Lions River Fire Protection Association
By Landowners – For Landowners

FIRE AWARENESS – NATURE & BEHAVIOUR

Complied by Bobby Hoole

Fire Awareness

This section has been included with the guidelines to help you better understand the nature and behaviour of fire , together with suppression activities and fire hazards. You may also wish to consider the benefits of joining your local fire association to increase your fire fighting skills and knowledge even further. Not only will you raise your skill levels and knowledge, you will also be providing a valuable service to your community. To find out more about being a LRFPA member and / or volunteer, contact LRFPA.

Types of Fire

Each type of fire creates its own peculiar hazards, which will require constant monitoring to ensure safe work practices are observed and carried out at all times. Fire s can generally be described in terms of the fuel in which they are burning – grass, scrub or forest plantation.

The following pages explain some of the characteristics of different types of fire, and defines important parts of a fire's perimeter.

Ground fire

This type of fire burns the organic material in the soil layer, as happens in a peat fire, and often also burns surface litter and small vegetation.

Characteristics

- Occurs in only a few parts of Australia.
- Smoulders with no flame and little smoke.
- These fires can burn unnoticed and may later ignite surface fires. You need to take care to avoid stepping into undetected hot spots in the ground.

Surface fire

This type of fire travels just above ground surface in vegetation such as grass, low scrub and forest litter. It presents a significant hazard to fire fighters because conditions can change rapidly due to strengthening winds or wind changes, rapidly increasing fire intensity and rate of spread.

Characteristics

- By far the most common type of fire.
- Burns in fuels lying on the ground.
- Consumes litter and low vegetation, such as grass and scrub.
- Does not extend into the crowns of trees.

Crown fire

This is a fire which burns in the crowns (tops) of trees ahead of, and above, an intense surface fire in the undergrowth and presents a significant hazard to fire fighters. Radiant heat and direct flame contact resulting from the surface fire will ignite tree tops. Strong winds carry the fire long the upper storey vegetation.

Characteristics

- It is a fast-travelling fire that is extremely destructive and often consumes all in its path.
- An intense surface fire follows crown fires shortly afterwards.
- Short or long distance spotting often accompanies crown fires. For example, spotting up to several kilometres have been recorded.
- Falling material from a crown fire can start further surface fires below. Crown fires are exposed to higher wind speeds in the upper air and because of this can move faster than surface fires.

Terms used during a fire / fire

The shape of a fire is defined by its perimeter, which is the outside edge of the burnt area. Within this there may be burning areas, smouldering areas and blackened areas, as well as pockets of unburnt fuel. There will also be a point of origin that may or may not be identifiable without detailed investigation.

Parts of a fire include:

- the head;
- the flanks or sides;
- fingers;
- the rear or heel (sometimes referred to as the back);
- spot fires ahead of the main fire;
- unburnt pocket or island; and
- point of origin.
- Unburnt pocket or island
- Wind direction
- Spot fires

The head of the fire

The head of a fire is where the fire is making its greatest progress (usually downwind or upslope) measured by its forward rate of spread. The head is also called the fire front. Flames are tallest and intensity of the fire is greatest at this point. The head of the fire is influenced by wind direction, fuel factors and topography, and will change accordingly.

Flanks or sides of a fire

Both sides of the fire between the head and the rear are called the flanks. They are roughly parallel to the main direction of spread. The intensity of the fire at the flanks is less than at the head. Often they are described by their geographic location (for example, the eastern or western flank of a fire) or by their orientation as viewed from the point of origin or rear of the fire (for example, the left or right flank of a fire).

Fingers

These are long and narrow slivers of the advancing fire, which may extend beyond the head or flanks, and are caused by varying wind direction or variations in fuel or topography.

Rear or heel

This is the section of the perimeter opposite to, and usually upwind or down slope from, the head of a fire. It is the least intense part of the fire's perimeter, with the lowest flames and slowest rate of spread. It may be described as the back of the fire.

Point of origin

This is the area where the fire started. The likely point of origin should, if possible, be left undisturbed for fire investigation.

Factors that Affect Fire Behaviour

There are three main factors that influence fire behaviour. Fire behaviour and fire spread can alter dramatically depending on changes in:

- fuel;
- weather; and
- topography.

An understanding of how these factors influence fire behaviour is crucial in predicting fire spread and therefore, planning and conducting fire suppression activities.

Fuel

Fuel is one of the most important factors that will influence the way fire behaves and travels. Variations in fuel will also influence the risk to fire fighter safety and firefighting suppression activities.

Fuel varies in its:

- type;
- size;
- quantity;
- arrangement; and
- moisture content.

Type

Common types of fuel involved in a fire include:

- grass;
- forest litter lying on the ground;
- small shrubs and scrub;
- trees and bark;
- decomposing humus and duff (fine ground litter);
- slash (material remaining after logging); and
- plantation prunings.

Given the right conditions, most of these fuels will readily ignite and burn at differing speeds and degrees of intensity. For example, a grass fire is likely to spread more rapidly than a fire in a tall, dense forest – but the forest fire would generally burn more intensely than the grass fi e due to greater quantities of fuel.

Size

Fuel is normally classified as fine or coarse (heavy) in relation to size.

Fine fuels, less than 6 mm in diameter (i.e. thinner than a pencil) such as leaves, twigs, grasses and some tree barks, burn readily and cause spotting as the burning embers are carried through the air. Eucalypt fuels, in

particular stiff ribbon type bark, are well known for causing long distance spotting, whereas stringy bark causes much of the short distance spotting.

Coarse or heavy fuels, greater than 6 mm in diameter (i.e. thicker than a pencil) such as sticks, branches and logs tend to ignite less readily, burn more slowly and burn for much longer periods.

Quantity

The more fuel there is – the greater the fire intensity.

Arrangement

The size of the fuel particles and the way pieces of fuel are arranged in relation to one another will affect how they burn. Fuels that are tightly packed together or compacted, such as peat, heavy leaf litter or hay bales, smoulder slowly because of the lack of oxygen. Grass hay, closely grouped and standing, will burn quickly and fiercely.

Well-separated pieces of fuel, such as sparse forest, are harder to ignite than more closely grouped collections of the same material. This is because radiant heat diminishes the further it travels and does not allow the pre-heating of fuel. A continuous ladder of fine fuel from the ground surface to the crown of the vegetation encourages the development of crown fires.

Moisture content

Fire behaviour is affected by how damp fuels are i.e. their moisture content (or dryness). The moisture content will vary depending on factors such as weather conditions, vegetation type, the moisture content of the soil and whether the fuel is dead or living vegetation.

All dead fuels take up or give off moisture according to the:

- daily temperature and relative humidity cycles – fine dead fuels change their moisture content
- rapidly in response to these cycles, while heavy dead fuels change slowly and rarely reach extremes of wetness or dryness;
- time since last rainfall and the amount of rain received – over several days, the effects of recent rainfall will disappear, this happens more rapidly in fine fuels than in heavy fuels; and
- dryness of the soil – dry soil will dry out fuels in contact with it, and wet soils will moisten such fuels.

The moisture content of fuels affects:

- ease of ignition;
- probability of spotting;
- rate of combustion;
- rate of fire spread; and
- degree of heat radiated from the flames.

Measuring fuel moisture content

Weather conditions, temperature, relative humidity and the current seasonal dryness must all be considered when determining fuel moisture content. Several techniques can be used to measure moisture content, including visual assessments of grass and crops, and the use of specialised fuel moisture meters.

Note: the "crackle" sound as you walk through fi ne fuels is a good indication of the fuel moisture content; the sharper the crackle, the drier the fuel.

Weather

Weather is a major factor that impacts on the spread of fire. The four key elements of weather are:

- air temperature;
- relative humidity;
- wind (speed and direction); and
- atmospheric stability.

Air temperature

The sun warms solid objects such as fuels and the surface of the land. This has the effect of raising the temperature of the fuels and the surrounding air. An increase in temperature, and the resulting decrease in relative humidity, will reduce the fuel moisture content and therefore, increase the ease of ignition.

Relative humidity

There is always a certain amount of water vapour in the air. Relative humidity (RH) is a measure of the water vapour content of the air, expressed as a percentage of it's maximum water vapour holding capacity at the same temperature. A high RH figure indicates a high level of water vapour in the air, a low RH indicates a low level of water vapour in the air.

On humid days (days of high RH), fine dead fuels will absorb moisture from the air (adsorption) and will therefore, burn more slowly or may not burn at all. On days of low humidity (low RH), the dry air will actually draw moisture out of fuels (desorption), they will become drier and therefore, ignite more easily, burn faster and more fiercely. In a fire situation, fire intensity increases as the temperature rises and relative humidity falls during the day, and reduces as humidity increases and temperature drops at night.

Wind

Wind is the most critical aspect affecting the shape, forward rate of spread and fire behaviour. Changes in wind direction and increased strength present serious hazards to fire fighters. A wind change can rapidly cause relatively quiet flanks to become active fire fronts – always keep fuel between you and the fire to a minimum.

Wind speed

Wind speed, or strength, is a major cause of rapid changes in fire behaviour. It will affect the intensity of a fire, the speed at which it travels and its shape.

The stronger the wind, the longer and narrower the fire will be. Wind supplies oxygen for the burning process; removes ash, smoke and moisture from fuels in the area; and slants the flames, hot air and gases over the unburnt fuel ahead of the fire, therefore, pre-heating the fuels and allowing the fire to spread faster. The wind may also lift burning materials, such as bark and other embers, and carry them ahead of the main fire starting spot fires. The stronger the wind, measured at 10 m above ground level in the open for forecasts, the faster a fire will spread.

Wind direction

It is critical fire fighters receive information regarding any potential changes in wind direction. This information is not only required for planning the attack on a fire, but also to ensure the safety of fire fighters in the event of the fire changing direction. Changes in wind direction can cause shifts in the fire front. These shifts are dangerous if they occur suddenly and unexpectedly, and can cause long and relatively quiet fire flanks to suddenly become active fire fronts.

Wind direction refers to the direction the wind is coming from i.e. a "north wind" means a wind originating from the north and travelling in a southerly direction.

For example:

At fire is being blown by a fairly strong northerly wind . The fire has an elongated shape with a narrow head. The fire intensity being higher at the head of the fire, the fire changes, when a south westerly wind change occurs. The wind change causes the cooler eastern flank to suddenly become the new head of the fire. The fire which was burning on a narrow head, is now burning on a wide front. The new head fire will move away at its maximum intensity and rate of spread. This change in direction will substantially increase the difficulty of fire suppression activities, but more importantly, presents an immediate threat to any fire fighters working on what was the eastern flank. Always be watchful of wind changes and if unpredicted changes occur in your area, warn the people around you and inform a crew member of LRFPA.

Atmospheric stability

Atmospheric stability refers to the vertical (upward) movement of air masses that occur when hot air rises and is replaced by cooler air. This results in an inversion layer forming i.e. a reversal of the normal variation of air temperature with altitude (normally the higher you go the colder it is). Vertical air movement can affect local wind patterns and can also determine cloud development and therefore, the possibility of thunderstorm development. In stable atmospheric conditions, fire behaviour will generally be predictable.

Visual indicators of stable conditions are:

- presence of stratus type clouds (clouds in layers);
- smoke columns drift apart after limited rise;
- vertical movement of air is limited;
- fog layers may be present; and
- winds are generally light and predictable.

In unstable atmospheric conditions, fire behaviour can be unpredictable.

Visual indicators of unstable conditions are:

- presence of cumulus (cotton wool) type clouds showing noticeable vertical growth;
- smoke columns can rise to great heights;
- winds are gusty and unpredictable;
- potential for thunder storms and therefore, lightning strikes; and
- dust whirls may occur.

Topography

The third major factor that impacts on the spread of fire is topography. Topography is the surface features of a particular area or region such as mountains, rivers, populated areas, roads, railways and vegetation. The topography of an area will affect the direction and speed at which a fire will travel. The effects can be quite complex as the topography will also affect the local wind speed and direction.

The three main concerns that arise in relation to topography are:

- slope;
- aspect; and
- the interaction between terrain and wind.

Slope

Slope will affect the speed, or rate of spread, of a fire. If a fire is travelling upslope as opposed to on level ground, there will be a shorter distance for radiant heat to travel from the flames to unburnt fuel. Therefore, fuels upslope of a fire will be preheated to their ignition temperature quicker than they would be on level ground. The opposite is true for a fire travelling down slope.

The following rules of thumb will help you calculate the affect slope will have on the speed of a fire.

- For every 10° of upslope, double the rate of spread. *For example: a fire is travelling at 2.5 km per hour on level ground towards a 20° upslope; it reaches the foot of the hill and continues to burn in the same direction; as it moves up the slope, the rate of spread will increase to 10 km per hour (approximately).*

- For every 10° of down slope, halve the rate of spread. *For example: a fire is travelling at 10 km per hour on level ground towards a 20° down slope; it reaches the edge of the level ground and continues to burn in the same direction down hill; as it moves down the slope, the rate of spread will decrease to 2.5 km per hour (approximately).*

Aspect

Aspect is the direction that a feature or slope faces. This influences the amount of solar radiation that it receives and, as a result, northerly and westerly aspects (which receive more sun) will be warmer and drier than southerly and easterly aspects. This in turn influences the nature of the vegetation growing on different aspects e.g. northern and western aspects generally have drier and more flammable vegetation than southern and eastern aspects, where vegetation tends to be lush and less flammable. As a result, fires on northern and western aspects will generally burn more fiercely than fires on southern and eastern aspects.

Terrain and wind

The way the wind interacts with terrain can be quite complex. Exposed faces of hills and ridges may have increased wind speeds, while their lee side, less exposed or sheltered areas may be almost calm. Under some circumstances, the leeside may have dangerous turbulent winds blowing in the reverse direction of the prevailing wind. Spot fires can be drawn back upslope against the prevailing wind. In mountainous country, winds tend to flow up or down valleys, irrespective of the general wind direction outside these areas. In fact, any change in terrain may have an effect on the wind. Coastal sea breezes are often experienced in the late afternoon in coastal areas and may effect fire behaviour, depending on local terrain.

Under clear skies, local winds can actually be generated by the terrain – upslope during the day and down slope during the night. Winds generated by any of these conditions will create complex fire behaviour that has the potential to threaten fire fighter safety.