Contents

OBJECTIVE(S)

Upon completion of this lesson, participants will be able to:

1. Provide an update of the NFDRS2016

NARRATIVE

I. INTRODUCTION

Over the last four decades, the National Fire Danger Rating System (NFDRS) has been used extensively to support fire management decisions nationwide. During that time, several system deficiencies have been identified and many lessons have been learned. In order to address these identified needs, three major changes are being implemented in the NFDRS: replacing the dead fuel moisture model, replacing the live fuel moisture model, and consolidating the existing fuel models to five fuel response types that are based on existing fire behavior fuel models. The following changes have been made in NFDRS 2016:

II. GROWING SEASON INDEX (GSI)

A. GSI

The live fuel moisture model in NFDRS 78/88 has long been known to be the weakest component of the entire fire danger rating system. While it performs adequately in some of the semi-arid Western United States regions where it was developed, it lacks sufficiently generality to be applicable to a wide range of ecosystems and it has no actual physiological foundations. Additionally, the current live fuel moisture model requires human intervention throughout the season to operate. In the 1978 system, the user must define the green-up date, the dormant date and other live fuel transition dates. In the 1988 revision, users must define Season Codes each year and Greenness Factors roughly weekly to maximize system performance.

A new vegetation phenology model, developed by Jolly et al (2005), was created to address these deficiencies. This model, called the Growing Season Index (GSI), operates on daily surface weather observations of minimum temperature, vapor pressure deficient and photoperiod, all of which can be directly calculated from sensible weather parameters already being measured at each RAWS station.

The main benefit of GSI is that is predicts green-up and dormancy from surface weather data. GSI requires no constant human intervention yet accurately reflects within season and between season live fuel conditions from daily weather observations. This removes the need to ‘manage’ the live fuel conditions such as green-up date, freeze date, cure date and dormant date that are inputs to the current model.

GSI is calculated daily and is the product of three indicator functions that are calculated from sensible weather parameters that are proxies for physiological mechanisms that limit plant functions. GSI has three inputs:

1. 24 hour minimum temperature (TMIN)

2. Vapor Pressure Deficit (evaporative demand)

    a. Calculated from relative humidity and air temperatures

        (1) RH = (VPact / VPsat) * 100

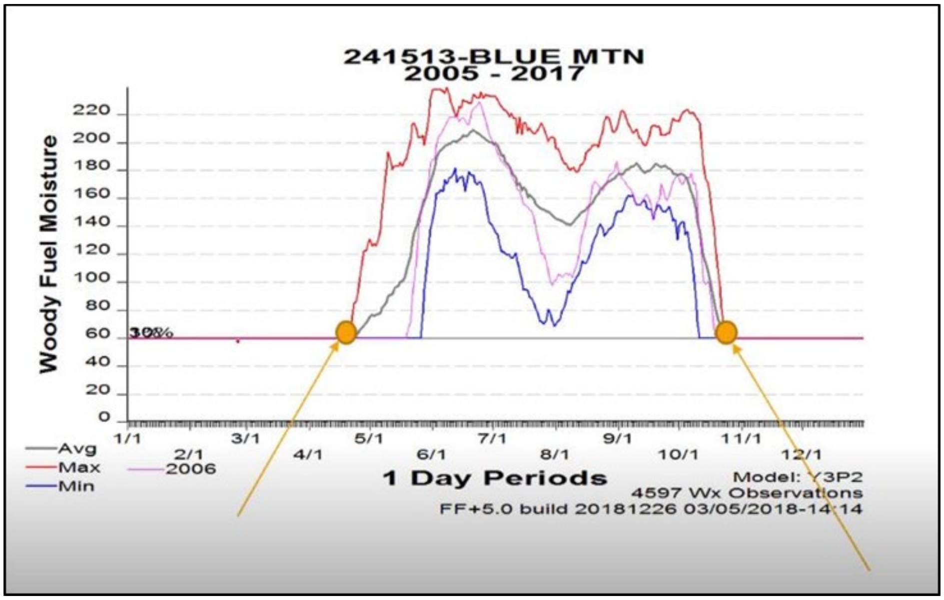
        (2) VPD = VPsat – Vpact

    b. Can be calculated from either 24 hour maximum or 24 hour average temperature (VPDmax and VPDavg, respectively)

3. Photoperiod (daylength).

    a. Calculated from station latitude and year-day

        GSI automatically predicts transitions from dormancy to growth throughout the season and it also depicts period of water stress where herbaceous fuels begin to cure or where woody plants begin to shed leaves. Automated predictions of live fuel conditions will eliminate the needs for NFDRS users to ‘manage’ live fuel conditions throughout the year and it will greatly facilitate historical comparisons of fire danger to fire activity, especially when green-up dates were not recorded. Additionally, this model can depict periods of variability with the timing of green-up between years as well as periods of frost (early or late) and periods of recovery prior to entering seasonal dormancy (Figure 1).



General threshold limits were derived from literature, assuming that phenological activity varied linearly from inactive (0) to unconstrained (1) between a pair of well-defined limits. The product of the three indices forms a combined model that is calculated daily and integrated as a running average (Table 1).

GSI Value	Classification / Interpretation
GSI Increasing	
0 to .5	Pre-greenup; dormancy
> .5	Greenup
.75 to 1.0	Closed green plant canopies
GSI decreasing	
1.0 to .75	Curing herbaceous vegetation
< 0.5	Leaf senescence
Below 0.5	Entering complete curing or dormancy

Table 1. General relationships between GSI values and plant canopy dynamics.

B. The Daily Growing Season Index

1. GSI is calculated as the product of the three daily indicators for minimum temperature, photoperiod and vapor pressure deficit. This final index is continuous and varies from 0 to 1 (Table 1). The index is related to the relative constraints of temperature, water and light limits on plant activity. This mathematical formulation is important because it allows any of the three variables to limit plant processes at any time. For example, if any of the individual indicators is zero (0) then the final product is zero. Also, if any of the individual indicators values is one, then they have no effect on the index.

   The graphs below (Figure 2) are example seasonal plots of minimum temperature (left) and vapor pressure deficit (right). During winter, the area is limited by temperature and during summer the area is limited by water availability.

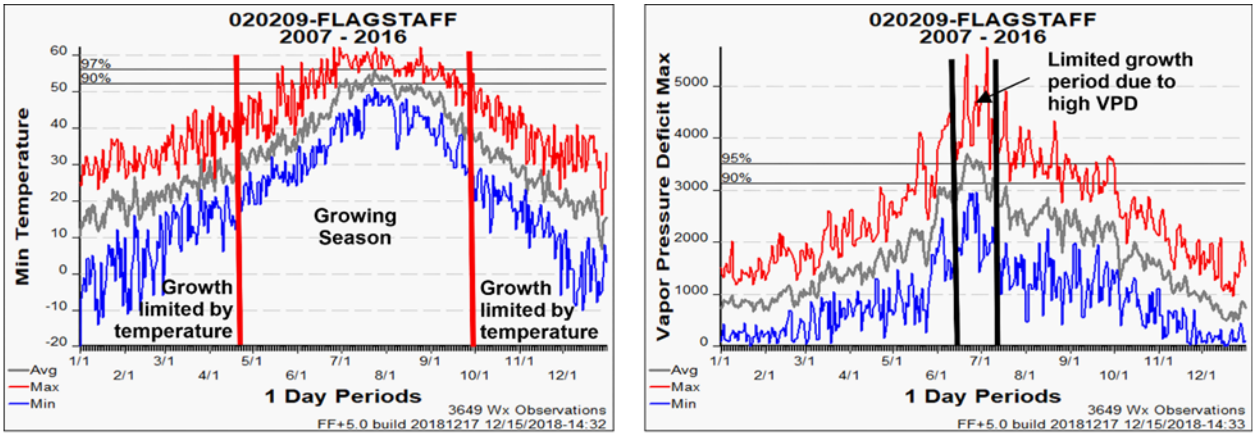


Figure 2. Minimum Temperature and Maximum VPD graphs depicting conditions limiting to plant growth (i.e. temperatures at 32 °F and below, maximum VPD values above 4,100 Pa).

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The GSI graph below (Figure 3) depicts the mid-season slowing in growth due to the limits imposed by the high level of the vapor pressure deficit. Once the green-up threshold of 0.5 is exceeded (spring) plants have greened up. When the GSI value falls below this threshold, plants have entered into dormancy (fall).

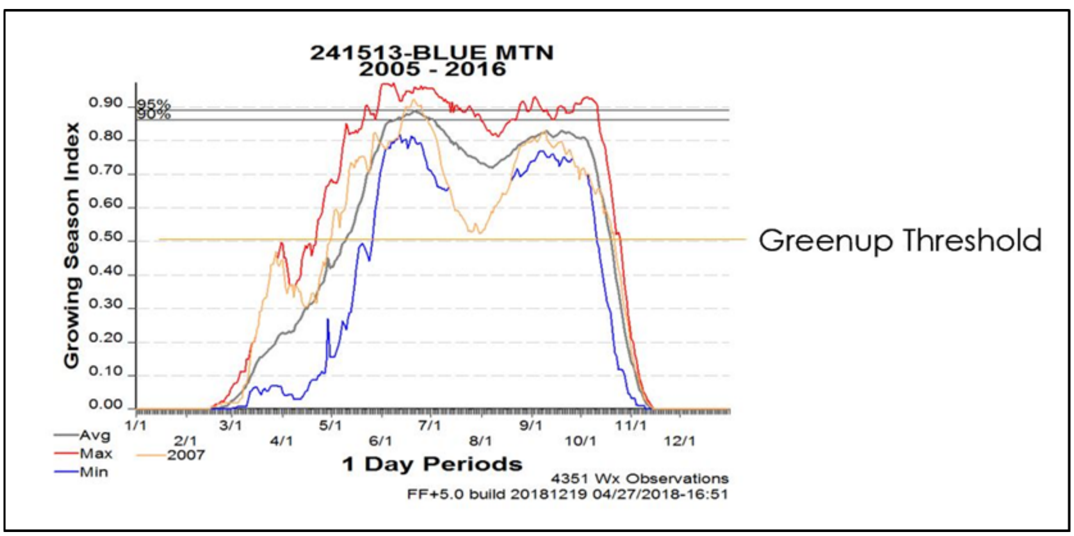


Figure 3. Growing Season Index graph depicting green-up (>.50) and dormancy periods (<0.50). Note seasonal-slowing growth during summer months due to high VPD values (limited moisture availability).

2. Final Growing Season Index

   a. The daily index is calculated and used in a 21-day running average.

b. This running average smooths the seasonal signal and limits fast increases and decreases in the index value due to discrete, short-term weather events such as one or two warm days early in the year.

3. Live Fuel Moisture

The calculations of live herbaceous and woody fuel moistures are a three-step process that begins with the calculation of the GSI and the "smoothing" using a running 21-day average. Then the raw values are rescaled (if necessary) based on the maximum GSI. This rescaled value is then used to calculate the live fuel moisture.

The model used to transform GSI to live fuel moisture only requires a green-up threshold and the definition of the minimum and maximum live fuel moisture values. While the user can edit some of these parameters, for most purposes the default values will be more than sufficient.

The indicator limits for each variable are listed in Table 3. Minimum temperatures less than 28.4 °F (-2 °C) are assumed to completely limit plant processes and above 41 deg F (5 °C), temperature is assumed to not limit plant function. VPD less than 900 pa is assumed to not limit plant processes and above 4,100 pa it is assumed to completely limit plant function. Photoperiods less than 10 hours are fully limiting and above 11 hours, photoperiod is assumed to have no effect.

	Lower Limit	**Upper Limit**
Minimum Temperature	28.4° F (-2°C) (T_{MMin})	41° F (5°C) (T_{MMax})
Vapor Pressure Deficit	900Pa (VPD_{Min})	4,100Pa (VPD_{Max})
Photoperiod	36,000 sec ($Photo_{Min}$)	39,600 sec ($Photo_{Max}$)

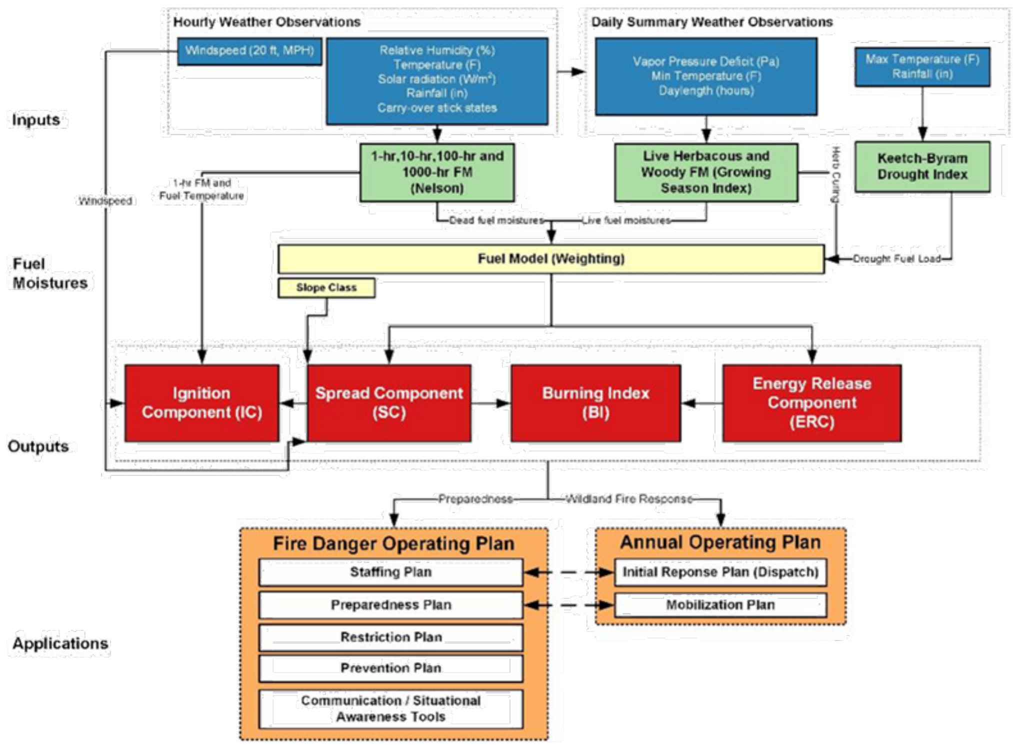
Table 3. Indicator limits for GSI variables.

Live Fuel Model (LFM) parameters:

- GSI indicator thresholds
- Maximum GSI value
    - Default is 1.0 but can be used for model calibration
- Green-up threshold
    - Default is 0.5
- Minimum and maximum live herbaceous and woody fuel moistures (FM)
    - *Minimum herbaceous FM is 30% and Maximum herbaceous FM is 250%
    - *Minimum woody FM is 60% and maximum herbaceous

FM is 200%

*These are the same maximum values used in NFDRS 1978 / 1988



REVIEW OBJECTIVE(S)

Upon completion of this lesson, participants will be able to:

1. Provide an update of the NFDRS2016

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