Vegetation Index
Pasture, Rangeland and Forage

Vegetation Index (VI) Pasture, Rangeland, and Forage (PRF) VI Technology

August 2014

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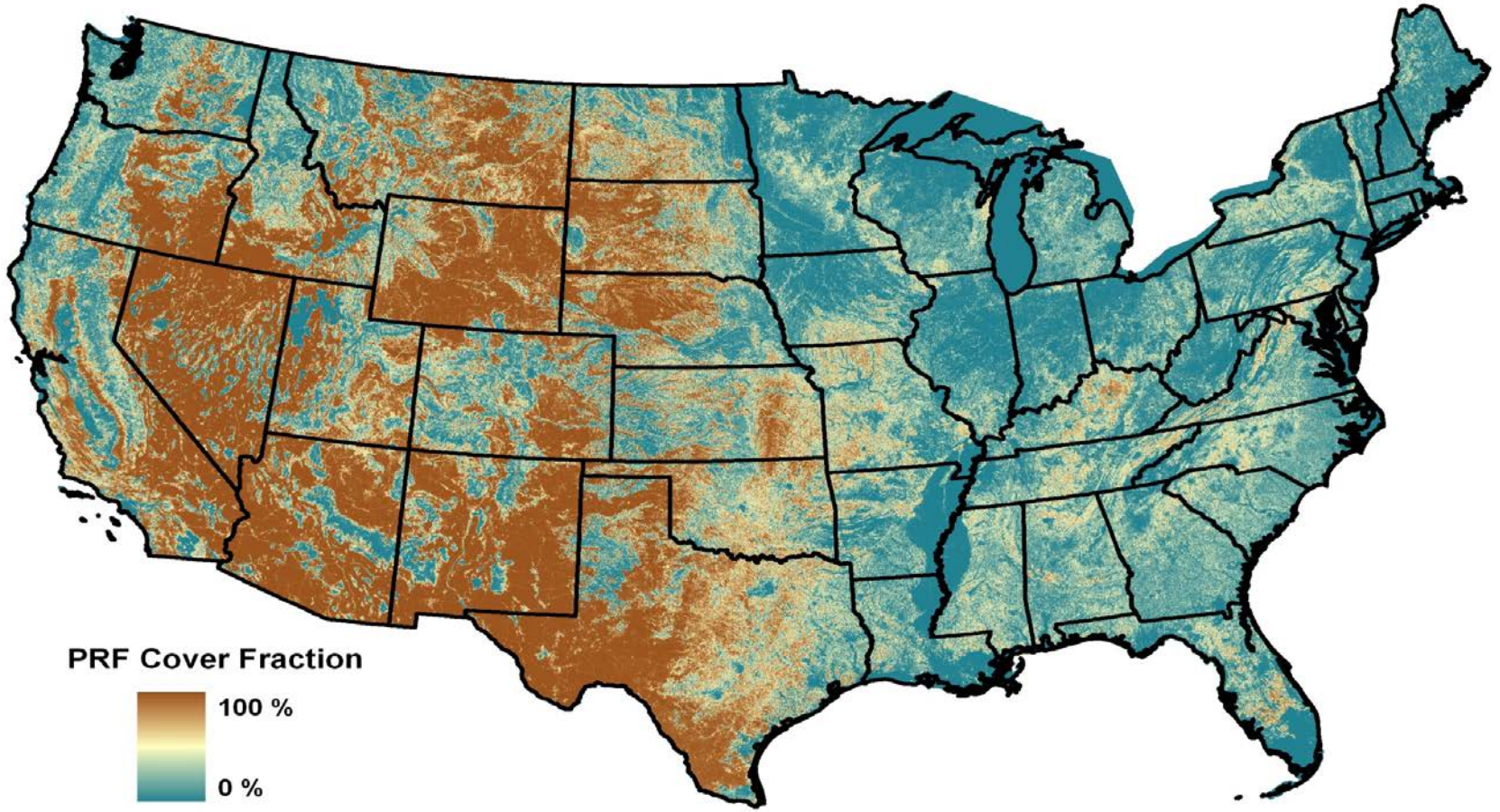
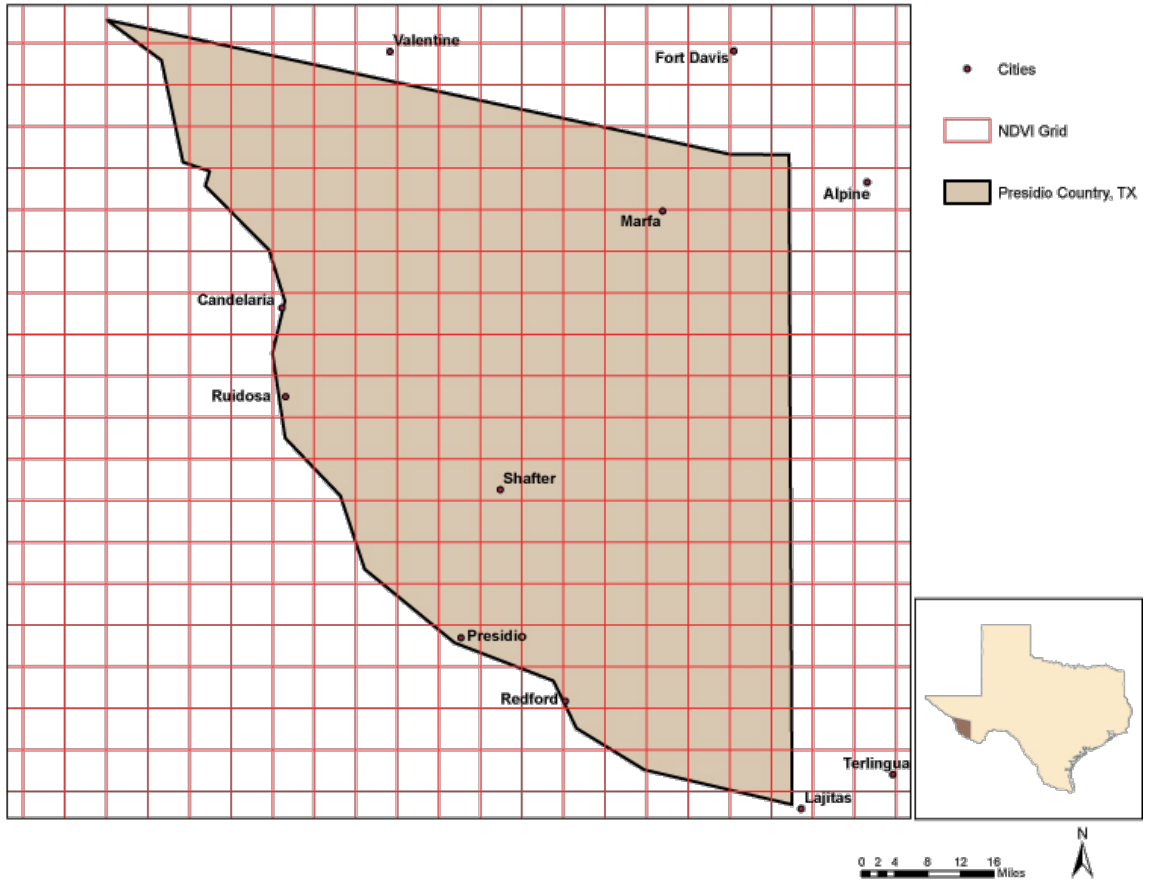
Vegetation Index PRF Cover



This map provides an overview of which areas PRF should correlate well. Producers should confirm how well the product has correlated to their past production using the Historical Indices and Decision Support Tool. Irrigation, row crops, and other plants will influence results.

Grid Overview

Insurance Area = 8 x 8 km (approximately 5 x 5 miles)



Program Overview

Index Intervals:

- Crop year divided into 10, 3-month index intervals;
  - Must select at least one interval.
  - Can select up to four intervals if available.
- Crop practice = index interval;
- Ability for producers to manage risk by selecting appropriate time periods that correlate to vegetation growth patterns and production seasons; and
- The 3-month intervals provide for greater reaction to biomass reduction events vs. a yearly average.

Technology

- United States Geological Survey (USGS) – Earth Resources Observation and Science Data Center (EROS).
- Historical Data can be retrieved from:
  - http://edcsns17.cr.usgs.gov/EarthExplorer/.
    - Select the AVHRR composites.
- Bi-weekly composite can be retrieved from:
  - http://ivm.cr.usgs.gov/.
    - NDVI is band 6 in the binary image.
    - Information about the data can be retrieved from: http://ivm.cr.usgs.gov/Metadata.doc.
- The EROS data center processes NDVI images. RMA does not process the images further.

Satellite Data Source

- Satellite data used for VI-PRF is from NOAA's Advanced Very High Resolution Radiometer (AVHRR) satellite.
- The AVHRR instrument has been flown on satellites since the late 1970s.
- The satellite measures the reflectance of the earth from five different spectral bands.

Science

- The wavelengths of visible and near-infrared sunlight reflected by biomass are captured by specialized sensors on the AVHRR satellite.
- When sunlight strikes biomass certain wavelengths of the light spectrum are absorbed and other wavelengths are reflected.
- The chlorophyll in a plant leaf strongly absorbs visible light (from 0.4 to 0.7 μm) for use in photosynthesis.

Science

- The cell structure in a plant leaf strongly reflects near-infrared light (from 0.7 to 1.1 µm).
- The more leaves a plant has, the more these wavelengths of light are affected.
- The spectral reflectance data can be used to measure and monitor plant vigor, cover, and biomass.

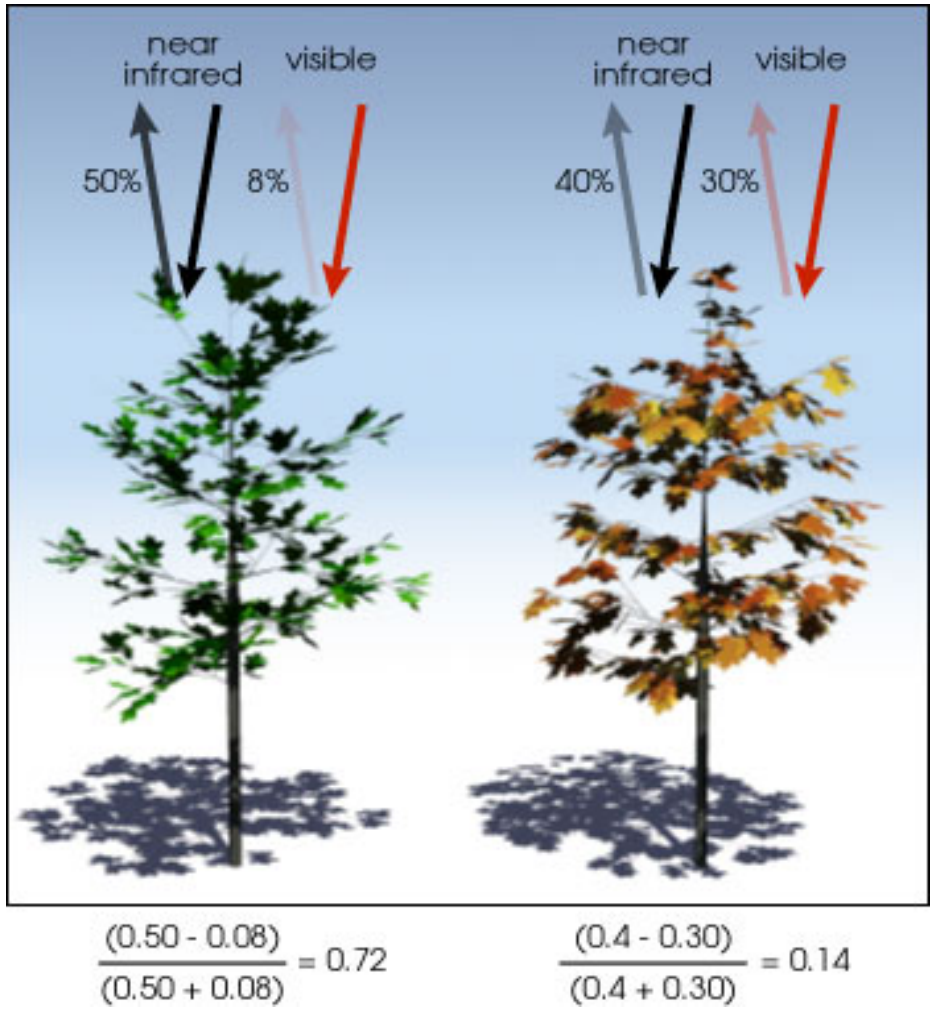
Normalized Difference Vegetation Index

A ratio of the visible and near infrared reflectance, as measured by the satellite, can then be used to calculate a standardized index called the Normalized Difference Vegetation Index (NDVI).

$$NDVI = \frac{(\text{NIR - VIS})}{(NIR + VIS)}$$

VIS = Visible reflectance
NIR = Near Infrared Reflectance

Vegetation Spectral Differences and NDVI



In this example:

- Green vegetation reflects only 8% visible light and 50% near infrared.

  NDVI = 0.72

- Senescing vegetation reflects 30% visible light and only 40% near infrared.

  NDVI = 0.14

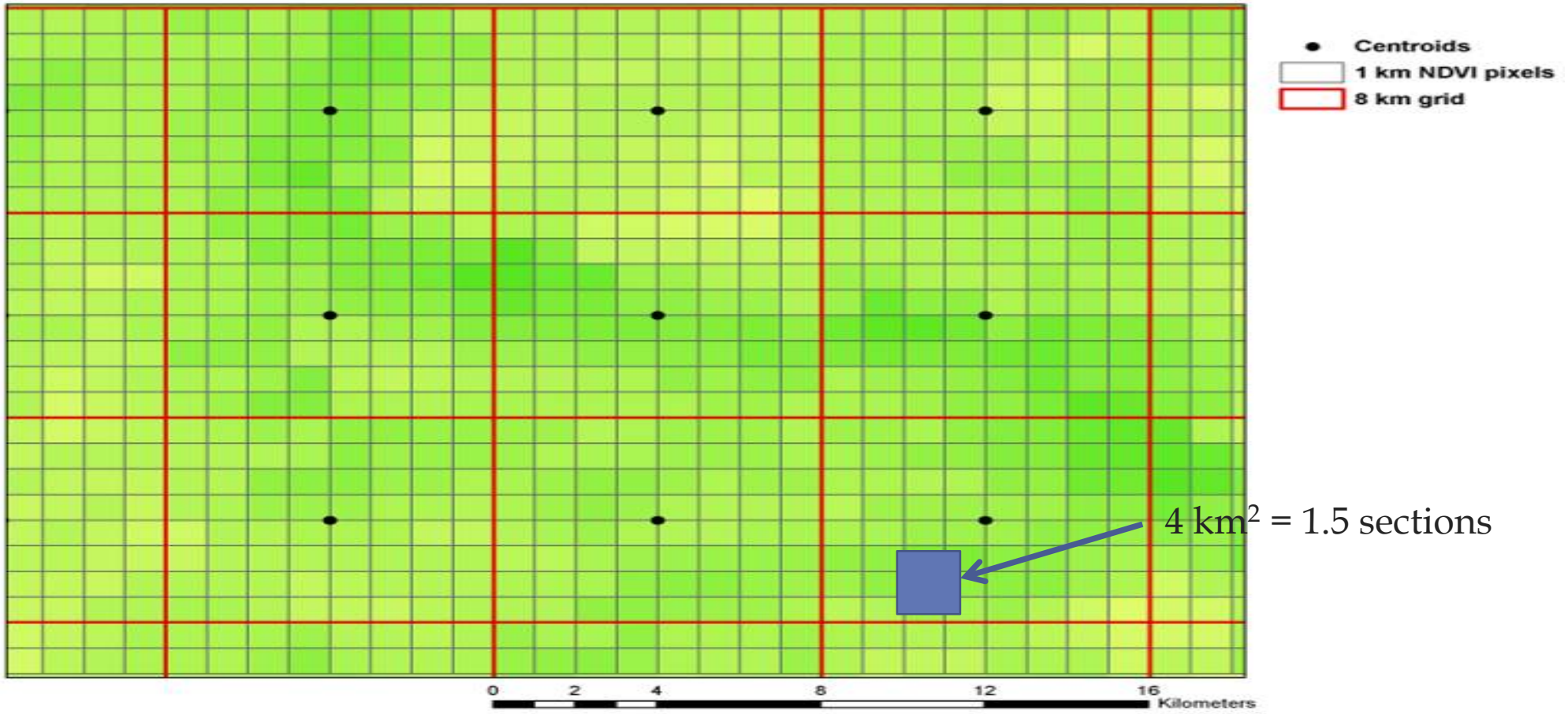
NDVI Characteristics

- Healthy vegetation absorbs most of the visible light that hits it and reflects a large portion of the near-infrared light
- Senescing, unhealthy, or sparse vegetation reflects more visible light and less near-infrared light.
- Calculations of NDVI result in a number that ranges from minus one (-1) to plus one (+1).
- Areas having no green leaves have NDVI values close to zero. Values near +1 (0.8 - 0.9) indicates the highest possible density of green leaves.

NDVI Characteristics

- Data from the AVHRR satellite are processed by USGS EROS and have been available since 1989.
- AHVRR data is collected daily, however the product used is the 14-day maximum NDVI composite image.
- Resolution of the data is 1-km, but aggregated to 8 km for VI-PRF.

1x1 km NDVI Grids Averaged to 8x8 km Grids



4 km^2 = 1.5 sections

Data Processing

- At the end of each index interval, the NDVI images are staged for insurance indexing. The data are screened to remove negative NDVI values, such as clouds and water.

- Negative NDVI values are not used in the index calculations.

Vegetation Index Calculations

Calculation of the Final Grid Index has 3 stages:

- Calculating of the daily index values;
- Averaging the daily index to calculate the interval index; and
- Standardizing the current interval index to the long-term average of the historical interval indices.

Daily Index Calculations

A daily vegetation condition index is calculated for each grid.

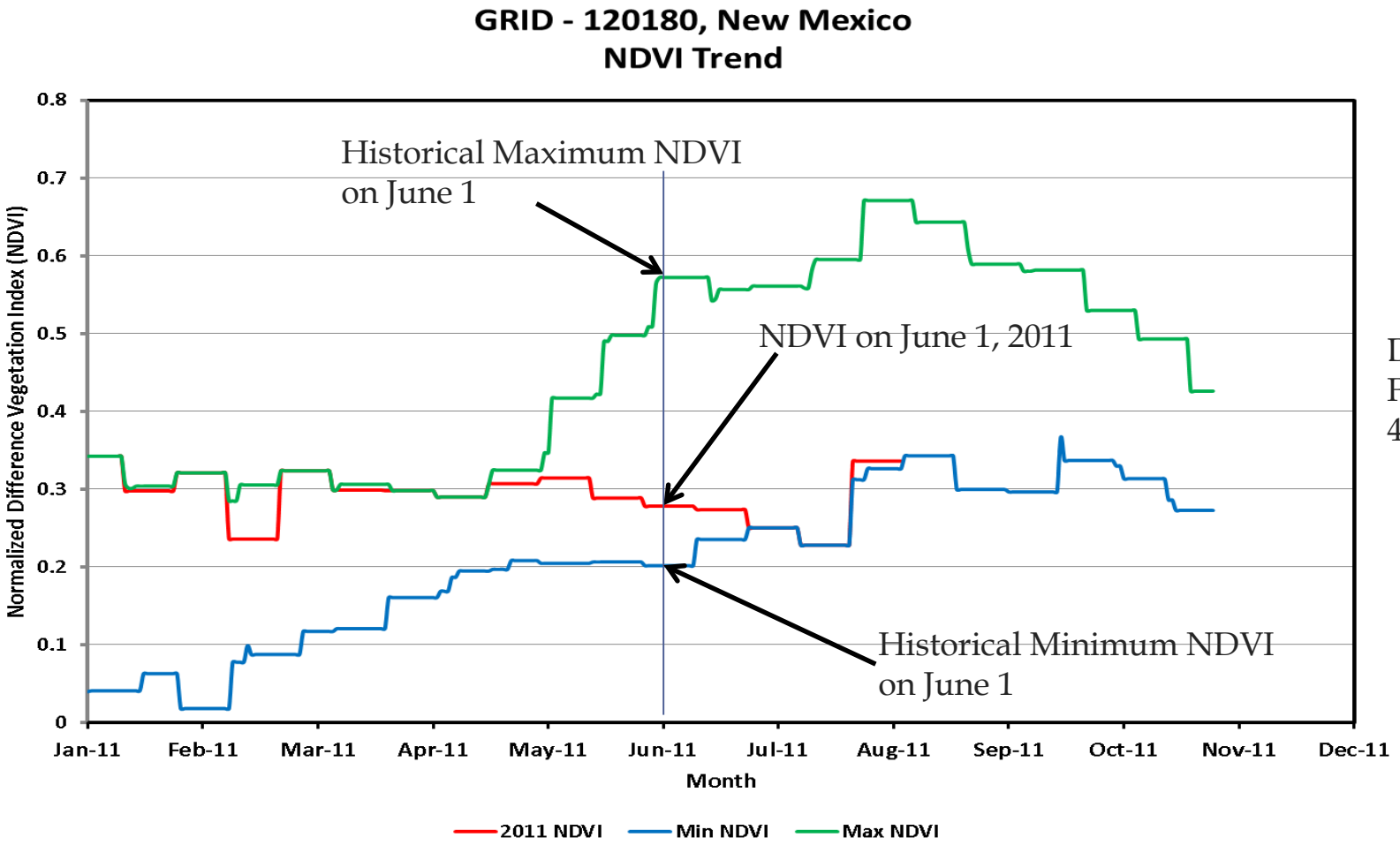
$$Daily\ Index_i = \frac{(NDVI_i - NDVI\min_i)}{(NDVI\max_i - NDVI\min_i)} * 200$$

Daily Index $_i$ = daily vegetation condition index for day i.
$NDVI_i$ = NDVI for day i.
$NDVImin_i$ = the minimum NDVI across all years for day i.
$NDVImax_i$ = the maximum NDVI across all years for day i.

Note: 200 is an arbitrary scalar

Adapted from Kogan (1990, 1995) Vegetation Condition Index.

Daily Index Calculation



Daily Index For June 1= 49.7

Example of progression in time of VI values and results. Note that while the spring of 2011 was very dry, a high value was reported due to a high level of carry over biomass from 2010. The drought results set new lows late summer and fall of 2011. This is an example of why it is critical to view the Historical Indices Tool to find the index interval that best correlates to production vs. spring green up.

Daily Index Calculation

- The Daily Index calculation answers the question, "How does today's vegetation condition compare to the historically 'best' and 'worst' conditions for this day as determined by the satellite."

- Daily Index values near zero indicate a relatively poor vegetation condition compared to the history for that day.
  - Does not mean that no vegetation is present!
  - So, if the "worst" day historically for a given day had evergreen vegetation present, such as cholla, creosote bush, and juniper then this "reflectance" does not influence the daily index value because it is the minimum value.

- High values indicate relatively good vegetation conditions compared to the history on that day.

Final Grid Index Calculation

- For each interval, the daily index values are averaged for the interval to calculate the interval index.

- The Final Grid Index is then calculated by dividing the interval index by the long-term average of the historical indices for the interval.

- **Key point - The first day matters as much as the last day.**

Questions?

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