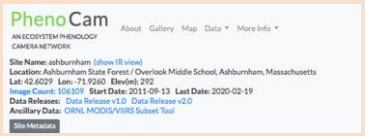
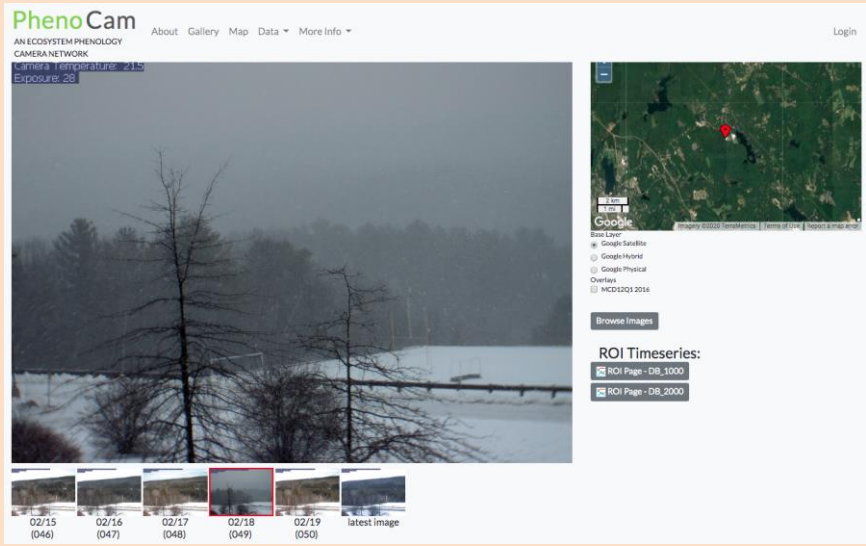
Lessons from the PhenoCam





Katherine Bennett

JR Briggs Elementary School

Ashburnham- Westminster Regional School District

Phenology is the study of recurring lifecycle events influenced by seasonal environmental changes. Classic examples include flowering by plants and migration by animals.

Harvard Forest Schoolyard Ecology Program

Research Projects

Buds, Leaves & Global Warming

Woolly Bully: The Invasive Pest, the Hemlock Woolly Adelgid

Water in the Landscape: Vernal Pools

Our Changing Forests: How Do Forests Grow and Change Over Time?

K-12 & Schoolyard LTER

Through the Fisher Museum and LTER program, the Harvard Forest offers a variety of formal and informal programs for local and regional schools.

Opportunities include:

- Harvard Forest Schoolyard LTER Program: Field-based research and professional development for K-12 students and teachers.
- Field trips to the Harvard Forest nature trails, research sites, and the Fisher Museum.
- Internship opportunities for Antioch University master's students.

NEXT GENERATION SCIENCE STANDARDS

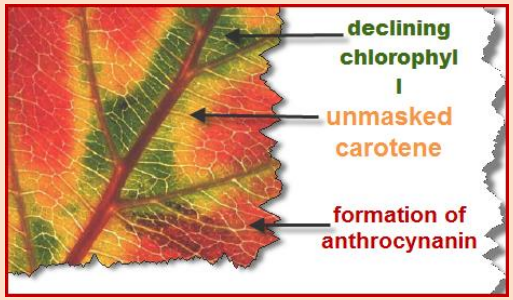
For States, By States

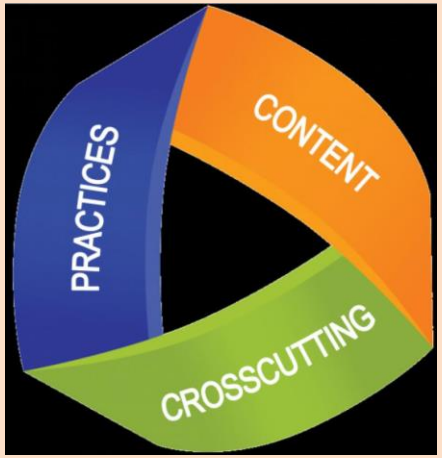
Massachusetts Department of ELEMENTARY & SECONDARY EDUCATION

2016 Massachusetts Science and Technology/Engineering Standards

Pre-Kindergarten to Grade 8 and Introductory High School Courses

Adopted by the Massachusetts Board of Elementary and Secondary Education January 26, 2016

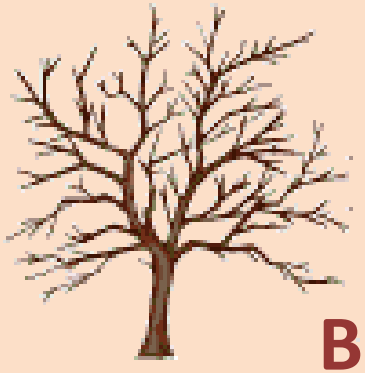




Practices describe behaviors that scientists engage in.

Crosscutting concepts have application across all domains of science such as patterns, cause and effect; systems, energy and matter.

Content focuses K–12 science curriculum, instruction and assessments on the most important aspects of science.



HARVARD FOREST
HARVARD UNIVERSITY
Established 1907 Long Term Ecological Research Site since 1988

Buds, Leaves, and Global Warming

Dr. John O'Keefe

How long is the growing season in our schoolyard?

How is the length of the season related to climate?

4116	JRB-buds-001	Bennett	4/9/2009	99	22	RM	4	0	
4121	JRB-buds-001	Bennett	4/16/2009	106	22	RM	4	0	
4127	JRB-buds-001	Bennett	4/23/2009	113	22	RM	4	0	
4133	JRB-buds-001	Bennett	5/4/2009	124	22	RM	4	3	
4139	JRB-buds-001	Bennett	5/11/2009	131	22	RM	4	3	
4145	JRB-buds-001	Bennett	5/19/2009	139	22	RM	4	4	10
4111	JRB-buds-001	Bennett	4/1/2009	91	26	RM	6	0	
4117	JRB-buds-001	Bennett	4/9/2009	99	26	RM	6	0	
4123	JRB-buds-001	Bennett	4/16/2009	106	26	RM	6	0	
4129	JRB-buds-001	Bennett	4/23/2009	113	26	RM	6	0	
4135	JRB-buds-001	Bennett	5/4/2009	124	26	RM	6	0	
4141	JRB-buds-001	Bennett	5/11/2009	131	26	RM	6	6	
4147	JRB-buds-001	Bennett	5/19/2009	139	26	RM	6	6	14
4151	JRB-buds-001	Bennett	4/14/2011	104	31	RM	12	0	0
4156	JRB-buds-001	Bennett	4/26/2011	116	31	RM	12	0	0
4161	JRB-buds-001	Bennett	5/3/2011	123	31	RM	12	12	
4166	JRB-buds-001	Bennett	5/10/2011	130	31	RM	12	12	3
9781	JRB-buds-001	Bennett	4/14/2014	104	31	RM	12	0	
9782	JRB-buds-001	Bennett	4/28/2014	118	31	RM	12	0	
9783	JRB-buds-001	Bennett	5/8/2014	128	31	RM	12	0	
9784	JRB-buds-001	Bennett	5/15/2014	135	31	RM	12	10	5
12166	JRB-buds-001	Bennett	4/14/2016	105	31	RM	12	0	0
12172	JRB-buds-001	Bennett	4/20/2016	120	31	RM	12	2	
12178	JRB-buds-001	Bennett	5/4/2016	125	31	RM	12	3	
12184	JRB-buds-001	Bennett	5/9/2016	130	31	RM	12	6	3
12190	JRB-buds-001	Bennett	5/13/2016	134	31	RM	12	6	4
12196	JRB-buds-001	Bennett	5/18/2016	139	31	RM	12	12	7
12202	JRB-buds-001	Bennett	6/2/2016	154	31	RM	12	12	10
12366	JRB-buds-001	Bennett	4/11/2017	101	31	RM	12	0	0
12372	JRB-buds-001	Bennett	4/24/2017	114	31	RM	12	0	0
12378	JRB-buds-001	Bennett	4/27/2017	117	31	RM	12	0	0
12384	JRB-buds-001	Bennett	5/1/2017	121	31	RM	12	4	1
12388	JRB-buds-001	Bennett	5/9/2017	129	31	RM	12	12	0
12394	JRB-buds-001	Bennett	5/16/2017	136	31	RM	12	12	7
12400	JRB-buds-001	Bennett	5/18/2017	138	31	RM	12	12	8
13665	JRB-buds-001	Bennett	4/24/2018	114	31	RM	12	0	0
13671	JRB-buds-001	Bennett	5/3/2018	123	31	RM	12	0	0
13677	JRB-buds-001	Bennett	5/7/2018	127	31	RM	12	9	2
13683	JRB-buds-001	Bennett	5/10/2018	130	31	RM	12	9	2
13689	JRB-buds-001	Bennett	5/14/2018	134	31	RM	12	12	3
13695	JRB-buds-001	Bennett	5/18/2018	138	31	RM	12	12	5.5
15503	JRB-buds-001	Bennett	4/24/2019	114	31	RM	12	0	0
15504	JRB-buds-001	Bennett	5/6/2019	126	31	RM	12	7	2
15505	JRB-buds-001	Bennett	5/13/2019	133	31	RM	12	12	4
15507	JRB-buds-001	Bennett	5/17/2019	137	31	RM	12	12	4
4173	JRB-buds-001	Bennett	4/4/2012	95	43	RM	12	0	
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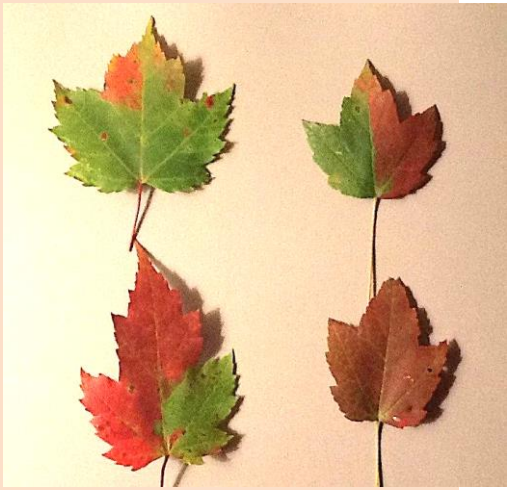


Harvard Forest Schoolyard Ecology
Buds, Leaves, and Global Warming

Autumn Student Data Sheet

December 2007

Name: Date:

Teacher: School:

Tree Number:____ Branch letter ____

Tree Species:_____

Please measure leaves only once at beginning of season.

	Leaf 1	Leaf 2	Leaf 3	Leaf 4	Leaf 5	Leaf 6
Leaf Length (cm.)						
Leaf Width(cm.)						

Put a check mark in the correct column below to show Leaf Color and Leaf Drop

Leaf #	Fraction/ Percent of Leaf Color (not green)				Leaf Drop
	0 – 25%	26 – 50%	51 – 75%	76 – 100%	0-not fallen 1- fallen
1					
2					
3					
4					
5					
6					
Whole Tree					N/A

Total number of study leaves observed per branch (fallen and not fallen)	
Total number of leaves fallen	

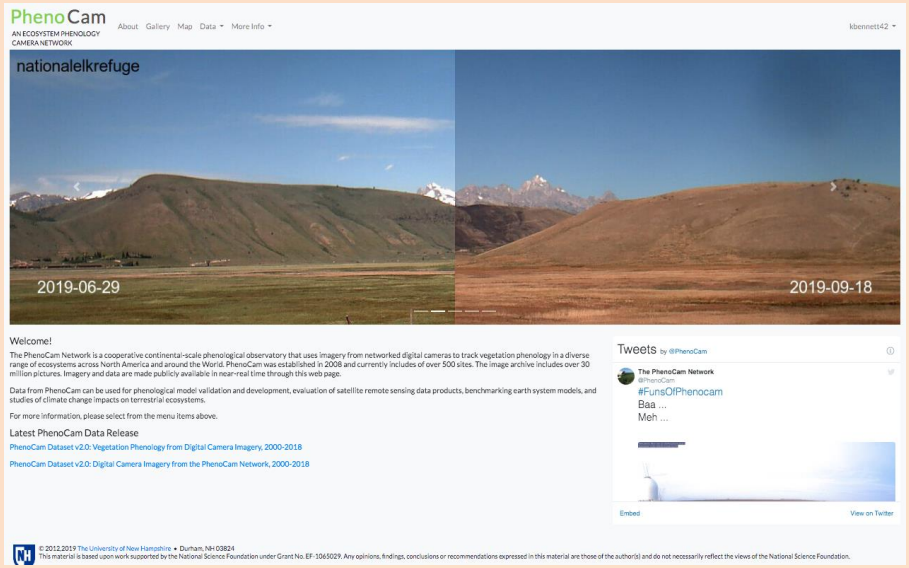
Teacher note: Remember that the branch total above must be added with branch totals from all branches on the same tree to get the total number of leaves dropped per tree to submit to Harvard Forest to post online.

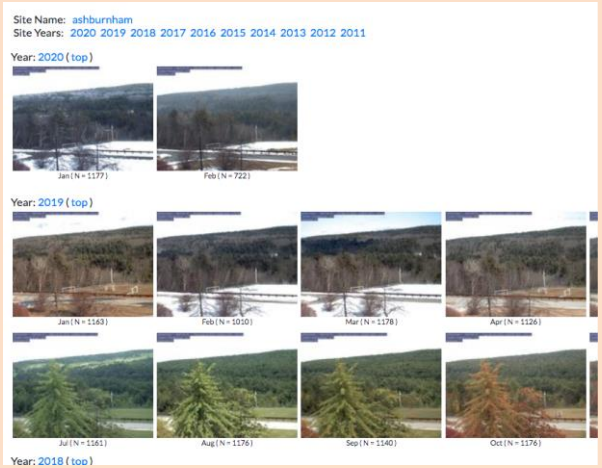
Optional Field Notes:

Weather Notes: **Animal/ Plant notes:**

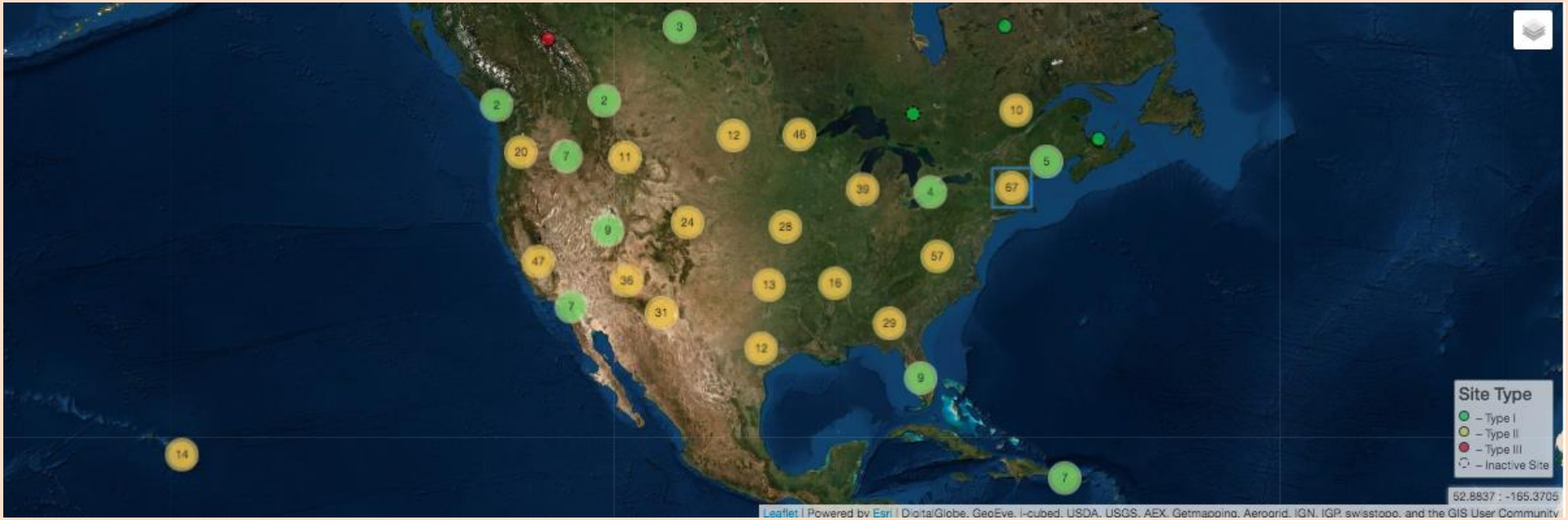
Research Experience for Teachers – RET

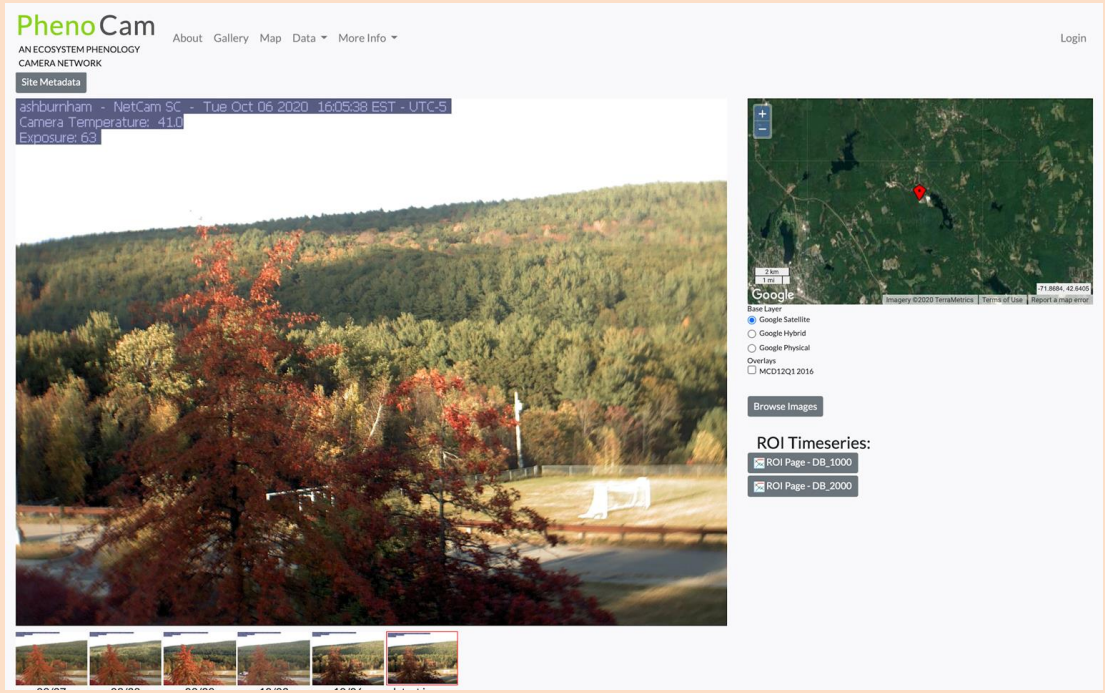
Teachers take an active part in research with mentor scientists. They translate their experience into cutting edge lessons in the classroom.

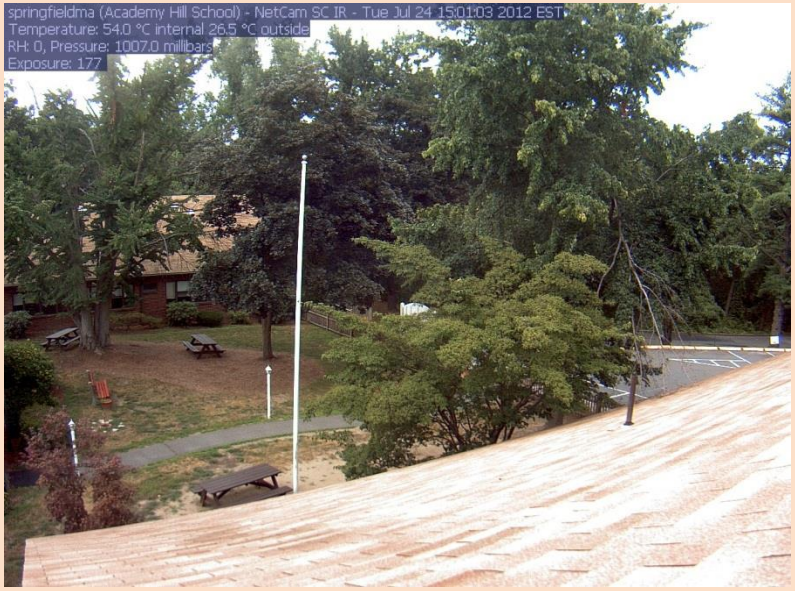




Ashburnham Westminster Regional School District joins Dr. Andrew Richardson's *Phenocam Network.*


Site Type
– Type I
– Type II
– Type III
– Inactive Site
52.8837 : -165.3705
Leaflet | Powered by Esri | DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


PhenoCam
AN ECOSYSTEM PHENOLOGY CAMERA NETWORK
About
Gallery
Map
Data
More Info
Login
Site Metadata
ashburnham - NetCam SC - Tue Oct 06 2020 16:05:38 EST - UTC-5
Camera Temperature: 41.0
Exposure: 63
Base Layer
Google Satellite
Google Hybrid
Google Physical
Overlays
MCD12Q1 2016
Browse Images
ROI Timeseries:
ROI Page - DB_1000
ROI Page - DB_2000



Academy Hill Springfield, MA

North Attleboro High School

Austin Prep School Reading, MA

PhenoCam
AN ECOSYSTEM PHENOLOGY CAMERA NETWORK

About Gallery Map Data More Info kbennett42

Type I Sites: (505)


alligatorriver
IR EC 1


arbutuslake
1


arbutuslakeinlet
IR 1


archboldavir
IR EC 1


archboldavirx
IR EC 1


archboldbahia
IR 1


archboldpnot
IR EC 1

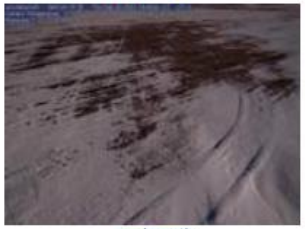

archboldpnotx
IR EC 1


archboldwet
IR EC 1


arsbrooks10
IR EC 1


arsbrooks11
IR EC 1


arscolesnorth
IR EC 1


arscolessouth
IR EC 1


arsgacp1
IR 1


arsgacp2
IR 1


arsgacp4
IR EC 1


arsgreatbasinltar098
IR EC 1


arsgreatbasinltar177
IR EC 1


bartlettir - NetCam SC IR - Sat Oct 12 2019 10:25:05 EST - UTC-5
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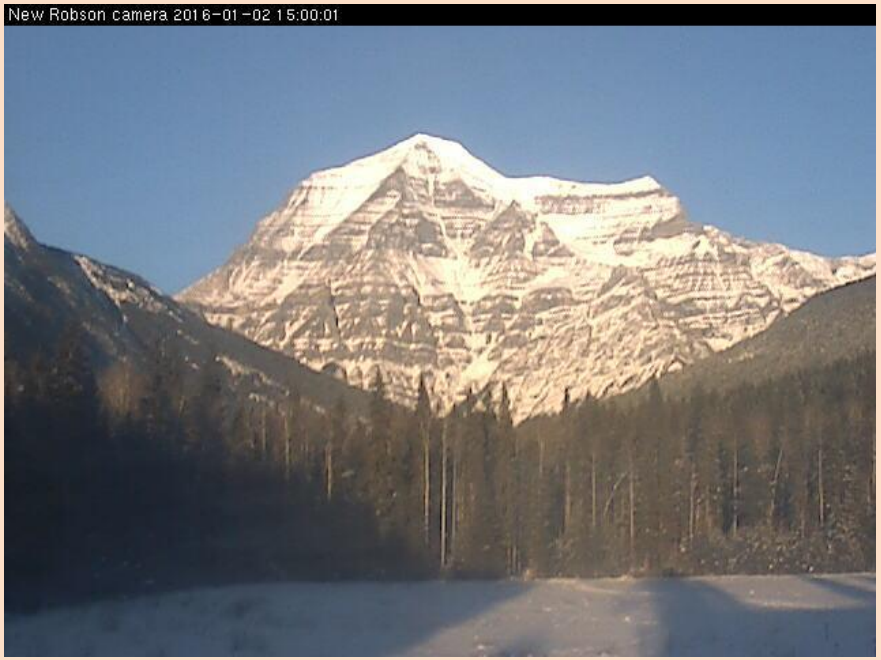
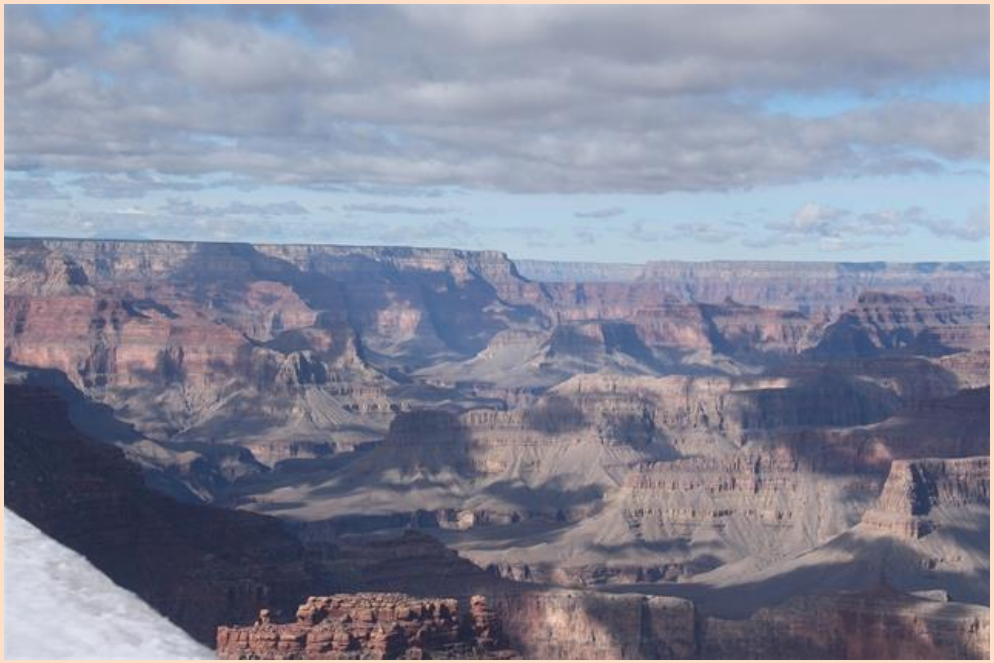
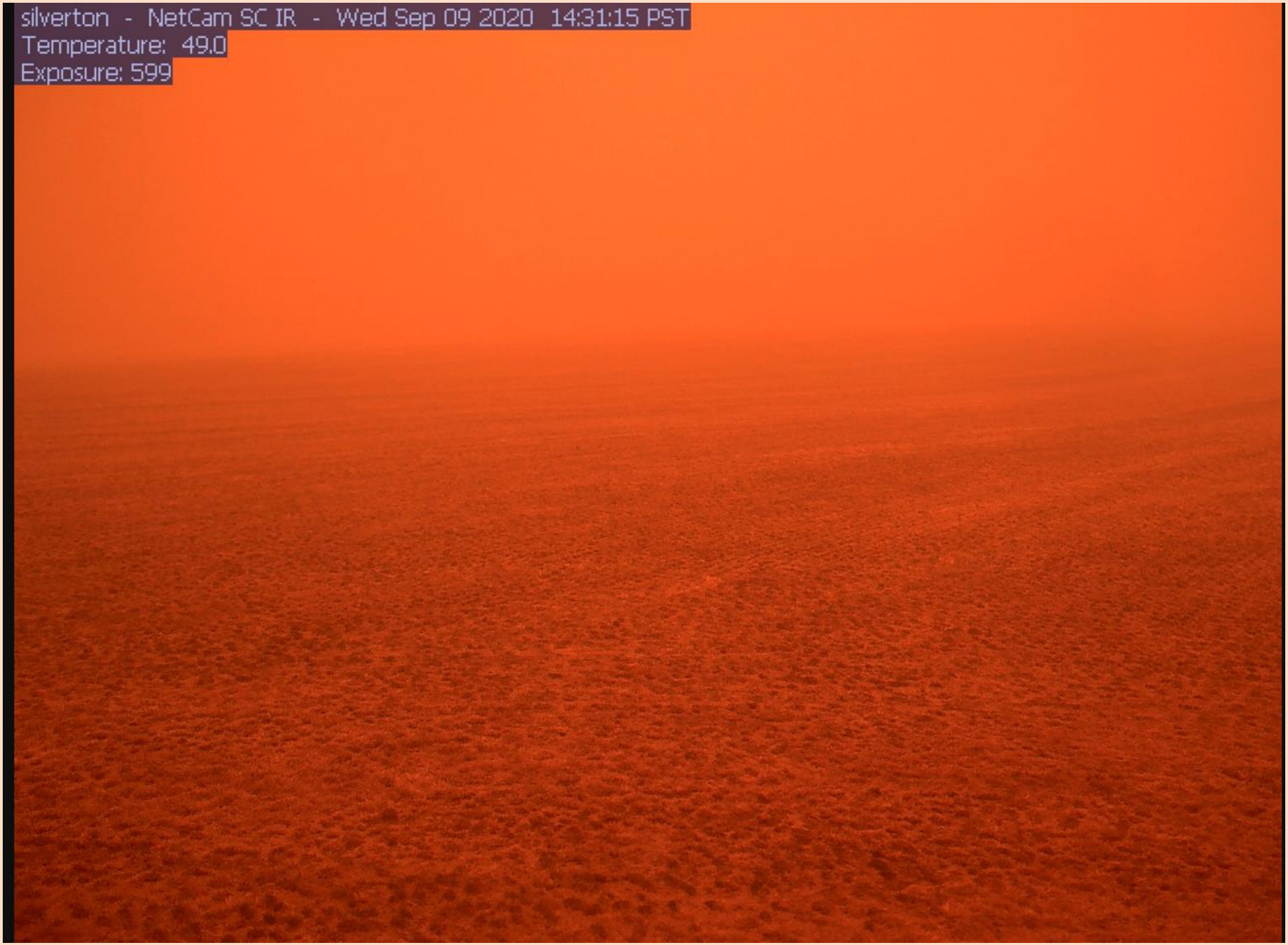
Exposure: 500


New Robson camera 2016-01-02 15:00:01



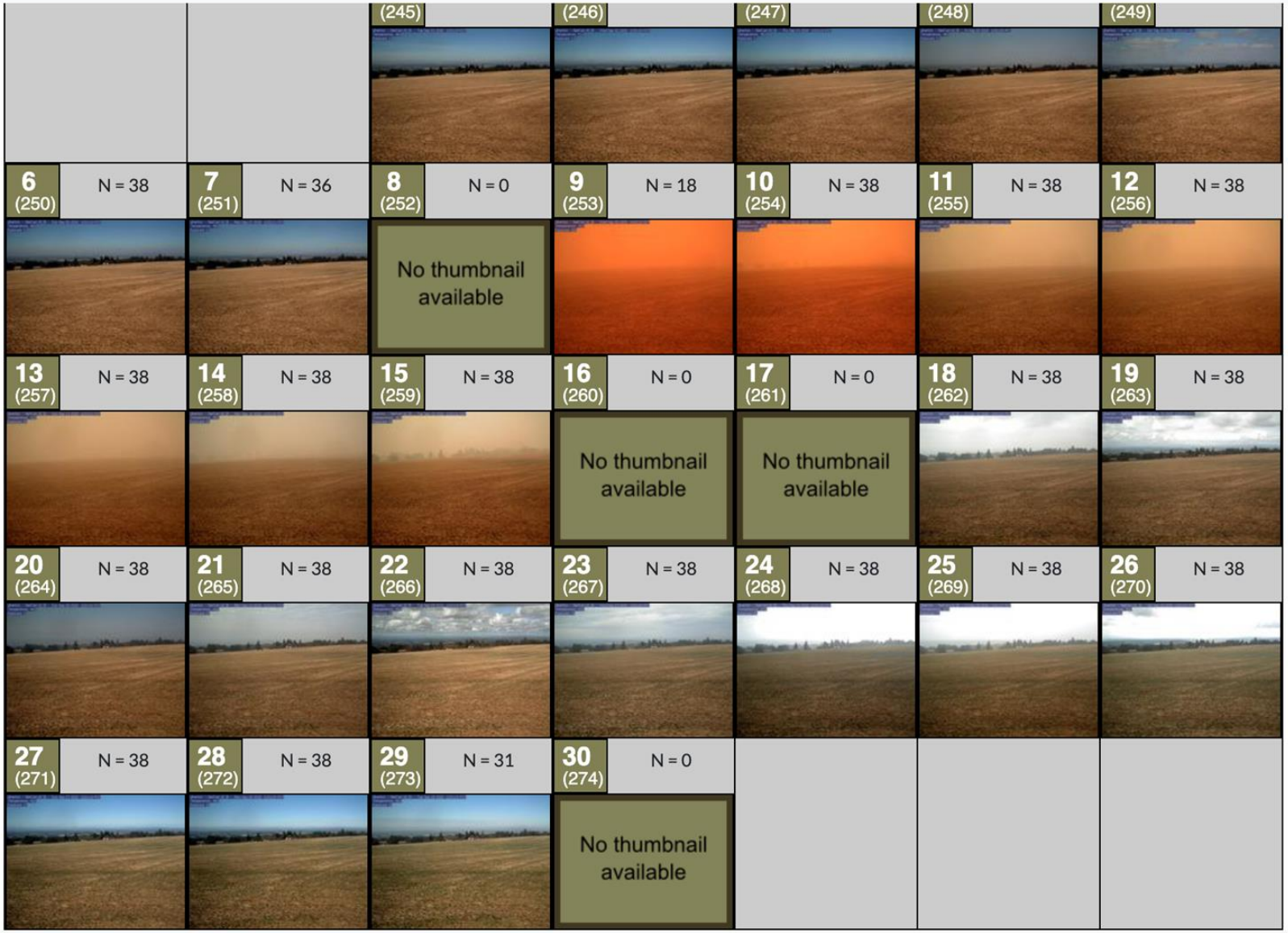

MOULTRIE
87°F
MERRIMACK #3
17 JUN

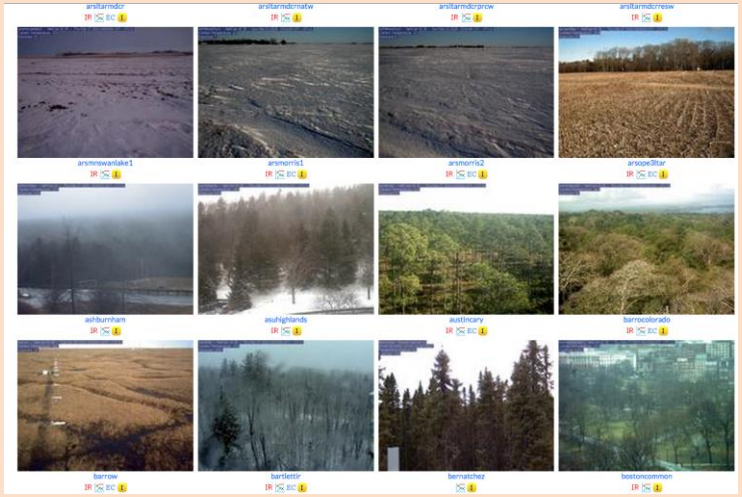

silverton - NetCam SC IR - Tue Sep 01 2020 14:31:17 PST
Temperature: 51.0
Exposure: 15

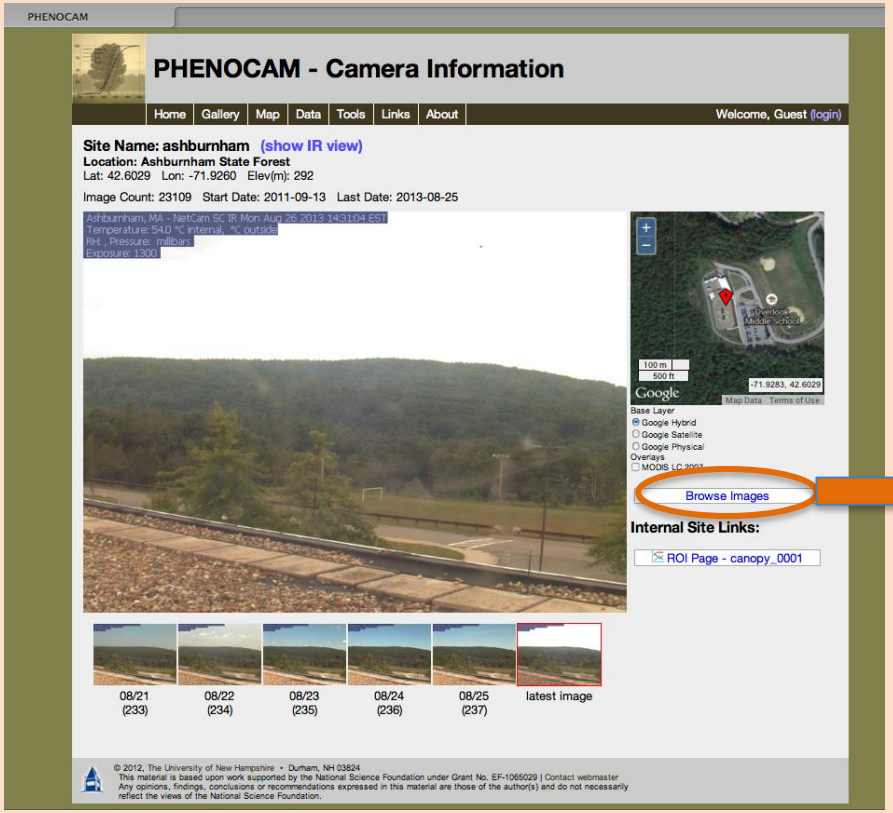

silverton - NetCam SC IR - Wed Sep 09 2020 14:31:15 PST
Temperature: 49.0
Exposure: 599

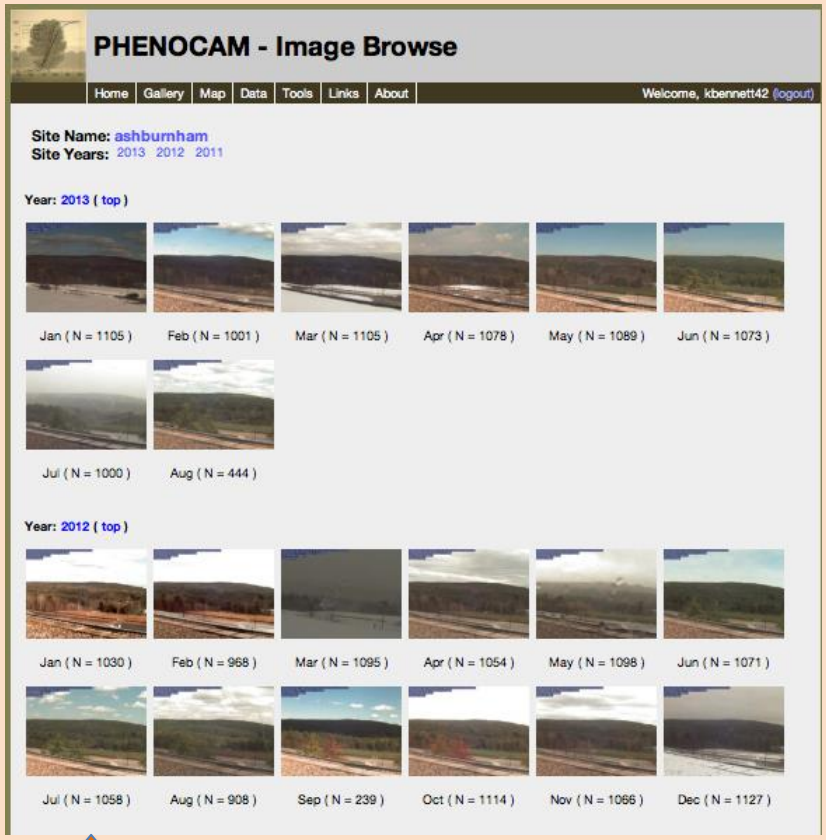
PhenoCam

AN ECOSYSTEM PHENOLOGY CAMERA NETWORK





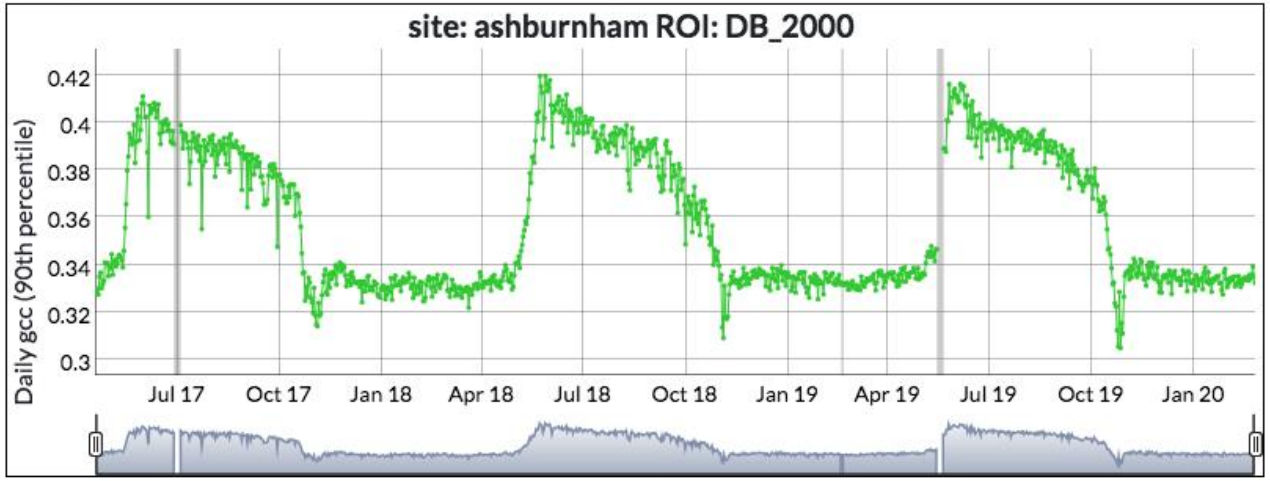




Click on Browse Images. Then on the year and month you want.

ROI Name: DB_2000 (canopy level DB (major FOV shift))

gcc (green chromatic coordinate) timeseries plot



PNG Plot

Provisional Data Links

The data plotted above are available via the links below. This data is provisional and subject to change. For a description of t

Provisional Data

ROI Mask List (1)

(Mask CSV file)

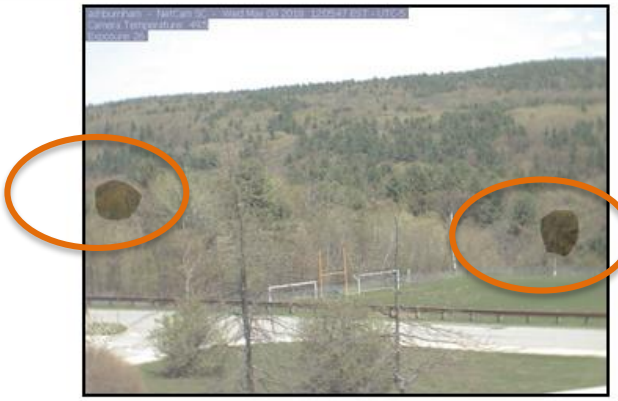
Mask: 1

Start Date: April 19, 2017, 12:05 p.m.

End Date: Dec. 31, 9999, midnight

Mask File: ashburnham_DB_2000_01.tif

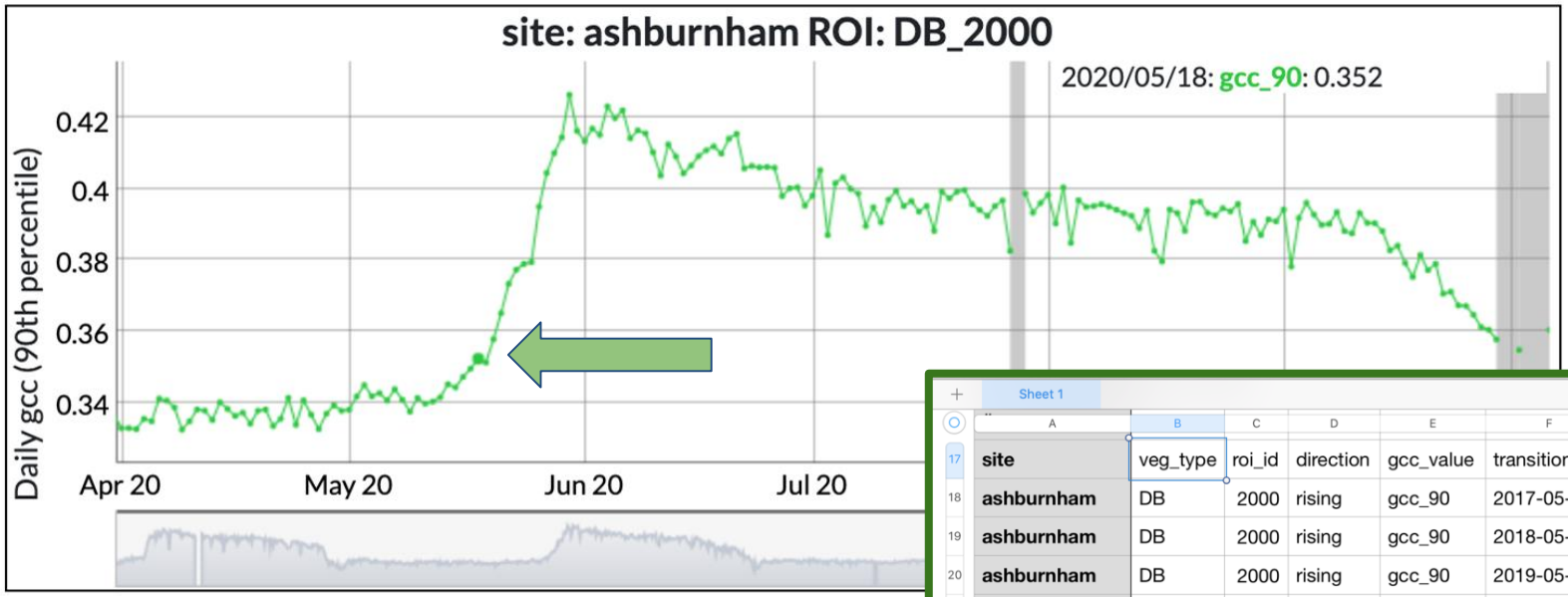
Toggle Mask



Site Name: ashburnham
Location: Ashburnham State Forest / Overlook Middle School, Ashburnham, Massachusetts
Lat:42.6029 **Lon:**-71.9260 **Elev(m):** 292
Image Count: 114387 **Start Date:** 2011-09-13 **Last Date:** 2020-10-06

ROI Name: DB_2000 (canopy level DB (major FOV shift))

gcc (green chromatic coordinate) timeseries plot



PNG Plot

Sheet 1

	A	B	C	D	E	F	G	H
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18	ashburnham	DB	2000	rising	gcc_90	2017-05-13	2017-05-15	2017-05-18
19	ashburnham	DB	2000	rising	gcc_90	2018-05-03	2018-05-09	2018-05-15
20	ashburnham	DB	2000	rising	gcc_90	2019-05-07	2019-05-17	2019-05-21
21	ashburnham	DB	2000	rising	gcc_75	2017-05-13	2017-05-15	2017-05-18
22	ashburnham	DB	2000	rising	gcc_75	2018-05-03	2018-05-09	2018-05-15
23	ashburnham	DB	2000	rising	gcc_75	2019-05-06	2019-05-16	2019-05-20
24	ashburnham	DB	2000	rising	gcc_50	2017-05-13	2017-05-15	2017-05-18
25	ashburnham	DB	2000	rising	gcc_50	2018-05-03	2018-05-09	2018-05-16
26	ashburnham	DB	2000	rising	gcc_50	2019-05-06	2019-05-16	2019-05-20
27	ashburnham	DB	2000	rising	gcc_mean	2017-05-13	2017-05-15	2017-05-18
28	ashburnham	DB	2000	rising	gcc_mean	2018-05-03	2018-05-09	2018-05-15
29	ashburnham	DB	2000	rising	gcc_mean	2019-05-06	2019-05-16	2019-05-20
30	ashburnham	DB	2000	falling	gcc_90	2019-10-21	2019-10-19	2019-10-12
31	ashburnham	DB	2000	falling	gcc_90	2018-10-29	2018-10-24	2018-09-28
32	ashburnham	DB	2000	falling	gcc_90	2017-10-26	2017-10-23	2017-10-18

Name_____

Choose a Phenocam site that interests you.

Site Name bozeman **Latitude/ Longitude** Lat 45.7831 Lon 110.7778 **Elevation (m)** 2,332 m

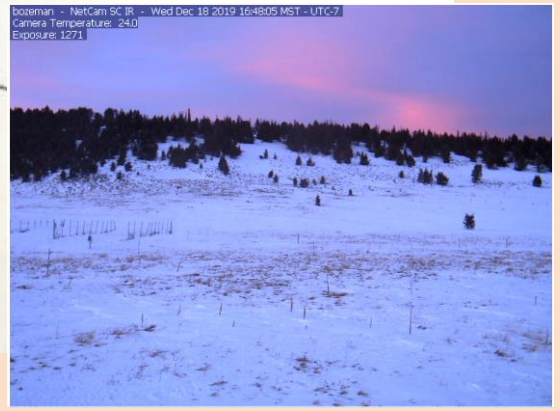
Location	Terrain	Urban/Suburban/Rural/Agricultural	Water Features	Vegetation
Bangtail study Area, Montana State University, Montana	• Mountains • Trees • Flat land	rangeland	None	• Conifer trees

Approximate Day of Budburst (Julian Day) 5-24-2019

Approximate Day of Leaf Drop (Julian Day) 9-28-2019

Length of Growing Season 127 days

2XX
-144
127



Name_____ **Choose a PhenoCam Site that interests you.**

Site Name _____ **Latitude/ Longitude**_____ **Elevation** _____**m**

Location	Terrain	Urban/ Suburban Rural/ Agriculture	Water Features	Vegetation

Using the most recent Timeseries graph determine:

Approximate Julian Day of Budburst _____

Approximate Julian Day of Leaf Drop _____

Length of Growing Season _____

Julian Day Calendar

After the Month of February add one to the Day Number for Leap Years; 2008, 2012, 2016, 2020, 2024, 2028, 2032, 2036, 2040.....

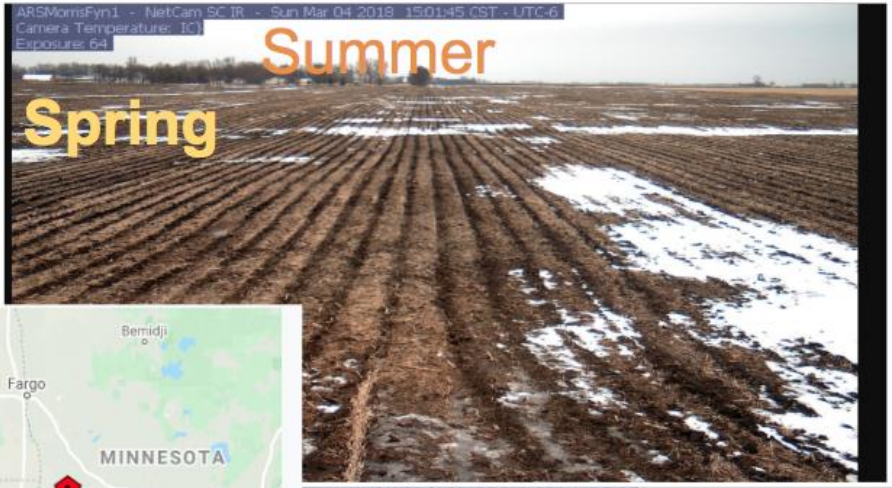
Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan	001	002	003	004	005	006	007	008	009	010	011	012	013	014	015	016	017	018	019	020	021	022	023	024	025	026	027	028	029	030	031
Feb	032	033	034	035	036	037	038	039	040	041	042	043	044	045	046	047	048	049	050	051	052	053	054	055	056	057	058	059	Leap Year 060		
Mar	060	061	062	063	064	065	066	067	068	069	070	071	072	073	074	075	076	077	078	079	080	081	082	083	084	085	086	087	088	089	090
Apr	091	092	093	094	095	096	097	098	099	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	
May	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
Jun	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	
Jul	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212
Aug	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243
Sep	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	
Oct	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
Nov	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	
Dec	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365

Bozeman, Montana

Longitude=110.7778

Latitude=45.7831

Growing season 2019:127 days



Lat 45.6167

Lon 96.1269

PhenoCam

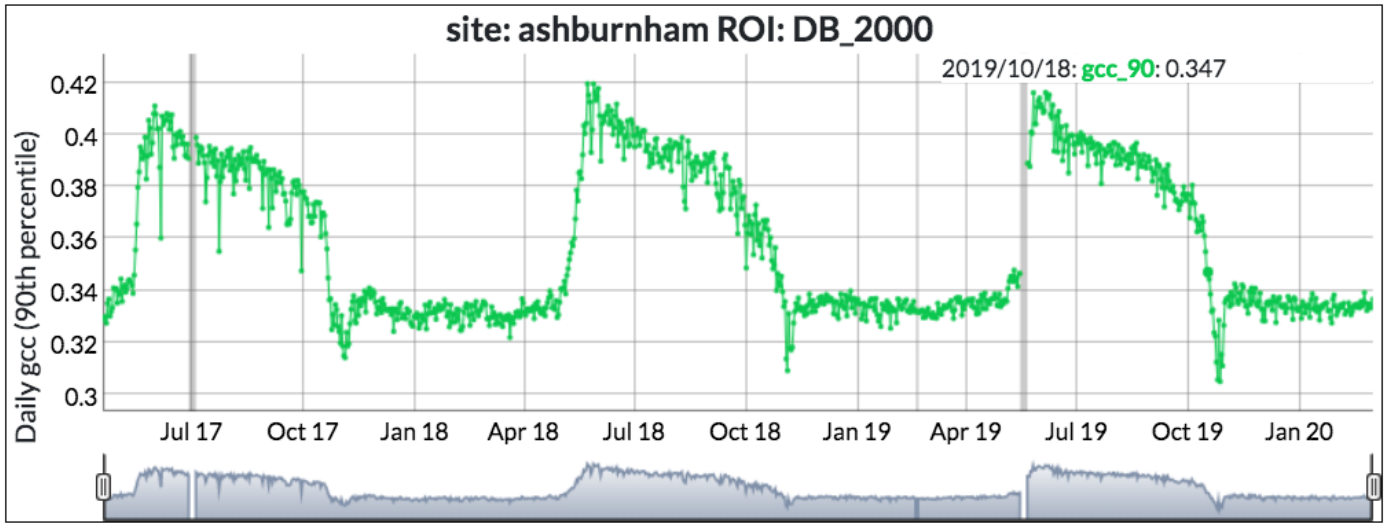
AN ECOSYSTEM PHENOLOGY CAMERA NETWORK

About Gallery Map Data More Info kbennett42

Location: Ashburnham State Forest / Overlook Middle School, Ashburnham, Massachusetts
Lat:42.6029 **Lon:**-71.9260 **Elev(m):** 292
Image Count: 106563 **Start Date:** 2011-09-13 **Last Date:** 2020-03-02

ROI Name: DB_2000 (canopy level DB (major FOV shift))

gcc (green chromatic coordinate) timeseries plot



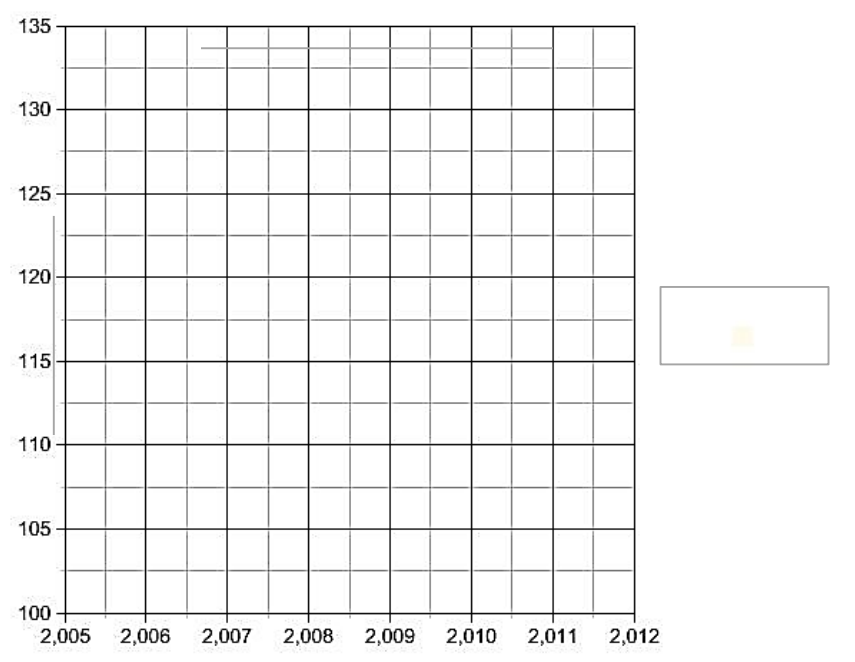
PNG Plot

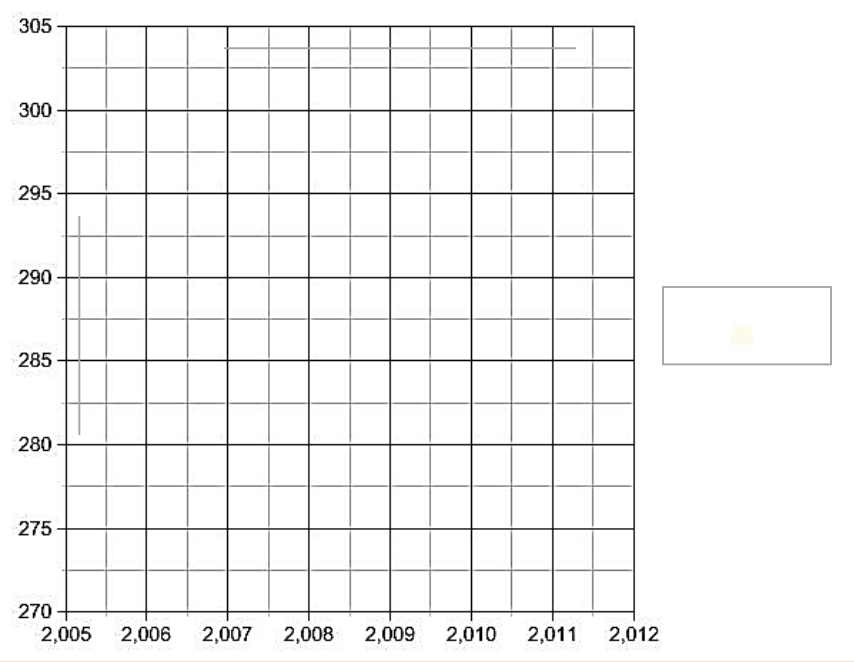
Provisional Data Links

year	budburst	leafdrop	growing season
2017	5-17	10-24	160
2018	5-14	10-14	171
2019	5-14	10-20	159

Name_____ Date_____

Using our Schoolyard data determine the day of year for budburst and 50 % leaf drop for the red maple tree. Be sure to label the x and y axis, title your graph, and make a key.





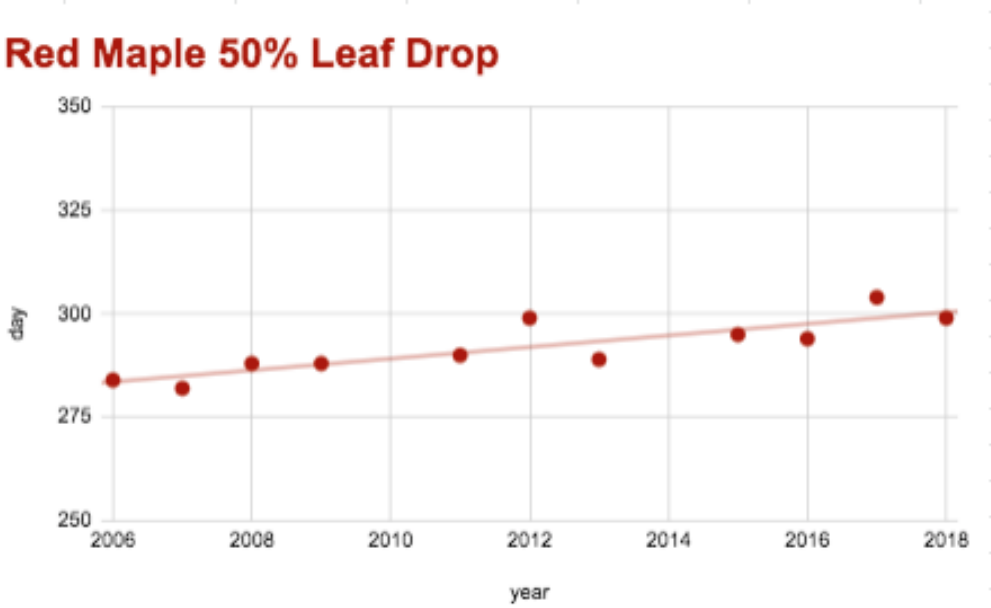
Do you see any trends over the years for budburst? Explain_____

_____

Do you see any for color change and leaf drop? Explain_____

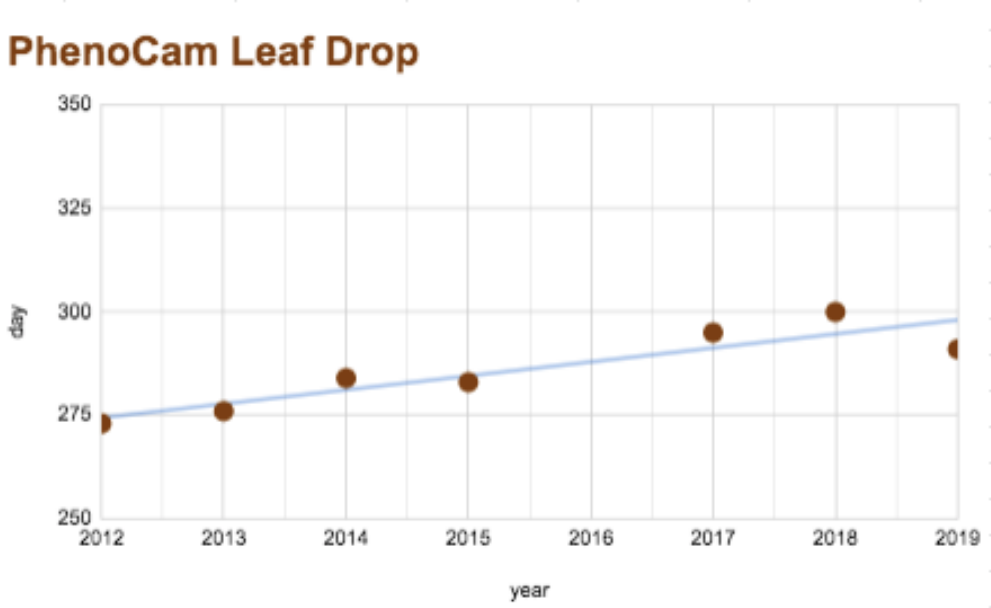
_____

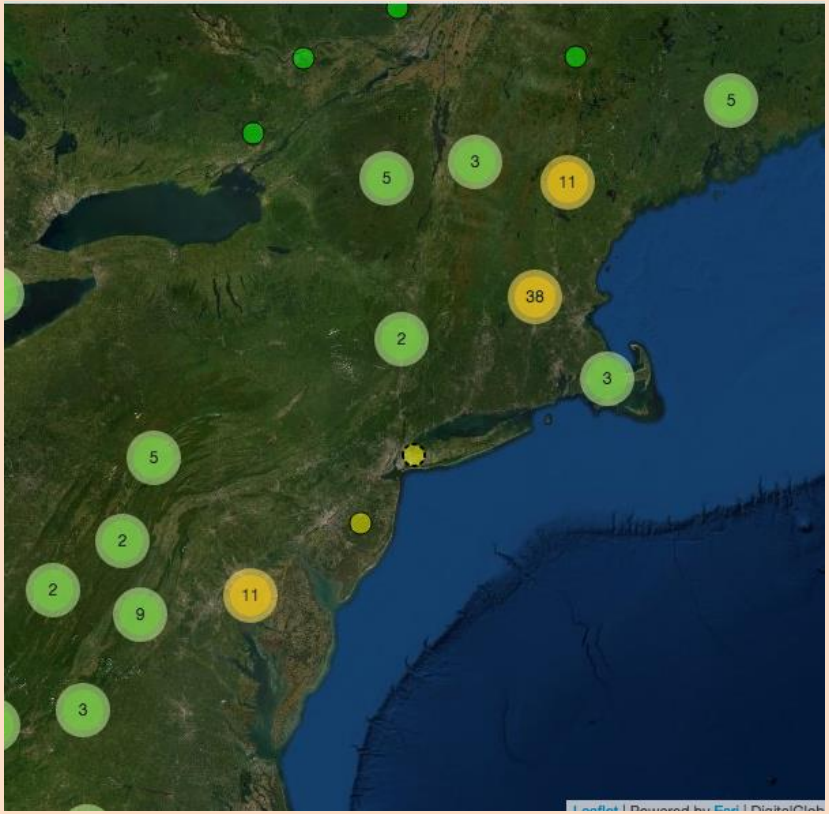
year	day
2006	284
2007	282
2008	288
2009	288
2010	
2011	290
2012	299
2013	289
2014	
2015	295
2016	294
2017	304
2018	299
2019	282



Phenocam

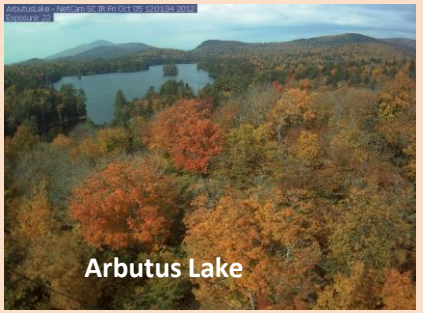
year	day
2012	273
2013	276
2014	284
2015	283
2016	
2017	295
2018	300
2019	291

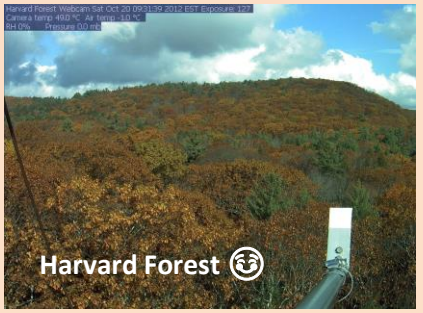




Using *PhenoCam* images to compare the timing of major phenology events across latitudes

site	latitude
shenandoah	38.5926
national capital	38.8882
usgsreston	38.9471
woodshole	41.5495
caryinstitute	41.7839
northattleboroma	41.9837
springfieldma	42.1352
harvard	42.5378
ashburnham	42.6029
hubbardbrook	43.9439
arbutuslake	43.9821
bartlett	44.0646





Ashburnham, MA

Lat: 42.6029 Lon: -71.9260 Elev(m): 292




January 17 **April 17** **July 17**

October 17



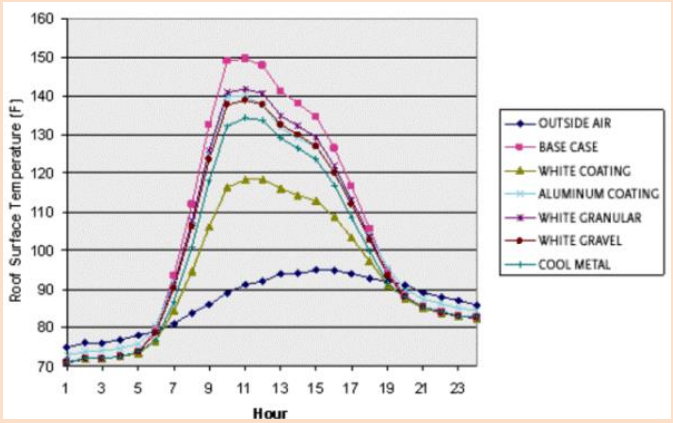

Boston Common, MA

Lat: 42.3559 Lon: -71.0641 Elev(m): 10

What cities are doing to address the problem -

Perennial Raingarden

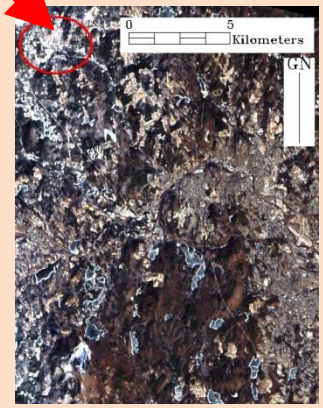
Roof gardens and increased green space make a big difference.



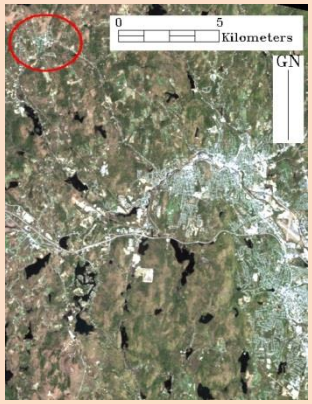
Using a white coating on rooftops reflects solar energy and helps keep the whole building cooler.

What are some ideas you have to help solve the problem of urban heat islands?

Ashburnham

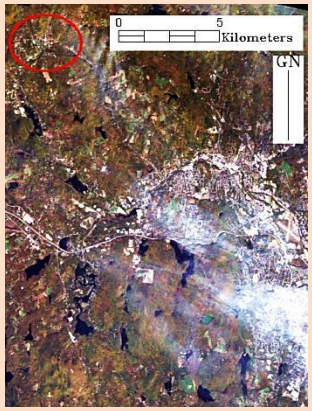


January 5



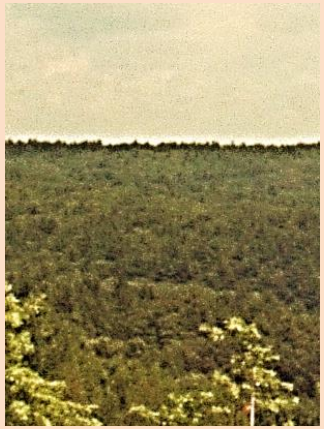
April 24

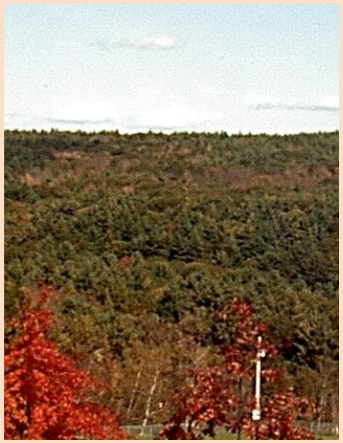
July 16

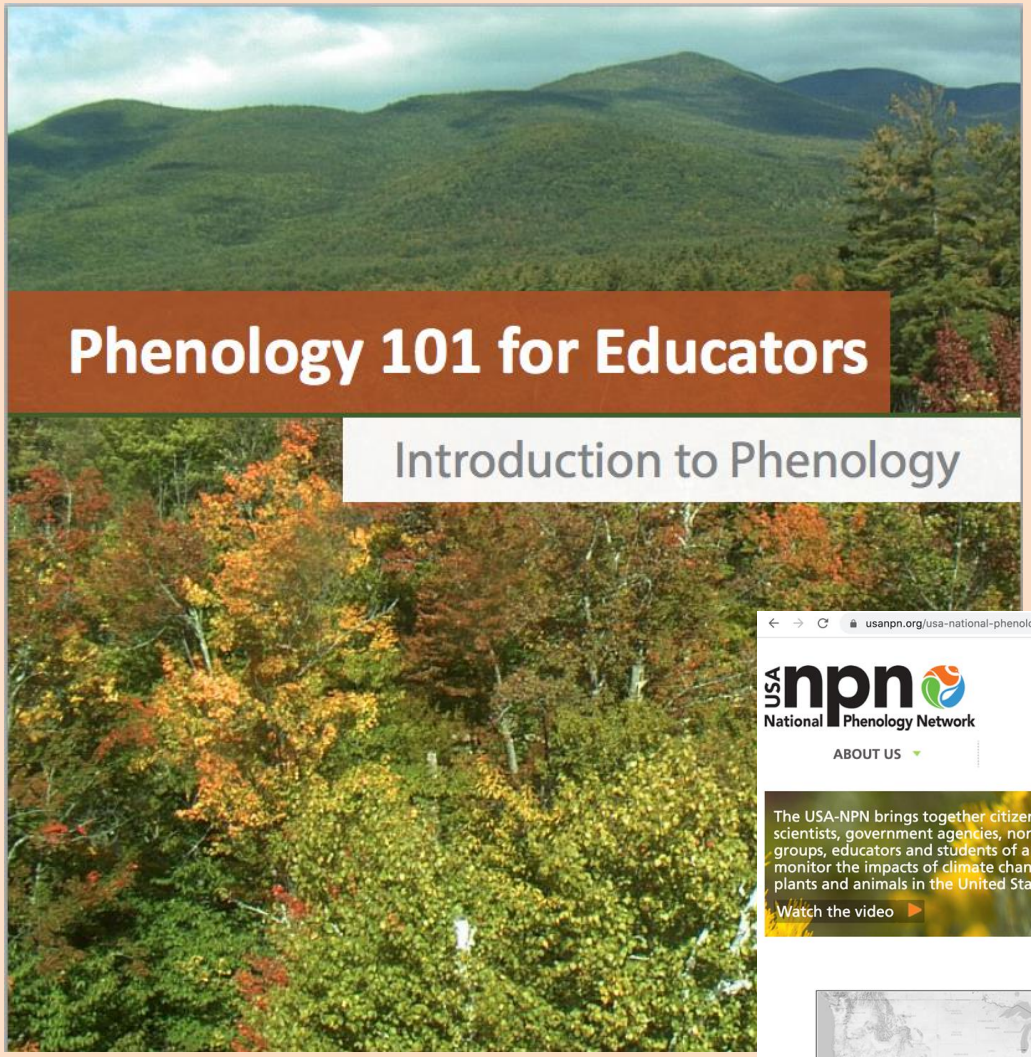


October 17

November 28






Phenology 101 for Educators
Introduction to Phenology


budburst
a project of the Chicago Botanic Garden
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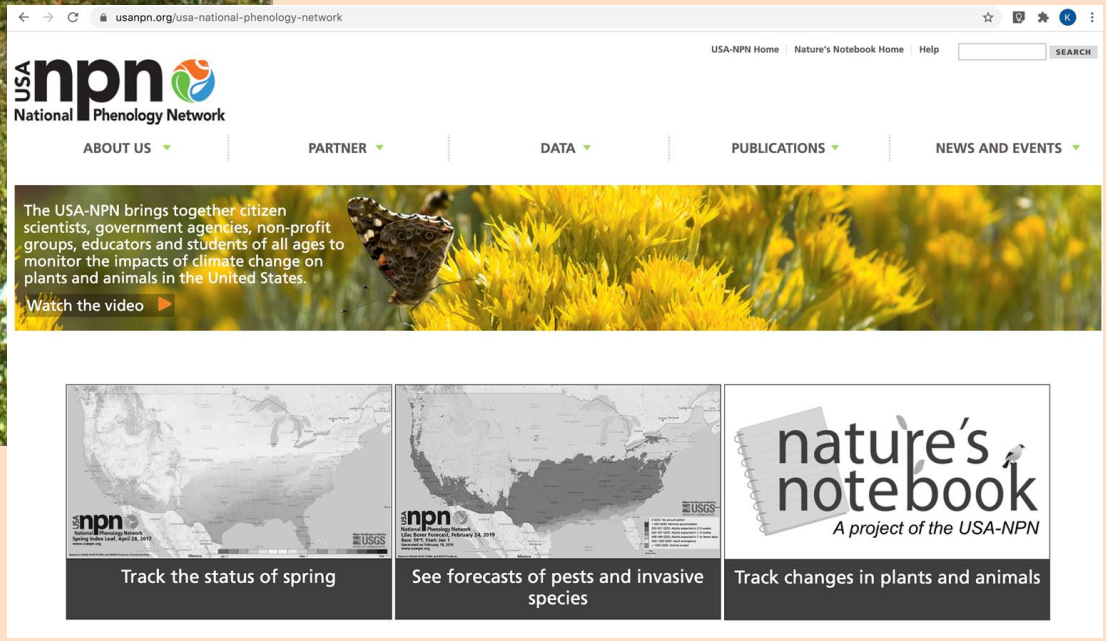
Plants
Projects
Data
Welcome to Budburst
Budburst brings together researchers, educators, gardeners, and citizen scientists on a shared journey to uncover the stories of plants and animals affected by human impacts on the environment. We hope that sharing these stories will increase appreciation of plants and the natural world and inspire conservation action.
GET STARTED
Photo courtesy of Bryan Thompson, Blackacre KY.
How to become a Budburst Citizen Scientist
1
Learn how to observe
2
Make an observation
3
Report your observation


usanpn.org/usa-national-phenology-network
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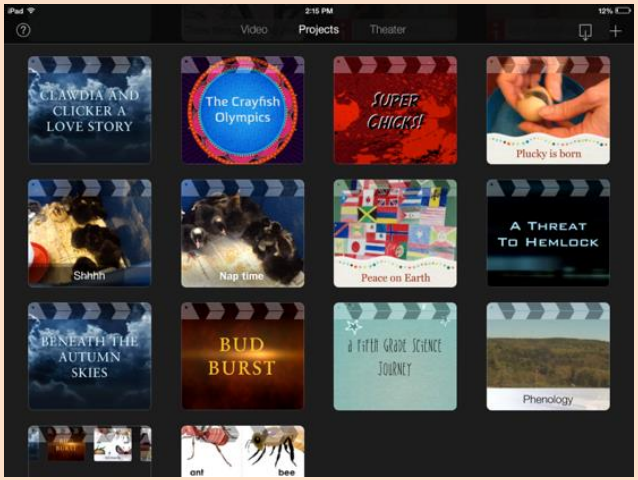
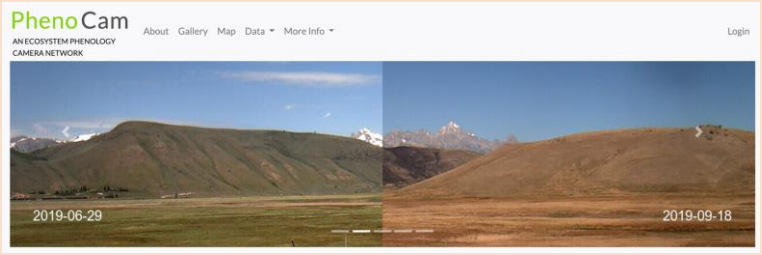
NEWS AND EVENTS
The USA-NPN brings together citizen scientists, government agencies, non-profit groups, educators and students of all ages to monitor the impacts of climate change on plants and animals in the United States.
Watch the video
Track the status of spring
See forecasts of pests and invasive species
nature's notebook
A project of the USA-NPN
Track changes in plants and animals

Get excited about Phenology-
Make your own IMovie trailers!





Making Pheno movies!

HARVARD FOREST
HARVARD UNIVERSITY
Established 1907 Long Term Ecological Research Site since 1988

PhenoCam
AN ECOSYSTEM PHENOLOGY CAMERA NETWORK

Site Name: ashburnham (show I
Location: Ashburnham State For
Lat: 42.6029 **Lon:** -71.9260 **Ele**
Image Count: 114387 **Start Dat**
Data Releases: Data Release v1
Ancillary Data: ORNL MODIS/V

Harvard LTER Schoolyard Program

NASA

NSF

LTER