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The Next Generation Brief: FWI2025 in Focus

GRASSLANDS IN THE FWI SYSTEM

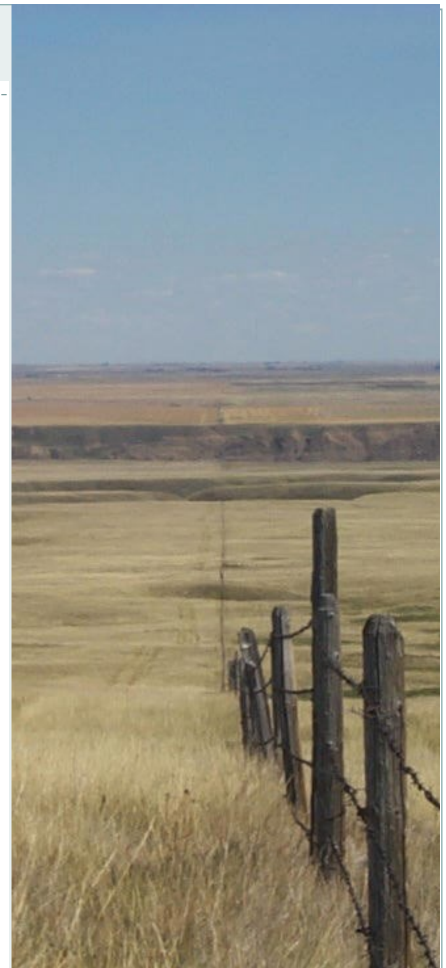
The update to the Canadian Forest Fire Danger Rating System (CFFDRS) includes new grassland components within the Fire Weather Index System (FWI2025), aimed at improving the accuracy and relevance of fire danger assessments in grassland ecosystems. These components support decision-making by providing standardized indicators of fire danger in open grasslands, helping guide operational choices for fire managers.

Since the Canadian Forest Fire Weather Index System was released in 1987, discussions with fire managers indicated that the System is less accurate in some situations, especially during the early spring when grassland fuels are exposed to the sun and dry quickly. Prescribed burns are commonly conducted in spring and fall, when fuel conditions are receptive, weather is more predictable, and ecological timing supports vegetation management. In spring, burns are often timed before green-up to reduce invasive species and recycle nutrients; in fall, they help remove accumulated thatch and control woody encroachment. To better reflect these dynamics, three new components—the Grassland Fuel Moisture Code (GFMC), the Grassland Spread Index (GSI), and the Grassland Fire Weather Index (GFWI)—are introduced in FWI2025 to address this fuel type that dries and spreads at significantly faster rates compared to the standard pine.

This newsletter will cover topics such as the physical process of curing, challenges in assessing the degree of curing of a grassland, the new FWI2025 grassland components, and a short overview of a prescribed burn in grasslands.

GUIDING PRINCIPLES

- ⇒ Standardising the FWI system to a finer timescale does not necessarily translate into interpreting FWI system outputs at a finer landscape scale. FWI2025 outputs are still intended for use in landscape-level planning.
- ⇒ FWI System models are simplifications of reality that produce estimates of fuel moisture and fire behaviour in the wildland fire environment. These models are built on scientific understanding and historical data, but they do not capture every nuance of real-world conditions. Instead, they provide useful approximations that help guide decision-making. Like the rest of the CFFDRS, the models used in FWI System balance complexity with usability - offering insights that are broadly applicable across landscapes, rather than precise predictions for specific locations. Users should interpret outputs as indicators of general fire potential, not as exact forecasts.



Source: Geological Survey of Canada, 2000

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Source: Turner, R. J. W. , 2004

DESCRIPTION OF THE NEW STANDARD FUEL TYPE: GRASSLANDS

The new grassland components assume a continuous layer of grass in an open, canopy-free zone. These areas should be large enough—about the size of a typical fire weather station clearing—so that wind flows freely without interference from nearby trees. Forest edges can create turbulence and wind shifts, which affect the wind inputs that GSI and GFWI rely on. Accurate wind representation is critical for predicting grassland fire behaviour. If clearings are too small, or readings are taken near tree lines or under sparse woodland canopy, the assumptions about surface wind strength may not hold, which could lead to overestimated spread and observed fire behaviour that is lower than the indexes suggest. Understanding these limits helps ensure safer, more reliable fire behaviour predictions.

GRASSLAND FUEL LOAD DESCRIPTION

Fuel load in grasslands is estimated using units of measurement expressed as weight per area (e.g. kg/m² or t/ha). Monitoring fuel load over time provides information that can help fire managers understand the potential fire danger in an area, supporting more accurate fire intensity estimates. The **default fuel load value is 0.35 kg/m² or 3.5 t/ha** for the FWI2025 grassland components.

The Field Guide for Predicting Fire Behaviour in Ontario's Tallgrass Prairie (commonly called the "Yellow Book") outlines two methods for estimating fuel load in standing grass: the Robel pole method, which measures visual obstruction, and a photo series showing fuel loads in tallgrass prairie. While the Robel pole method offers more precise measurements, it is time-consuming and less practical during fire operations. In those cases, the photo series provides a quicker alternative for estimating fuel load. As mentioned in the curing assessments section, visual methods can be influenced by personal judgment. Matted layers of grass, for example, may be difficult to detect in standing vegetation. Grasslands, like all fuel types, are not uniform—they often contain patches with different species or fuel densities. When time permits, each relatively uniform area should be assessed separately to determine its fuel load.

HISTORICAL INSIGHT

The default grass fuel load used in the Fire Behaviour Prediction (FBP) System has evolved over time. Originally set at **3.0 tonnes per hectare (0.30 kg/m²)** in the 1992 version, this value did not account for natural variability across landscapes.

Subsequent research from **Australia and New Zealand** indicated that grass fuel loads are typically higher, averaging around 3.5 t/ha (0.35 kg/m²). Field data from various regions, including experimental burns and observations in Alberta, supported this adjustment.

In **2009**, the default fuel load for grass types *O-1a* and *O-1b* was updated to **3.5 t/ha (0.35 kg/m²)**, with a recommendation that users apply **site-specific measurements** when available.

WHAT'S THATCH ABOUT?

The amount of thatch present depends on how the land is used and managed. Without fire to remove or minimise the matted layer, vegetation from previous years accumulates, diminishing the amount of grass while increasing the distribution of shrubs and woody vegetation. However, if there is a fire in the area, the soil surface will change. This is because there will be less vegetation blocking the way of light, which will make the soil less damp as the temperature will increase due to solar radiation.

Source: *de Groot, W.J. 1993. The pole-mounted logo of the Canadian Forest Fire Danger Rating System (CFFDRS) found in most of the photos was used for scale. The sign is 30 x 30 cm and the alternate markings on the pole are 30 cm in length.*

ASSESSING THE DEGREE OF CURING

Accurately assessing the degree of curing is important for estimating fire danger throughout the fire season. Operationally, the degree of curing is usually estimated visually on site, either in person or via webcams positioned along highway corridors, or by analysing satellite imagery. However, visual estimates can be subjective, resulting in variations between observers. A study[3] on grass curing and fuel dynamics in Australia found that visual assessments overestimated curing and failed to capture the correct degree of curing. It is difficult to distinguish between senescent and dead fuel, particularly in undisturbed areas. Senescent fuel comprises grass that is changing from a living to a dead state, with colours ranging from pale green to yellow. Newly dead fuel comprises dead grass from the current season's growth. This grass is usually still standing and appears bleached and dry.

The complexity of these undisturbed areas is further compounded by the fact that the proportion of old, dead grass forming a matted, horizontal layer close to the ground is difficult to spot, which makes it challenging to accurately assess the degree of curing. Furthermore, factors such as species differences, growth rates, growth season, precipitation and climate influence the amount of grass present and therefore the visual perception of the degree of curing. One conclusion from this study was that better training and visual assessment materials should reduce individual bias. Given that the degree of curing is an input for grass components in the FWI2025 system, there should be discussions about national training needs to improve visual assessment of curing across different grasslands.

PHYSIOLOGICAL PROCESS OF CURING

Grass growth and curing are influenced by genetics but triggered by environmental factors like sunlight, drought, temperature, and competition between plant species. The speed at which grass cures depends largely on the climate it grows in and how well it has adapted to those conditions. For example, tallgrass prairies in southern Ontario typically reach full curing in the fall before snowfall. In contrast, in Australia, the hot and dry summer leads to full curing by mid-summer.

Once the grass has died, it can stay upright for a while, depending on how much rain, wind and snow there is, but eventually, it will collapse and become **thatch**. Decomposition also depends on the local conditions and if the grass is in contact with the ground. It will be slower in drier environments. If not disturbed by fire, the thatch will persist into the next grass growing cycle.

It's also important to know that grasslands can be composed of annual and perennial species. For the Ontario tallgrass prairies, perennial species are the most common, and these grasses can grow again if it rains enough towards the end of the season. These new growths are not evenly distributed through the vertical profile of the grassland and are more present at the ground level. This leads to having a mixture of plants at different states of growth, resulting in patchy, heterogeneous curing patterns; an important feature to note when looking at grass curing effects on fire behaviour.

SOLAR RADIATION INFLUENCING FUEL TEMPERATURE

The grassland fuel moisture code (GFMC) is calculated using a solar radiation input. Grasslands are open environments where plants are exposed to environmental factors such as the amount of direct sunlight they receive. Direct sunlight can heat fuels to more than 20 to 30°C above the usual air temperature. This is especially important in grasslands in the spring, when the previous season's growth has been flattened by snow resulting in a matted layer of vegetation that is a good receptor and holder of heat from the sun.

Source: Natural Resources Canada, 1999

GRASSLAND FUEL MOISTURE CODE (GFMC)

The GFMC in open grasslands serves the same purpose as the FFMC in forested environments: it is an indicator of fine fuel flammability and has a maximum value of 101 and a lower value of zero. The GFMC uses modified models from the Grass Moisture Model for the Canadian Forest Fire Danger Rating System paper by Wotton (2009). This work was operationalized in the Field Guide for Predicting Fire Behaviour in Ontario's Tallgrass Prairie (Kidnie et al., 2010), which provided practitioners with an effective field manual. The GFMC uses two separate moisture models, one for fully cured matted grasses and one for fully cured standing grasses, corresponding to spring and fall conditions, respectively. The GFMC captures the rapid drying in open grasslands (Kidnie and Wotton, 2015) which is enhanced by the exposure to the sun and higher winds speeds due to the open (treeless) environment.

Like other moisture codes of the FWI System, the GFMC is a bookkeeping system meant to monitor the exchange of moisture in the grass fuels over time. Drying rates are significantly faster for the GFMC, resulting in a faster recovery of the GFMC following precipitation compared to the FFMC. This provides a better representation of the actual fire potential in grassland fuels.

GRASS FUEL KEY MESSAGES:

- ⇒ Grass fuels respond more rapidly to wind and changes in moisture than forest fuels.
- ⇒ Due to their open and canopy-free nature, grass fuels become available for ignition more rapidly than forest fuels.
- ⇒ Grassland indices serve as decision-support tools, offering standardized indicators of fire danger specific to grass fuels.

GRASSLAND SPREAD INDEX (GSI)

The Grassland Spread Index (GSI) provides an indication of potential fire spread rate in grasslands. It combines the moisture in the cured fuels in the grassland, the wind speed and the state of curing of the grassland. Similar to the ISI, the GSI exhibits a strong dependence on wind speed; however, GSI differs from ISI in that its inclusion of the degree of curing allows it to be responsive to changes throughout the growing season. The curing factor accounts for the changing proportion of live vegetation in the fuel bed throughout the growing season, inversely impacting the GSI and reflecting reduced spread potential as live biomass increases.

GRASSLAND FIRE WEATHER INDEX (GFWI)

The GFWI is a scaled, unitless transformation of grassland fire intensity. The GFWI incorporates the GSI and GFMC, accounting for both dead fuel moisture as well as the curing state of the fuels. Similar values of FWI and GFWI should correspond to similar head fire intensity values. However, due to the differences in the pine and grassland fuel types, the interpretation of these intensity levels in terms of suppression difficulty may be different. This new index will enable fire managers to more accurately and effectively plan for grass fire suppression and management, and will provide a more accurate indicator for planning prescriptions and other management activities with respect to grassland fuels. The index is also suitable for communicating Fire Danger classes in regions with extensive grasslands and similar open fuels.

PRESCRIBED BURN IN RONDEAU PARK (2010)

In April 2010, staff from CFS, AFFES, and Ontario Parks conducted controlled burns across seven grassy plots in Rondeau Provincial Park. The burns took place over a single day, following cold and wet conditions—including over 25 mm of rain in the two days prior and light snow the evening before. Based on these conditions, the grass spread model in the Canadian FBP System predicted no fire spread, and the FWI1987 indicated poor fire potential due to unreceptive fuels.

However, hourly fire weather data told a different story. Despite calm conditions early in the day, wind speeds increased sharply by afternoon, contributing to a gradual rise in the diurnal FFMC and ISI, and a much more pronounced increase in the GSI, which peaked at 47.5. The GSI's sensitivity to wind and solar radiation under clear skies helped explain the unexpectedly high fire intensity and rapid spread rates observed in the field—reaching up to 40 metres per minute—contrary to FBP O1 model predictions.

Time	Temp	RH	WS/Dir	Sky cond.	dFFMC	GFMC	ISI	GSI
8:00	1.2	88	0.0/WNW	clear	30	77	0	0
9:00	6.2	66	1.6/WNW	clear	32	80	0	7.5
10:00	7.6	61	4.8/WSW	clear	38	83	0	19
11:00	8.2	71	9.7/SSW	clear	44	84	0	25
12:00	8.9	65	12.9/SW	clear	52	84	0.6	29.8
13:00	9	64	14.5/SSW	clear	49	84	0.9	32.8
14:00	10.4	54	16.1/SSW	clear	53	84	0.9	40
15:00	11.6	50	14.5/SSW	clear	56	85	1	42
16:00	11.7	51	12.9/SW	clear	58	84	1	47.5

Hourly fire weather observations on the day of the Rondeau burns show a sharp increase in wind speed, which drove a gradual rise in the diurnal FFMC (dFFMC) and ISI, but a much more pronounced increase in the GSI. The GSI's sensitivity to wind and solar radiation under clear skies helped explain the high-intensity grass fire behavior observed in the field, despite poor fire conditions predicted by FWI1987.

Source: Country Fire Authority, Australia

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Stay tuned for the third newsletter in which we will focus on the difference between daily and hourly FWI outputs!

REFERENCES:

Kidnie, S.M.; Wotton, B.M.; Droog, W.N. 2010. Field guide for predicting fire behaviour in Ontario's tallgrass prairie. Natural Resources Canada. Ontario Ministry of Natural Resources 65p. https://ostrnrcan-dostrncan.canada.ca/handle/1845/246080

Kidnie, S., Cruz, M. G., Nichols, D., Hurley, R., Gould, J., Bessell, R., & Slijepcevic, A. (2015). *Effects of curing on grassfires: I. Fuel dynamics in a senescing grassland*. International Journal of Wildland Fire. 24. 828-837. http://dx.doi.org/10.1071/WF14145

Lawson, B.D.; Armitage, O.B. 2008. Weather Guide for the Canadian Forest Fire Danger Rating System. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. 84 p. https://ostrnrcan-dostrncan.canada.ca/handle/1845/219568

Parks Canada. (2025, May 21). *Prescribed fires – Grasslands National Park*. Government of Canada. https://parks.canada.ca/pn-np/sk/grasslands/nature/conservation/feu-fire[1](https://parks.canada.ca/pn-np/sk/grasslands/nature/conservation/feu-fire)

Wotton, B.M.; Alexander, M.E.; Taylor, S.W. 2009. Updates and Revisions to the 1992 Canadian Forest Fire Behavior Prediction System. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p. https://publications.gc.ca/site/eng/9.565261/publication.html

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Source: Canadian Forest Service, 2010