

# Land Surface Phenology: Overview of the MODIS Phenology ArcMap Toolbox

Kevin James

Heartland Inventory & Monitoring Network

February 12, 2014



# Acknowledgements

- Jeffrey T. Morisette
  - North Central Climate Science Center
- Colin Talbert
  - USGS Fort Collins Science Center
- Don Brown
  - Cherokee Services Group
- Marian Talbert
  - North Central Climate Science Center



# Project Funding

- USGS/NPS National Park Monitoring Project: Status and Trends of Biological Resources Program
- Great Northern Landscape Conservation Cooperative



# Phenology

- Direct observation - life cycle events
  - National Phenology Network
  - I&M Plant Phenology Monitoring Protocol:
    - Northeast Temperate Network
    - California Phenology Project
- Remote sensing - land surface phenology
  - seasonal pattern of variation
  - vegetated land
  - Normalized Difference Vegetation Index (NDVI)
  - Enhanced Vegetation Index (EVI)
- Monitor seasonal change



# Data Sources

- North American Carbon Project Phenology Product
  - NASA, GSFC
- MOD09PHN: MOD09EVI, MOD09NDVI
- 250m spatial resolution
- 8-day temporal resolution
- MOD09PHN is derived from spatially gap-filled and temporally smoothed MOD09 estimated EVI and NDVI
- Phenology metrics are derived from TIMESAT using a smoothing function

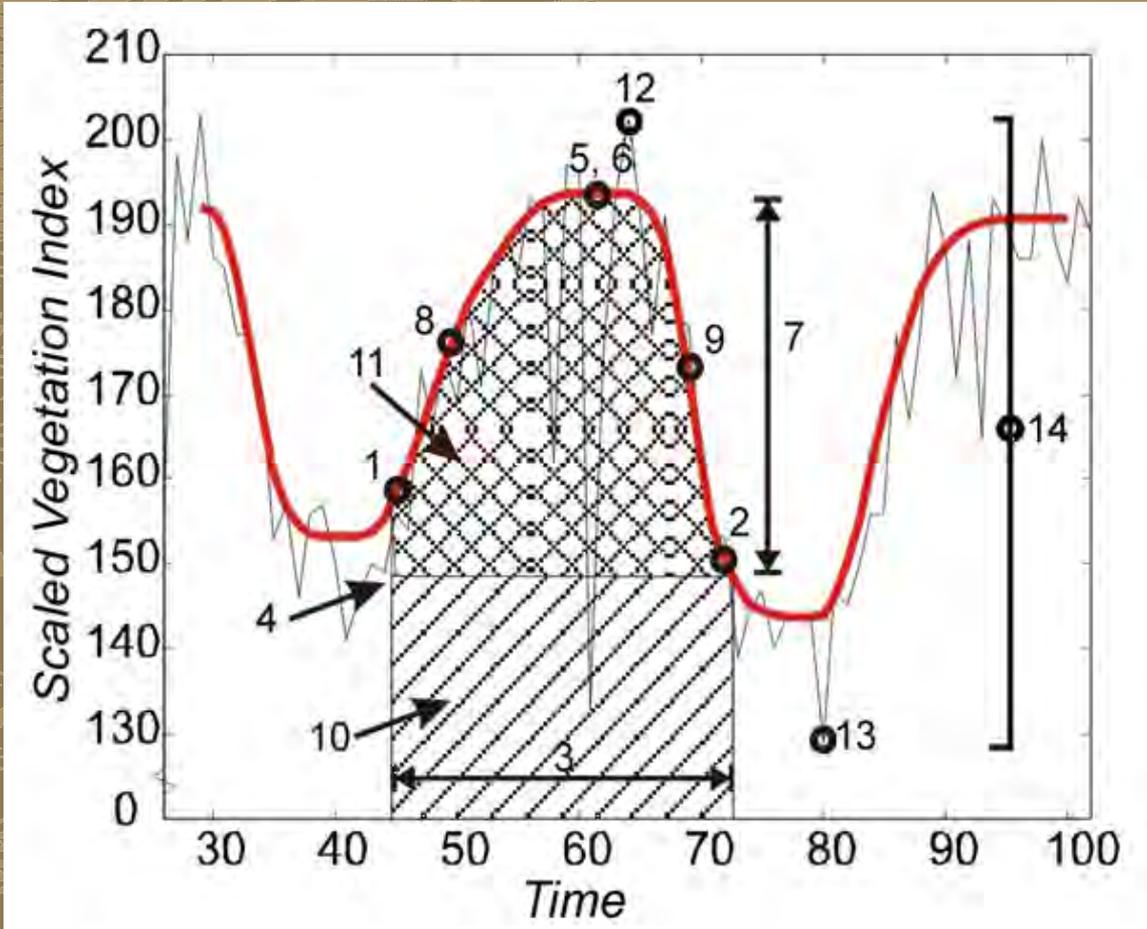


# Key References for TIMESAT Metrics

- Jönsson and Eklundh. 2004. *Computers & Geosciences* 30(8): 833-845
- Gao et al. 2008. *IEEE Geoscience and Remote Sensing Letters*, 5(1): 60-64
- Tan et al. 2011. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 4(2): 361-371



# Phenology Metrics



1. greenups
2. browndowns
3. season lengths
4. base levels
5. peak dates
6. max peak values
7. amplitudes
8. greenup rates
9. browndown rates
10. large integrals
11. small integrals
12. annual maximum value
13. annual minimum value
14. annual mean value



# Software Requirements

- ArcGIS 10.0
- Python 2.6 installed to work properly with ArcGIS
- R statistical package version 2.14
- Adobe Reader X
- Internet connection for ArcGIS Image Services





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of vegetation health observed by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. The land-surface **phenology** product ... is referred to as **phenology**. Recurring life-cycle events that are initiated and driven by environmental factors include animal migration and plant flowering ... the NASA-funded 250-meter (m) spatial resolution land-surface **phenology** product for North America. This product is calculated from an annual record ...

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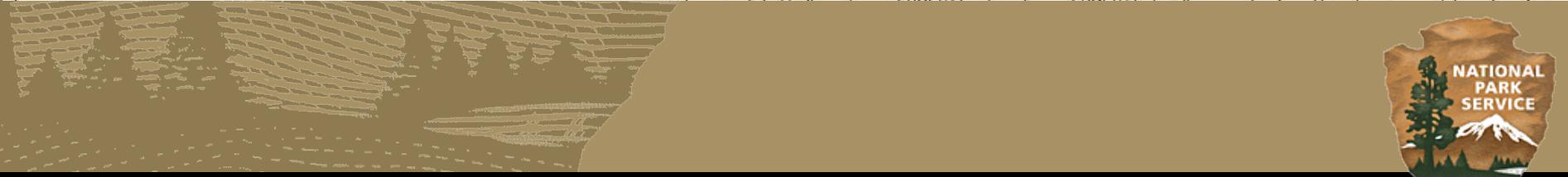
### [MODIS Phenology Image Service ArcMap Toolbox Report](#)

of vegetation health observed by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. The land-surface **phenology** product ... is referred to as **phenology**. Recurring life-cycle events that are initiated and driven by environmental factors include animal migration and plant flowering ... the NASA-funded 250-meter (m) spatial resolution land-surface **phenology** product for North America. This product is calculated from an annual record ...



#### [An enhanced TIMESAT algorithm for estimating vegetation phenology metrics from MODIS data](#)

and retrieve a set of **phenology** metrics. This algorithm has been applied to two MODIS VIs: Normalized Difference Vegetation Index (NDVI) and Enhanced ... and pre-processed MODIS VI. All retrievals were compared with ground **phenology** observations, some made available through the National **Phenology** Network. Our ... of the **phenology** metrics. Among three sets of TIMESAT/MODIS VI combinations, the start of the growing season metric ...



MODIS Phenology ArcMa x

← → ↻ 🏠 <https://www.sciencebase.gov/catalog/item/5196af9be4b0d3919cca1efc>

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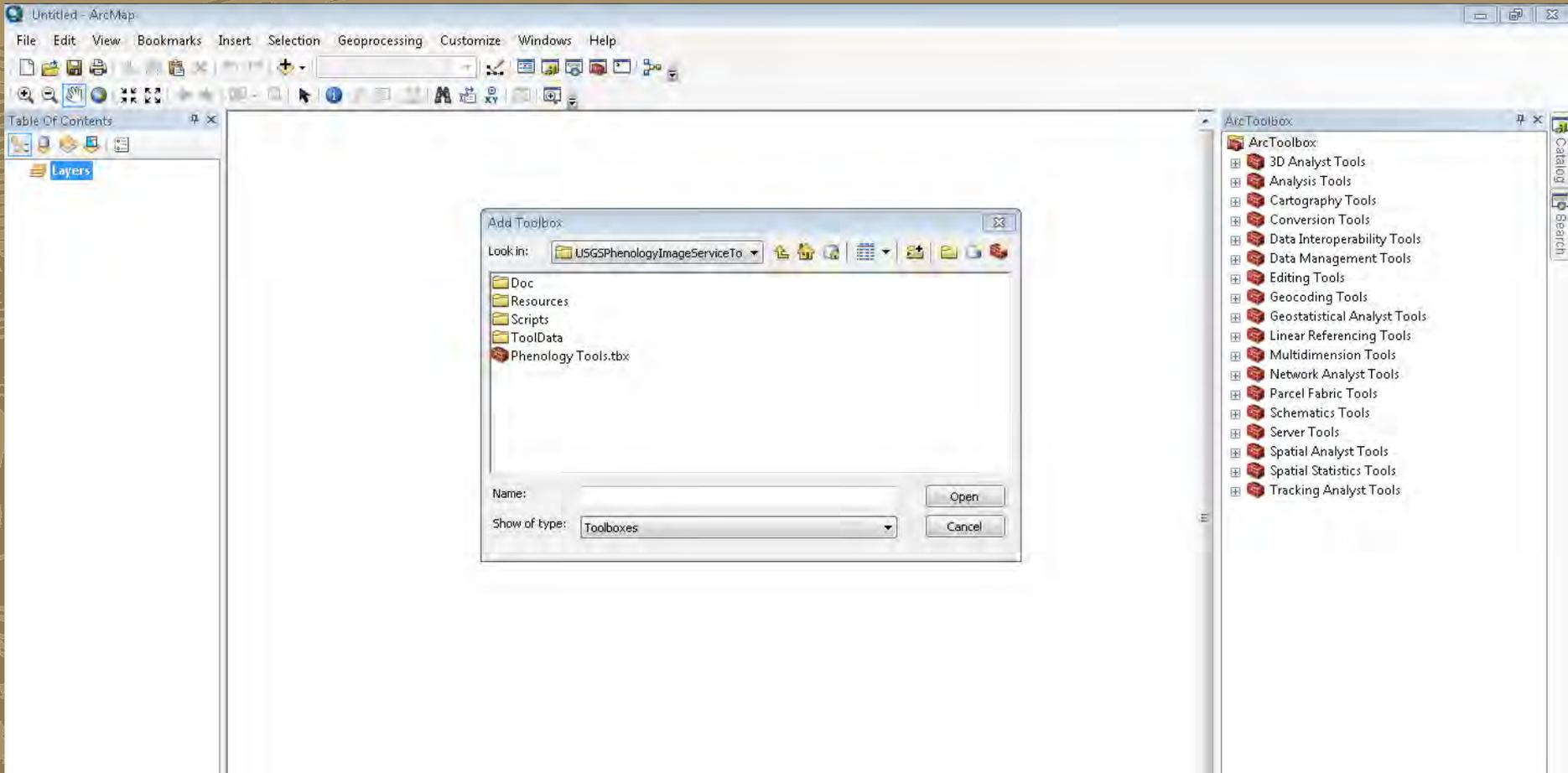
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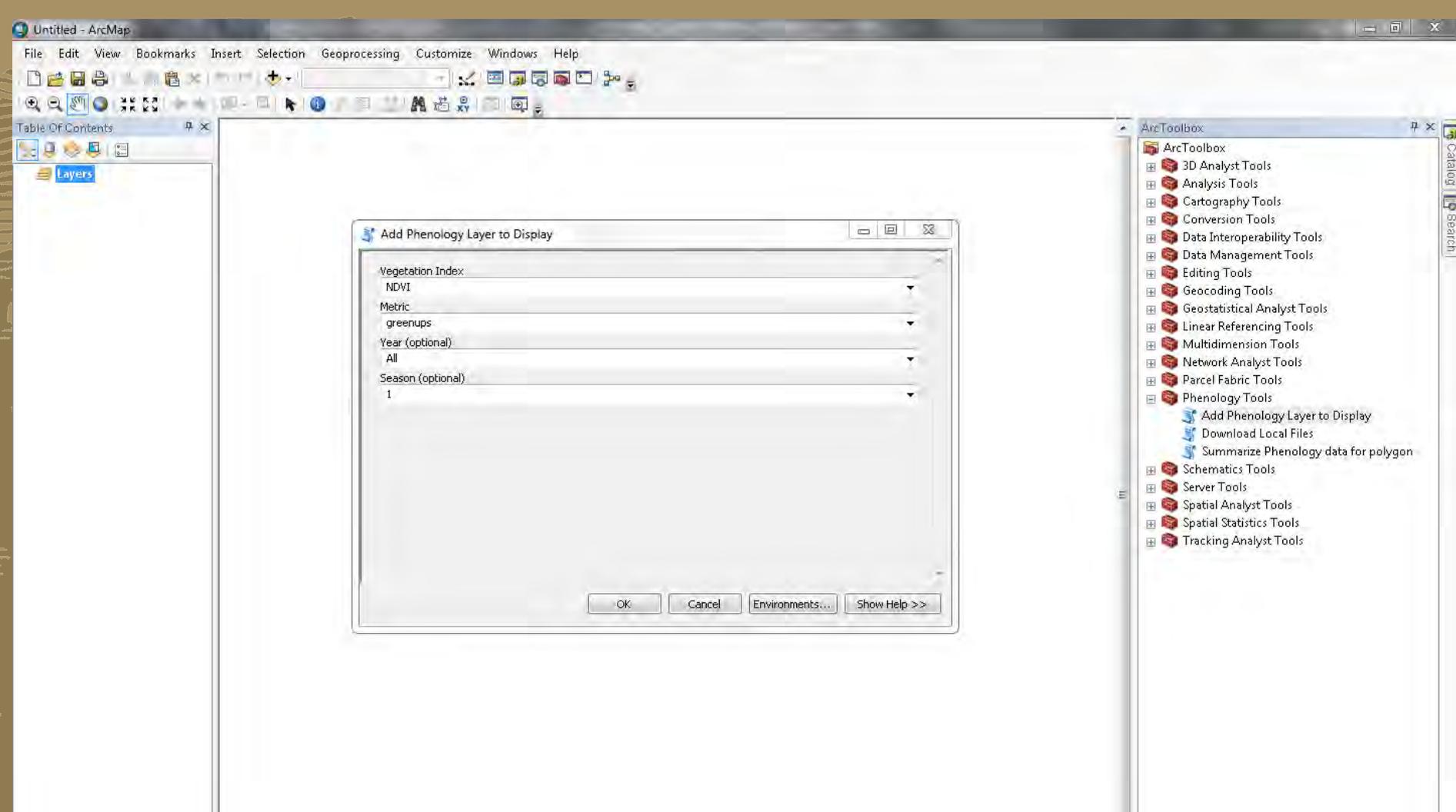
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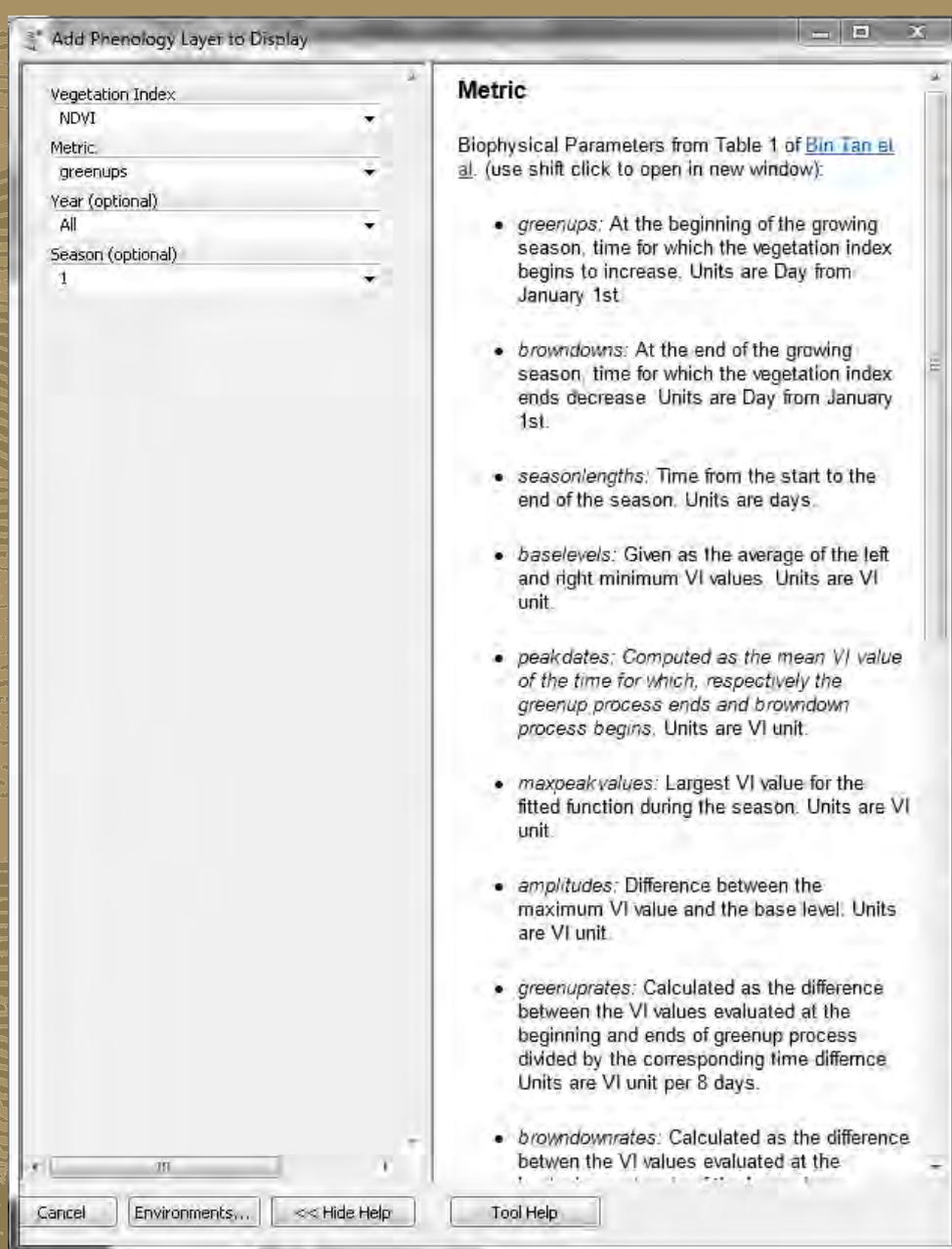


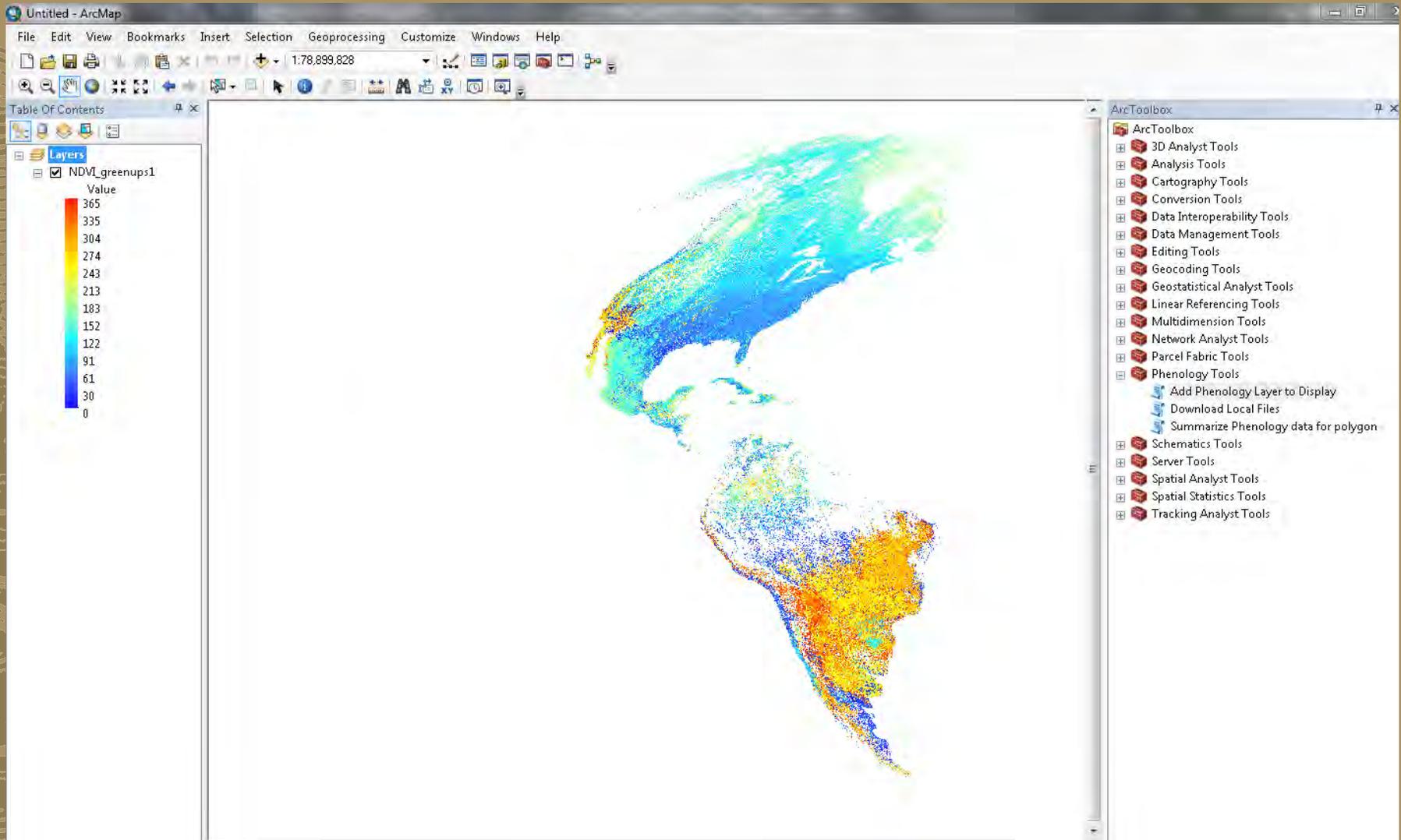


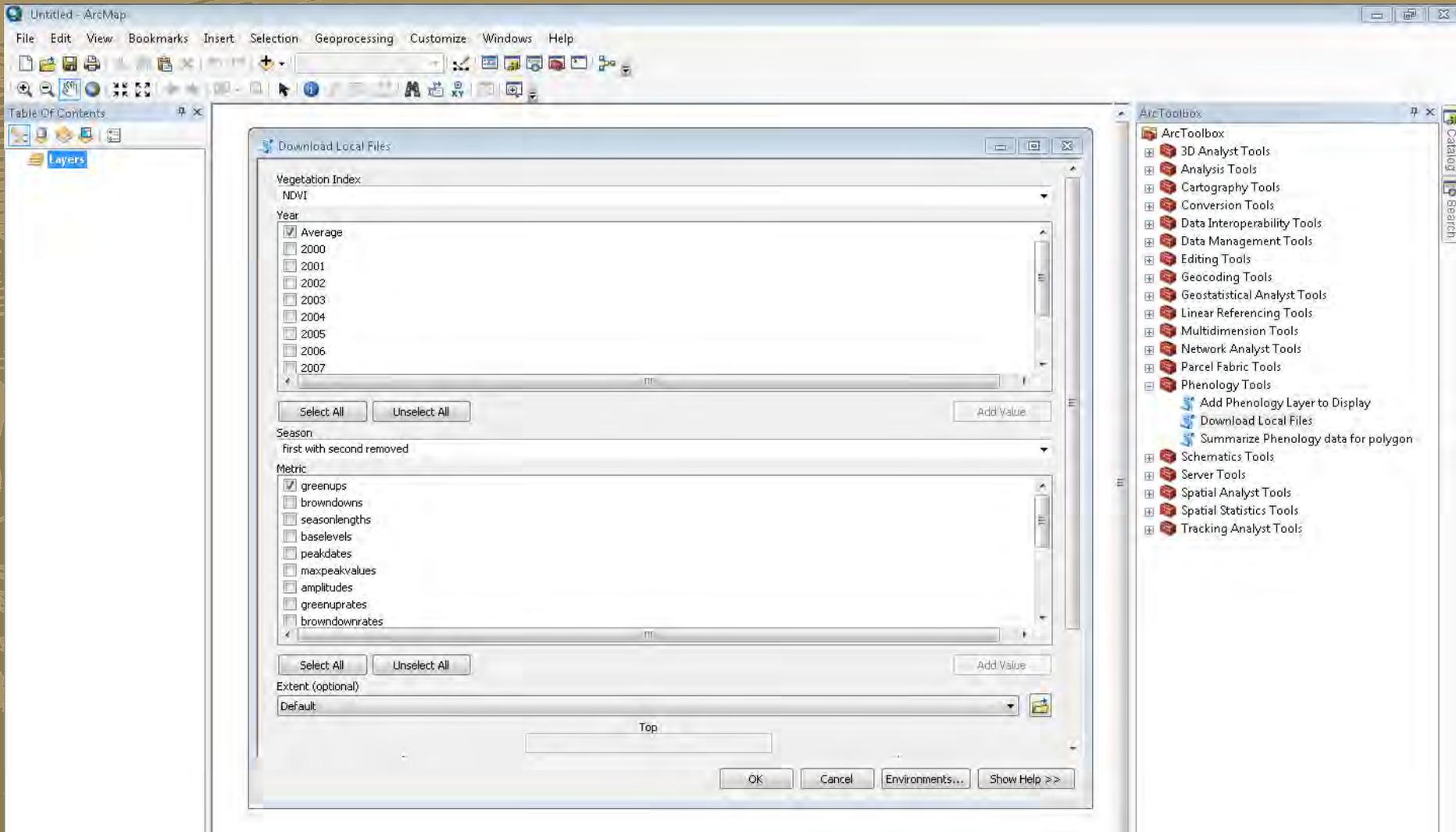


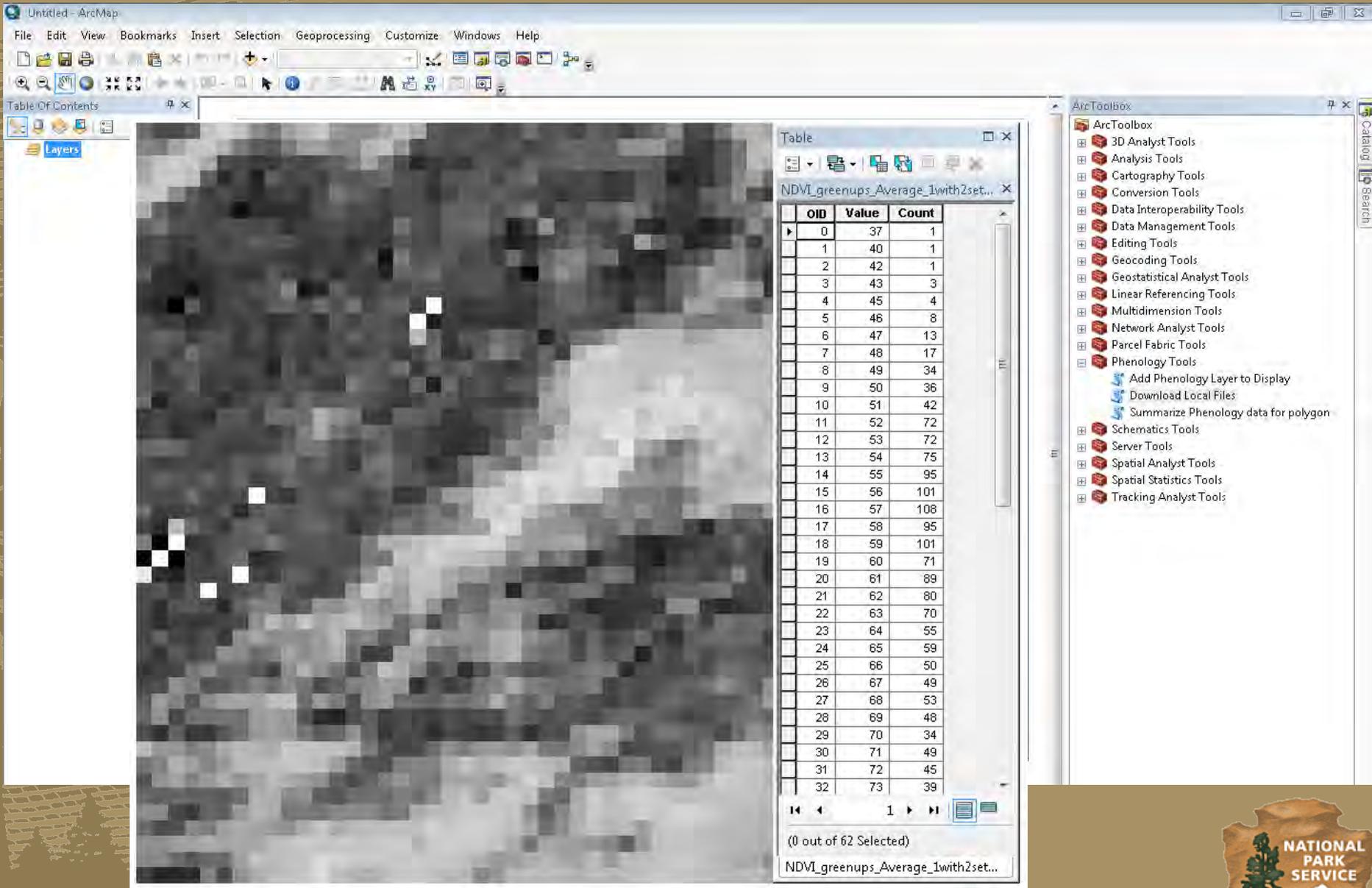
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Untitled - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:5,192,669 CH\_BCR01 500

Editor Alaska Pak Animation

Dr Summarize Phenology data for polygon

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- OzarkHighlands
- peri\_veg
  - VegetationType
  - Bottomland Deciduous Woodland and Fo
  - Developed Land
  - Dry Deciduous Woodland and Forest
  - Eastern Redcedar Woodland and Forest
  - Marsh
  - Mowed Grassland
  - Restored Tallgrass Prairie
  - Ruderal Grassland and Shrubland
  - Silver Maple Forest
  - Typic Upland Deciduous Woodland and F
  - Water

Analysis Polygon(s) file  
peri\_veg

field  
VegetationType

Output folder  
C:\Users\kmjames\Documents\ArcGIS\scratch

R install directory  
C:\Users\kmjames\Documents\R

Vegetation Index  
NDVI

Remove Second Season Pixels

Extract all metrics

**Vegetation Index**

The MODIS (Moderate Resolution Imaging Spectroradiometer) Vegetation Index (VI) used to derive the phenology product. Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) are used. For a NASA write up of NDVI and EVI see <http://earthobservatory.nasa.gov/Features/MeasuringVegetation/>

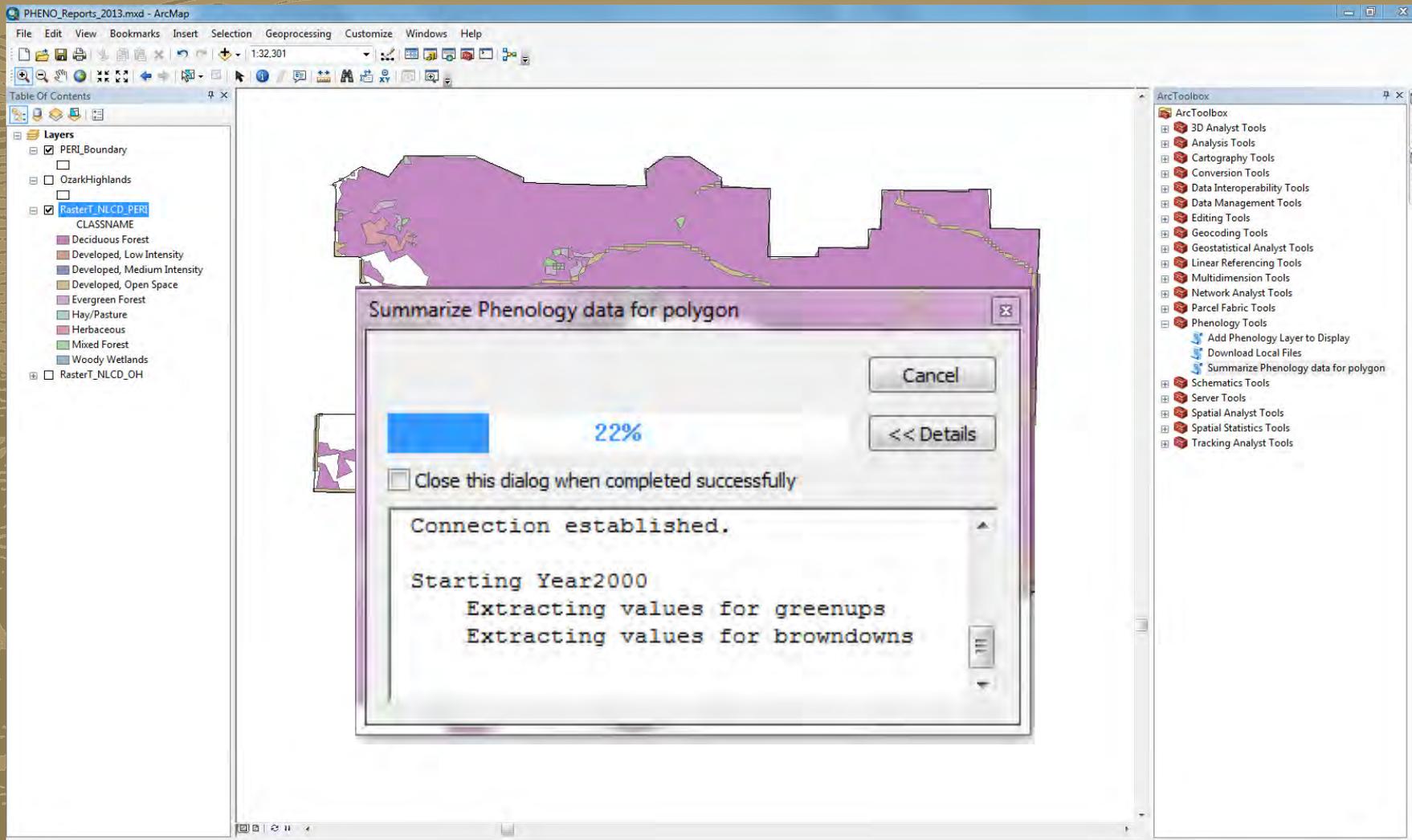
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-82.644 38.496 Decimal Degrees





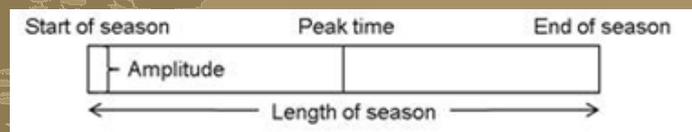
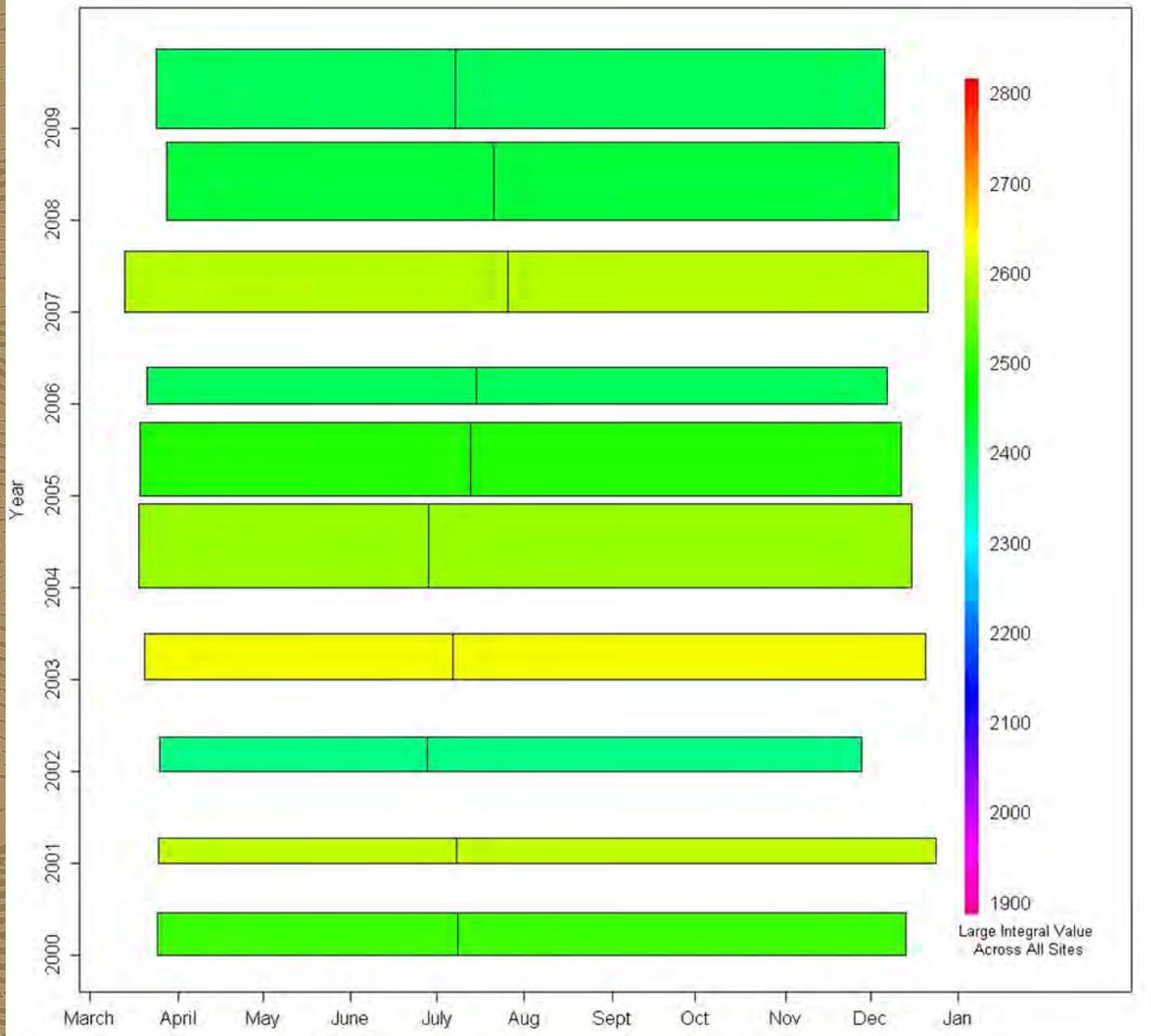
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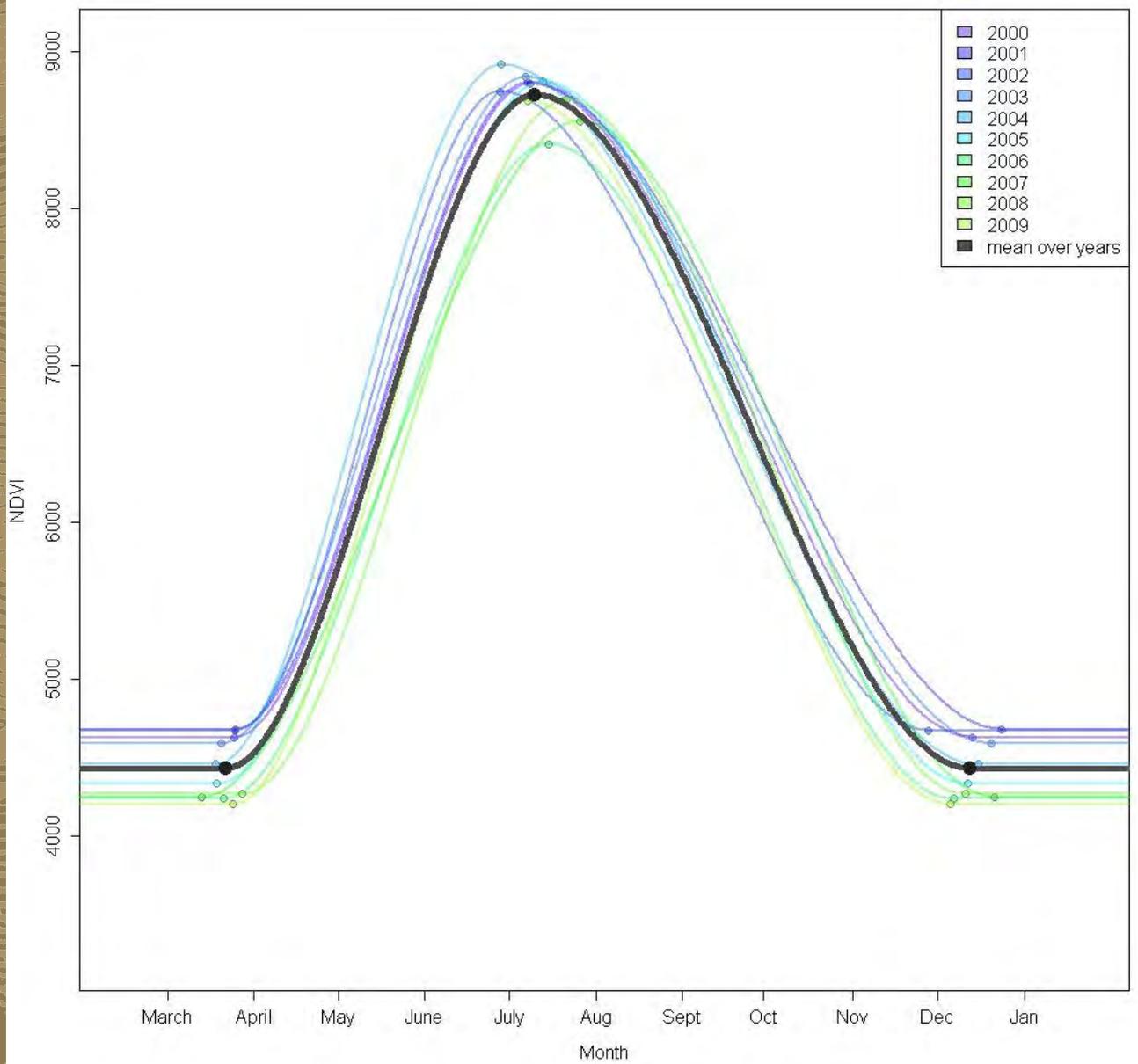
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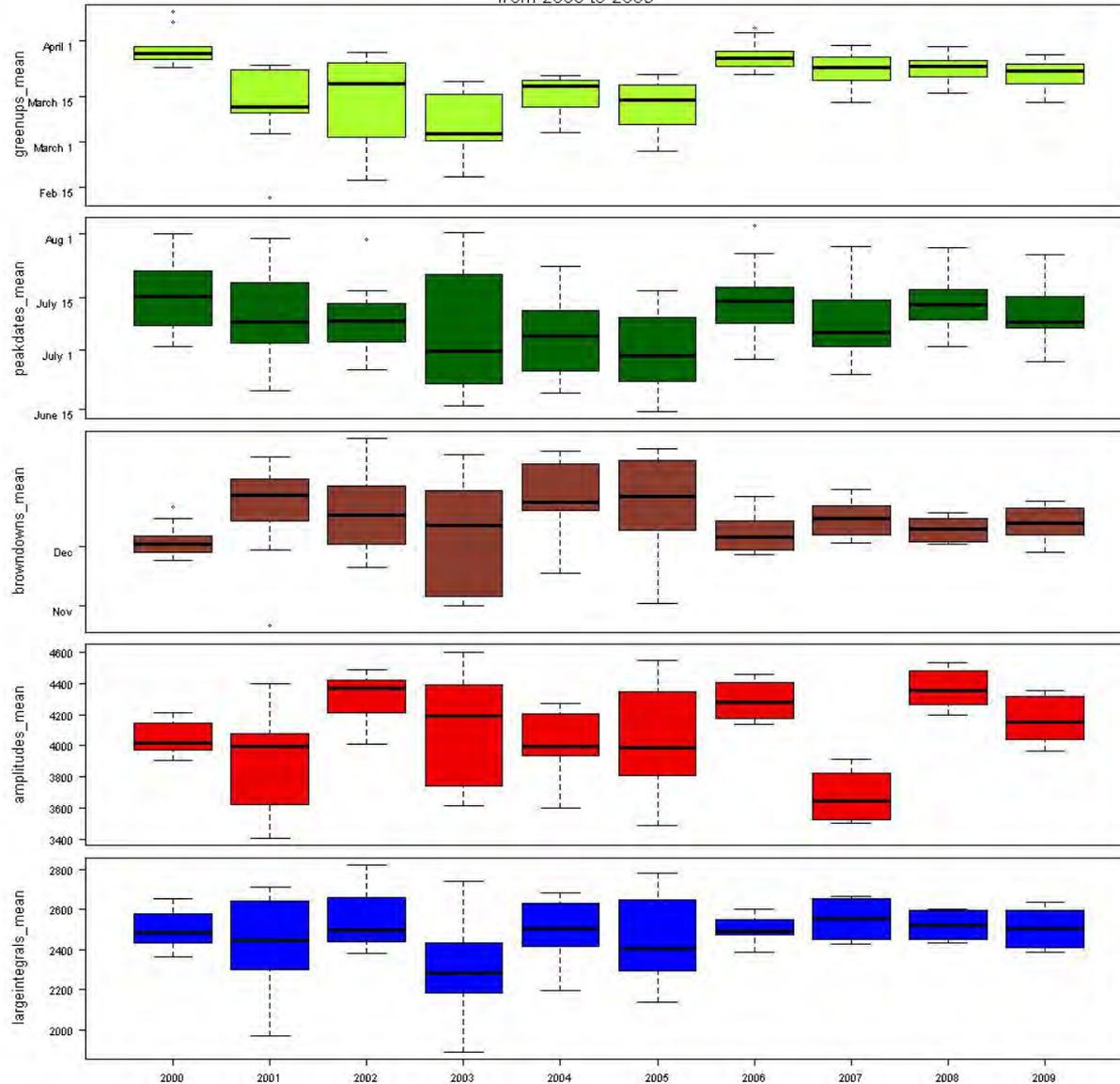
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| RasterTNLCDPERI_Deciduous ForestPlot.jpg                | JPEG image                                  | 94 KB  |
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| RasterTNLCDPERI_Developed, Open SpacePlot.jpg           | JPEG image                                  | 90 KB  |
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| YearBoxplotPlot.jpg                                     | JPEG image                                  | 101 KB |
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| RasterTNLCDPERI_Mixed Forest_PhenoSummaries.csv         | Microsoft Excel Comma Separated Values File | 5 KB   |







Trend in several metrics for all sites  
from 2000 to 2009



| year | greenups_count | greenups_max | greenups_mean | greenups_median | greenups_min | greenups_std |
|------|----------------|--------------|---------------|-----------------|--------------|--------------|
| 2000 | 225            | 111          | 89.52888889   | 94              | 28           | 16.9036567   |
| 2001 | 225            | 100          | 85.85333333   | 87              | 49           | 6.55240753   |
| 2002 | 225            | 95           | 85.47555556   | 86              | 44           | 5.429186784  |
| 2003 | 225            | 93           | 82.66222222   | 85              | 45           | 6.368788089  |
| 2004 | 225            | 93           | 80.90666667   | 85              | 31           | 9.407571419  |
| 2005 | 225            | 94           | 80.29333333   | 83              | 17           | 9.980567786  |
| 2006 | 225            | 93           | 80.31555556   | 82              | 52           | 7.588469486  |
| 2007 | 224            | 102          | 75.73214286   | 80              | 21           | 15.24559781  |
| 2008 | 225            | 101          | 90.05333333   | 93              | 53           | 8.671629348  |
| 2009 | 225            | 95           | 85.04444444   | 87              | 44           | 8.580483166  |
| 2010 | 225            | 94           | 81.24888889   | 82              | 68           | 4.122600162  |



MODIS Phenology ArcMap

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