**Introduction**

Range conditions can be assessed weekly from your desktop PC using PhenoMap, the phenology monitoring web browser application developed by the Western Wildland Environmental Threat Assessment Center (WWETAC). Phenology is the study of recurring biological events such as emergence, elongation, and flowering of grassland plants. PhenoMap is a web map built with ESRI ArcGIS On-Line software and it is free and open to all users. No additional software (other than a web browser) is required.

**What can you view in PhenoMap?**

**NDVI - ‘Greenness’**

Using remotely sensed data, we can assess vegetation “greenness” using the Normalized Differential Vegetation Index (NDVI) as a proxy for the collective phenology in a ~15 acre pixel. In addition to NDVI, PhenoMap also contains information on how the current NDVI value of a pixel compares to its historical (2000-2015) and maximum NDVI. Every Friday, the NDVI values are updated and published online. The current week along with the previous three weeks are displayed in the PhenoMap web map (fig. 1).

**Accumulated growing-degree-day**

The growing degree-day is a measure of the daily mean temperature above an established threshold (Base temperature). The seasonal cumulative total (starting 1 January) of these daily values (Accumulated growing degree-day - AGDD) is a strong predictor of phenological events. PhenoMap displays AGDD layers from the USA National Phenology Network (https://www.usaepn.org/) using 50 degree F and 32 degree F base temperatures. Anomaly layers depict the departure of the current AGDD from the 30 year (1981-2010) mean value for the same date (fig. 2).

**Precipitation**

Rainfall can vary widely across space and time from forecast estimates. Knowledge of precipitation amounts in the near (past 14 and 30 days) and mid (past 60 days) can help inform range management, while longer range precipitation estimates provide information for current and out-year planning. PhenoMap has 14, 30 and 60 day cumulative estimated precipitation layers, and cumulative estimates for the water year (since 1 Oct) to date produced by the National Weather Service using a combination of satellite and ground observations (https://water.weather.gov/precip/) (fig. 3).

**Validation studies**

Those colors on the map are pretty, but what do they mean on the ground? We answered this question with two studies:

1. We conducted a detailed field study on the Buffalo Gap National Grassland in western South Dakota. Weekly in-situ phenology field measurements were taken at 21 sites during the 2016 growing season (fig. 4). The data from these sites was correlated to the weekly NDVI greenness satellite data (fig. 5).

2. As a proxy for field data, we used greenness measures from the PhenoCam network of fixed-view digital cameras that collect multiple images per day. These greenness values (green chromatic coordinate—gcc) were correlated with the NDVI values for 2014-2016 (fig. 6).

Both studies showed a strong relationship between the satellite NDVI and the field measurements and PhenoCam greenness.

**Conclusions**

PhenoMap is a tool designed to help managers assess rangeland and grassland conditions across the vast landscapes under their care. Increasingly volatile climate extremes are resulting in phenological changes across both time and space. PhenoMap contains a wealth of information that can help inform management decisions such as stocking rates, rest and rotation, and utilization. It is a new tool in your toolbox for managing rangelands and grasslands.

Launch PhenoMap and give us feedback on changes/improvements that would help you do your job!

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For more information, see the following web pages:

https://www.fs.fed.us/wwetac/threat-map/TRMPheonoMap.php
https://www.fs.fed.us/wwetac/threat-map/threatmap.php

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