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Confused meanings for common fire terminology can lead to fuels mismanagement. A new framework is needed to clarify and communicate the concepts.

Theresa B. Jain

Research Forester, Rocky Mountain Research Station, Moscow, Idaho

The ineffective and inconsistent use of terminology among fire managers, scientists, resource managers and the public is a constant problem in resource management. In fire management and fire science, the terms fire severity, burn severity and fire intensity are defined in a variety of ways, used inconsistently and, in some cases, interchangeably. This problem has become more apparent as the use of these terms has increased, partly because:

1) The occurrence of large wildfires, especially in the wildland-urban interface, has engaged many interest groups and citizens in discussions concerning fuel treatments, fire management and fire suppression;

2) The passage of the Healthy Forest Restoration Act emphasizes the need for understanding wildland fire risk; and

3) The addition of funding through

the Joint Fire Sciences Program and the National Fire Plan has enabled the scientific community to conduct an increasing number of studies on fire behavior and effects and has increased the use of fire as a management tool.

As a result, fire severity, burn severity and fire intensity are terms used in discussions, presentations, publications and meetings where people of widely different backgrounds are exchanging information, ideas and making decisions.

CONFUSING LEGACY

The term fire severity has no single definition; rather, it is a broad concept that can be applied to a variety of fire effects and often has been described as a “whittling and arguing concept” among fire scientists and managers. Albert Simard of the Canadian Department of Natural Resources concluded the definition of fire severity would vary

depending on the characteristics of interest and how they are measured.

The effects from the fire are sometimes described as the “direct results of the combustion process and are primarily heat induced chemical processes.” Hydrologists, soil scientists, atmospheric scientists and ecologists often describe the effects a fire has on water quality, stream flow, erosion, air quality, species diversity, soil productivity and nutrient cycling. The effects a fire has on society can be measured in the number of homes damaged, firefighter deaths, changes in the values and perceptions of burned lands, and the monetary costs associated with fire suppression and rehabilitation efforts.

In an attempt to separate these different definitions, “burn severity” was introduced to reflect the effects a fire has on the environment, while “fire intensity” usually has been used to

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describe fire characteristics such as flame length and energy produced.

These various approaches to defining fire severity, burn severity and fire intensity are certainly useful, but often all three terms are used interchangeably, among which can lead to miscommunication fire management, land managers and the public, whose common understanding is essential for concerted action. Therefore, a new framework is necessary as a communication tool for users to clarify the concepts.

CONCEPTUAL FRAMEWORK

This new framework, called the Fire Disturbance Continuum, incorporates the pre-fire, fire and post-fire environments and the response. The pre-fire environment includes the environmental characteristics before the fire. The fire environment includes the environmental characteristics during the fire. The post-fire environment includes the environmental characteristics after the fire when the flames, heat and smoldering have ended. The response is the biological and physical reaction to the environment or the indirect effects on various ecosystem components and processes after the fire.

This framework describes our understanding of fire as a disturbance and uses general fire terminology to describe that disturbance. A disturbance is any relatively discrete event in time that disrupts an ecosystem, community or population structure and changes resources or the physical environment. Fire is one of many disturbances that influences how forests, woodlands, rangelands, grasslands and deserts function and change through time and space. For example, a one-hectare fire may be a major disturbance for a narrowly distributed rare plant but inconsequential to a 1,000 hectare ponderosa pine forest.

The pre-fire environment includes the location, vegetation, climate and short-term weather just prior to the fire. The location reflects the climate and soil, which determines the vegetation type. The vegetation and soils are described by:

- Overstory vegetation,
- Midstory vegetation,
- Lower vegetation,
- Woody debris, and
- Mineral soils and forest floor.

The weather over a period of weeks to months — and in the case of drought, years — influences the cur-

rent moisture content of the dead and live vegetation, woody debris, mineral soils, and forest floor. Another pre-fire environment component often overlooked, but becoming more important, is the condition of houses within the wildland-urban interface.

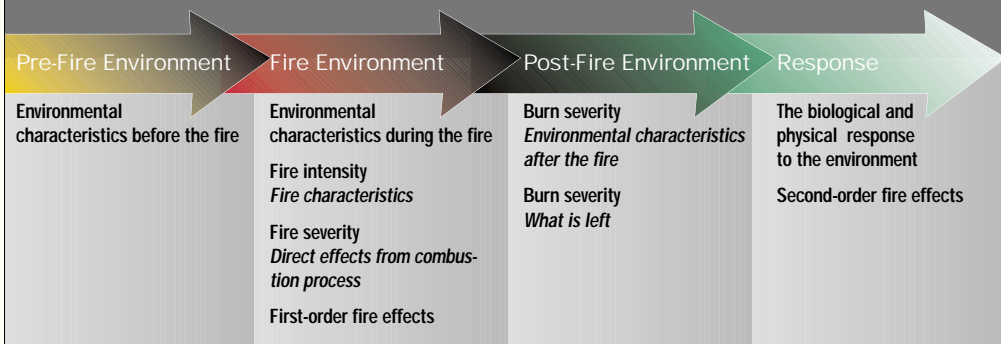
THE FIRE AND BEYOND

The fire environment includes the surrounding conditions, topography and weather that determine the behavior and combustion during a fire. For vegetation, the characteristics include the amount of fuel moisture within the different live and dead vegetative strata during the fire, the presence or absence of individual strata, or the presence of a shake roof on a house. The weather during the fire includes wind speed and direction, relative humidity, temperature, and atmospheric stability, all of which dramatically influences fire behavior.

Physical setting is composed of aspect, slope, drainage location and direction, and topographic position. Vegetative structure, which also can include homes, weather and physical setting interact to create the fire's characteristics, or fire intensity, which

The Fire Disturbance Continuum

The Fire Disturbance Continuum illustrates the four components included in describing fire.



includes flame length, rate of spread, amount and location of torching, distance a fire spots, and energy produced.

At this same moment the combustion process is directly killing plants, heating soils, producing smoke, consuming the forest floor and burning houses. These direct effects on the environment are

often referred to as fire severity and are also referred to as first-order fire effects. Fire severity for trees would include the degree of change from the pre-fire environment, such as the proportion of the pre-fire tree crowns that were consumed by the fire and the proportion of the tree cambium that is dead after the fire.

Technically, how a community reacts to fire suppression activities or how smoke affects breathing also could be considered a direct fire effect, although it's not currently considered a part of characterizing fire severity.

The post-fire environment is the condition of the live and dead vegetation,

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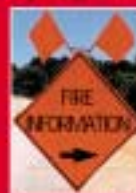
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forest floor and soils after a fire, when all the flames, smoldering and heat are gone, or in simpler terms, what is left after the fire is out. Usually these components are described using the same strata present in the pre-fire environment. For example, the condition of the forest floor is described as the proportion of soil surface covered by litter after the fire.

The post-fire environment for trees includes the proportion of tree crowns with green needles, brown needles and no needles and the proportion of the tree cambium that is alive after the fire. The post-fire environment also would include the presence of a chimney surrounded by the charred remains of a house.

Conversely, the post-fire environment does not describe what was consumed, nor does it describe the influence of the fire alone. It instead assumes the pre-fire environment, fire environment, and the fire intensity and combustion process all contributed to

creating the post-fire environment. Although the term fire severity has been used in the past to cover this part of the fire continuum, we feel that burn severity may be a more appropriate term as it describes the burned environment and not the fire process

The ecosystem responses to the post-fire environment are often referred to as "second-order fire effects." These include erosion of soils and sedimentation of streams, release of serotinous cones by lodgepole pine, colonization of burned forests by certain woodpecker species, and introduction of new plant species. It also may include the homeowners' reaction when they see their house burned or how a community reacts to post-fire rehabilitation activities. These responses vary over time and space and are highly interdependent.

COMMUNICATION IS THE GOAL

The terms fire intensity, fire severity and burn severity have been used to



The term fire severity means the direct effects of the combustion process, such as flames, while burn severity is what is left after the fire.

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describe various parts of the Fire Disturbance Continuum. Confusion is added when people combine the combustion process, post-fire environment and the response and call all those components "fire severity."

Sometimes people separate and concentrate on only one of these components and describe that component as containing a particular "fire severity or intensity." Other instances may include trying to classify the degree of intensity or severity, such as low, moderate and high. Currently all categorizations are arbitrary, and the categories may vary depending on a person's interests. Moreover, other disturbances such as high-intensity rainstorms may occur after a fire, thus creating a multiple disturbance continuum with its own response.

The terms fire intensity, fire severity and burn severity are all being used regularly. Sometimes they are applied as described in the Fire Disturbance Continuum but more often they are not.

Rather than avoiding the use of the terms altogether, deal directly with the ambiguity. First, when reading or listening to information concerning fire, identify the portion of the continuum that is being referenced and define the terminology. This will help with understanding the information.

Second, when communicating to others, define these ambiguous terms and explain where they fall within the continuum. If the subjects are flame length, rate of spread, the heating process or fuels consumed (first-order fire effects), the terms fire intensity and fire severity could apply. If the subject is focused on what is left after the fire is over, burn severity may be a more appropriate term.

In addition, clarifying the time frame of an event or response, such as whether something is occurring days or years after the fire, can enhance understanding across various disciplines. Short- and long-term effects vary by discipline

and context, and these terms can inadvertently cause more confusion.

The audience seeking information about wildfires fire continues to grow, and the need to communicate effectively has never been more critical. Using the Fire Disturbance Continuum to explain the process can provide a scaffold for presenting or receiving information. Terms that have multiple meanings should be defined and used carefully. The terms fire intensity, fire severity and burn severity may eventually evolve to single, agreed-upon definitions, but for now, you might want to ask, "When and how did you measure that?" **W**

Theresa B. Jain is a research forester for the Rocky Mountain Research in Moscow, Idaho. She is a silviculturist with expertise in vegetation dynamics, disturbance, soils, landscape ecology and statistics. Jain received her bachelor and master of science degrees and her Ph.D. from the University of Idaho.

Russell T. Graham, research forester; and David S. Pilliod, research ecologist for the Aldo Leopold Wilderness Institute, assisted with this article.

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