



Hawk-Eye™



# Green-Up

at

## Bretton Woods Recreation Center Potomac, MD

Spring 2018



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# The Experiment

From prior viewing of night-time thermal imagery it was hypothesized that a long time series of thermal images during late winter could be used to locate winter kill and/or deadspot occurrence in warm season grasses well before green-up.

Superintendent Joe Villegas (Jvillegas@bwrc.org) of Bretton Woods Recreation Center in Potomac Maryland had a location that was frequently a slow to green-up area in fairway nr11.

In January 2018, a Hawk-Eye™ System was set-up in a tree about 10 feet above ground level to overlook the subject area. Continuous thermal and visual image data was collected every 10 minutes between 22 January – 12 May.

In well managed turf, homogeneity of the temperature and visual images in a similarly managed location such as a fairway is the norm. Deviations from that are areas to be investigated and evaluated.

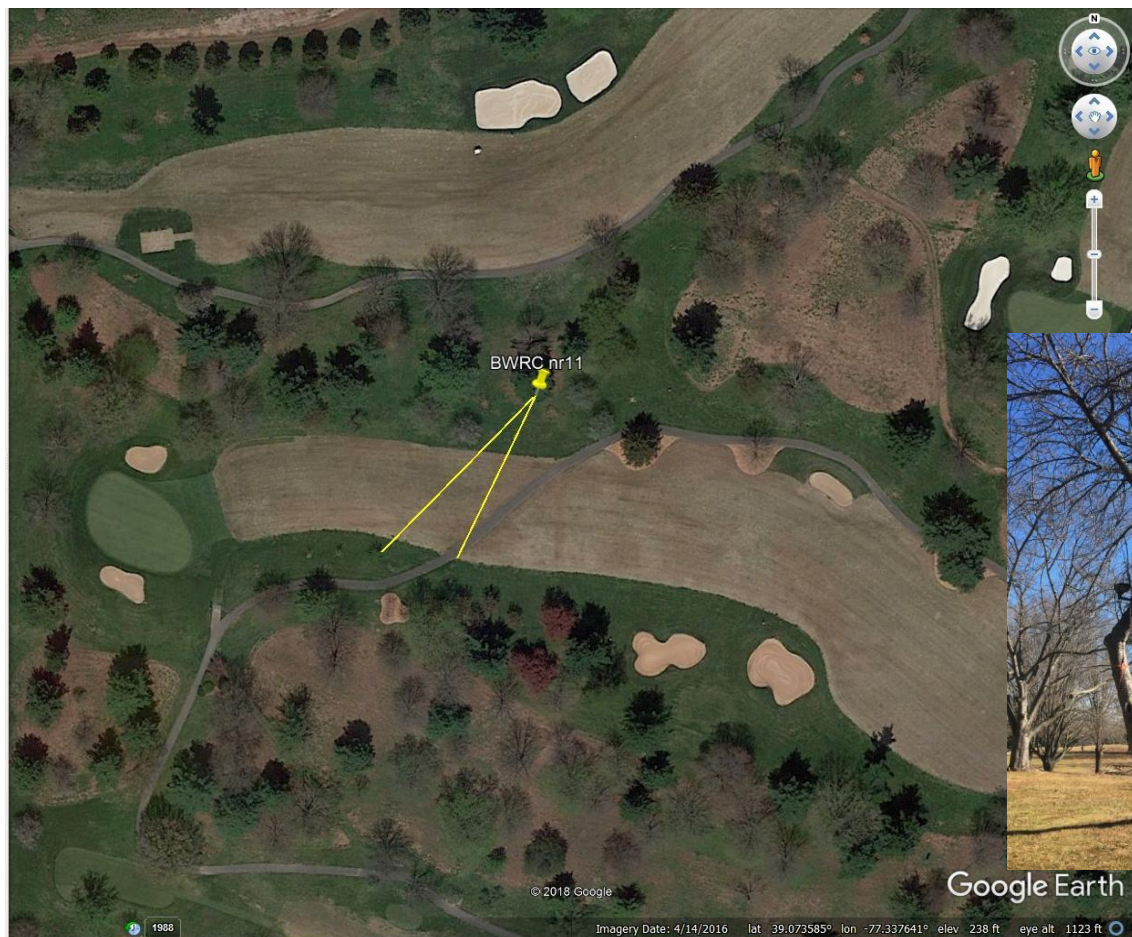
From the February-March nighttime thermal images a pattern of deviation from homogeneity was noted. The pattern of green-up in April-May matched it.



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# Hawk-Eye™ Set-Up looking south across nr11 fairway

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# Area Orientation

## Day Visual

Tue, 01-May-2018 11:59 AM

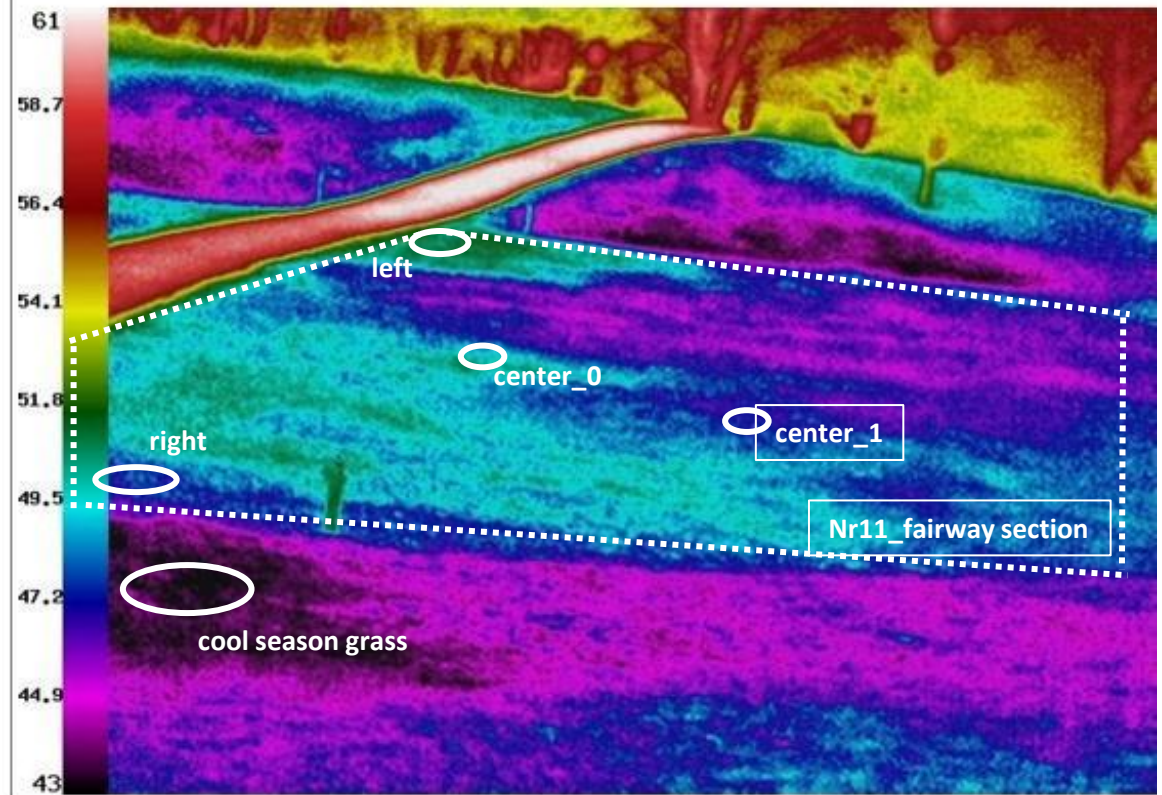
74.7° F - SRad: 571.49 - RH: 12% - DP: 18.7 - SSW @ 0 MPH



## Night Thermal

Tue, 01-May-2018 11:59 PM

58.6° F - SRad: 0.00 - RH: 51% - DP: 40.6 - SSW @ 0 MPH







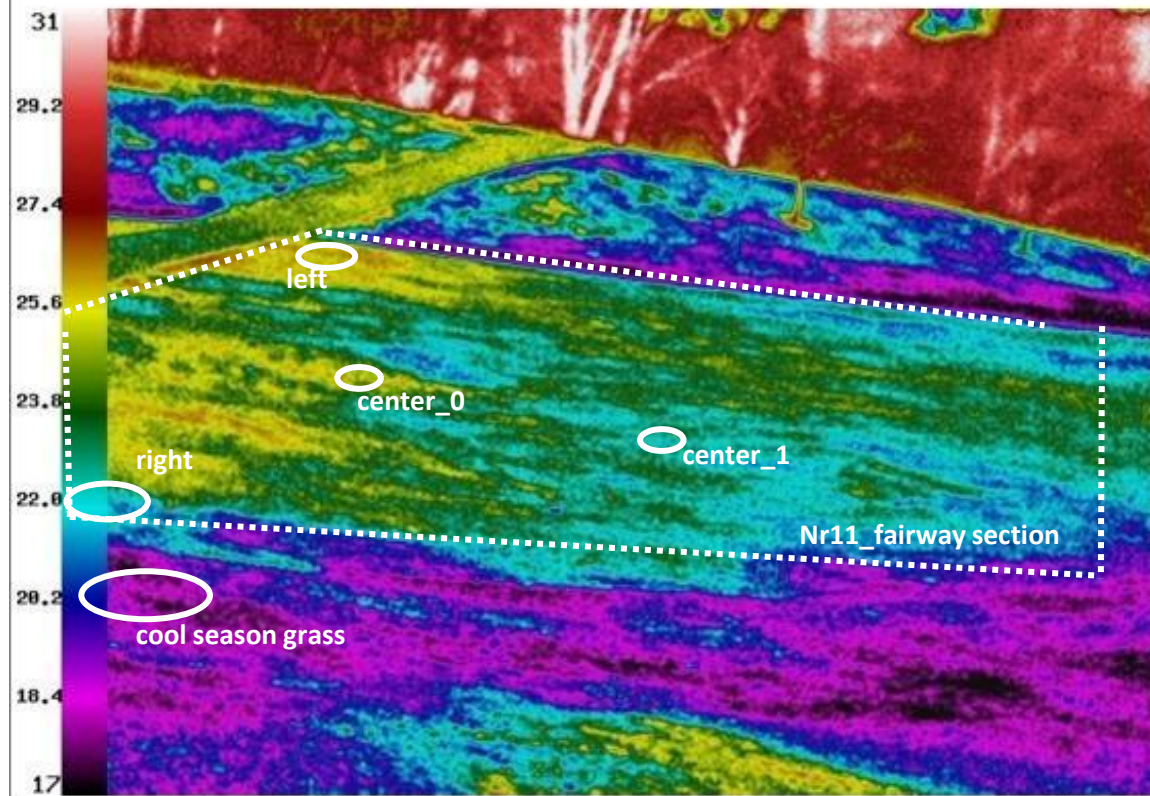
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**11:55 PM, 12 Feb 2018**

Mon, 12-Feb-2018 11:55 PM

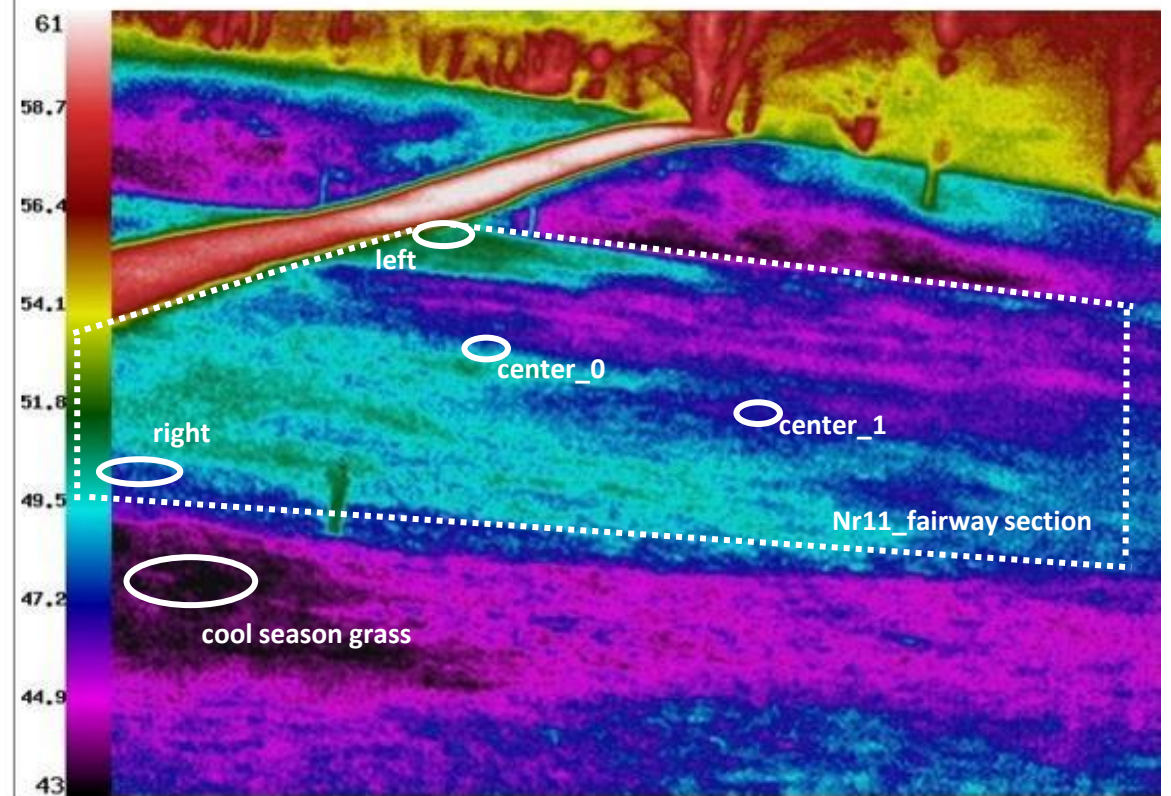
34.7° F - SRad: 0.00 - RH: 37% - DP: 11.1 - SW @ 0 MPH



**11:59 PM, 01 May 2018**

Tue, 01-May-2018 11:59 PM

58.6° F - SRad: 0.00 - RH: 51% - DP: 40.6 - SSW @ 0 MPH



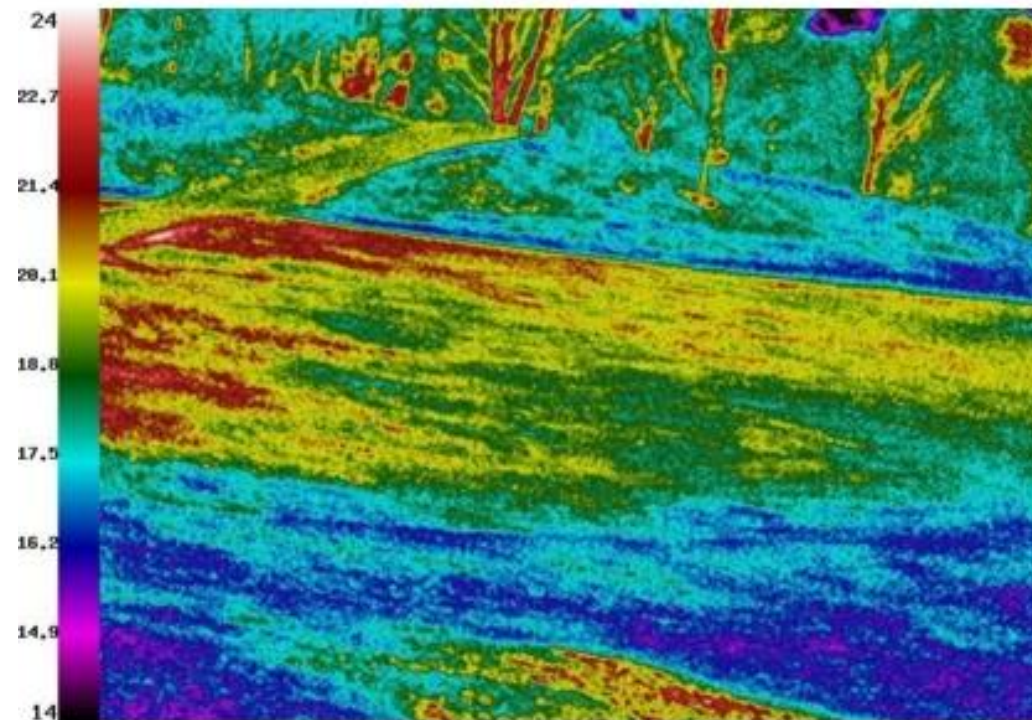




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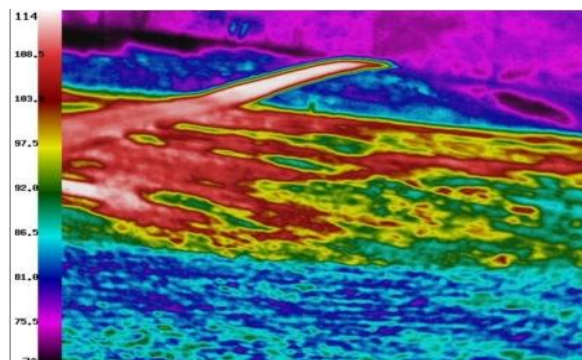
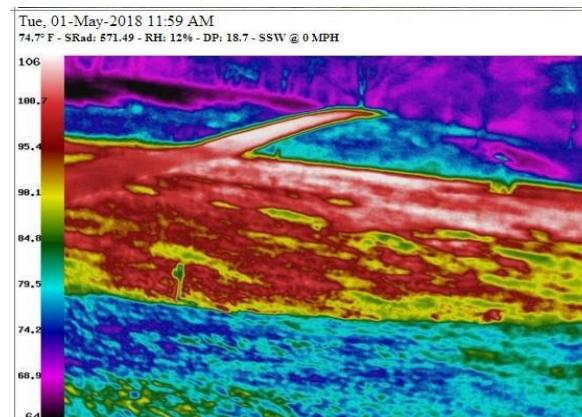
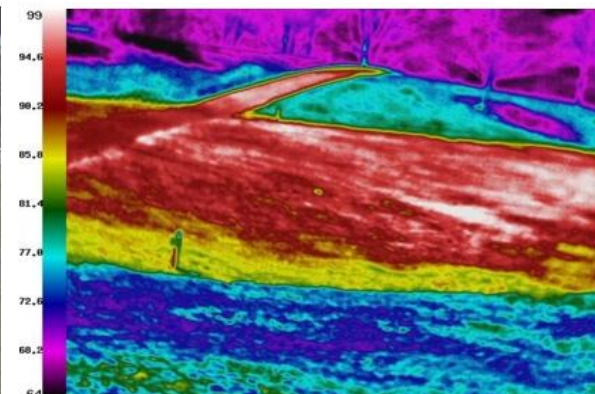
# Nighttime Pattern, February-March





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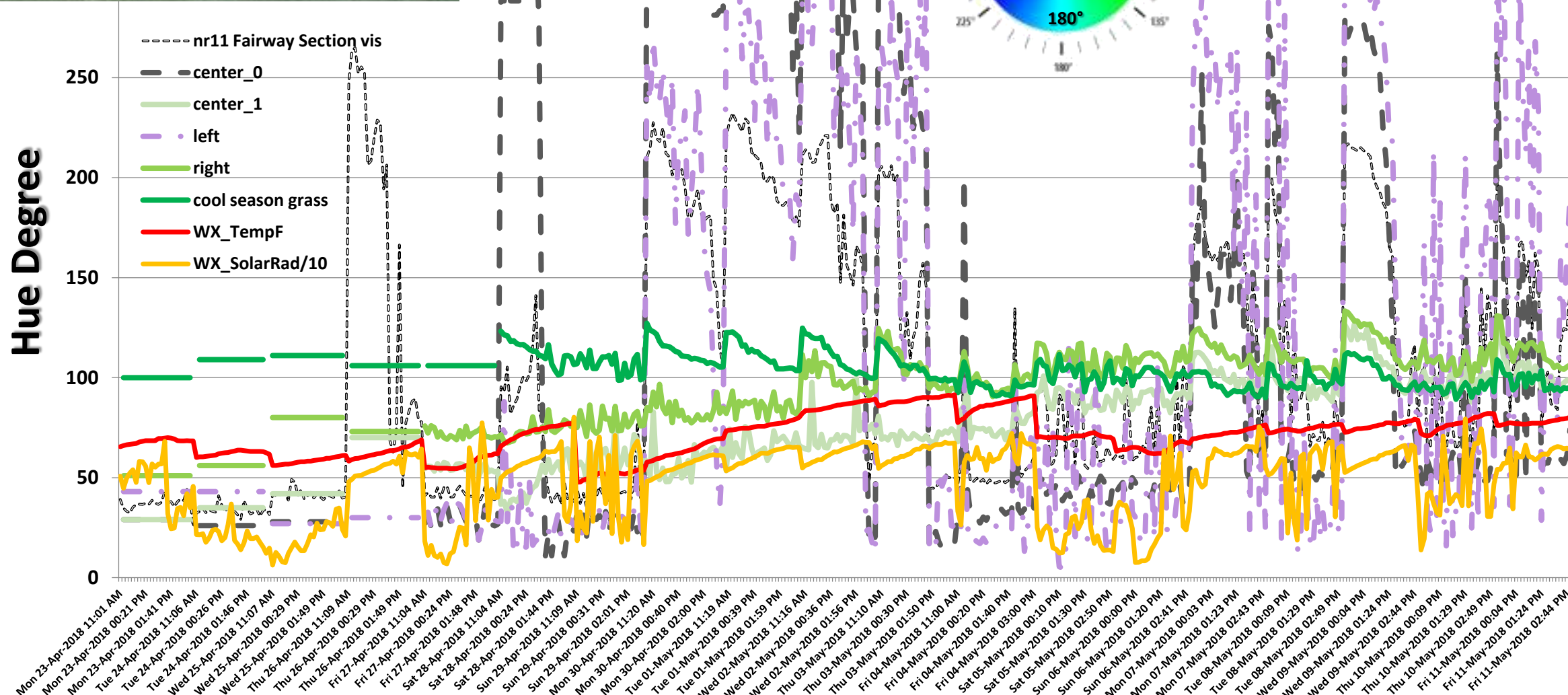
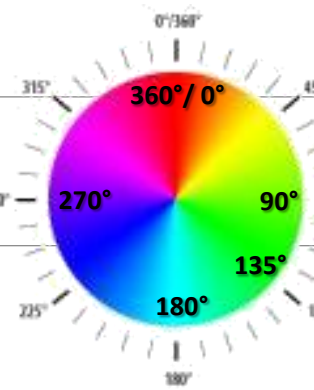
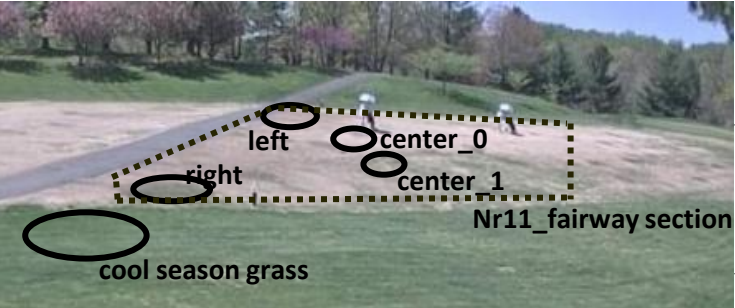
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# Green-Up

There are no boundaries when enthusiasm and excitement are applied to the task at hand.



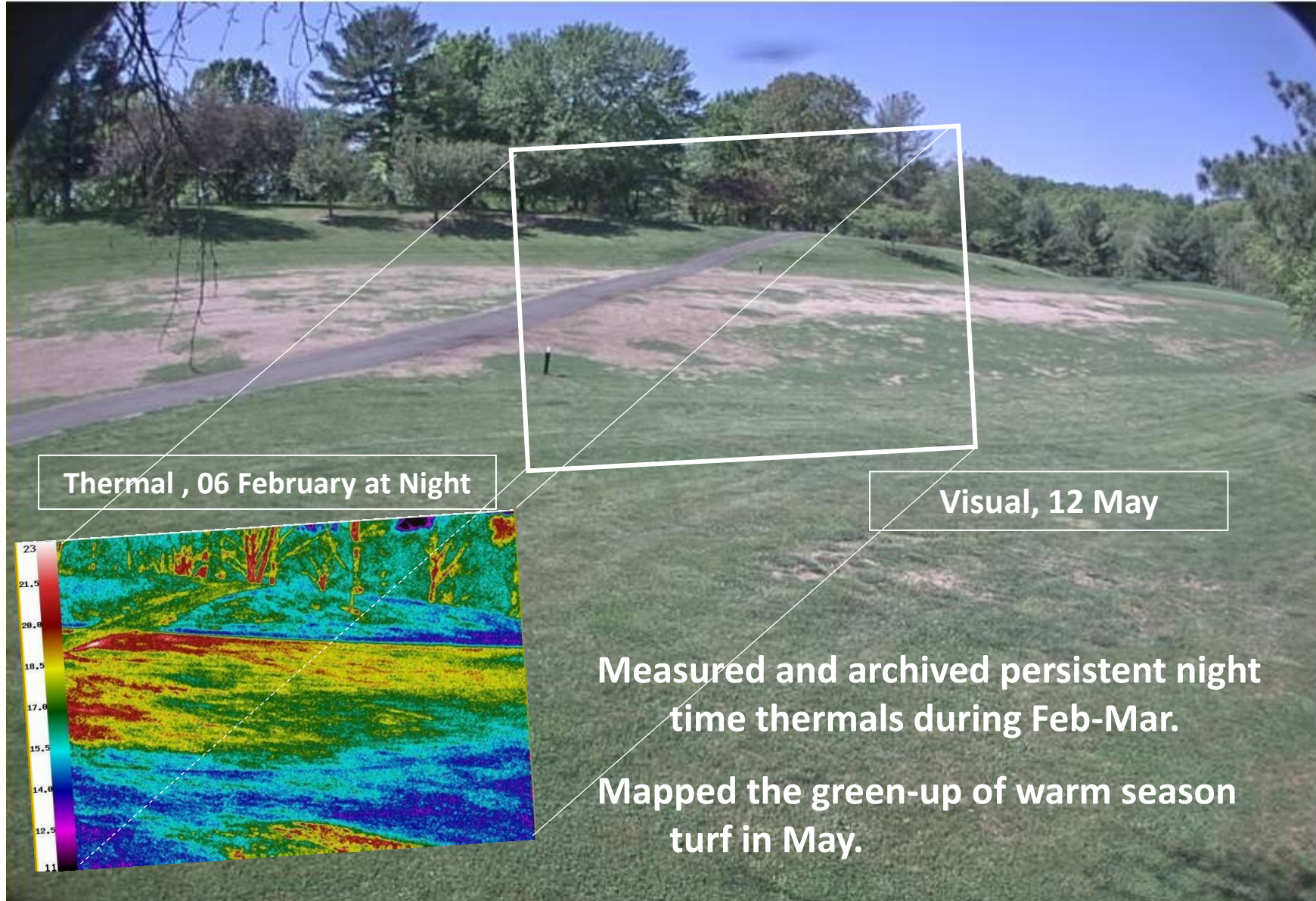


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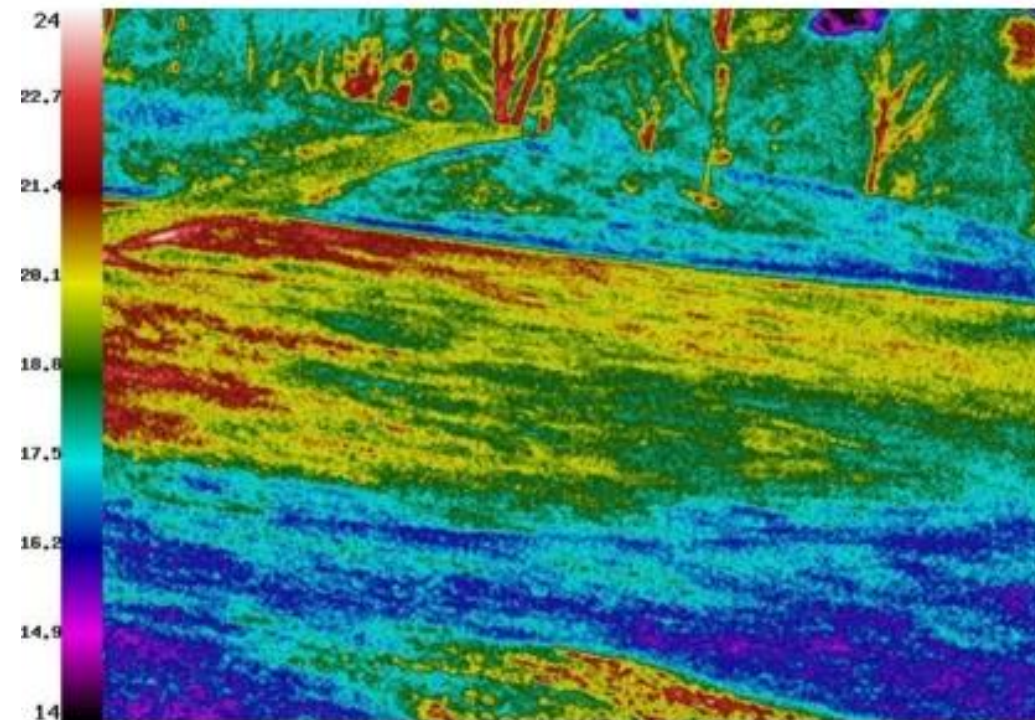


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Tue, 06-Feb-2018 01:15 AM

24.6° F - SRad: 0.00 - RH: 70% - DP: 16.2 - SW @ 0 MPH





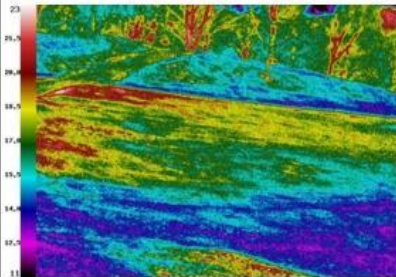


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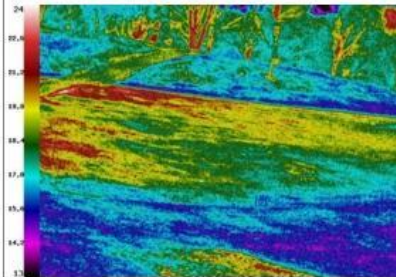
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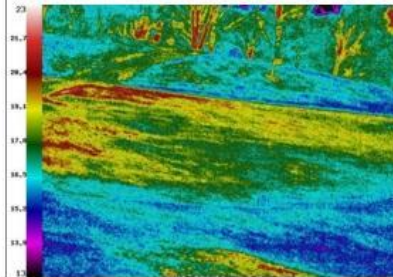
Tue, 06-Feb-2018 00:15 AM  
24.1° F - SRad: 0.00 - RH: 64% - DP: 13.6 - SW @ 0 MPH



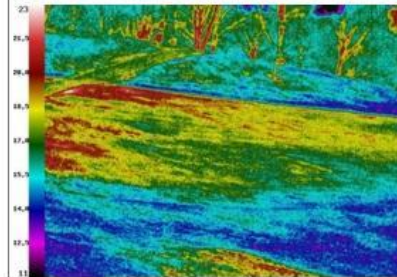
Tue, 06-Feb-2018 00:25 AM  
24.1° F - SRad: 0.00 - RH: 66% - DP: 14.4 - SW @ 0 MPH



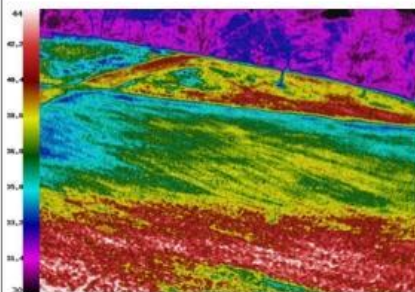
Tue, 06-Feb-2018 00:35 AM  
24.1° F - SRad: 0.00 - RH: 67% - DP: 14.7 - WSW @ 0 MPH



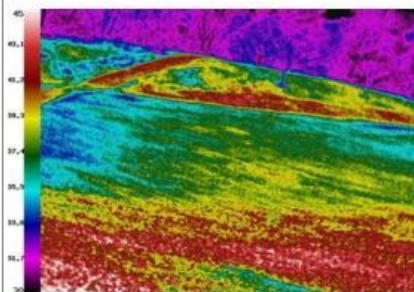
Tue, 06-Feb-2018 00:45 AM  
24.3° F - SRad: 0.00 - RH: 67% - DP: 14.9 - SW @ 0 MPH



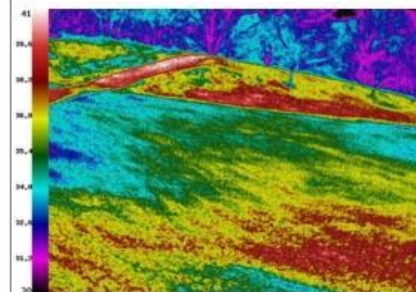
Tue, 06-Feb-2018 11:55 AM  
35.6° F - SRad: 177.86 - RH: 48% - DP: 17.8 - North @ 1 MPH



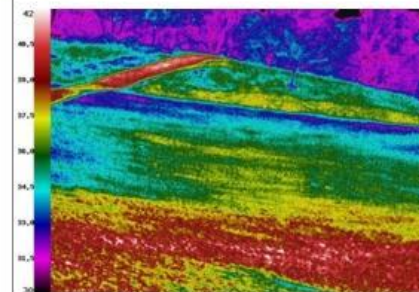
Tue, 06-Feb-2018 00:05 PM  
35.8° F - SRad: 171.55 - RH: 48% - DP: 18.0 - SSE @ 0 MPH



Tue, 06-Feb-2018 00:15 PM  
36.0° F - SRad: 147.71 - RH: 48% - DP: 18.1 - WSW @ 0 MPH



Tue, 06-Feb-2018 00:25 PM  
36.1° F - SRad: 154.47 - RH: 48% - DP: 18.3 - NNW @ 3 MPH



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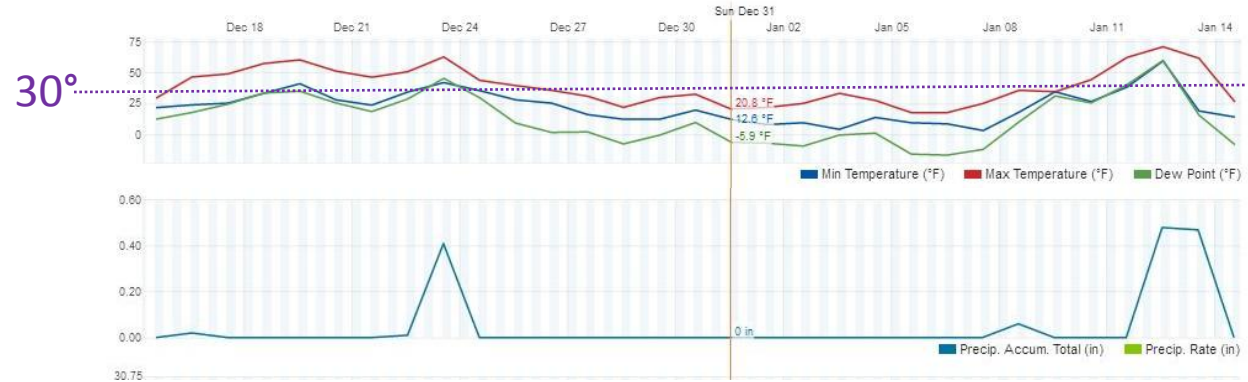
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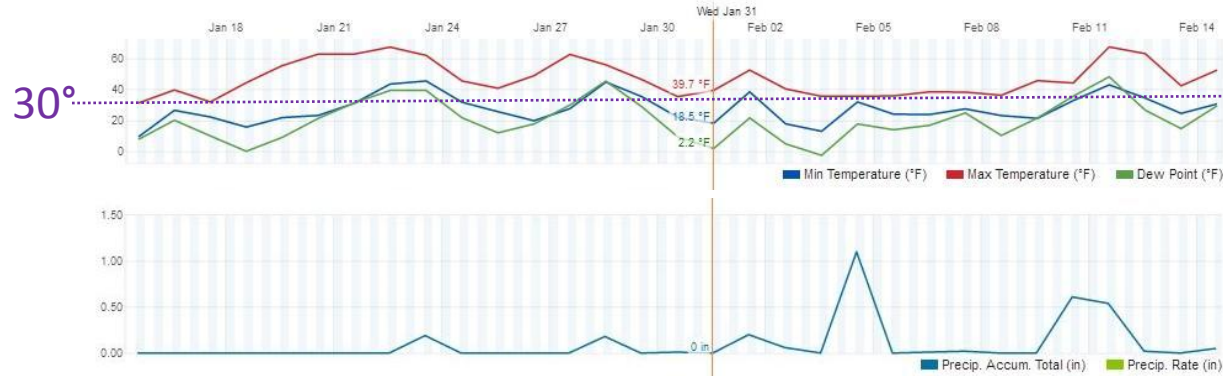
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# Weather Summary

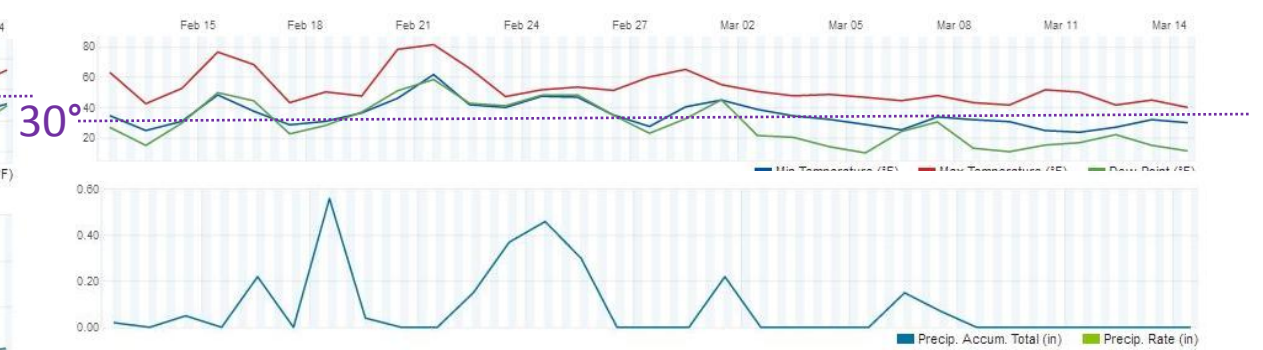
Weather History Graph  
December 15, 2017 - January 14, 2018



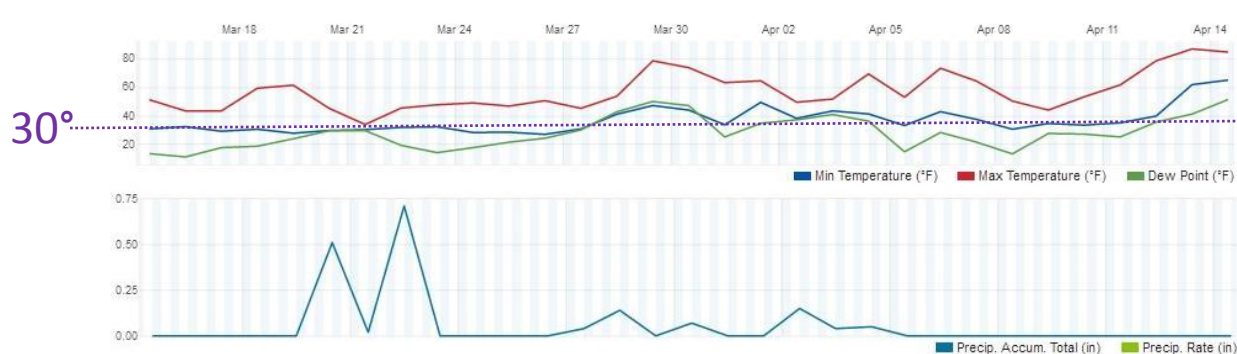
Weather History Graph  
January 15, 2018 - February 14, 2018



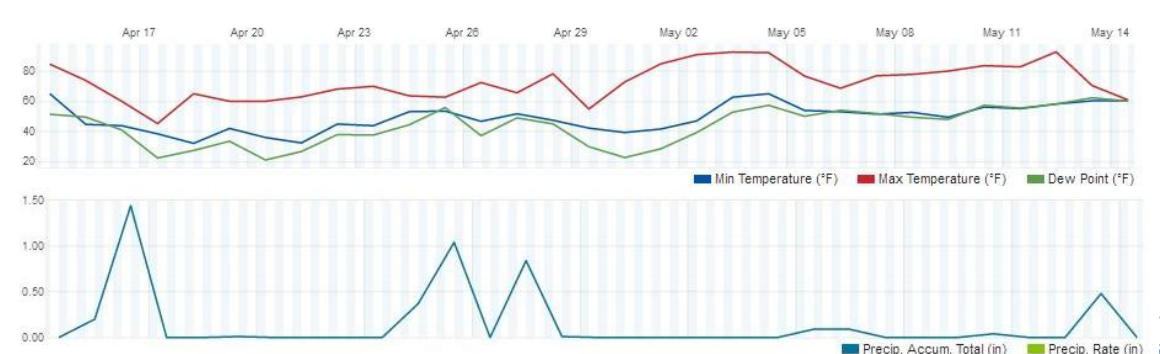
Weather History Graph  
February 12, 2018 - March 14, 2018



Weather History Graph  
March 15, 2018 - April 14, 2018



Weather History Graph  
April 14, 2018 - May 14, 2018



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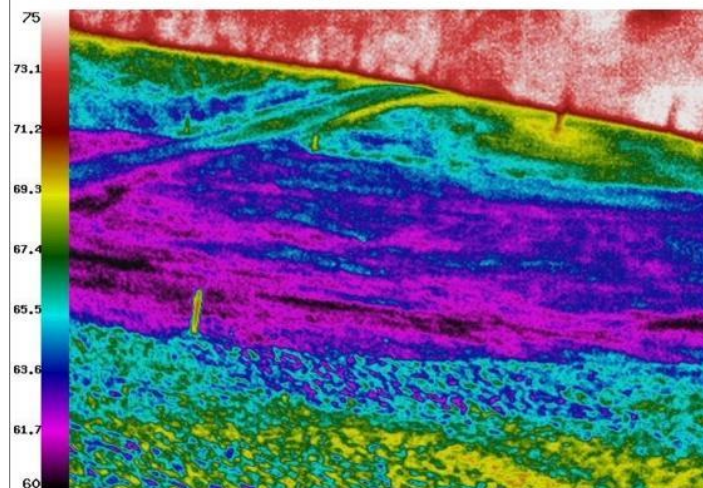
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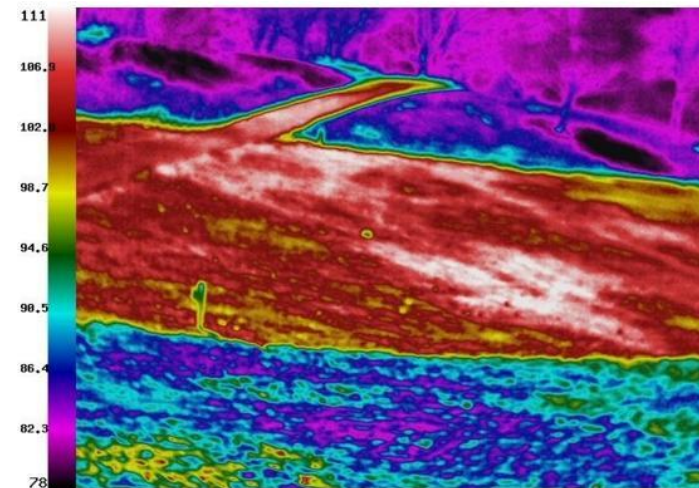
# Dry period for 7 days preceding 14 April



Sat, 14-Apr-2018 00:21 AM  
73.8° F - SRad: 0.00 - RH: 40% - DP: 48.0 - SW @ 4 MPH



Sat, 14-Apr-2018 00:41 PM  
79.5° F - SRad: 570.35 - RH: 40% - DP: 53.1 - SSW @ 9 MPH



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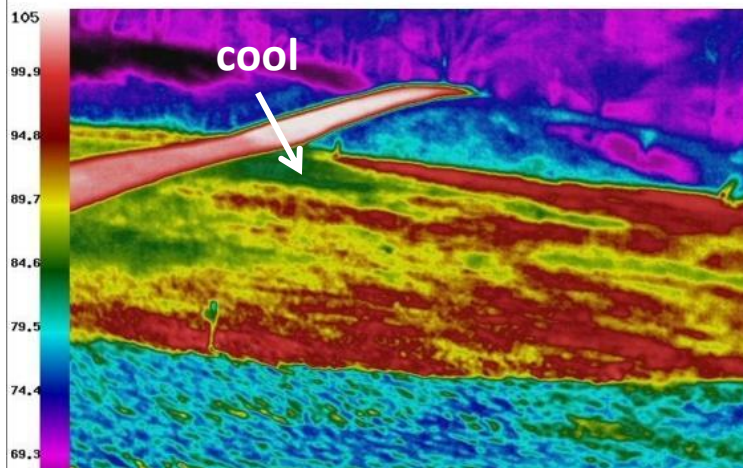
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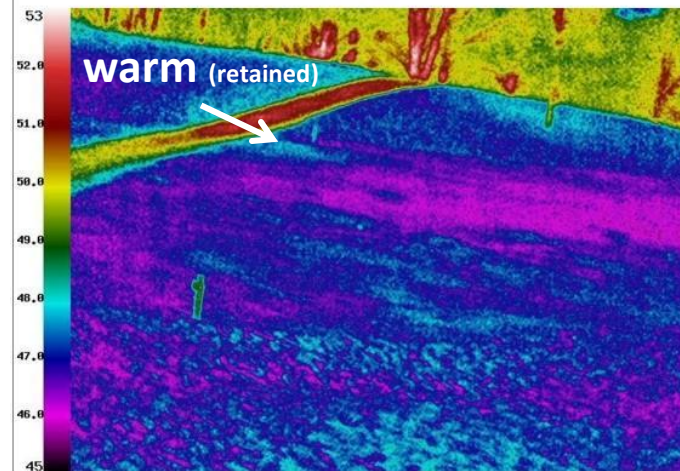
# After Rain



Sat, 28-Apr-2018 00:34 PM  
73.0° F - SRad: 582.13 - RH: 31% - DP: 40.6 - SSE @ 3 MPH



Sun, 29-Apr-2018 00:44 AM  
52.2° F - SRad: 0.00 - RH: 53% - DP: 35.6 - South @ 1 MPH



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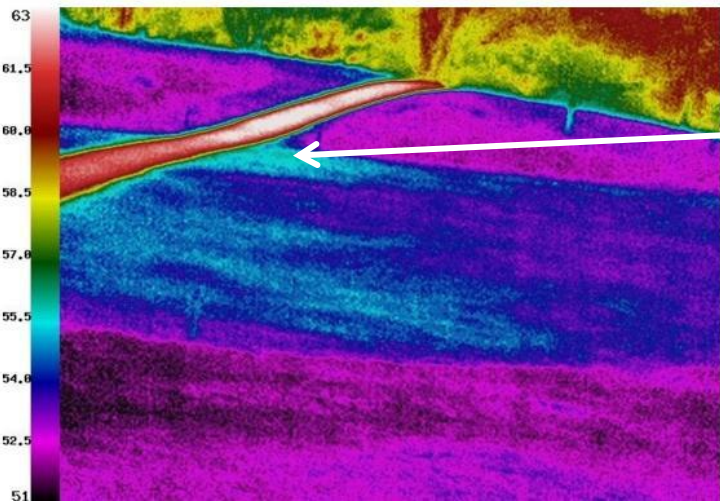




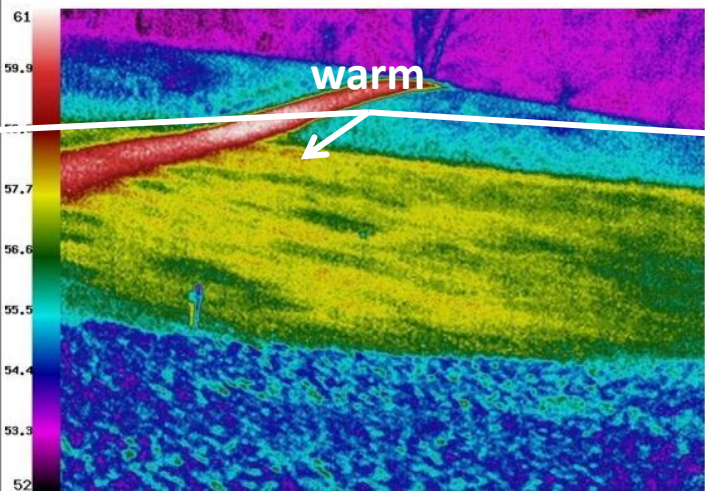
# Before Rain



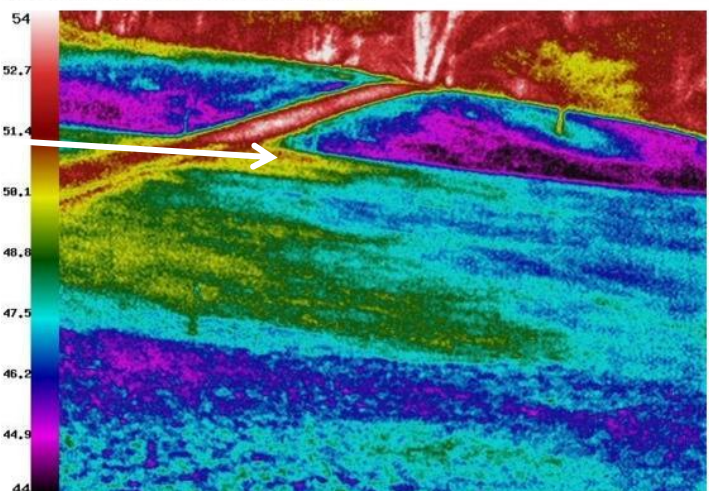
Fri, 27-Apr-2018 00:19 AM  
60.1° F - SRad: 0.00 - RH: 51% - DP: 41.9 - SW @ 0 MPH



Fri, 27-Apr-2018 00:34 PM  
54.5° F - SRad: 129.12 - RH: 87% - DP: 50.7 - SW @ 0 MPH



Sat, 28-Apr-2018 00:08 AM  
52.3° F - SRad: 0.00 - RH: 92% - DP: 50.2 - SW @ 0 MPH



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**Poor drainage.**  
**Persistent wet areas.**  
**Persistently below freezing temperatures** (more than 3 days in a row)

**Frozen roots = winter kill**

Green-Up, The Movie: <https://vimeo.com/269639967>