

From Greek words "phaino" (to show or appear) and "logos" (to study)

- The study of recurring biological events.
- The study of cyclic events of nature in response to seasonal and climatic changes in the environment.
- The sequence of natural events through the season.

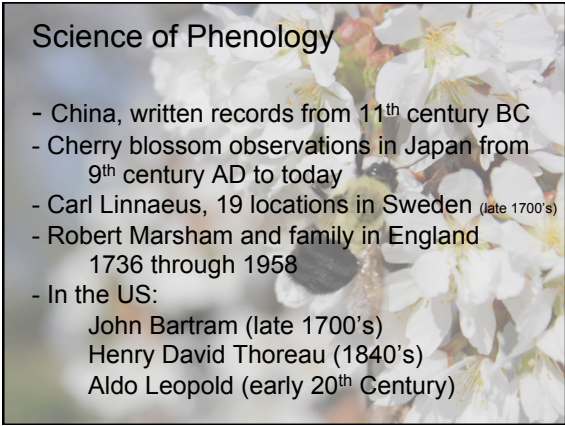
Origins of Phenology

- Observations used by hunter-gatherers
- Important in early agriculture

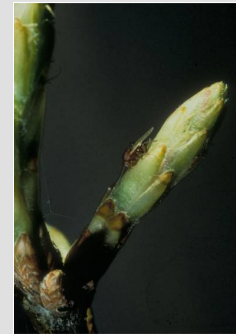


Science of Phenology

- China, written records from 11th century BC
- Cherry blossom observations in Japan from 9th century AD to today
- Carl Linnaeus, 19 locations in Sweden (late 1700's)
- Robert Marsham and family in England 1736 through 1958
- In the US:
 - John Bartram (late 1700's)
 - Henry David Thoreau (1840's)
 - Aldo Leopold (early 20th Century)



Ohio's Phenology Calendar Google: GDD OSU



Key Premise:
Development rate of plants and insects is temperature dependent.

Degree Day Overview



Daily temperature readings can be used to calculate growing degree-days, which is a measure of accumulated heat.

Avg. daily temp – 50F = DD

Degree Day March Example

March 6
High of 60, low of 40

- Base temp is 50
- 60 + 50 = 110
- 110/2 = 55
- 55 - 50 = 5 DD

March 7
High of 70, low of 50

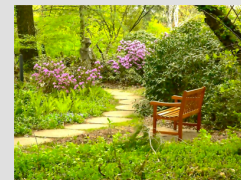
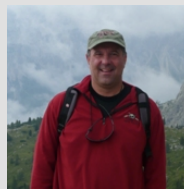
- 70 + 50 = 120
- 120/2 = 60
- 60 - 50 = 10DD

Add yesterday's units, gives us a running total of 15 DD

May Example: 238 GDD

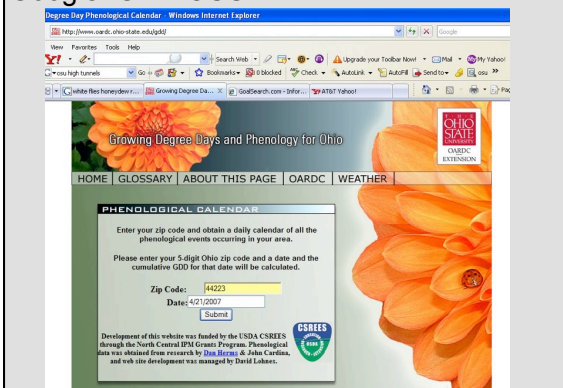
May 6	May 7
High of 80, low of 60	High of 86, low of 60
• 80 + 60 = 140	• 86 + 60 = 146
• 140/2 = 70	• 146/2 = 73
• 70 - 50 = 20 DD	• 73 - 50 = 23DD
238 GDD + 20= 258 GDD	258 GDD + 23= 281

Dr. Dan Herms, Calendar Development



5 Years data collection at Dow Gardens in Michigan and 5 years data collection at Sequest Arboretum, Ohio

Google: GDD OSU



MASSILLON		0	
Silver Maple	first bloom	34	F B F
Cornelancherry	first bloom	40	F B F F
Dogwood	first bloom	40	F B F F
Silver Maple	full bloom	42	F B F F
Red Maple	first bloom	44	F B F F
Speckled Alder	first bloom	52	F B F F
Northern Lights Forsythia	first bloom	58	F
Japanese Pieris	first bloom	60	F F
Red Maple	full bloom	75	F B F F
Star Magnolia	first bloom	83	F B F F
White Pine Weevil	adult emergence	84	F
Border Forsythia	first bloom	86	F B F F
Eastern Tent Caterpillar	egg hatch	92	F B F F
Manchu Cherry	first bloom	93	F F
Northern Lights Forsythia	full bloom	94	F F
Speckled Alder	full bloom	97	F F
Cornelancherry	full bloom	98	F B F F
Dogwood	full bloom	98	F B F F
Norway Maple	first bloom	116	F F
Border Forsythia	full bloom	116	F B F F
Chanticleer Callery Pear	first bloom	123	F B F F
Sargent Cherry	first bloom	127	F F
Larch Casebearer	egg hatch	128	F F
Japanese Pieris	full bloom	129	F F

Species	Event	Growing Degree Days	Link
Red Horsechestnut	full bloom	440	F B F F
Boxwood Leafminer	adult emergence	440	F
Doublefile Viburnum	full bloom	444	F F
Bush Cinquefoil	first bloom	444	F F
Snowmound Nippon Spiraea	first bloom	445	F F
Red Prince Weigela	first bloom	446	F B F F
Pink Princess Weigela	full bloom	446	F
Redosier Dogwood	full bloom	448	F
Scarlet Firethorn	first bloom	459	F F
MASSILLON		467	
Black Locust	first bloom	467	F B F F
Ohio Pioneer Thicket Hawthorn	full bloom	470	F
Red Buckeye	full bloom	471	F B F F
Common Ninebark	first bloom	478	F F
Pagoda Dogwood	full bloom	479	F
Umbrella Magnolia	full bloom	480	F
Sweet Mockorange	first bloom	482	F B F F
Oystershell Scale	egg hatch	497	F B F F
Miss Kim Manchurian Lilac	full bloom	498	F B F F
Smokebush	first bloom	501	F B F F
Calawba	full bloom	503	F B F F

Species	Event	Growing Degree Days
Two-spotted Spider Mite	egg hatch	627
Bagworm	egg hatch	630
Washington Hawthorn	first bloom	635
American Holly	full bloom	642
Multiflora Rose	full bloom	643
Northern Catalpa	first bloom	675
GLENDALE		702
American Elder	first bloom	707
Sweet Mockorange	full bloom	717
Red Prince Weigela	full bloom	727
Fuzzy Deutzia	first bloom	727
Fletcher Scale	egg hatch - 1st generation	730
Washington Hawthorn	full bloom	731
Calico Scale	egg hatch	748
European Fruit Lecanium Scale	egg hatch	767
Greater Peach Tree Borer	adult emergence	775
Striped Pine Scale	egg hatch	783
Winterberry Holly	first bloom	794
Japanese Tree Lilac	full bloom	808
Rhododendron Borer	adult emergence	815
Northern Catalpa	full bloom	816

March 19, 2012

Species	Event	Growing Degree Days	Link
Silver Maple	first bloom	34	F P P
Corneliancherry Dogwood	first bloom	40	F P P P
Silver Maple	full bloom	42	F P P
Red Maple	first bloom	44	F P P P
Speckled Alder	first bloom	52	F P
Northern Lights Forsythia	first bloom	58	F
Japanese Pieris	first bloom	60	F P
FAIRPORT HARBOR			68
Red Maple	full bloom	75	F P P
Star Magnolia	first bloom	83	F P P P
White Pine Weevil	adult emergence	84	F
Border Forsythia	first bloom	86	F P P P
Eastern Tent Caterpillar	egg hatch	92	F P P P
Manchu Cherry	first bloom	93	F P

March 19, 2011

Summary of Phenological Events

Species	Phenological Event	GDD	Link
FAIRPORT HARBOR		20	
Silver Maple	first bloom	34	F P P
Corneliancherry Dogwood	first bloom	40	F P P P
Silver Maple	full bloom	42	F P P
Red Maple	first bloom	44	F P P P
Speckled Alder	first bloom	52	F P
Northern Lights Forsythia	first bloom	58	F
Japanese Pieris	first bloom	60	F P
Red Maple	full bloom	75	F P P
Star Magnolia	first bloom	83	F P P P
White Pine Weevil	adult emergence	84	F
Border Forsythia	first bloom	86	F P P P
Eastern Tent Caterpillar	egg hatch	92	F P P P

Red maple, *Acer rubrum*



March 19, 2012

Species	Event	Growing Degree Days	Link
Silver Maple	first bloom	34	F P P
Corneliancherry Dogwood	first bloom	40	F P P P
Silver Maple	full bloom	42	F P P
Red Maple	first bloom	44	F P P P
Speckled Alder	first bloom	52	F P
Northern Lights Forsythia	first bloom	58	F
Japanese Pieris	first bloom	60	F P
FAIRPORT HARBOR			68
Red Maple	full bloom	75	F P P
Star Magnolia	first bloom	83	F P P P
White Pine Weevil	adult emergence	84	F
Border Forsythia	first bloom	86	F P P P
Eastern Tent Caterpillar	egg hatch	92	F P P P
Manchu Cherry	first bloom	93	F P

April 25, 2011

Species	Phenological Event	GDD	Link
Silver Maple	first bloom	34	F P P
Corneliancherry Dogwood	first bloom	40	F P P P
Silver Maple	full bloom	42	F P P
Red Maple	first bloom	44	F P P P
Speckled Alder	first bloom	52	F P
Northern Lights Forsythia	first bloom	58	F
Japanese Pieris	first bloom	60	F P
FAIRPORT HARBOR			71
Red Maple	full bloom	75	F P P
Star Magnolia	first bloom	83	F P P P
White Pine Weevil	adult emergence	84	F
Border Forsythia	first bloom	86	F P P P
Eastern Tent Caterpillar	egg hatch	92	F P P P
Manchu Cherry	first bloom	93	F P

March 20, 2015

Growing Degree Days and Phenology for Ohio

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The GDD of FAIRPORT HARBOR on 3/20/2015 is 9

Summary of Phenological Events

Species	Phenological Event	GDD	Link
FAIRPORT HARBOR		9	
Silver Maple	first bloom	34	M
Corneliancherry Dogwood	first bloom	40	M
Silver Maple	full bloom	42	M
Red Maple	first bloom	44	M
Speckled Alder	first bloom	52	M
Northern Lights Forsythia	first bloom	58	M
Japanese Pieris	first bloom	60	M
Red Maple	full bloom	75	M



Since plant development is temperature-dependent, phenological events of plants can also be used to track degree-days...



...and create a **biological calendar** to predict pest activity and schedule pest management appointments.



Donald Wyman Crabapple	first bloom	197
Snowdrift Crabapple	first bloom	198
Compact Garland Spirea	full bloom	205
Koreanspice Viburnum	full bloom	205
Azalea Lace Bug	egg hatch	206
Spring Snow Crabapple	full bloom	209
Viburnum Leaf Beetle	first egg hatch	210

Key Phenological Events



First bloom: date first flower on the plant opens to reveal pistils and/or stamens.



Full bloom: date 95% of flowers have opened (1 out of 20 buds remains closed).

Red maple, *Acer rubrum*



Corneliancherry dogwood, *Cornus mas*



Star Magnolia, *Magnolia stellata*



Border Forsythia, *Forsythia x intermedia*



Eastern tent caterpillar egg hatch



Saucer Magnolia, *Magnolia soulangiana*



Bradford Callery Pear, *Pyrus calleryana* 'Bradford'



European pine sawfly egg hatch



Serviceberry, *Amelanchier* spp.

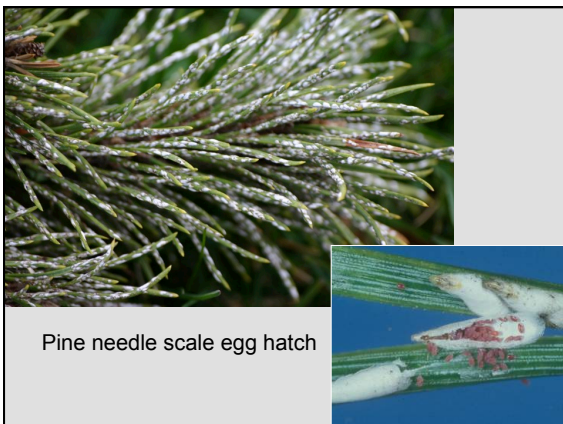
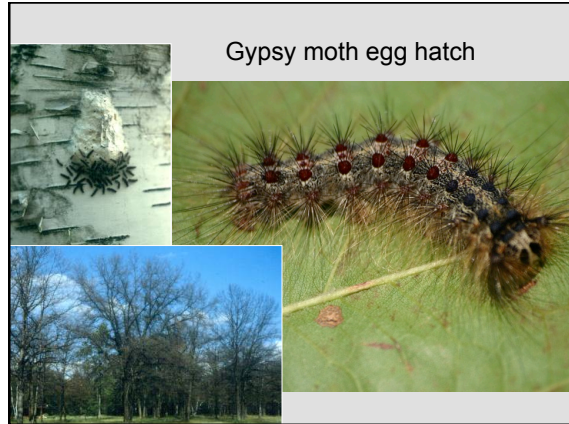


PJM Rhododendron, *Rhododendron* x 'PJM'



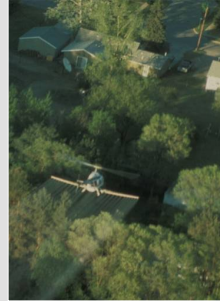
Spruce spider mite egg hatch



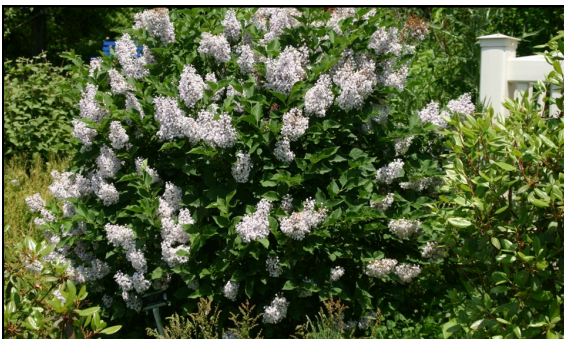




Black cherry, *Prunus serotina*



Optimal timing for aerial Bt applications for gypsy moth



Miss Kim Lilac
Syringa patula 'Miss Kim'



Oystershell scale egg hatch

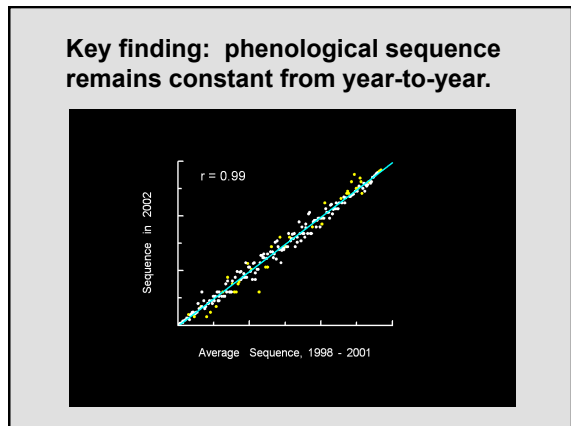
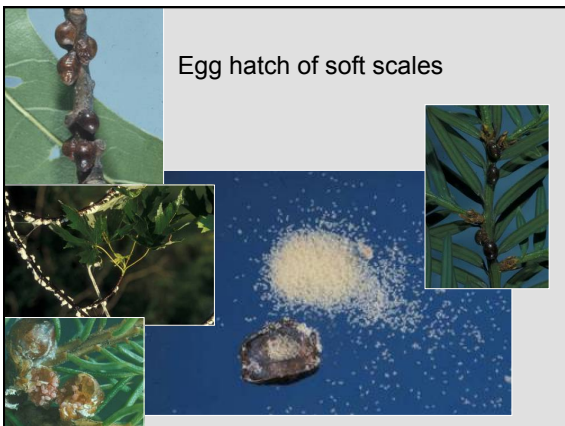


Black locust, *Robinia pseudoacacia*



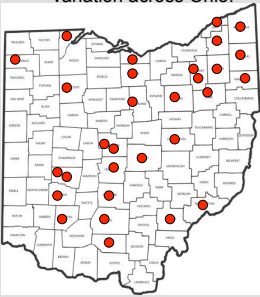
Adult emergence: bronze birch borer, emerald ash borer







OSU Phenology Garden Network

A state-wide network of identical gardens to quantify geographic patterns of phenological and climatic variation across Ohio.




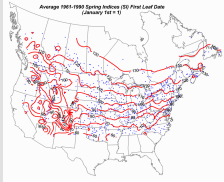




Coordinators: Dr. Dan Herms, Denise Ellsworth

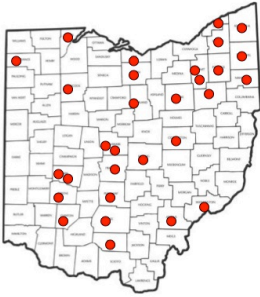
NPN: Lilac Observations

Syringa chinensis 'Red Rothomagensis'

Phenology Garden Network

A state-wide network of identical gardens across Ohio, now studying native plants and pollinators.



<i>Agastache scrophulariifolia</i>	Blue Giant Hyssop
<i> Dalea candida</i>	White Prairie Clover
<i>Eryngium yuccifolium</i>	Rattlesnake Master
<i>Eupatorium perfoliatum</i>	Common Boneset
<i>Eutrochium purpureum</i>	Sweetscented Joe Pye Weed
<i> Monarda fistulosa</i>	Wild Bergamot
<i> Pycnanthemum muticum</i>	Clustered Mountainmint
<i>Ratibida pinnata</i>	Primate Prairie Coneflower
<i> Verbena hastata</i>	Swamp Verbena
<i> Veronicastrum virginicum</i>	Calver's Root
<i> Zizia aurea</i>	Golden Zizia

Coordinators: Dr. Dan Herms, Denise Ellsworth

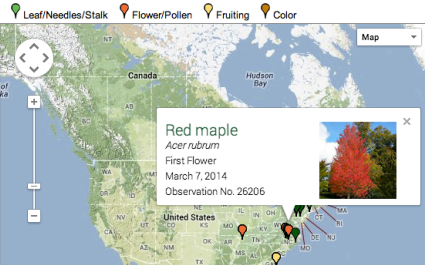



Google: Project BudBurst

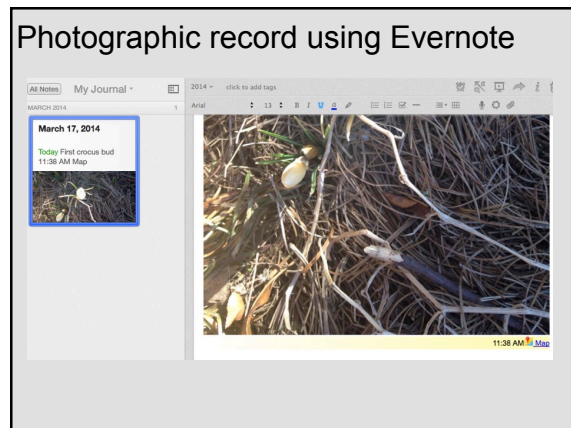
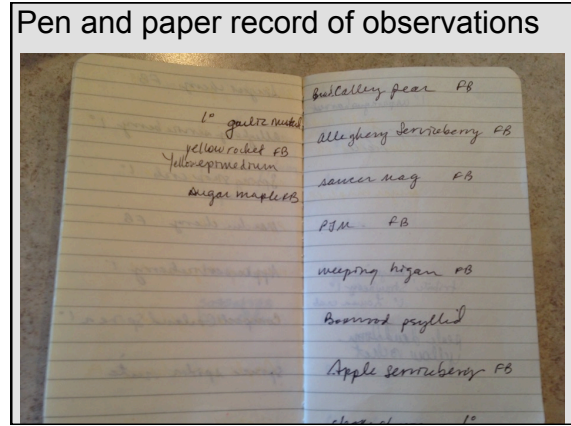
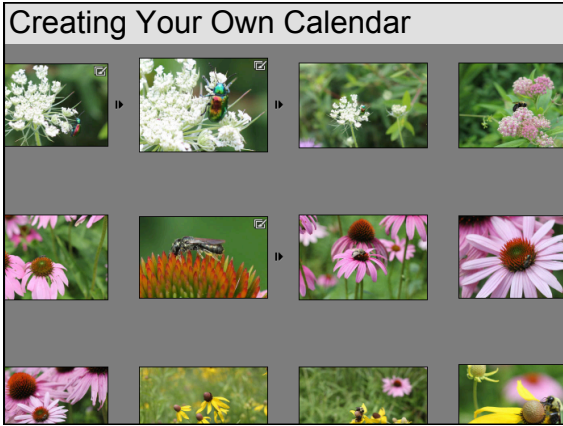
2014 Live Map for Red maple:

Below you can view all observations that have been reported in 2014 for Red maple (if the map below is empty then there have not been any 2014 observations reported.)

Use the navigation buttons on the left to zoom in/out and pan around. Click on each place marker to get detail information about that observation.



Project BudBurst



Reconstructing a record from photos

Japanese Beetle	adult emergence	970	M
Rosebay Rhododendron	first bloom	1,010	
Greenspire Littleleaf Linden	full bloom	1,047	M
Southern Catalpa	full bloom	1,073	M
Species	Event	Growing Degree Days	Link
Wooster		1,089	
June Bride Littleleaf Linden	full bloom	1,115	M
Bottlebrush Buckeye	first bloom	1,158	M
Ural Falsespirea	first bloom	1,170	M
Panicled Goldenraintree	full bloom	1,251	M
Rose-of-Sharon	first bloom	1,347	M
Pine Needle Scale	egg hatch - 2nd generation	1,349	M
Mimosa Webworm	egg hatch - 2nd generation	1,920	M

6/16/2013, Wooster OH. *Stewartia*

