Export image to Drive

Export image to Cloud

Update URL for sharing

**4. Exploration**

pre date: 20190623

post date: 20210617

pre-NDVI: 84.28

delta-NDVI: -43.00

Show/Hide Legend

Close Panel

**Layers**

- State borders
- County borders
- fs proclaimed
- Hillshade
- NDVI change - forest only
- NDVI change - no water
- NDVI change - all lands
- Pre True Color
- Post True Color
- Pre Date Used
- Post Date Used

**NDVI Change**

- >26
- 11 to 25
- 6 to 10
- 3 to 5
- 4 to -6
- 7 to -9
- 10 to -12
- 13 to -15
- 16 to -18
- 19 to -21
- 22 to -25
- 26 to -29
- 30 to -33
- 34 to -37
- < -37

The *HiForm* "workflow"

- masking
- metrics
- methods
- visualization

**Google Earth Engine**

Scripts | Docs | Assets

Christie2023/505F-616/52 v5 harvest bmp FL 041423 (copy)

```
var geometry: Polygon, 11 vertices
var image: Image

// HiForm Timber Harvest Script - Identify and optionally export large patch timber harvests as polygons or points
//
// 1. "Run" the script to display the counties, pan and zoom the map, centered on your area of interest
// 2. Decide the extent from which to report, choose 1 of 3 possibilities:
//    a) by a single county (default), edit line 39, type the county name and state abbreviation (like shown),
//    b) by multiple counties, edit lines 95, 96, comment-out line 71 (using //), make active line 72 (remove //)
//    c) by a hand drawn polygon, using the map "Geometry Import" tool, select "New Layer" to "Draw a shape"
//    comment-out lines 71 and 72 (using //), make active line 73 (remove //), go to 4)
// 3. Select "Run" at the top of the Code Editor window, and watch for the completion status in the "Layers" tab
//    (if needing to export a geospatial product, wait for the layers to draw before proceeding to 4)
// 4. Optional: to export, go to "Tasks" tab and select the "Run" next to the product of interest (exports save to Drive)
```

**Inspector**

UNSUBMITTED TASKS

- moderate\_ndvi\_change\_polygons\_SHAPEFILE
- moderate\_ndvi\_change\_centroids\_SHAPEFILE
- moderate\_ndvi\_change\_textfile
- severe\_ndvi\_change\_polygons\_SHAPEFILE
- severe\_ndvi\_change\_centroids\_SHAPEFILE
- severe\_ndvi\_change\_textfile
- SCTOAZ\_zones\_severeANDmoderate\_lyrNDVIchange\_092122\_RGB\_pr...

**SUBMITTED TASKS**

The '*HiForm* Timber Harvest Script' employs and extends the workflow

Provided a simplified 'Graphical User Interface' (GUI), it executes a customized workflow of specific mapping tasks, difficult to modify

No GUI, full development control with all capabilities available, easily modifiable

# Why we prefer 10m Sentinel-2? (for BMP and everything else)

...compared to 30m Landsat



5-day repeat

9x better spatial resolution than Landsat

'near-tree-crown' resolution

Available the next day in GEE

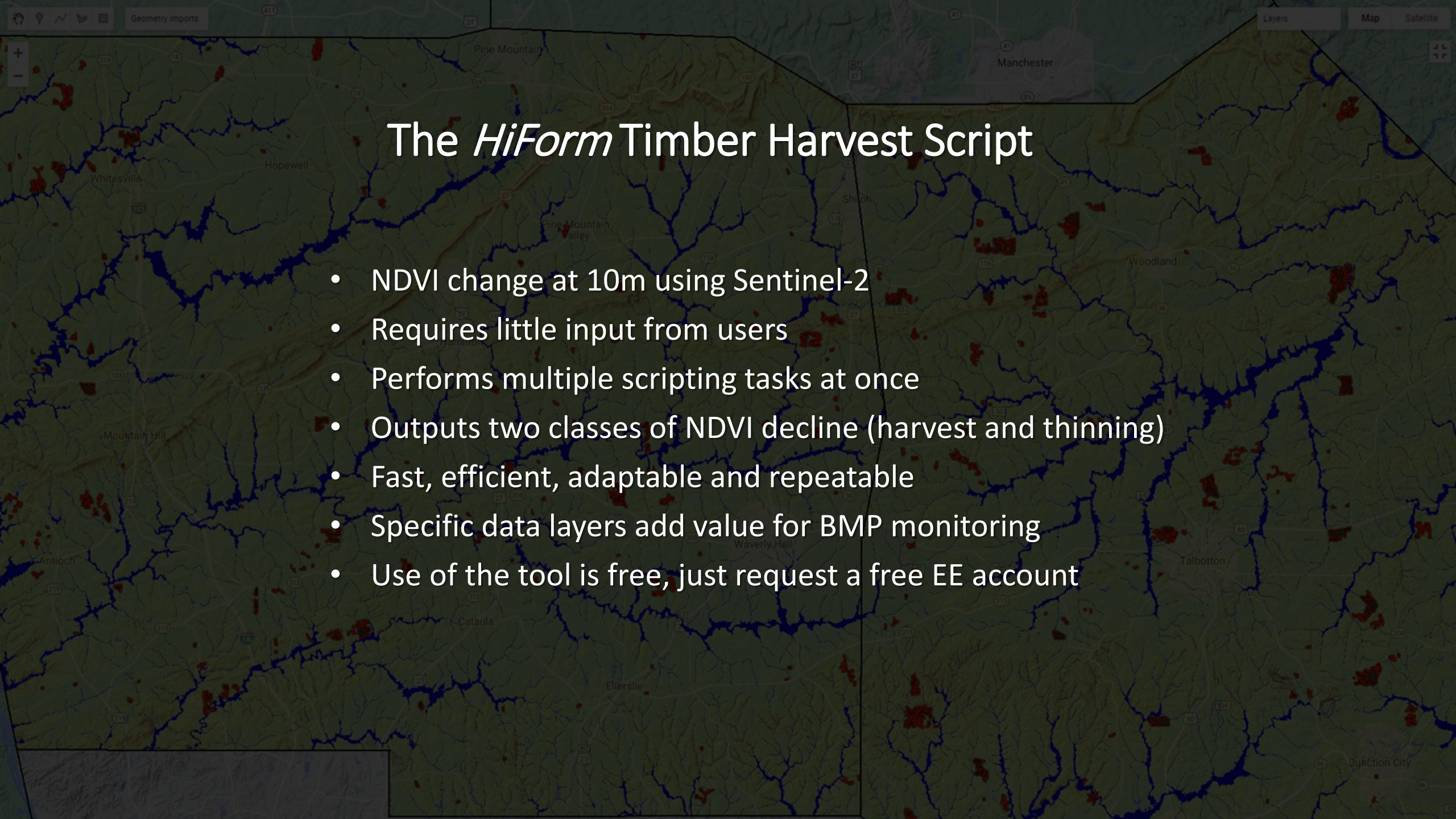


7-day repeat

Often takes weeks for an image to become available in Earth Engine

Great for long term baseline NDVI change mapping at 30m

Sentinel-2 is sensor-of-choice for the *HiForm* BMP tool

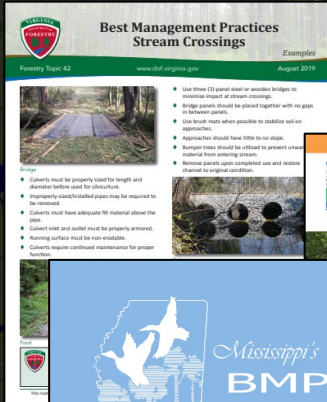


# The *HiForm* Timber Harvest Script

- NDVI change at 10m using Sentinel-2
- Requires little input from users
- Performs multiple scripting tasks at once
- Outputs two classes of NDVI decline (harvest and thinning)
- Fast, efficient, adaptable and repeatable
- Specific data layers add value for BMP monitoring
- Use of the tool is free, just request a free EE account

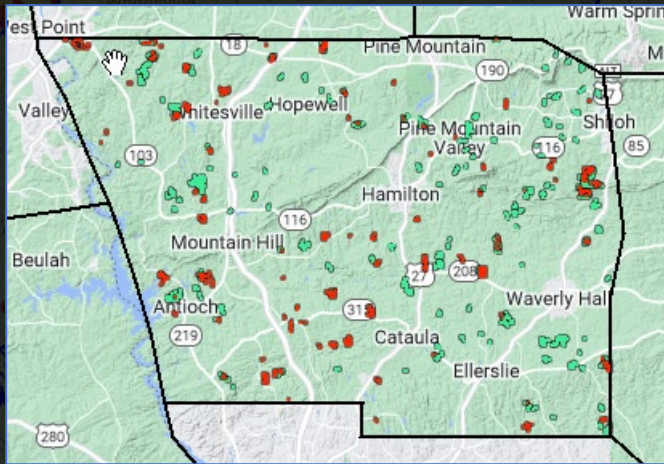
# Why map timber harvest?

- 'Best Management Practice' (BMP)
  - Water quality and supply
  - Tracking implementation and compliance
  - Forested wetland status and trends
  - Annual reporting and tracking
  - Salvage logging from large disturbance events
  - Others?

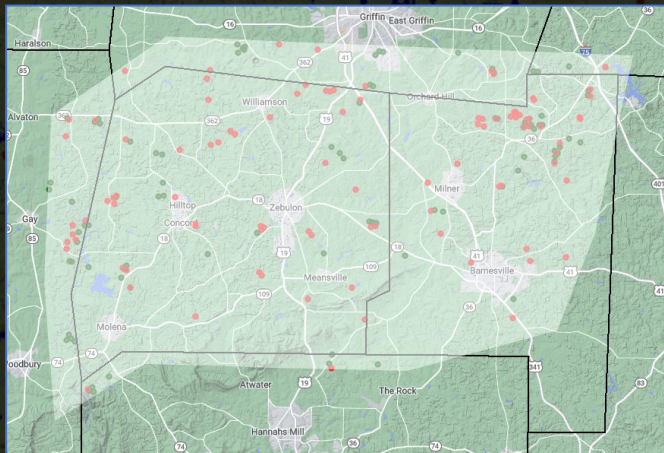


# HiForm Timber Harvest Script (user input required)

by single county, polygon display



by hand-drawn polygon, centroid display



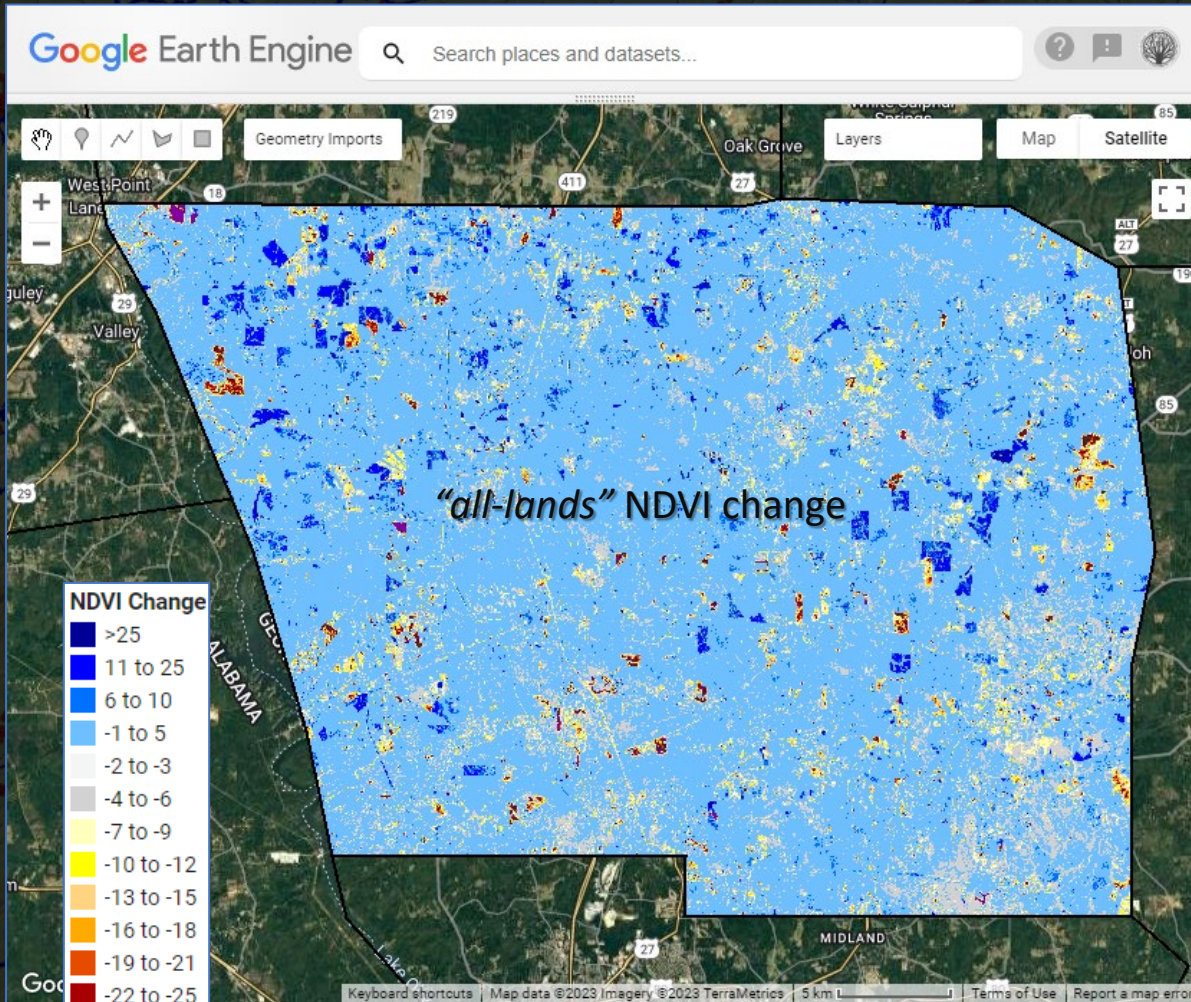
- Requires Chrome and a free Google Earth Engine account, now open to all users
- Your choice, report by **County(s)** or **hand-drawn polygon**
  - Pre-applies (pre- and post disturbance) dates to create the NDVI change product
    - Default - 1yr growing season (8-weeks) change using anniversary dates, or
    - Your own timeframe, within the same years' growing season (ex: 3-mo.), can be more cloudy
  - Auto-applies forest mask using 2019 NLCD and mean growing season NDVI
  - Auto-applies an NDVI filter for severe-, and moderate NDVI decline (-20 NDVI change)
  - Auto-applies a 'large patch' filter to show only 0.5ha in size, and greater harvests
- Press **'Run'** to display results; use 'Inspect' to obtain a lat-long for navigation
  - Optional: Export (writes to Google-Drive)
    - Polygon or point shapefile
    - Point lat-long text file
    - NDVI change raster GeoTiff
      - For use on desktop, in AG Field Map or Avenza)



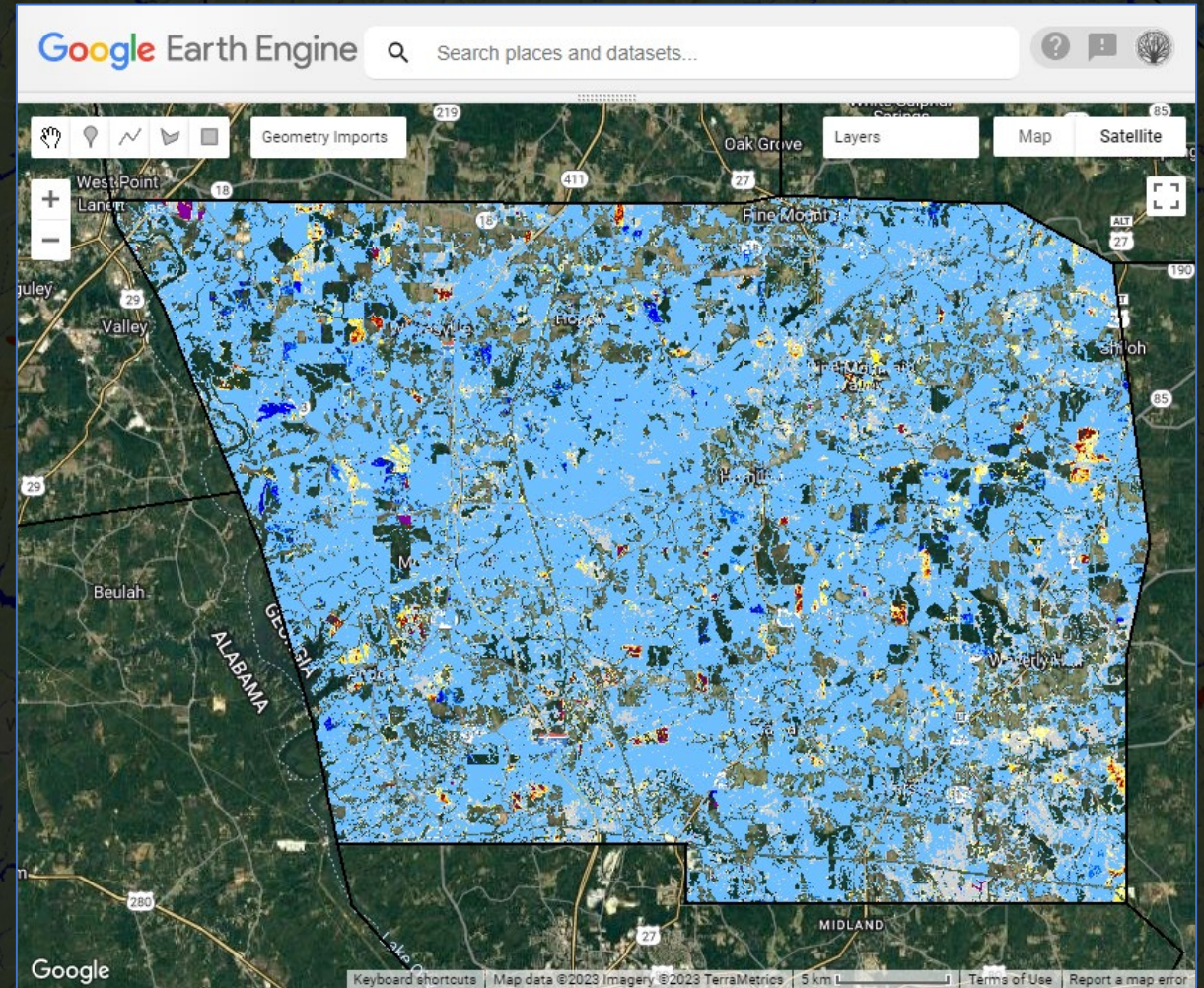
# Generalized Workflow

Starts with an 10m, 1yr NDVI change product (8-wk composite)

Mask to NLCD 2019 Forest and mean-range NDVI



'Pre' date range – 05/21/2021 thru 07/21/2021  
'Post' date range – 07/21/2022 thru 09/21/2022



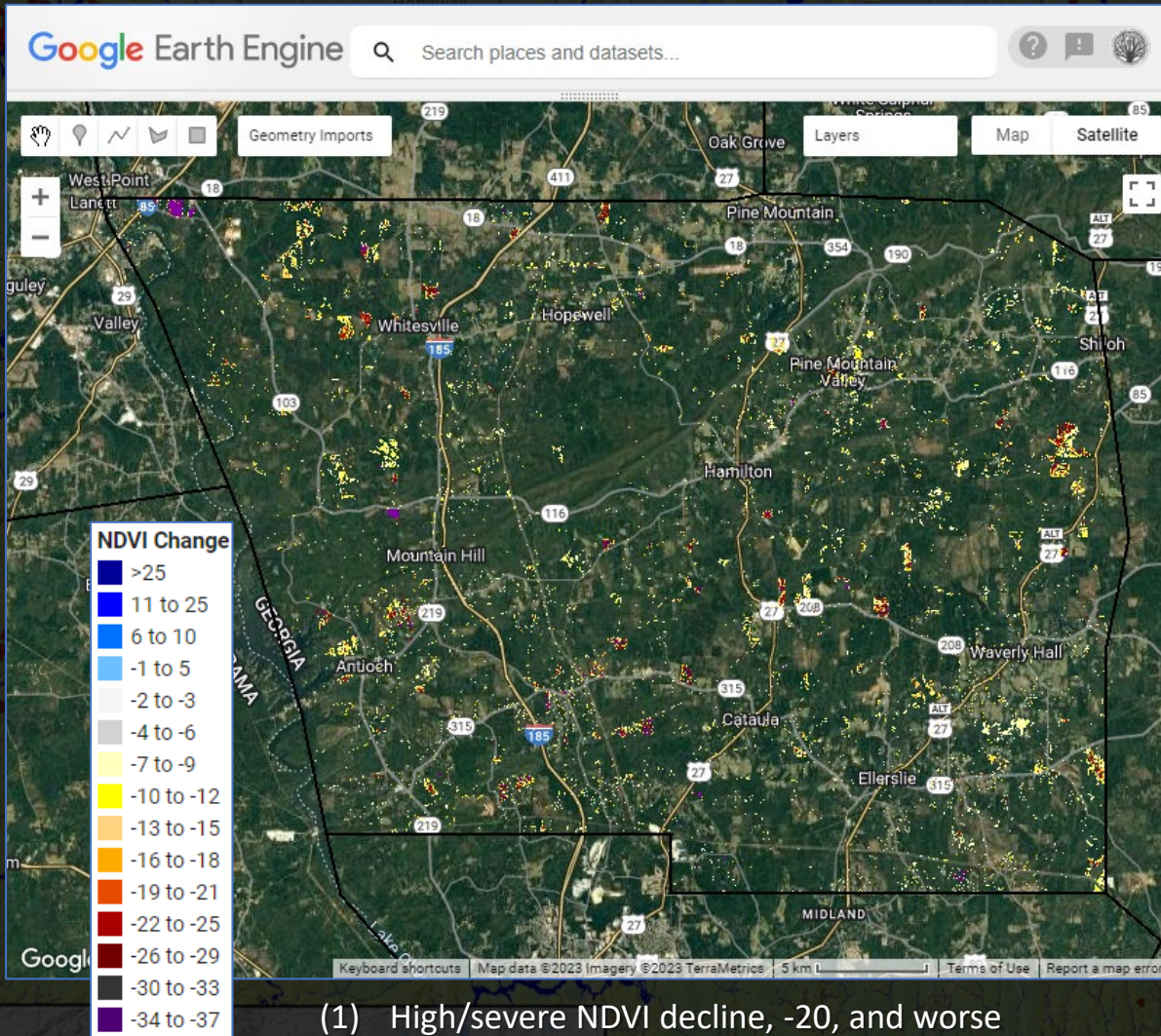
RE: the second forest filter "mean-range NDVI" (GTE 45) is used because of two shortcomings of NLCD: (1) it's often outdated with respect to forest due to more harvesting after the date of the version used, and prior to the compositing period used, and (2) it's coarse at 30m, compared to the more precise 10m NDVI change product



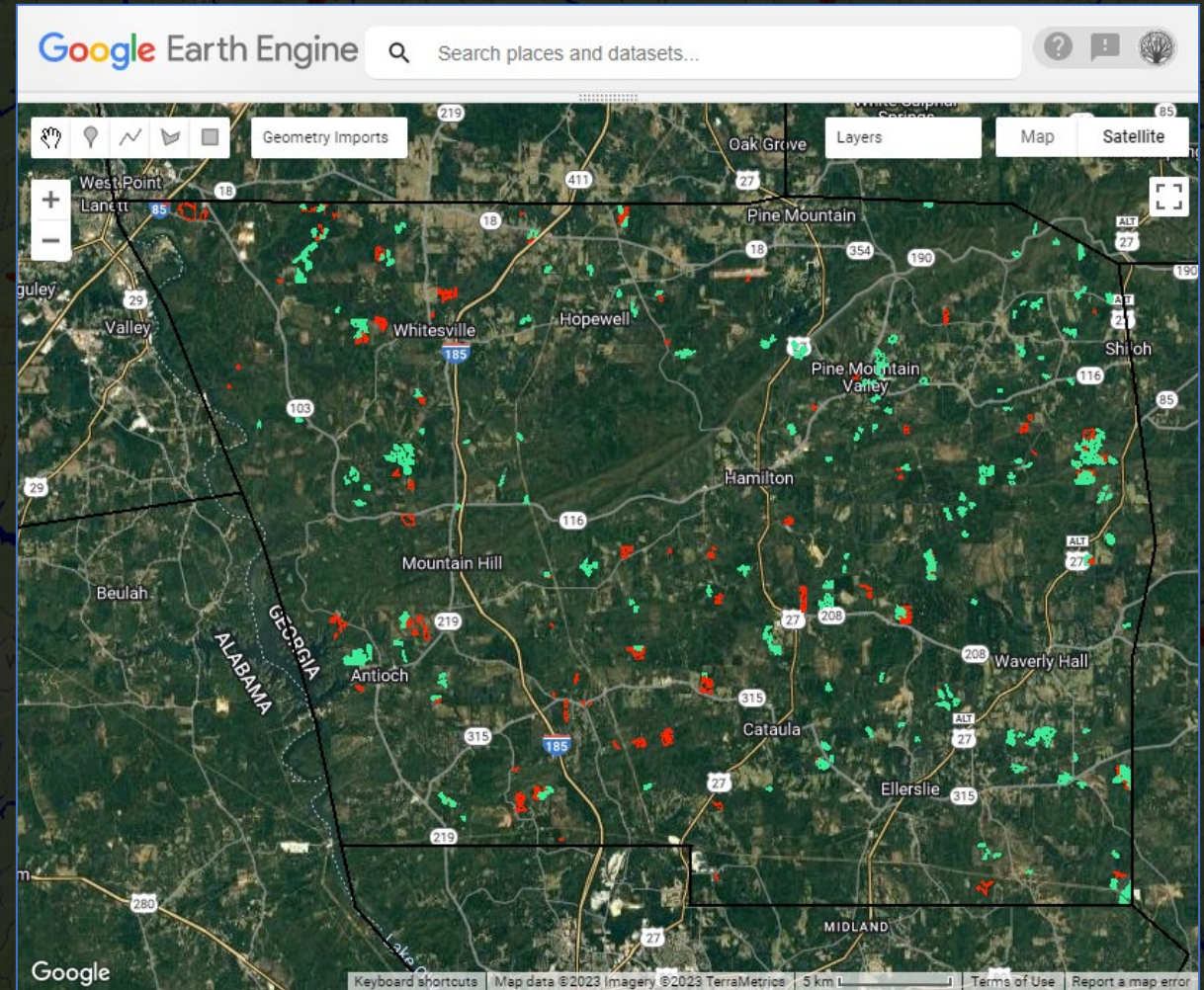
# Generalized Workflow

Threshold forest-NDVI-change into 2-levels of decline

Filter for min. patch size, then convert to polygons & points

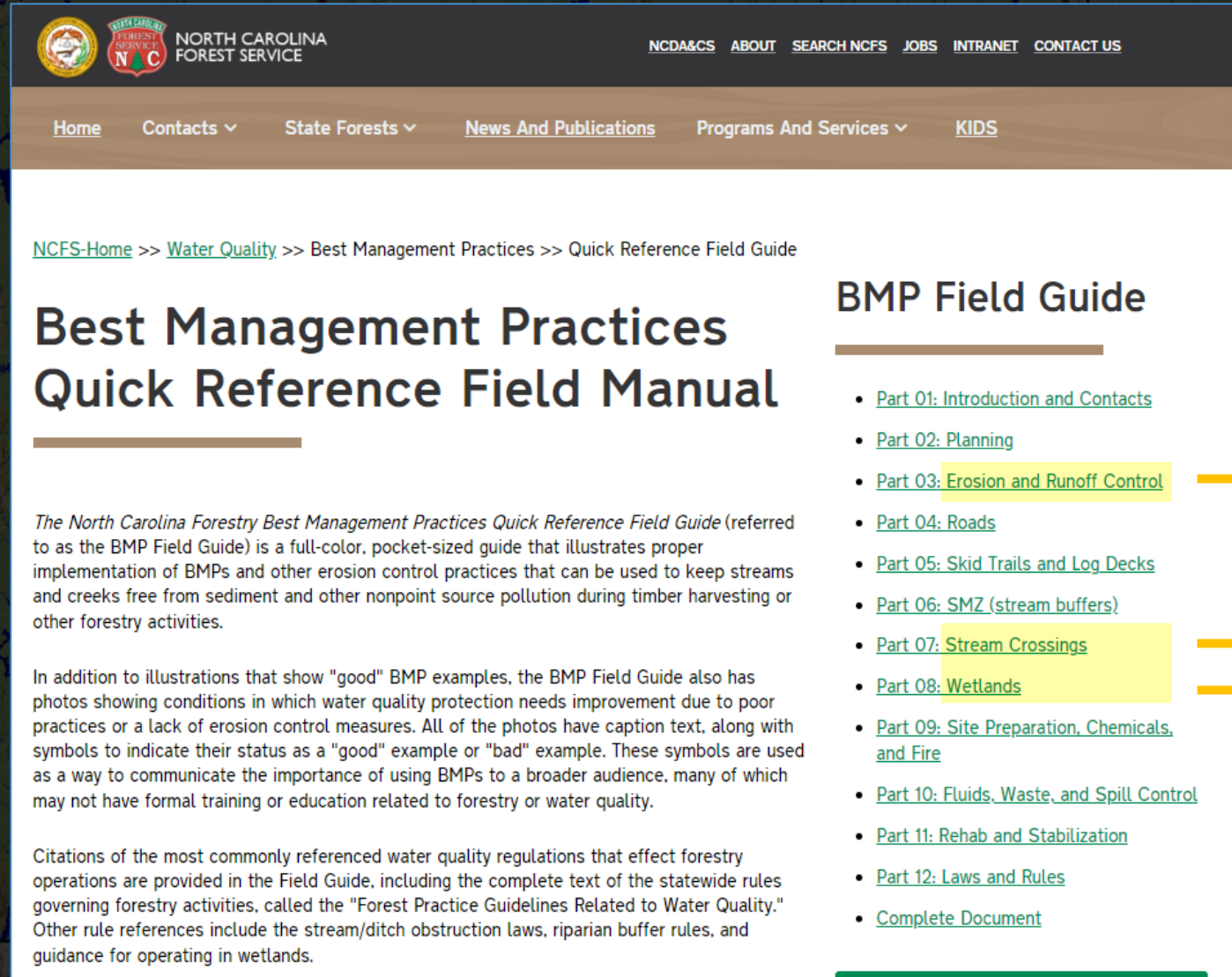


- (1) High/severe NDVI decline, -20, and worse
- (2) Moderate NDVI decline, -7 to -19



- (1) High/severe NDVI decline,  $\geq 2.5$  acres (red polygons)
- (2) Moderate NDVI decline,  $\geq 5$  acres (green polygons)

# Add value to the Harvest Script by including BMP-related data layers (to help assess potential impacts to water resources)



The screenshot shows the North Carolina Forestry Service website. The header includes the NCDA&CS logo and navigation links: ABOUT, SEARCH NCFS, JOBS, INTRANET, CONTACT US. The main navigation bar contains: Home, Contacts, State Forests, News And Publications, Programs And Services, KIDS. The page title is "Best Management Practices Quick Reference Field Manual". The content includes a description of the manual and a list of 12 parts. Three parts are highlighted in yellow: Part 03: Erosion and Runoff Control, Part 07: Stream Crossings, and Part 08: Wetlands. Three yellow arrows point from these highlighted parts to the right, where they are linked to text annotations: "Percent slope", "Detailed streams; 303(d) Impaired", and "Floodplains (denotes bottomland hardwood wetlands, hydric soils)".

[NCFS-Home](#) >> [Water Quality](#) >> Best Management Practices >> Quick Reference Field Guide

## Best Management Practices Quick Reference Field Manual

*The North Carolina Forestry Best Management Practices Quick Reference Field Guide (referred to as the BMP Field Guide) is a full-color, pocket-sized guide that illustrates proper implementation of BMPs and other erosion control practices that can be used to keep streams and creeks free from sediment and other nonpoint source pollution during timber harvesting or other forestry activities.*

In addition to illustrations that show "good" BMP examples, the BMP Field Guide also has photos showing conditions in which water quality protection needs improvement due to poor practices or a lack of erosion control measures. All of the photos have caption text, along with symbols to indicate their status as a "good" example or "bad" example. These symbols are used as a way to communicate the importance of using BMPs to a broader audience, many of which may not have formal training or education related to forestry or water quality.

Citations of the most commonly referenced water quality regulations that effect forestry operations are provided in the Field Guide, including the complete text of the statewide rules governing forestry activities, called the "Forest Practice Guidelines Related to Water Quality." Other rule references include the stream/ditch obstruction laws, riparian buffer rules, and guidance for operating in wetlands.

### BMP Field Guide

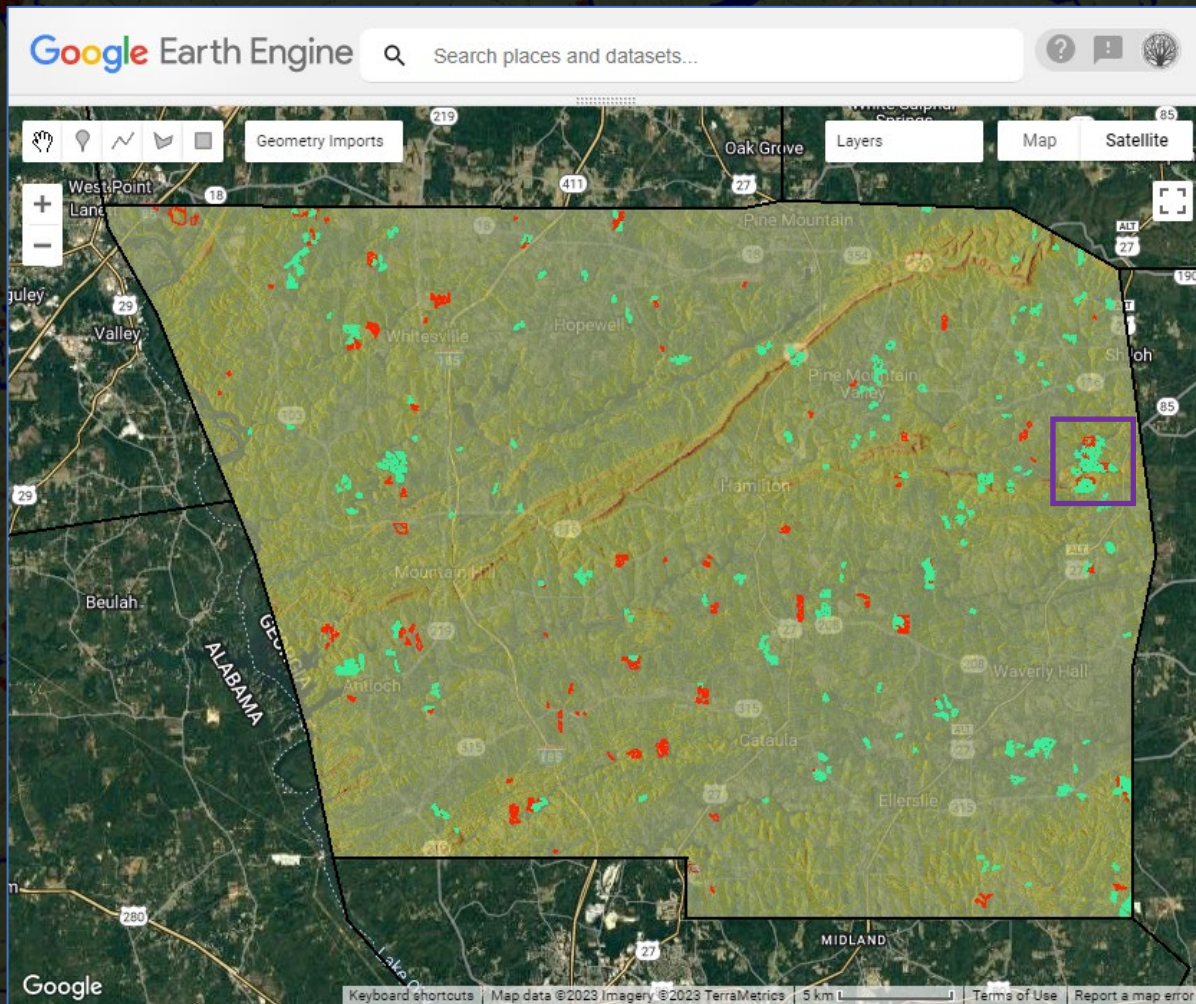
- [Part 01: Introduction and Contacts](#)
- [Part 02: Planning](#)
- [Part 03: Erosion and Runoff Control](#)
- [Part 04: Roads](#)
- [Part 05: Skid Trails and Log Decks](#)
- [Part 06: SMZ \(stream buffers\)](#)
- [Part 07: Stream Crossings](#)
- [Part 08: Wetlands](#)
- [Part 09: Site Preparation, Chemicals, and Fire](#)
- [Part 10: Fluids, Waste, and Spill Control](#)
- [Part 11: Rehab and Stabilization](#)
- [Part 12: Laws and Rules](#)
- [Complete Document](#)

• Percent slope

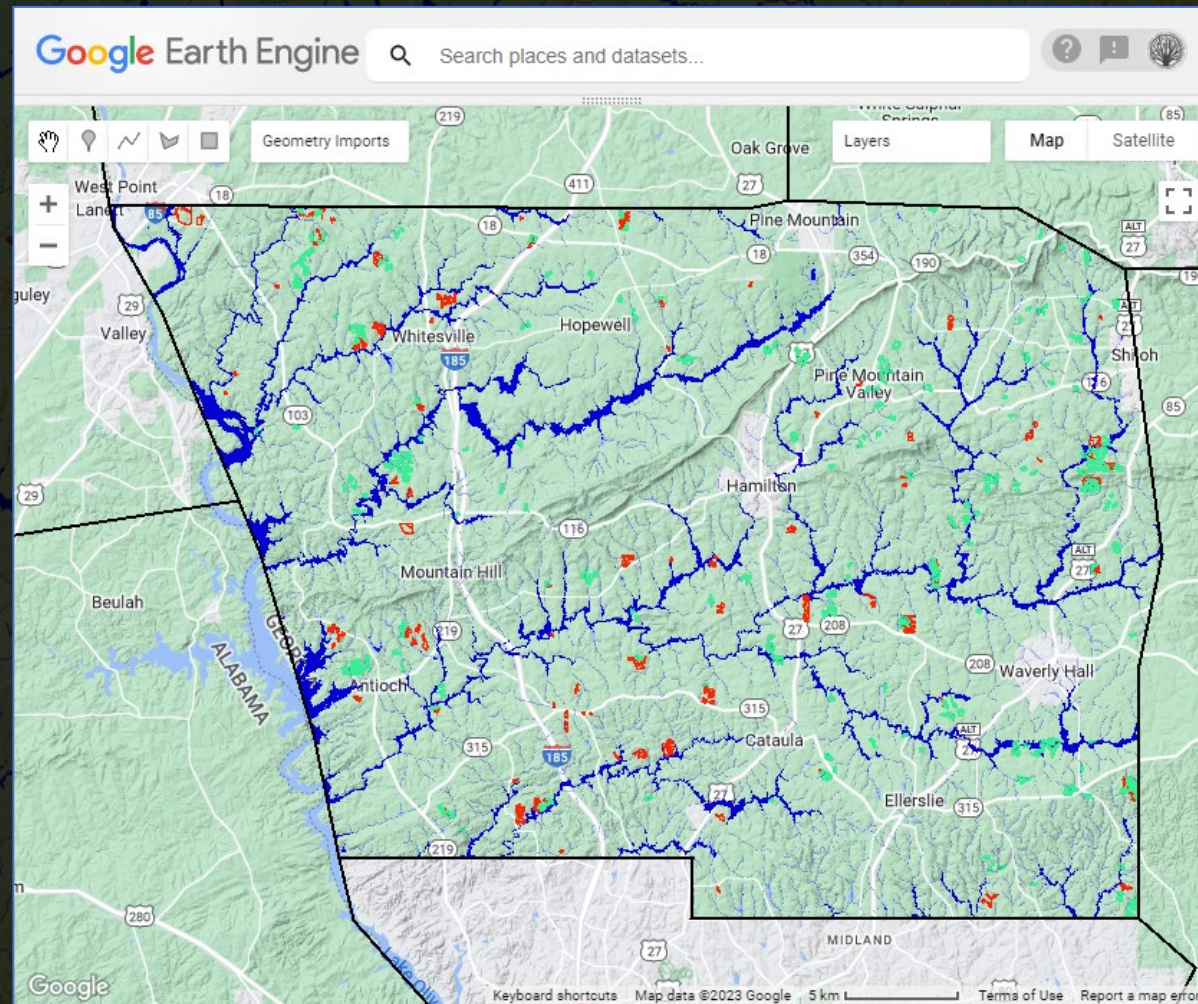
• Detailed streams; 303(d) Impaired  
• Floodplains (denotes bottomland hardwood wetlands, hydric soils)

# BMP-related Data Layers

*Erosion and Runoff Control -  
Percent Slope from USGS 10m DEM*

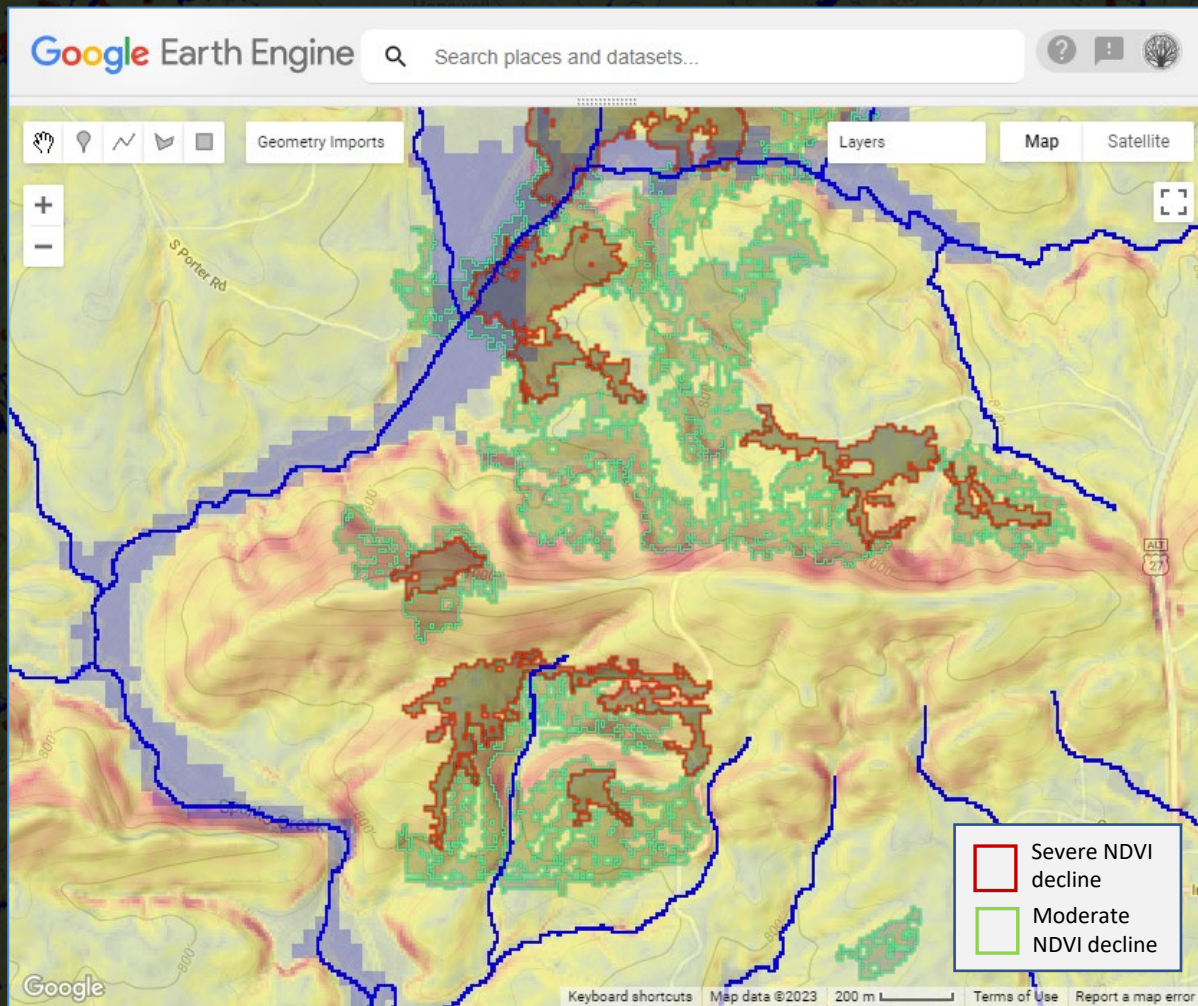


*Stream Crossings and Wetlands -  
Detailed USGS Streams and Floodplains*

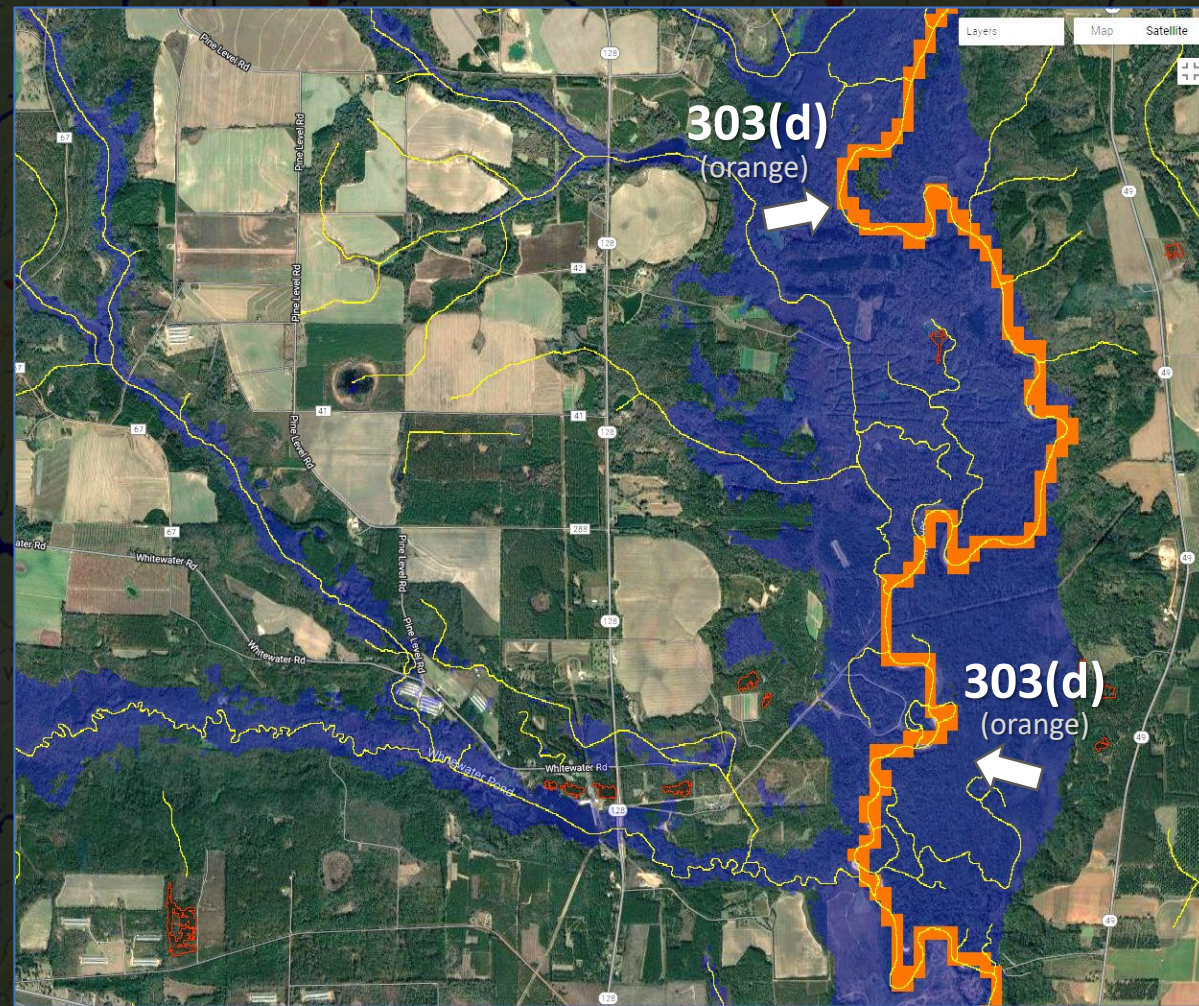


# BMP-related Data Layers

Percent slope, detailed streams, floodplain wetlands and 303(d) Impaired streams



Harris County, GA



Oglethorpe County, GA

# Guide to Interpretation – product use, vetting, confirmation of silvicultural activity

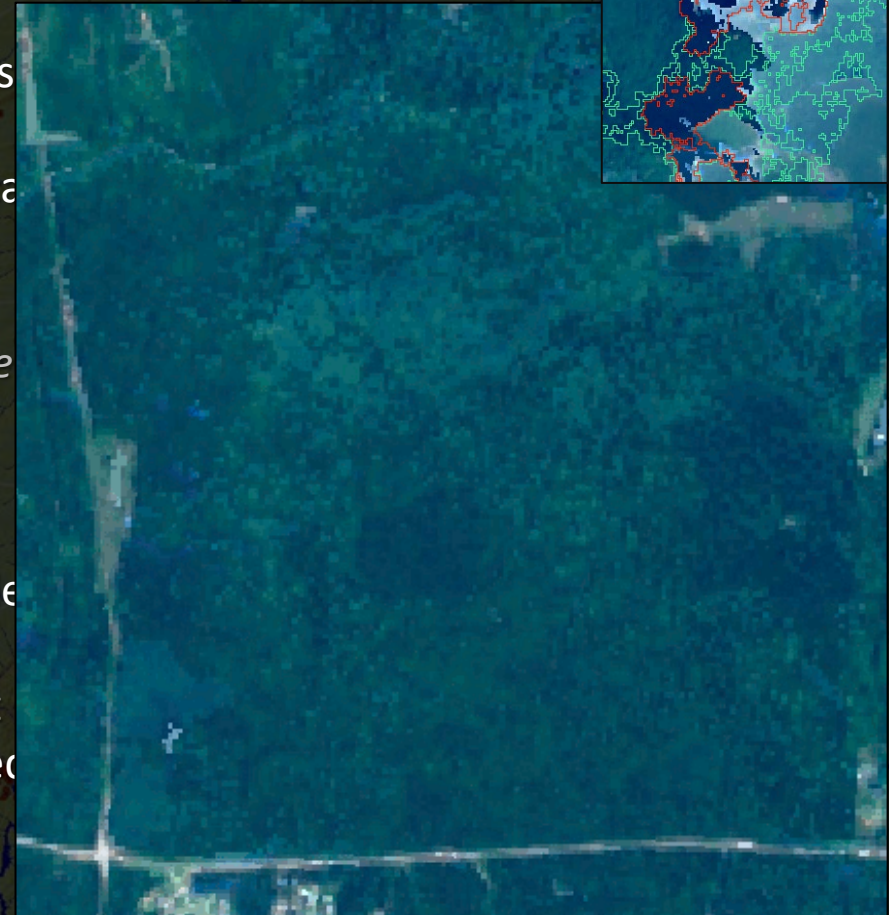
## *A beginner's guide to assessment*

❖ **SEVERE NDVI DECLINE POLYGONS** are the easiest to detect, it's the user's responsibility to assess cause and if silviculture-related, development, large-patch defoliation/mortality, severe weather, flooding, etc.

- Toggle the pre- and post-natural color images to assess and interpret cause
  - It's possible to remove clouds by adjusting the 'post' dates used to calculate NDVI

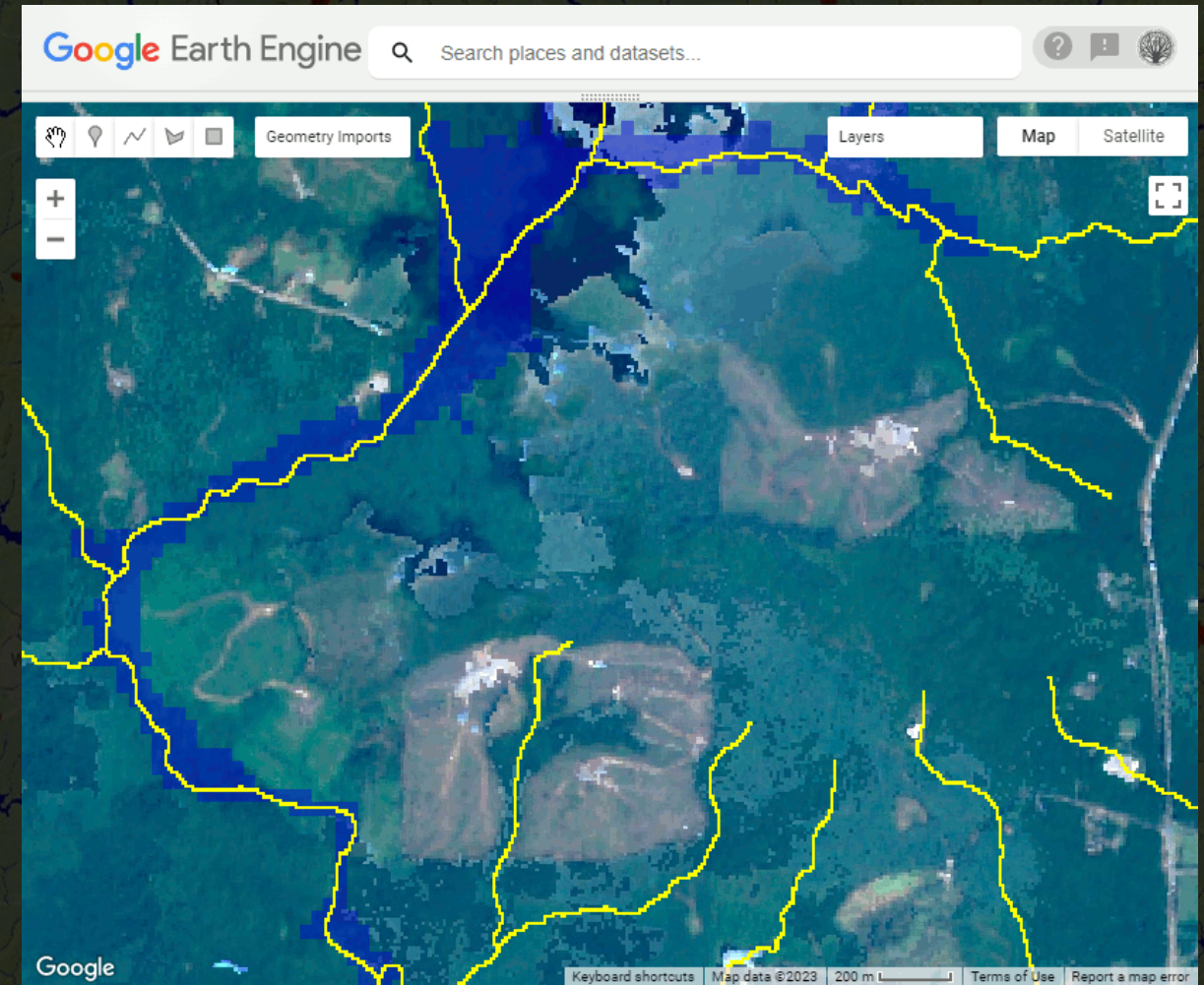
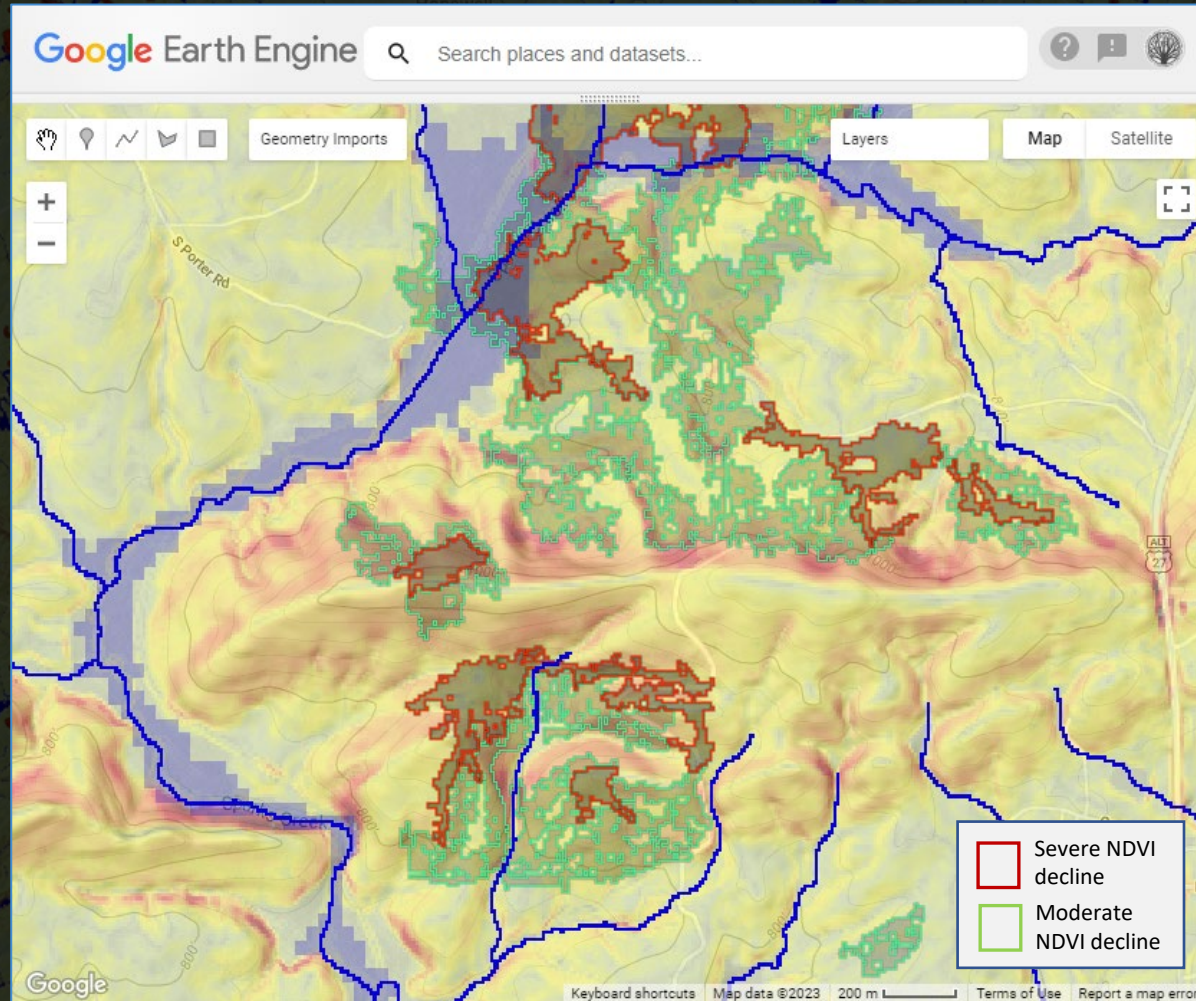
❖ **MODERATE NDVI DECLINE POLYGONS** are a result from a multitude of possible causes

- First, observe their proximity to the red 'severe' NDVI decline polygons
  - Close proximity - likely related to clear cut activity, just lower NDVI decline
  - Disjunct, could indicate possible thinning, interpret the pre and post images, note the character, and color of NDVI change, also view the 'forest-masked' polygons



# Guide to Interpretation – product use, vetting, confirmation of silvicultural activity

Use the post true-color to show the full extent of the harvest site



One can potentially remove the presence of clouds (in the 'post' image) by changing the timeframe of the default date range in the script (adaptive tool)

Step-by-step instructions

Exports are automatically created and staged

The screenshot displays the Google Earth Engine web interface. At the top, there is a search bar and navigation tabs for 'Scripts', 'Docs', and 'Assets'. The 'Scripts' tab is active, showing a code editor with a script titled 'HiForm Timber Harvest Script - identify and optionally export large patch timber harvests as polygons or points (03/07/2023)'. The script contains instructions for running the script, selecting the extent, and exporting results. A red arrow points to the search bar, and another red arrow points to the 'Inspector' tab in the top right corner.

The map view shows a topographic map of a region with a blue polygon highlighting a specific area of interest. The 'Inspector' tab is open, showing a list of 'UNSUBMITTED TASKS' with 'RUN' buttons next to each task name.

Task Name	Action
moderate_NDVI_change_polygons_SHAPEFILE	RUN
moderate_NDVI_change_centroids_SHAPEFILE	RUN
moderate_NDVI_change_centroids_TEXTFILE	RUN
severe_NDVI_change_polygons_SHAPEFILE	RUN
severe_NDVI_change_centroids_SHAPEFILE	RUN
severe_NDVI_change_centroids_TEXTFILE	RUN
S2TOA_2bins_severeANDmoderate_1yrNDVichange_092122_RGB_pre...	RUN

\*\*\* It's not necessary to export anything, use the 'Inspector' tool to get the lat-long, then paste to Google Maps for navigation. \*\*\*

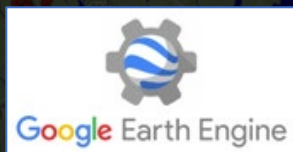
# How to get started? (red - required user input)

Using Google Chrome, **sign-in** using an established Gmail acct, then request an EE account, <https://earthengine.google.com>

When approved, execute this script-link, <https://code.earthengine.google.com/7b8e5e528a85058af621ecd572428f7d>

Step-by-step instructions are provided at the top of the script

- A. *Optional:* set the map center and zoom level
- B. Decide the extent to map, **choose 1 of 3**
  1. Type-in a **single county name** (default)
  2. Type-in **multiple county names**, or
  3. **Draw** on the screen
- C. Select **Run**
- D. *Optional:* export, Inspector tool for lat-long







South Carolina Forestry Commission

## Questions and discussion

1. How does this compare with other approaches?
2. Have we captured broad harvest-related needs?
3. What do you like, not like, or need to make it better?
4. Going forward - *engage with GISC for input regarding the design of a 'user interface' for the HiForm BMP tool*

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[steven.norman@usda.gov](mailto:steven.norman@usda.gov) (Research Ecologist)

The *HiForm* website: <https://hiform.org>

Earth Engine sign-up: <https://earthengine.google.com/>

*(create a new Gmail address to use for EE sign-up and work)*