



# New gridded phenology products to support invasive species management

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# What's Phenology

Phenology refers to recurring plant and animal life cycle stages, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. It is also the study of these seasonal changes, especially their timing and relationships with weather and climate.



## Primary goals

- Advance the science of phenology
- Support the use of phenological information in decision-making

## What We Do

- Make phenology data, models and related information available.
- Encourage people of all ages and backgrounds to observe phenology.

*UNDERSTAND* HOW SPECIES  
AND LANDSCAPES ARE  
RESPONDING TO CLIMATE  
CHANGE.



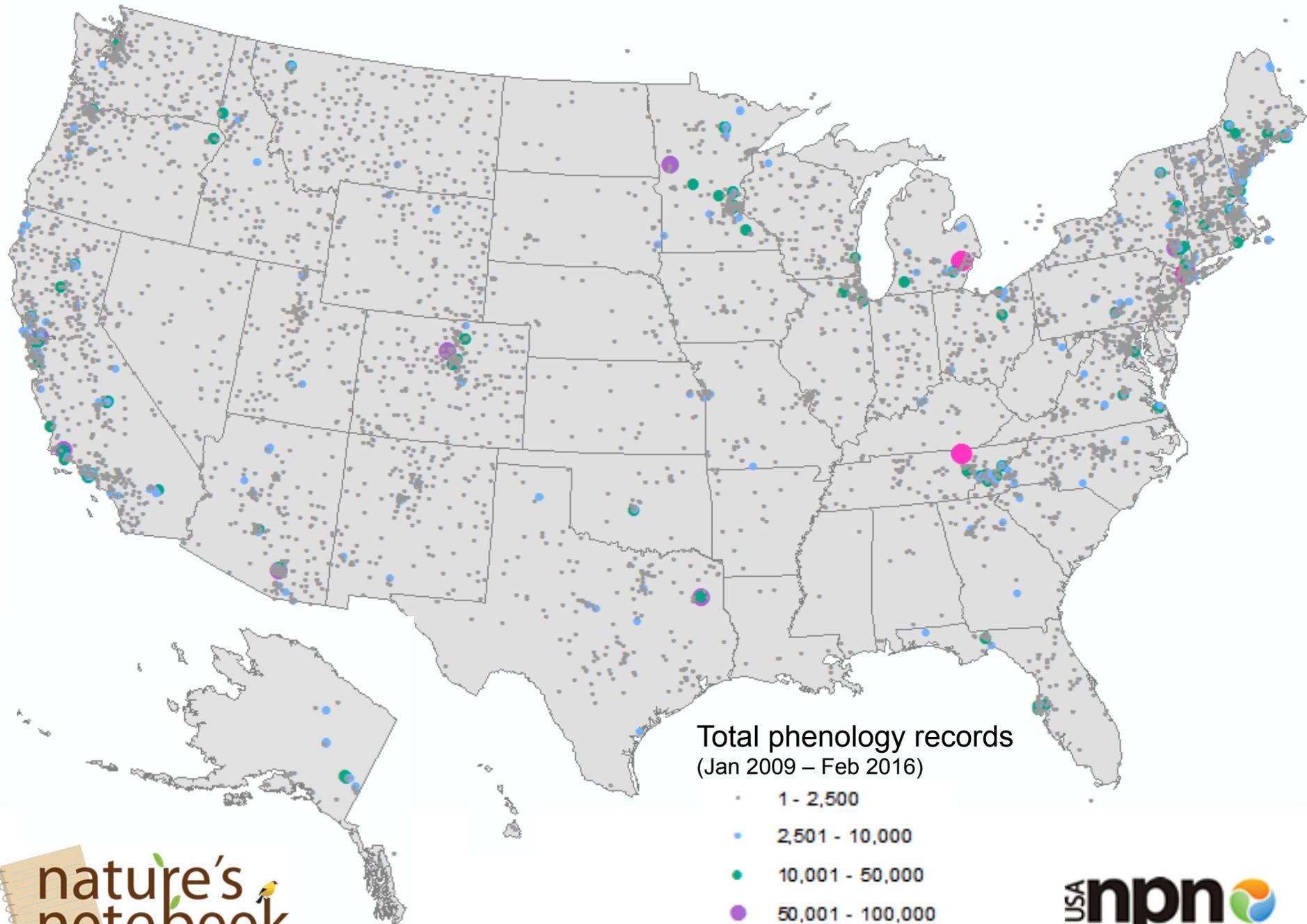
Photo credit: C. Enquist



- Standard protocols
- Web & mobile apps
- Tools for download and visualization, with climate data
- Campaigns
- Quality Assurance/Quality Control
- Published science and management applications published



**TRACKING**  
Seasonal **CHANGES**  
IN PLANTS AND ANIMALS

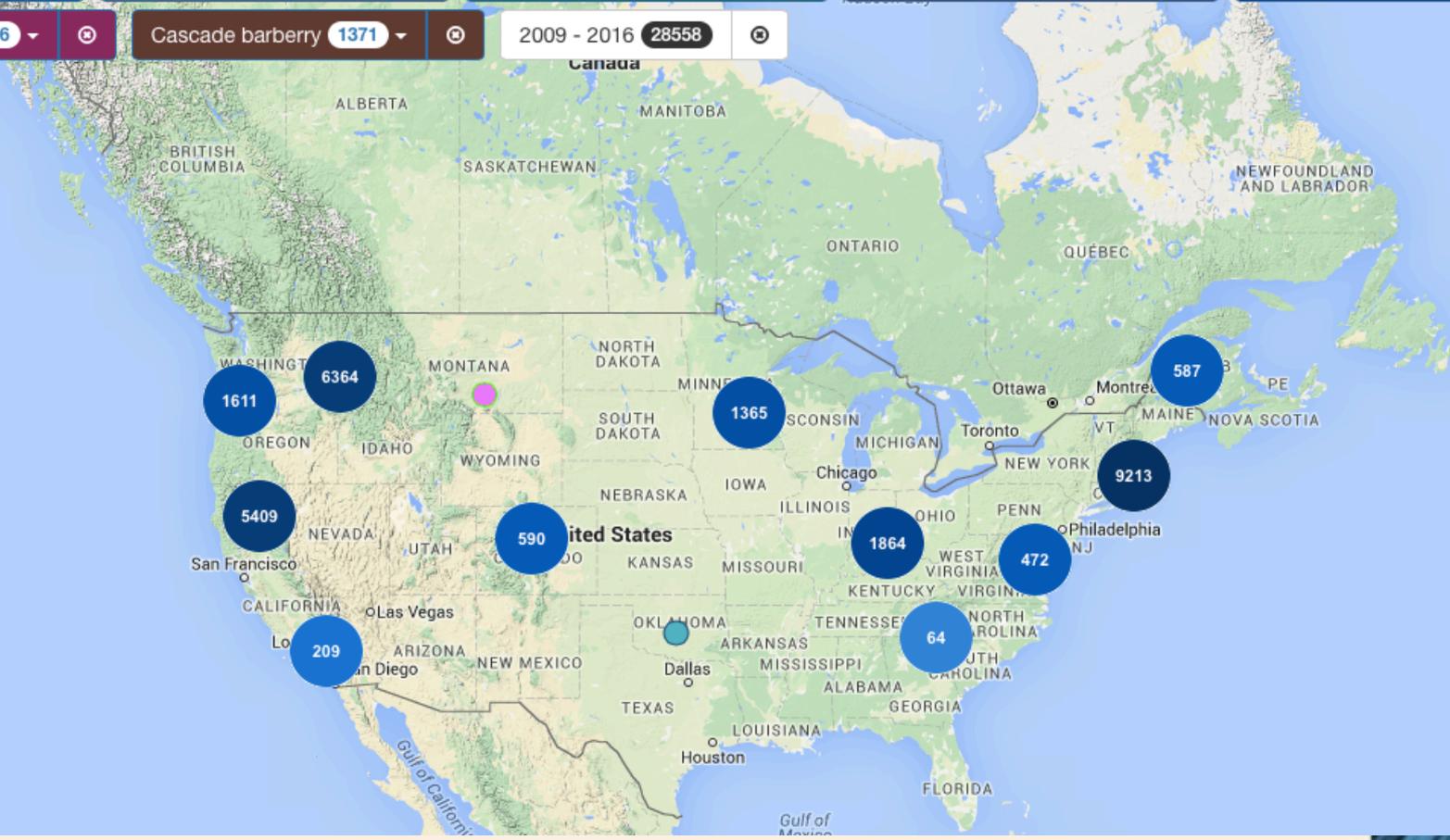


# Invasive Species Data



Black locust 7383   Yellow star-thistle 1785   Spotted knapweed 2310   Japanese knotweed 1358   Rugosa rose 8435

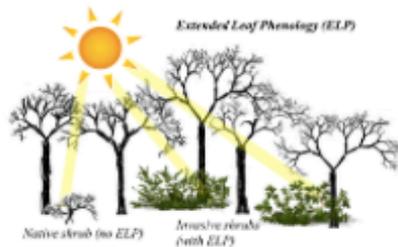
Lodgepole pine 5916   Cascade barberry 1371   2009 - 2016 28558



## Shady Invaders

### PROJECT BACKGROUND

Invasive shrubs are becoming increasingly common in eastern forests. These shrubs are top competitors for native shrubs - they can break bud earlier in the spring and hold onto leaves longer in the fall. This phenomenon is called Extended Leaf Phenology (ELP), and allows these early-leafing invaders to take advantage of the greater amount of light reaching the forest floor in early spring.



ELP of these shrubs can create shading on the forest floor at times when native herbs, tree seedlings, insects, reptiles and more depend on that greater sunlight.

Shady Invaders is a project created by researchers at Penn State University to explore the timing of leaves on invasive and native shrubs. The goal of the project is to start to quantify ELP on a regional scale so that we can understand how or if increased shading is actually impacting deciduous forest ecosystems.

[Learn more about what defines an invasive species](#)

### JOIN US!

We are seeking observers in the eastern U.S. to document changes in the growth of invasive and native shrubs. Each list is ordered with the easiest plants to identify at the top and the most difficult at the bottom. However, not all of these species will be found in every forest.

### SIGN UP FOR CAMPAIGN MESSAGES!

You will receive messages chock-full of findings, observation tips, and campaign-specific opportunities. Don't miss out!

If you can't see the sign-up checkbox and link above, login to [Nature's Notebook](#) or [create an account](#)

### SHADY INVADERS CAMPAIGN KICK-OFF WEBINAR

In this recorded webinar, Erynn Maynard, researcher at Penn State University, explains why your observations of invasive and native shrubs are important, and gives you tips and tricks on identifying these species and their phenophases.  
*Recorded on March 17, 2016*

[Watch the Webinar](#)

**Phenology status data**

**Climate data**

**Meteorological data**

**Phenometrics** → **Pheno-climatic models**

1. Growing Degree Day
2. Spring Indices

**Historical Gridded Maps**

- Annual
- Long-term average

**Current Year Gridded Maps**

- Real time (Jan 1 through a 6 days forecast)
- Anomalies
- Sub-season (1-3 month)

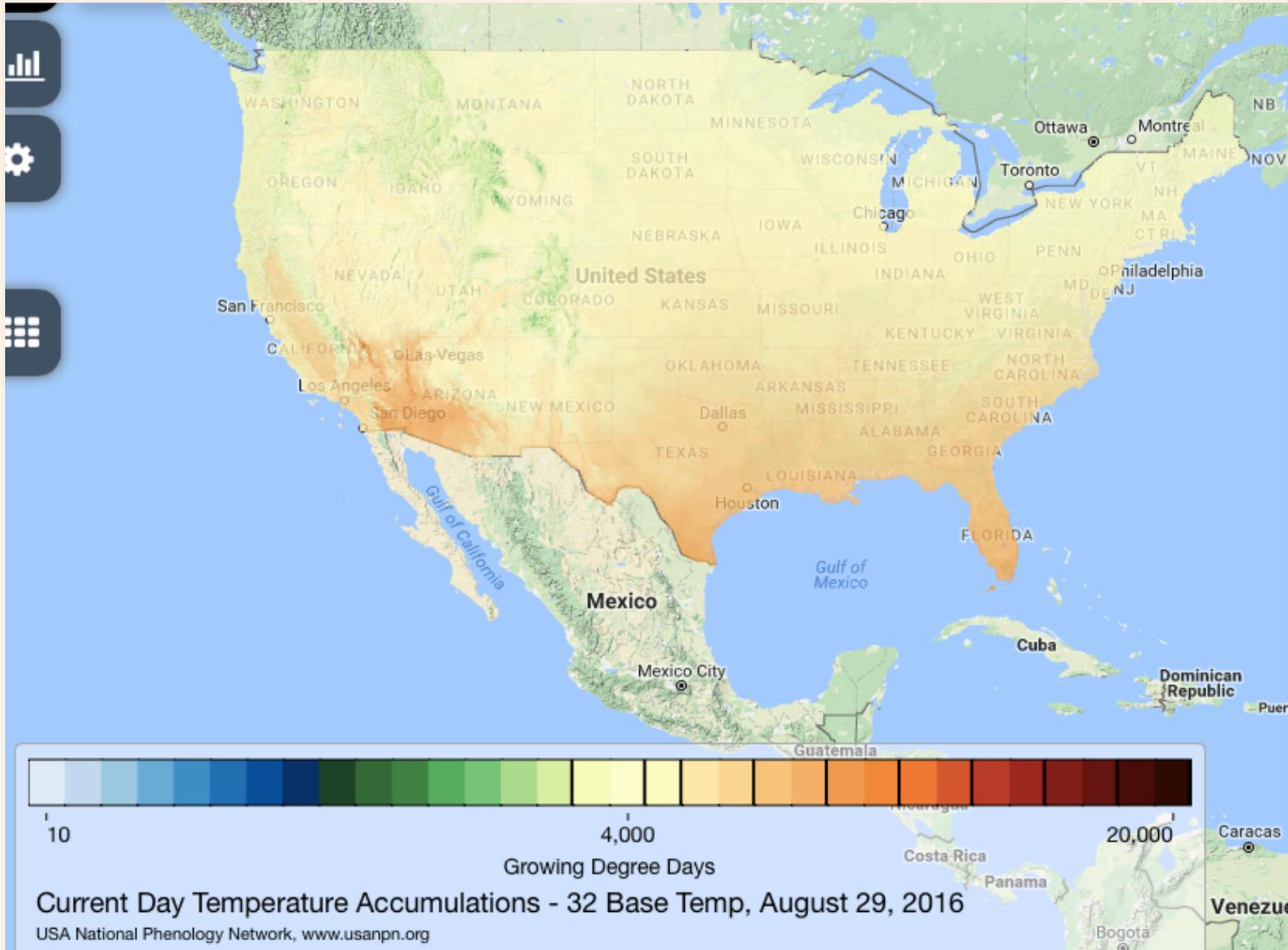
**Projections**

- 10-100 years

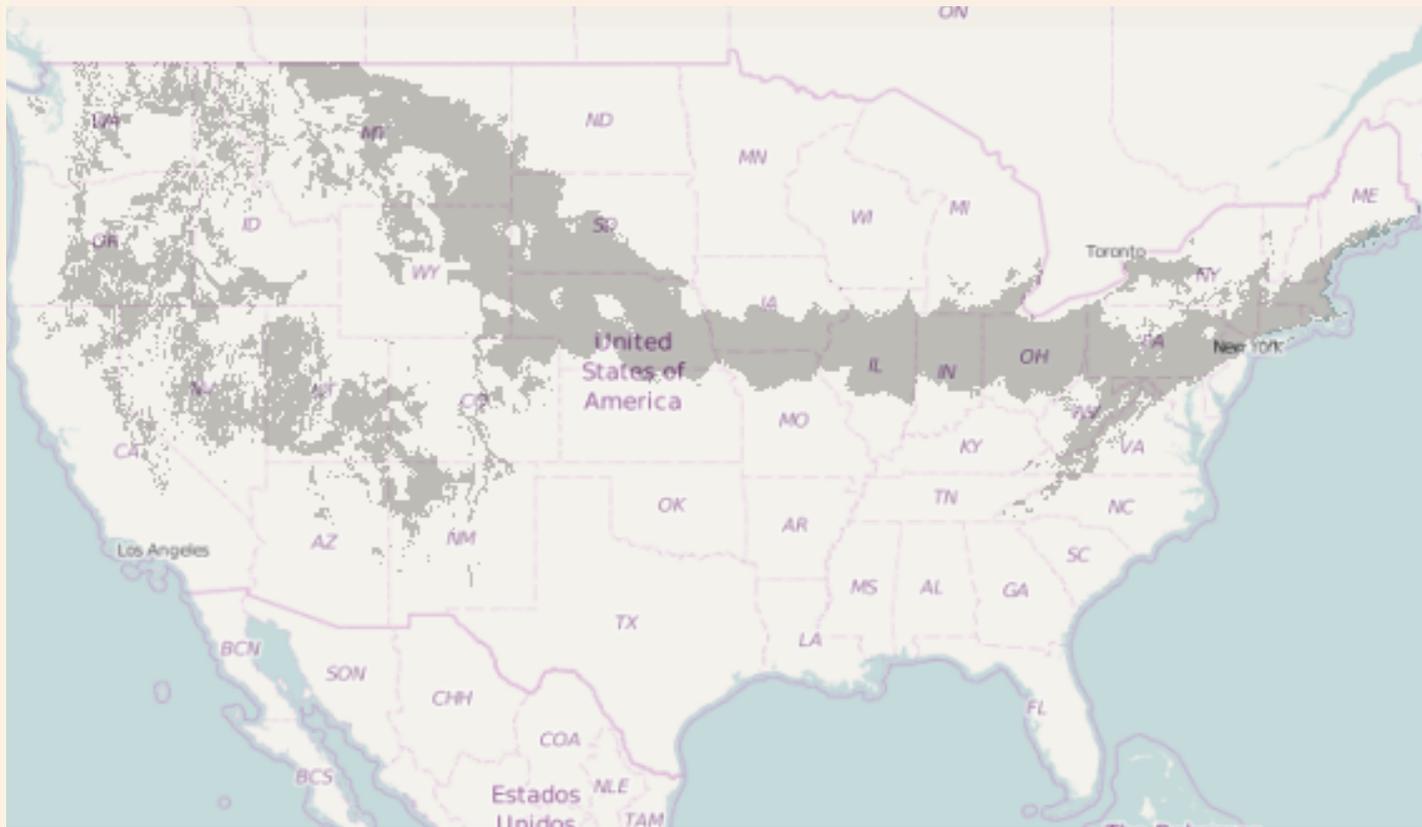
Leverage existing climate data sets to understand phenology, regionally or locally:

- With the **Accumulated Growing Degree Day Model**:
  - When can we expect certain species to undergo life cycle changes?
  - Is this year warming up (is heat accumulating) faster or slower than usual?

# Accumulated Temperature by Day



# Red Sorrel Ramet First Emergence



Map for: 3/1/2016

Scale: 2.5 km

Grey: AGDD greater than 110 & less than 265

Source: NCEP (URMA, RTMA and NDFD)

GDD Model Source: White et al 2015

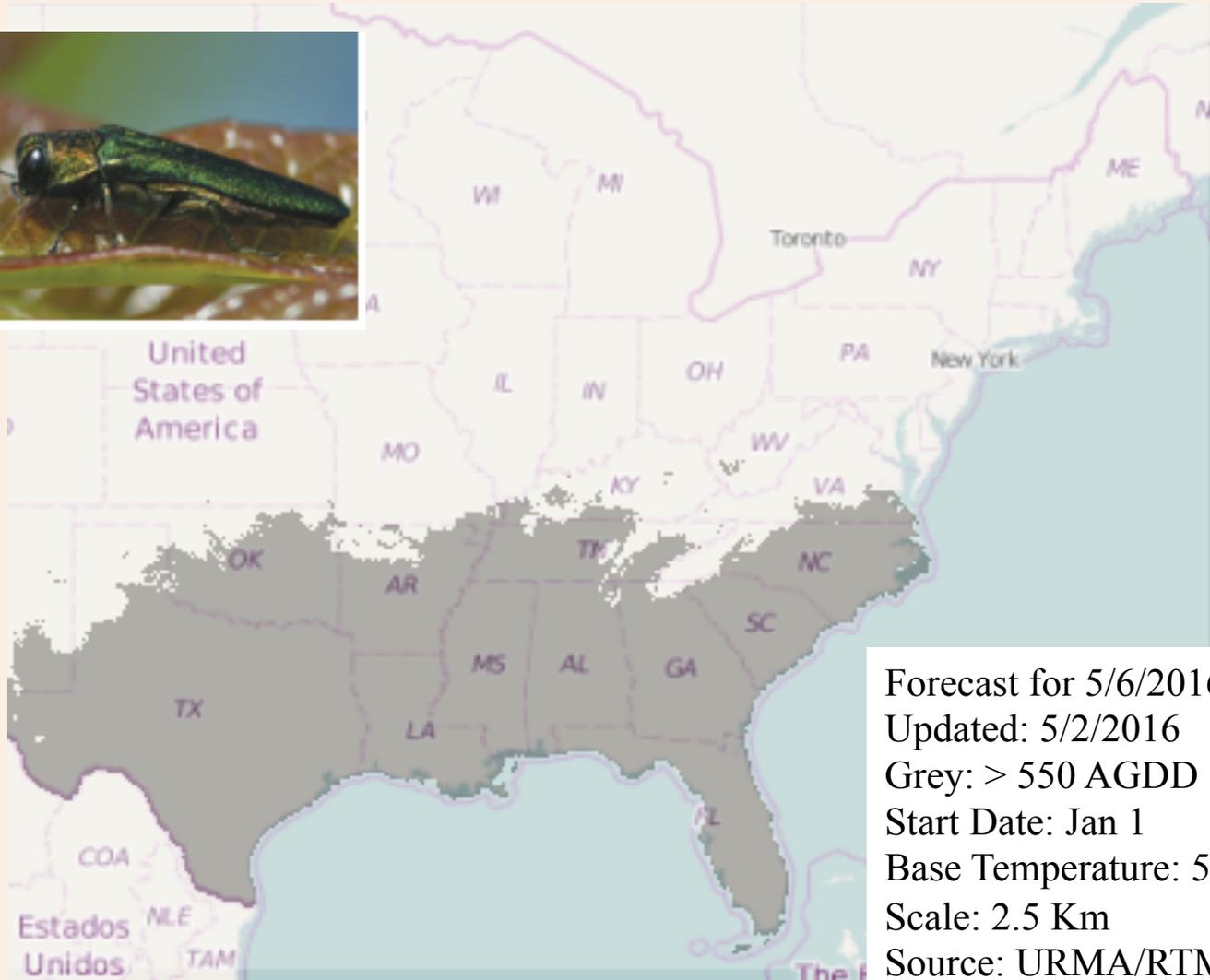
Model developed in Nova Scotia

Red sorrel (*Rumex acetosella*)

Noxious weed

Image: Oregonstate.edu

# Predicted EAB Adult Emergence



Forecast for 5/6/2016

Updated: 5/2/2016

Grey: > 550 AGDD

Start Date: Jan 1

Base Temperature: 50°F

Scale: 2.5 Km

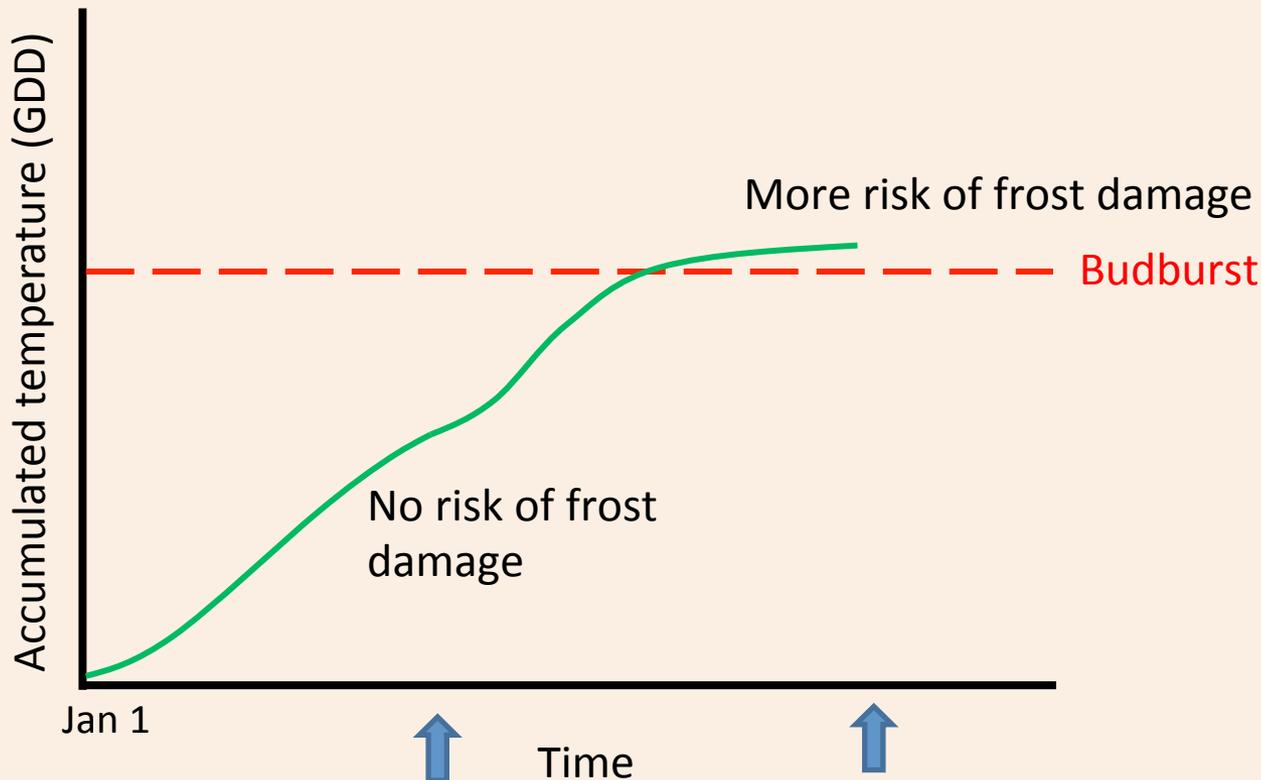
Source: URMA/RTMA/NDFD

GDD Model Source: Duarte 2013 MS Thesis

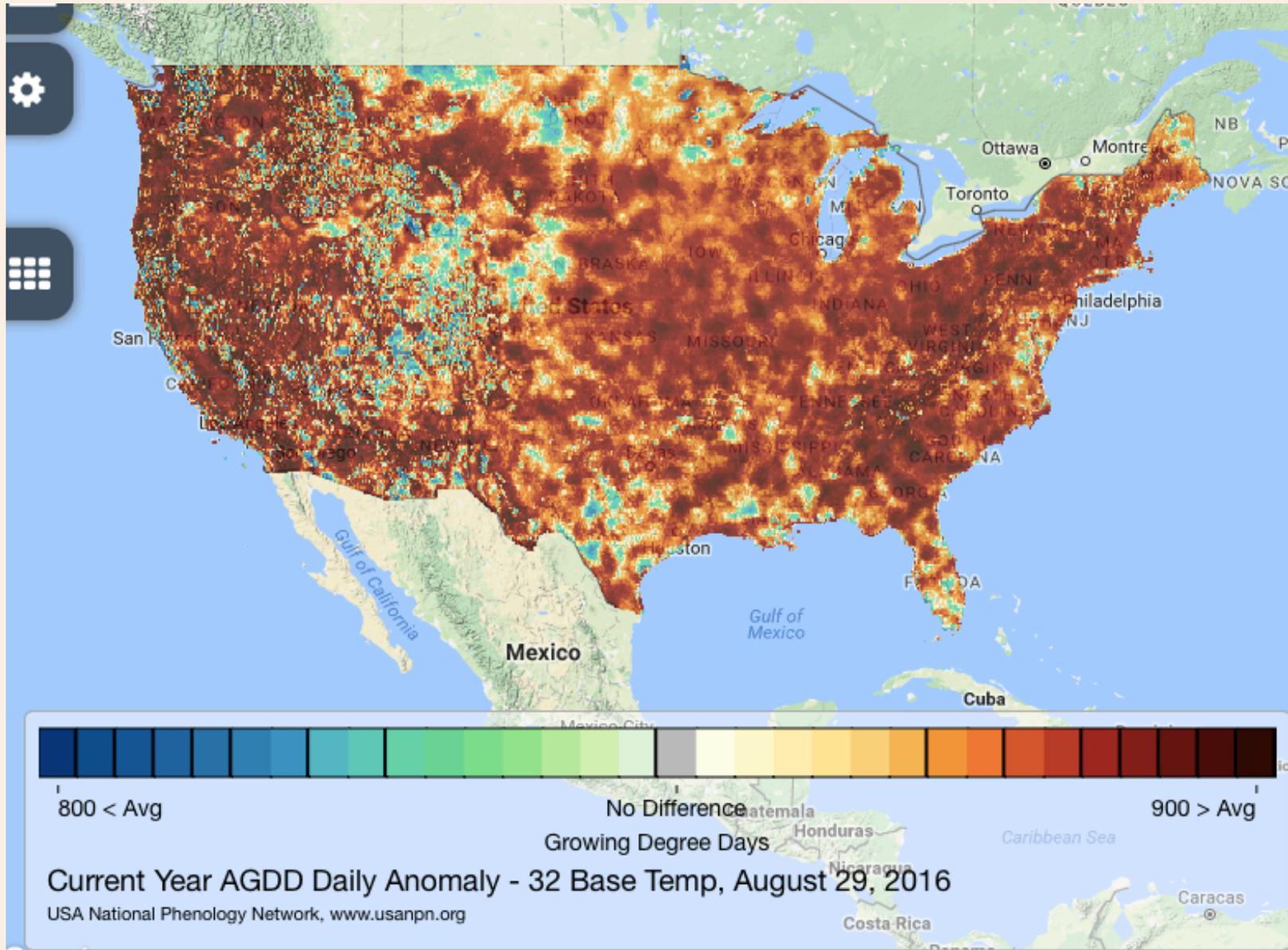
Model developed in Great Lakes

# Protecting Pecan Buds

Nut growers want advance warning of potentially harmful frosts, but only when their trees in vulnerable condition.



# Accumulated Temperature Anomaly

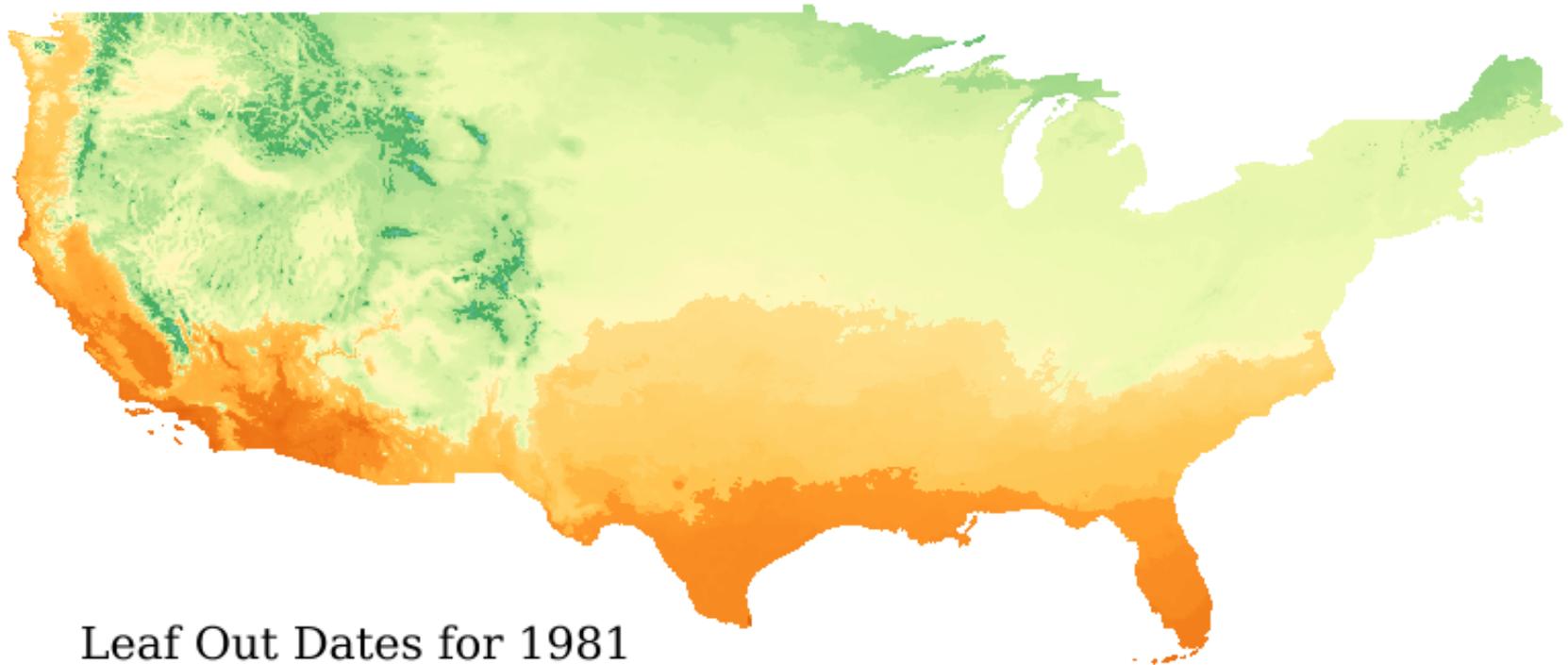


Leverage existing climate data understand phenology, regionally or locally:

The Spring Index is a heat accumulation model based on historic records of lilac and honeysuckle leafing and blooming.



- With a **Spring Index model**:
  - Has the timing of spring been changing?
  - Is the timing of spring getting more variable?
  - Is this spring earlier or later than usual?



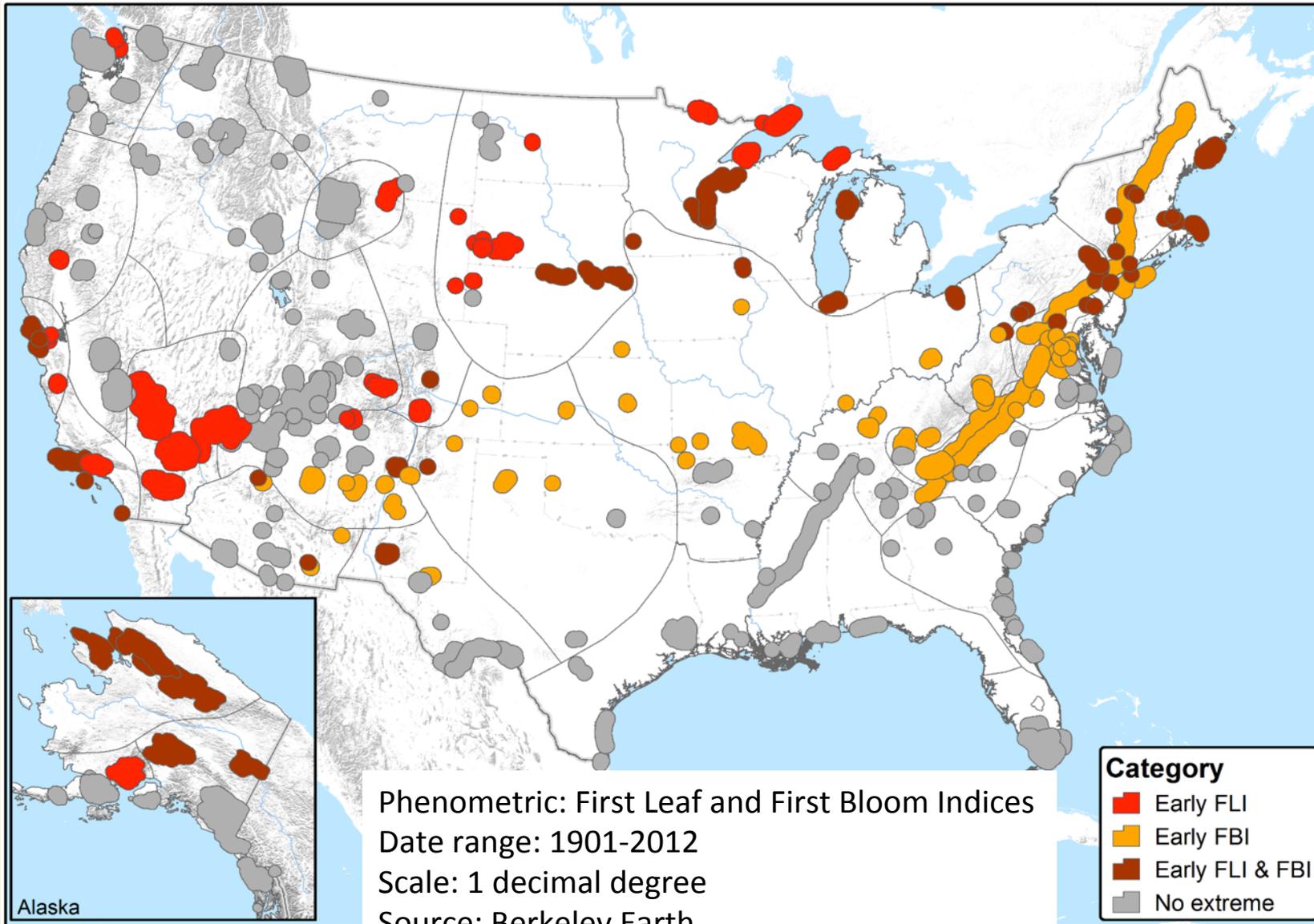
Date range: 1981-2015

Scale: 4 km

Source: PRISM

Jan 1  
Jan 15  
Feb 1  
Feb 15  
Mar 1  
Mar 15  
Apr 1  
Apr 15  
May 1  
May 15  
June 1  
June 15  
July 1  
July 15  
Aug 1  
Aug 15  
Sept 1

# Spring advancing at NPS Units



Phenometric: First Leaf and First Bloom Indices

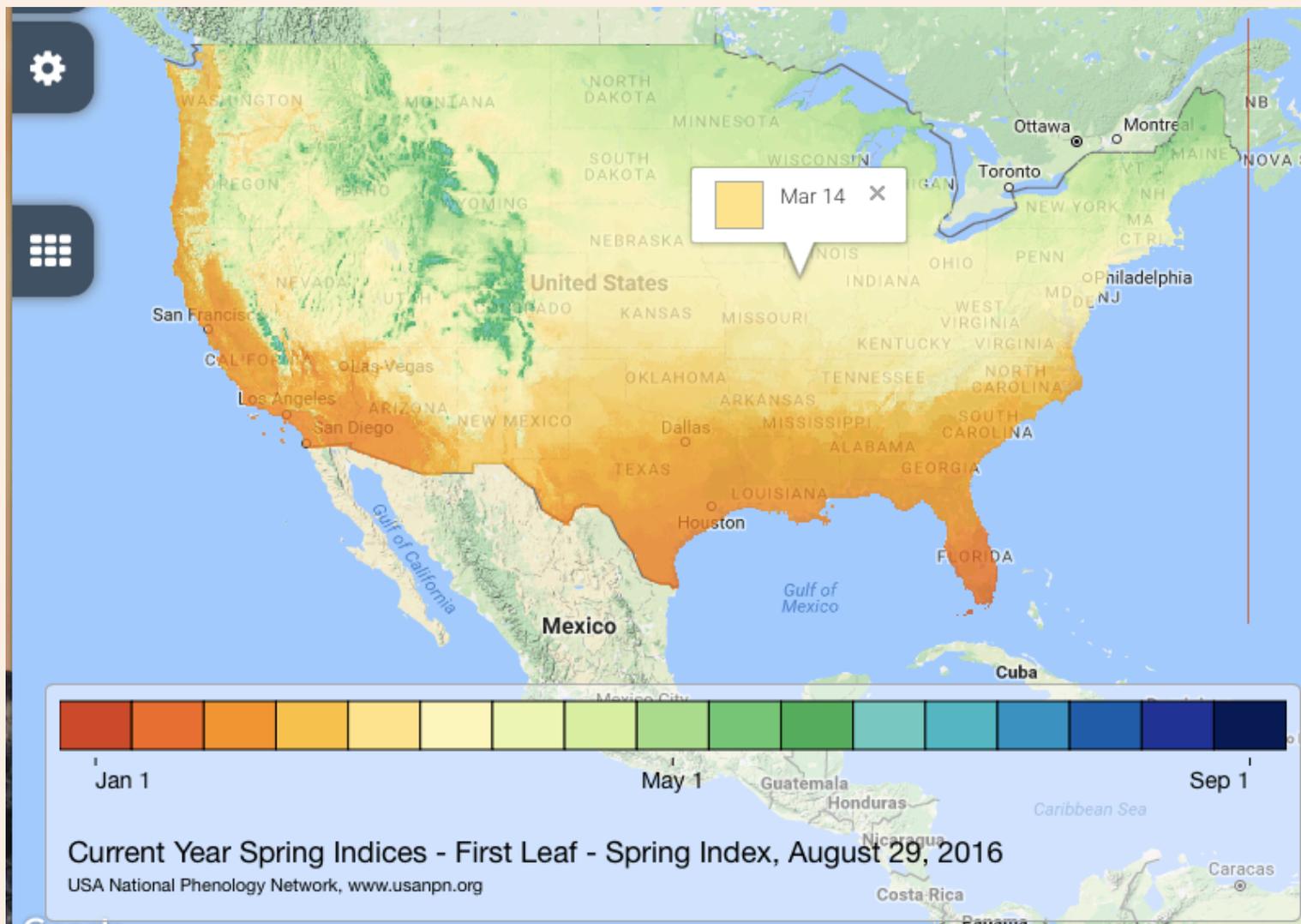
Date range: 1901-2012

Scale: 1 decimal degree

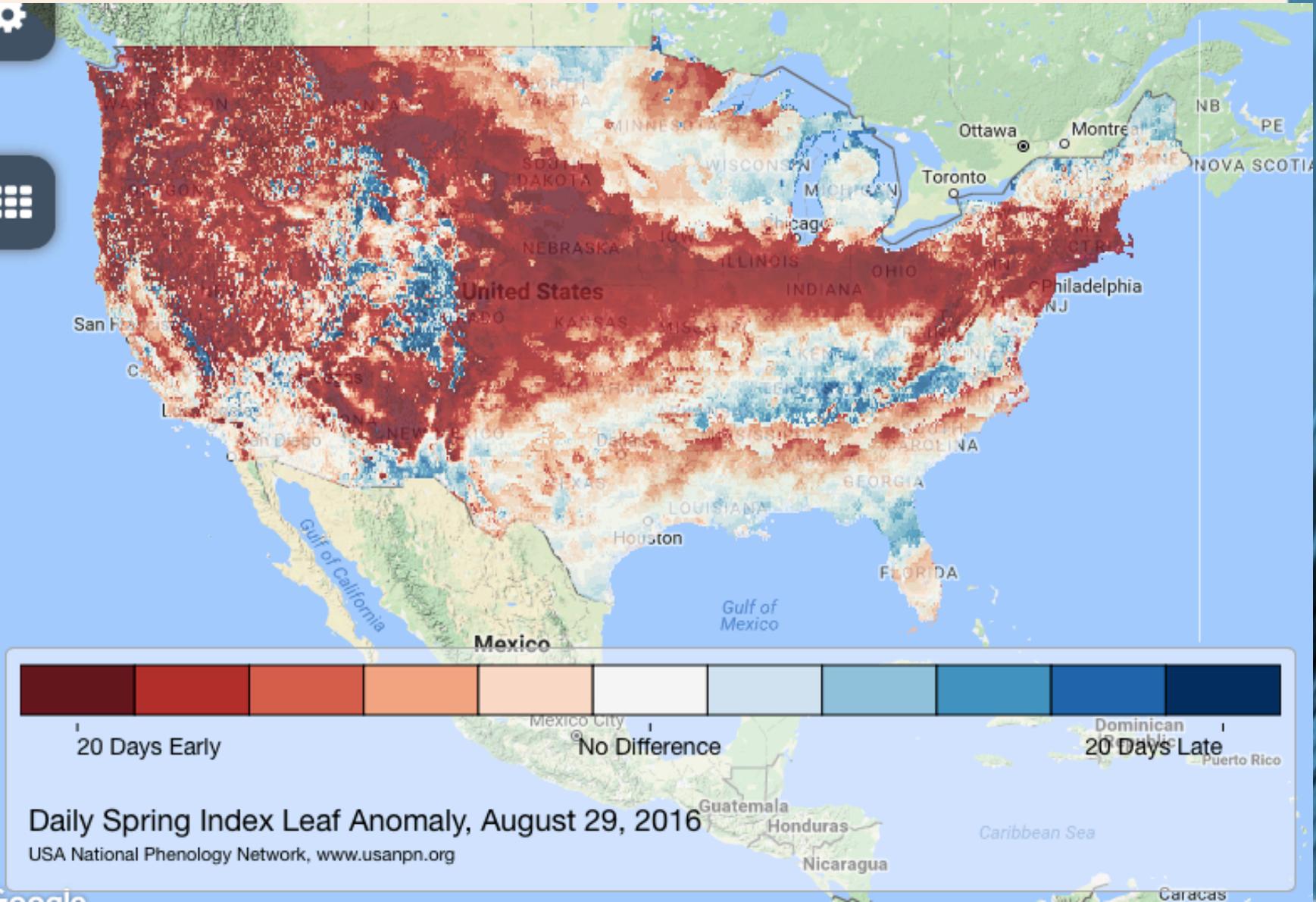
Source: Berkeley Earth

Citation: Monahan et al *in Pres,s*, Ecosphere

# Spring Index - First Leaf 2016



# First Leaf Anomaly 2016



Daily Spring Index Leaf Anomaly, August 29, 2016

USA National Phenology Network, [www.usanpn.org](http://www.usanpn.org)

Both tell you something about how this spring compares to prior springs, trends over time, and what will happen near term.

## Accumulated Heat

Accumulated GDD value for each day of year

Info about spring before thresholds are met.  
If you know the AGDD required for species/phenophase of interest; you can use this as a data source to predict it



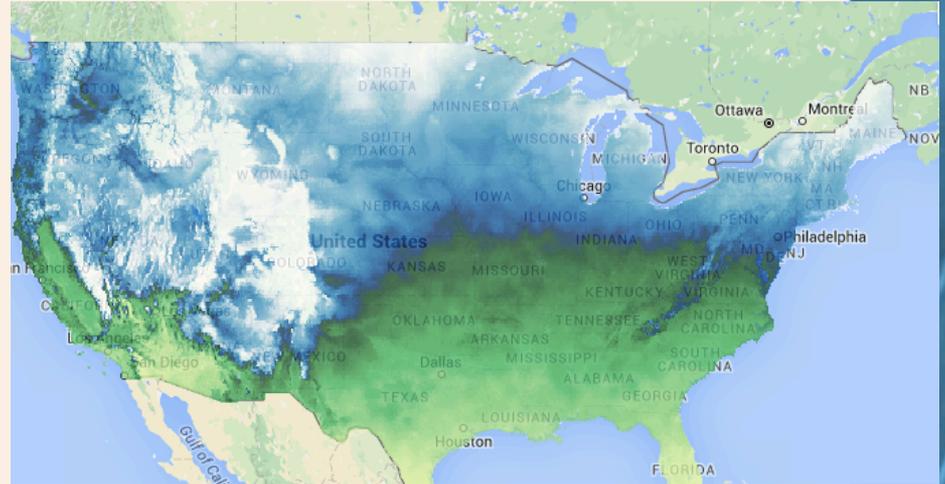
## Spring Indices

Leaf out date each year  
Bloom date each year

Synthesis of biologically relevant climate information  
Facilitates comparisons across years in timing of spring

- USA-NPN Phenology Visualization Tool
  - Historical and Real-time

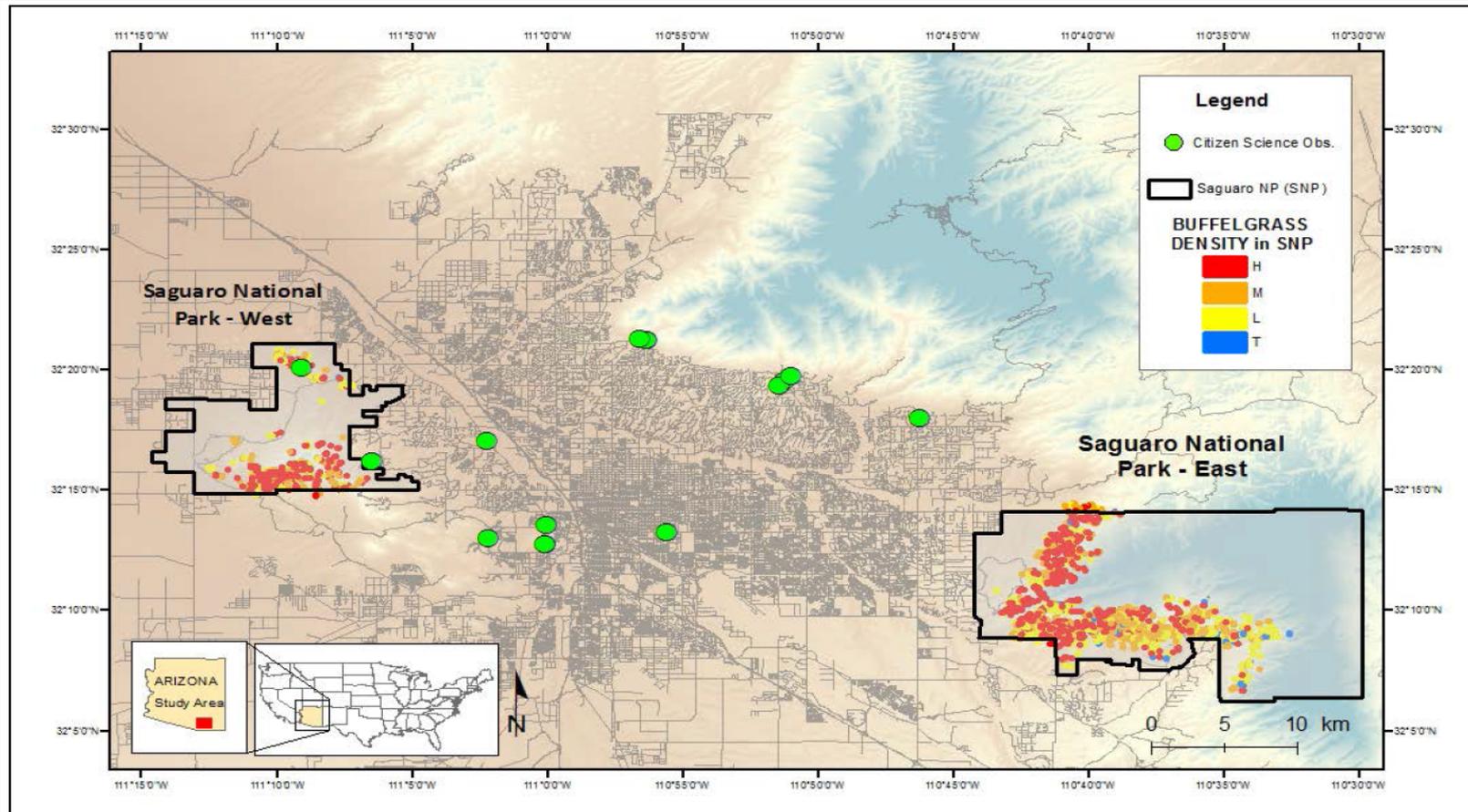
[usanpn.org/data/visualizations](http://usanpn.org/data/visualizations)



- Geoserver
  - Historical, Real-time and 6 day forecast
  - Web Mapping Service
    - Generates images and animations
    - Format examples: PNG, GeoTIFF, OpenLayers, KML.
  - Web Coverage Service
    - Generates files for analysis (with GIS products and R)
    - Format example: GML, XML, GeoTIFF, NetCDF.

[usanpn.org/data/phenology\\_maps](http://usanpn.org/data/phenology_maps)

Chemical control ideal when bufflegress is greened up, but native vegetation is not.



- US Geological Survey
- US Fish and Wildlife Service
- National Park Service
- Cooperative Extension
- US Forest Service



## Connect with USA-NPN...

- Explore gridded products
- Check out phenology data and sign up for researcher newsletter: [www.usanpn.org/data/overview](http://www.usanpn.org/data/overview)
- Partner with us: [www.usanpn.org/partner](http://www.usanpn.org/partner)



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