Forestry Department

Protecting our Forests; Sustaining Lives

Forest Fire Management

Training Handbook

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Introduction

The vulnerability of Jamaica's forests to fire-related impacts is significant. Economic devastation and social disruption are also severe ramifications of forest fires. These were on full display during the year 2015 in Jamaica, when hundreds of hectares of forests and farmlands were severely damaged by several forest fires. Millions of dollars' worth of agricultural produce and animals were lost during this year.

Most forest fires in Jamaica are caused by human interaction with the environment. Approximately 80% of Jamaican fires occur during the two dry seasons extending from December to March, and in July and August. (Barrett and Virgo; 2005). Burning in Jamaica has historically been used as an inexpensive means of clearing agricultural lands, burning pastures for weed control and disposing of solid waste. These fires often burn out of control and spread from agricultural lands to forests. This results in high mortality in young plantations and disruption of the ecological processes of adjacent natural forests. Even after a fire is put out, there are long-term impacts in the area where forest cover has been disturbed, including erosion, flooding, landslides, overgrowth of invasive alien species and pests, and altered watersheds.

Approximately 80% of Jamaican fires occur during the two dry seasons extending from December to March, and in July and August.

Purpose of the Handbook

The main purpose of this training handbook is to promote actions that will assist in prevention, planning, preparedness and suppression of forest fires.

Objectives:

- To sensitise community members in basic forest fire management which will lead to the mitigation of fire incidents within the targeted communities
- To build capacity at the community level enabling residents to effectively manage forest fires (prevention and suppression).
- To engender a positive relationship between the Agency and communities which is expected to result in the creation of a positive perception in the minds of residents.

Legislative and Policy Framework

Government actions are based on policies, laws and jurisdictional authority. This is also true regarding fire management programmes. Forest fire prevention and suppression efforts will not be effective unless they are carried out in observance of clear policy, legal and institutional framework.

The four main pieces of legislation which are applicable in the Jamaican context are:

Forest Act

1996

Forest Regulations

2001

Natural Resources Conservation Authority Order

(Environmental Protection Measures)

2016

Country Fires Act

1942

These documents provide a basic framework for the development of forest fire management goals and objectives.

Forest Act 1996

Section 31(1)(c) of the Forest Act 1996 provides that the activities of keeping, kindling or carrying a fire in a forest reserve, forest management area or protected area are prohibited.

These offences carry a maximum penalty of **$200,000** or **2 years** imprisonment.

Forest Regulations 2001

Regulation 13 of the Forest Regulations provides that a person shall not light or make use of an open fire or charcoal kiln in or within 1 km of a forest estate, forest management area or protected area except in compliance with a burning permit issued under these Regulations.

The maximum penalty for the above offences is $50,000 or 1 year imprisonment

Regulation 14 states that a person shall not- (a) drop a burning substance in or within 1 km of a forest estate; or 5 (b) in a forest estate smoke a lighted cigarette, cigar, pipe or any other matter used for smoking. If the fire is started by the person under Regulation 14, that person shall immediately take all reasonable steps to extinguish the fire, if the fire can be extinguished, and after that promptly to report the fire to an authorized officer.

Natural Resources Conservation Authority (Environmental Protection Measures) Order, 2016

The above Order states that during the period commencing February 1 and ending October 31 in every year, activities on any land within the following watershed areas shall, in addition to any other requirements relating to land use, be subject to the environmental protection measures:

- Black River Watershed
- Bull Savannah Watershed
- Fresh River Watershed
- Hermitage Watershed
- Hope River Watershed
- Rio Cobre Watershed
- Rio Minho Extension Watershed
- Rio Minho Watershed
- Wag Water Watershed
- Yallahs Valley Watershed

The activities which are prohibited in the areas above in accordance with the Environmental Protection Measures are:

A. setting, building, maintaining, attending or using an open fire of any kind;
B. discharging any firework or pyrotechnic device;
C. carrying out any activity in the open air that causes or is likely to cause a fire;
D. open burning of solid waste;
E. use slash and burn methods of clearing any land; and
F. careless disposal of lighted flames, including cigarette butts.

Module 1 : Basic Concepts of Forest Fires

This module will introduce participants to the basic concepts of forest fires. It will place specific focus on:

1.1 The Chemistry of Combustion/Fire
1.2 Methods of Heat Transfer
1.3 Basic Terminology
1.4 Hand Tools for Forest Fire Management

Objectives

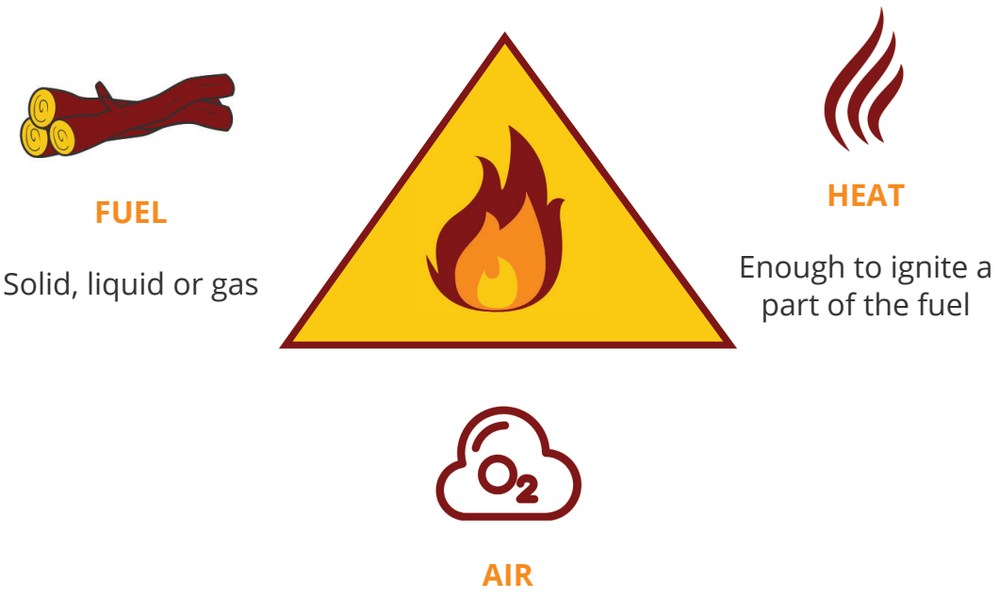
Upon completion of this module, participants will be able to:

- Define a forest fire.
- Identify basic fuel types.
- Describe the various methods of heat transfer.
- Define some of the basic terminologies used in relation to parts of a fire and behaviour of a fire.
- Identify and demonstrate use of various forest fire management tools.

1.1 The Chemistry of Combustion/Fire

Burning requires the combination of three (3) elements. These three elements or sides compose what is called the “fire triangle”. Remove any single one, and there can be no fire.

Figure 1
Triangle of Combustion



What is a Forest Fire?

A forest fire is an uncontrolled fire occurring in a forested area. It is important to note that not all forest fires start within a forest. They may begin outside of the forest area and spread into the forest. A forest fire is often referred to as a wildfire because of the untamed and devastating manner in which the element can rip and tear through vegetation; completely destroy property; take the lives of humans and animals; and ruin agricultural production.

Forest Fire

An uncontrolled fire occurring in a forested area.

Basic Fuel Types

Definition of Fuel

Fuel is simply defined as any burnable material. It is the source of energy that drives the fire. This includes forest fuels which can either be living and/or dead plant material. It also includes houses (board), sheds, etc. It is important to note that fire behaviour is dependent on certain fuel characteristics such as **fuel type**.

Some fuel types include:

- Grass
- Shrub
- Timber litter
- Slash-blowdown (debris left after natural events (e.g. hurricanes) or human activities)

Pictures 1 & 2
Example of Slash-blowdown fuel
(Mt Airy – Jamaica)

1.2 Methods of Heat Transfer

It is important that we know how a fire, once started, spreads. Heat must be able to move from one burning piece to another, or the fire triangle will be broken. This movement is called heat transfer. Fires/heat can spread in three different ways: conduction, convection, radiation and direct flame contact/direct burning.

Heat Transfer

The movement of heat from one material to another.

Conduction

Conduction is the transmission of heat from one particle to another for example, heating metal.

Think of conduction as a spoon in a hot drink. By conduction, the heat from the hot drink is tranferred to the spoon.

Heat is conducted from one fuel particle to another in the same way, through direct contact. Wood is a poor conductor, that is, heat will not travel through it easily. For example, a wooden handle on a hot frying pan remains cool enough to be held by the bare hands.

Convection

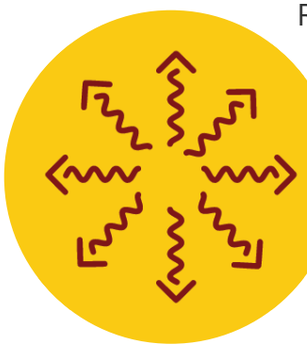
Convection is the transfer of heat by the movement of hot masses of air. As air is heated, it expands. As it expands, it becomes lighter than the surrounding air and it rises.

Due to convection, This is why the air near the ceiling of a heated room is warmer than that near the floor.

Convection forms heated air and smoke gases that spread heat in any direction, depending on the movement of the air. In a forest fire, fuels are pre-heated when they come in contact

with this hot air and smoke gases. Hot embers and fire brands may form an existing fire in the air. These heat sources fall to the ground and may cause spot fires should they land on suitable fuel. Convection also causes "torching" and contributes to the start of a crown fire.

Radiation



Radiation is the transfer of heat through space. Heat moves through space as energy waves.

Radiation is the type of heat one feels when sitting in front of an open fire.

Radiant heat can dry surrounding fuels and sometimes ignite them. A large fire with high flames will pre-heat and ignite fuels faster than a small one.

Since radiation causes the pre-heating of new fuel, it is an important cause of the spreading of surface fires. Radiation may pre-heat fuels across a fuel break and contribute to the fire jumping the fuel break.

Radiation is important to fire behaviour since it:

- **enables a surface fire to spread;**
- **may contribute to a fire jumping a fuel break**

Direct flame contact/Direct burning

Direct burning is the transmission of heat due to the flame being in direct contact with combustible material.

1.3 Basic Terminology

Parts of the Fire

Point of origin: The precise location where the ignition source came into contact with the material first ignited and sustained combustion occurred.

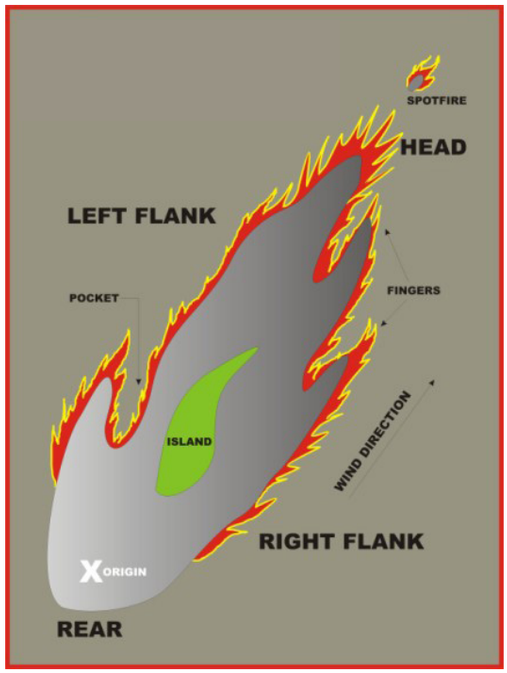
Head of a fire: The side of the fire having the fastest rate of spread.

Flank of a fire: The part of a fire's perimeter that is roughly parallel to the main direction of spread. May have active fire, but not as hot as the head of the fire.

Rear/Heel of a fire

- That portion of a fire spreading directly into the wind or down slope
- That portion of a fire edge opposite the head
- Slowest spreading portion of a fire edge

Figure 2
Parts of a Fire



(Source: http://www.state.sc.us/forest/refwild.htm)

Fire Perimeter: Boundary line of the fire or fire edge.

Fingers of a fire: The long narrow extensions of a fire projecting from the main body.

Pockets of a fire: Unburned indentations in the fire edge formed by fingers or slow burning areas.

Island: Area of unburned fuel inside the fire perimeter.

Spot fire: Burning area outside the main fire perimeter, often caused by wind-blown embers or rolling debris.

Fire Behaviour

One of the most important things to know in managing forest fires is the behaviour of forest fires. There is no chance of being successful in the management of suppression activities without the knowledge of how a forest fire behaves. Fire behaviour can be defined as the way fuels ignite, flames develop and the fire spreads and exhibits other phenomena.

Smouldering: Fire burning without flame and barely spreading.

Creeping fire: Fire burning with a low flame and spreading slowly.

Running: Fire spreading rapidly with a well-defined head.

Backing: That portion of the fire with slower rates of fire spread and lower intensity, normally moving into the wind and/or down slope. Also called a heel fire.

Picture 3
A Smouldering forest fire

Spotting: Behaviour of a fire producing sparks or embers that are carried by the wind and which start new fires beyond the zone of direct by the main fire.

Torching: The burning of the foliage of a single tree or a small group of trees, from the bottom up.

Crown fire: A fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire.

Flare up/Blow up: Any sudden increase in fire intensity or rate of spread of a fire sufficient to preclude direct control or to upset existing suppression plans.

Fire whirl: Any sudden increase in fire intensity or rate of spread of a fire sufficient to preclude direct control or to upset existing suppression plans.

Other useful terms

Anchor Point: Any sudden increase in fire intensity or rate of spread of a fire sufficient to preclude direct control or to upset existing suppression plans.

Fireline: Any cleared strip or portion of a control line from which flammable material has been removed by scraping or digging to mineral soil.

Control line: An inclusive term for all constructed or natural barriers and treated fires edges used to contain a fire.

Mop-up: Final extinguishment of a fire after it is lined. Removing burning material near control lines.

Contained: The status of a forest fire suppression action signifying that a control line has been completed around the fire, and any associated spot fire, which can reasonably be expected to stop the fire's spread.

Picture 4
A crown forest fire

(Source: http://bushfireawarness.weebly.com/types-of-bushfires.html)

Types of Fire

Sub-surface fires: There are three main types of forest fires: the sub-surface, surface and crown.

A sub-surface fire burns in the organic material under the surface litter and, by itself, will spread slowly. It may be from several centimetres to one metre deep. The sub-surface fire can present control problems because of the difficulty in locating the fire's edge and extinguishing it.

Surface fires: A surface fire is a fire which burns in the fuel on the surface of the ground. This category would include burning slash, brush, grass and surface litter (twigs, dry leaves, needles and other undecomposed material), or anything which burns on the surface of the ground.

Crown fires: A crown fire develops from a surface fire where the fuels will carry the fire and gases from the surface into the crown fuel layer. The crown fire burns independently of fire burning on the surface and advances from tree top to tree top. The crown fire usually occurs in conifer stands with a continuous crown cover. Fires burning in the crown layer are extremely difficult to control and spread quite rapidly.

1.4 Hand Tools for Forest Fire Management

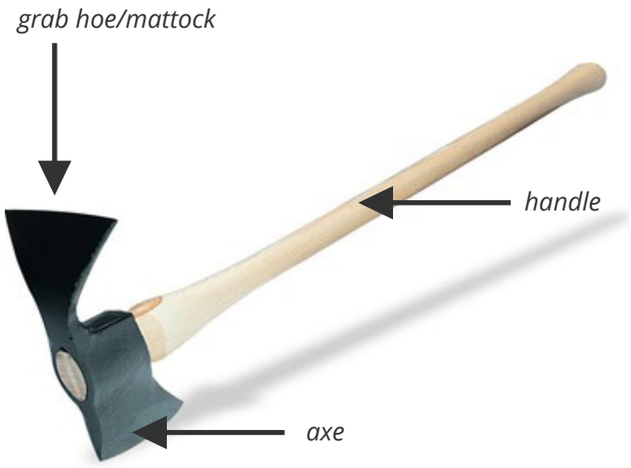
Successful forest fire suppression depends on a well-balanced combination of people, equipment, tools and training. For any forest fire control organisation, to be effective it is important that they are provided with appropriate fire control tools and equipment. These are necessary in the prevention and suppression of any forest fire.

There are several tools which are used to prevent and/or suppress forest fires. The following may be considered the most popularly used:

Pulaski

The tool combines an axe and an adze in one head with a rigid handle of wood, plastic, or fiberglass.

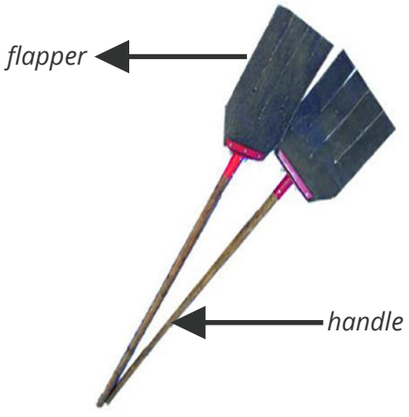
The pulaski is a versatile tool for constructing firebreaks, as it can be used to both dig soil and chop wood. It is also well adapted for trail construction, gardening, and other outdoor work.



Fire beater

A fire beater is a forest fire firefighting tool that resembles a broom with metal bristles. It is also called a swatter.

It is designed for extinguishing minor fires and is built with a long handle and a series of lamellas which allows firefighters to stand well back from the fire. The lamellas are constructed in either rubber or steel, though practically any other fireproof material could be used.



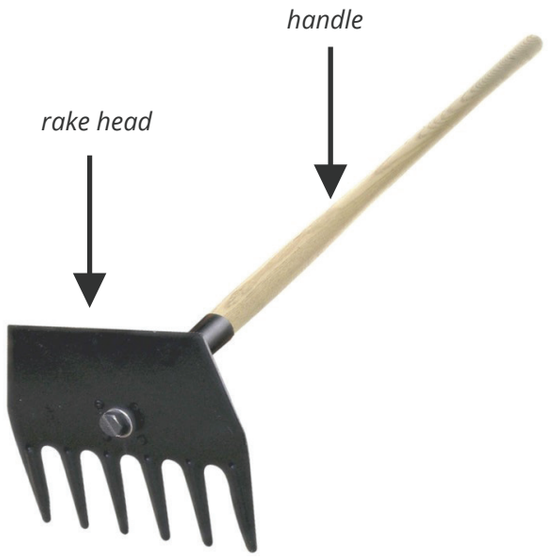
The fire is attacked from the wind-side by lightly swatting out the flames or glows with the thick flap. When the flapper hits the ground, oxygen supply to the fire is stopped and the fire will be extinguished. The flapper can also be dragged along the fire edge to smother the fire. If used too hard it can add more oxygen to the fire.

Due to a flapper's small size it is unfit for use against a blazing forest fire or large burning fields. The tool's design makes it only suitable for minor flames or glows within a limited area.

Fire rake

A fire rake is used to rake a fire break with the sharp teeth enabling it to reach fire in undergrowth in addition to loose surface debris.

A fire fighter will rake burning material back into the area already burned moving the fire from the fuel ahead of it creating a fire break. The burning material is left to burn itself out, away from the edge of the fire line, or another fire fighter with a fire flapper will smother it if required.



Shovel

Tool used for digging, lifting, and moving bulk materials, such as soil, gravel or sand. It is good for digging dirt when needed for cooling.

Module 2 : Forest Fire Prevention

This module will introduce participants to the basic concepts of forest fires. It will place specific focus on:

2.1 Basics of Forest Fire Prevention

2.2 Creation of Firelines

Objectives

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

- List the elements of a Forest Fire Environment Triangle.
- Describe the elements necessary to prevent forest fires.
- Explain what is a fireline and describe and demonstrate some of the principles governing its creation.
- List some of the critical forest fire prevention tips.

2.1 Basics of Forest Fire Prevention

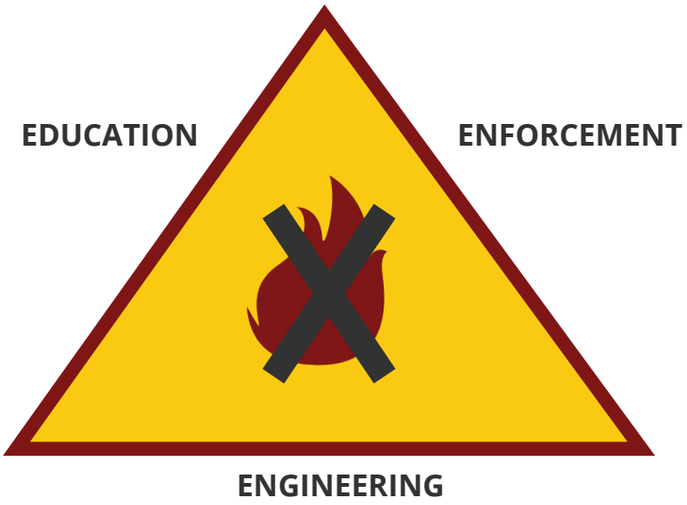
Preventing fires is always a less costly and effective way for suppressing them. Prevention programmes that are accepted and promoted within the community not only reduce costs and resource damage, but also promote understanding of the role and impact of fire in the ecosystem.

The fire prevention activities are grouped within the components of:

EDUCATION **ENFORCEMENT** **ENGINEERING**

These are referred to as the “three E’s” of fire prevention. It is important to understand how each of the three activities are crucial to forest fire prevention.

Figure 3
Fire Prevention Triangle



Education

This includes those activities that are aimed at changing people's behaviour by increasing their awareness and knowledge. These activities include the use of mass media (e.g. television, print media and radio), electronic media, signage and meetings among others.

Engineering

Engineering is an activity designed to shield an ignition source (e.g. spark arrester) or remove the fuel which could ignite from a spark or fire brand. It includes the reduction of hazards in high-risk areas and the creation of firelines/ fire breaks.

Enforcement

Experience worldwide has shown the higher the levels of voluntary compliance, the smaller the fraction of public resources that will need to be committed for enforcement efforts. Enforcement of the applicable laws will include conducting forest fire investigations to determine the source, cause and responsible parties.

Fire Hazard Reduction

Forest fires may occur in any vegetation cover type when conditions are favourable for burning. At the beginning of any fire management activity, it is important to investigate and establish source of sparks or flames which could start a forest fire. Every fire requires some spark or flame to start it.

Fire hazard (fuel) is one factor which can contribute to the starting of forest fires. There are both natural and man-made fire hazards.

There are many types of fuels that create hazards, among others:

- Slash accumulations in timber cutting
- Large accumulation in forests of flammable leaves, dead trees, dry brushes, etc
- Rubbish accumulation in and around residences, storage areas, and other buildings

2.2 Creation of Firelines

What is a Fireline?

A fireline (also called a firebreak or fuelbreak) is a gap in vegetation or other combustible material that acts as a barrier to slow or stop the progress of a forest fire. A fireline may occur naturally where there is a lack of vegetation or fuel, such as a river. Firelines may also be man-made, and many of these also serve as roads, such as a logging road, secondary road, or a highway.

A fireline should be constructed by removing vegetation and exposing bare ground or mineral soil. This is done to keep the fire from creeping across the firebreak and escaping. Bare ground firelines are the safest to work with, but not the only type that can be used.

Picture 5
Examples of a bare ground fireline

Constructing a Fireline

In the suppression of a forest fire, constructing a fireline cuts off the supply of fuels.

The objective of constructing a fireline is to remove or to reduce the flammable materials that allow the fire to build up in intensity or continue to spread. This is done by removing deadwood and undergrowth down to mineral soil.

The general goals of firelines are to slow the spread of forest fires, and to hopefully reduce the size of forest fires.

The factors to consider when deciding how and where to construct a fireline are: type and amount of available fuel, topography, and weather conditions. Heat by radiation and convection may ignite fuels outside the line if it is too narrow and does not have adequate overhead clearance (see Figures 4 & 5). Convection may also cause spot fires across the line. If the line is not deep enough, a fire may cross the line by burning through organic materials.

Figure 4
Spread of Fire Across Fireline by Radiation

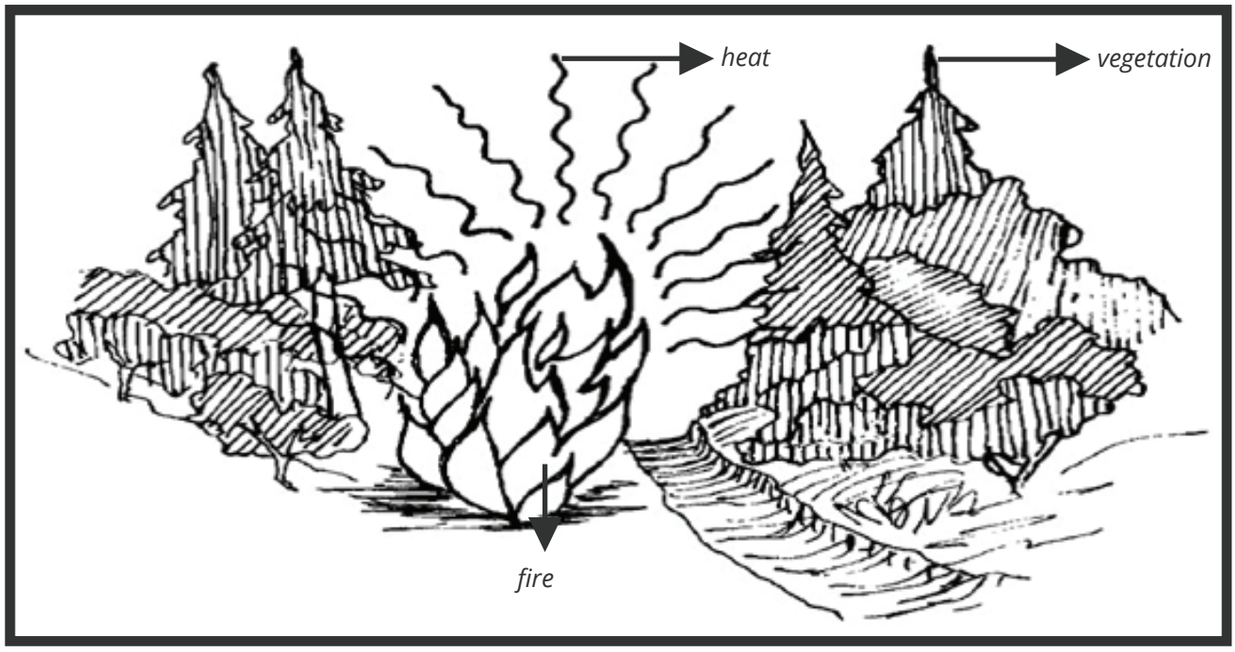
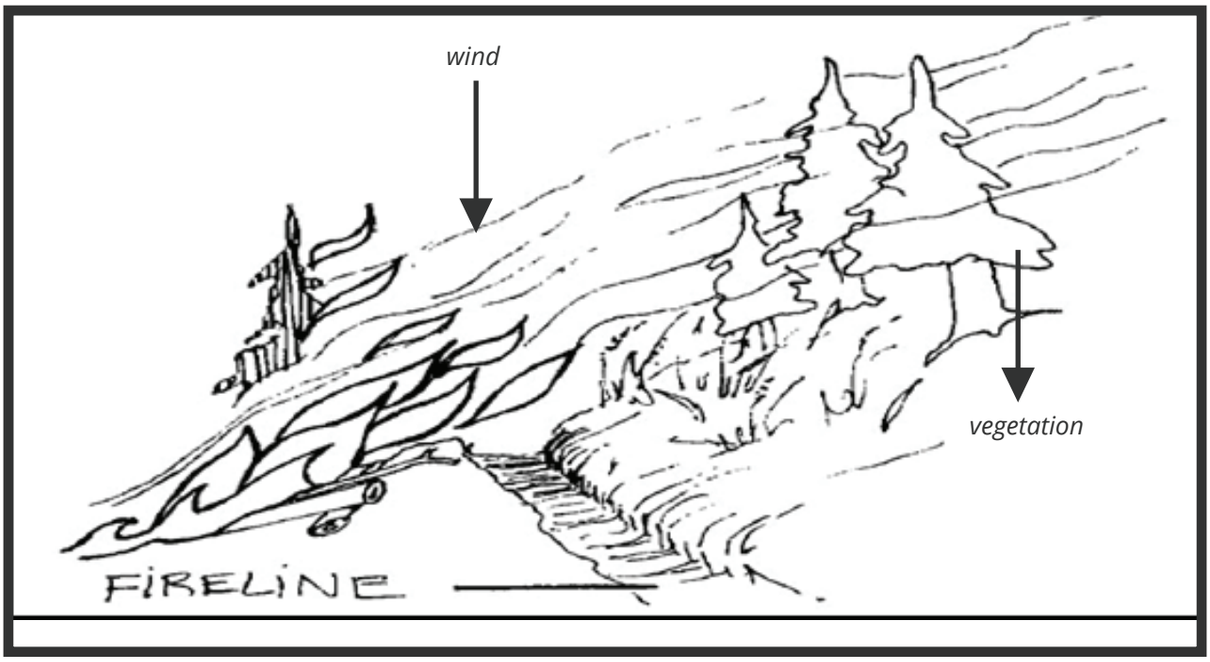


Figure 5
Spread of Fire Across Fireline by Convection



Sparks and embers may also blow across the fireline in high wind. They may also roll across the fireline when the fire is burning on a slope. A fireline that is constructed to overcome this hazard requires a cup trench or V-trench to catch rolling embers and sparks. This type of line is sometimes referred to as an underslung fireline.

Unburned fuels next to the line become drier and more available as a result of radiated and convective heat.

The following are some of the more important principles of fireline construction:

Principle 1

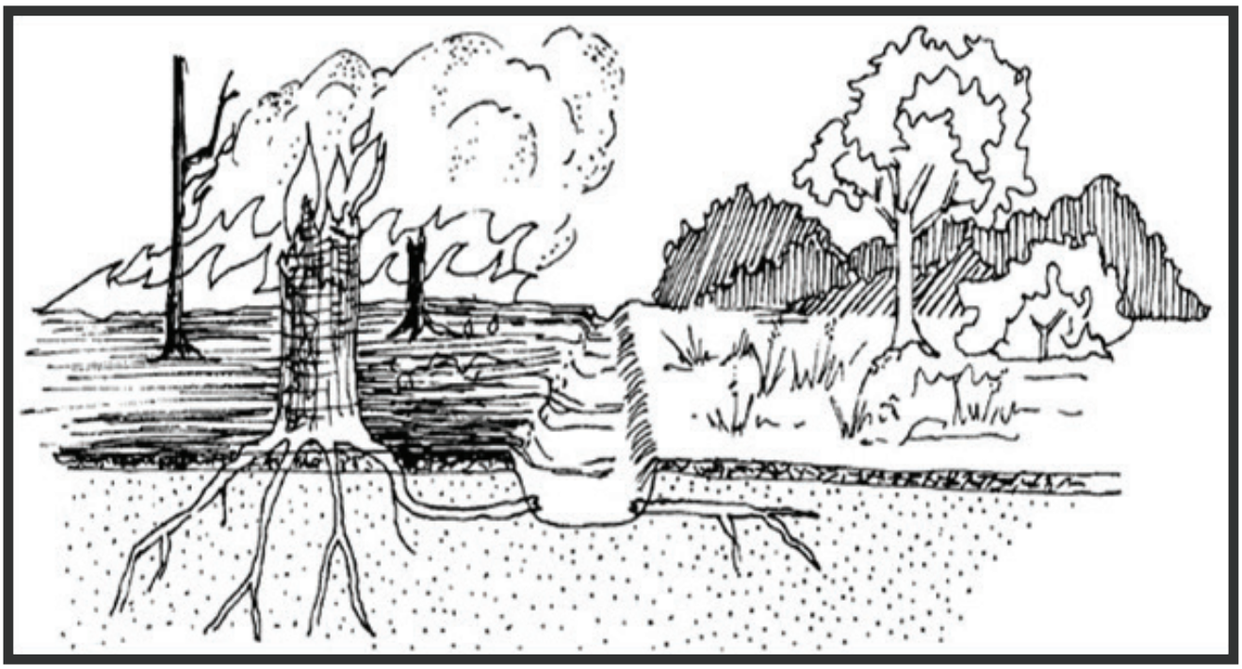
The typical width of a fireline is **10 feet**.

Make a fireline no wider than necessary. The time and energy saved by keeping firelines no wider than necessary to stop a fire can be better utilized in construction of more firelines to encircle or control the fire. The width of the strip will depend on the type of fuel, location, topography of the land, and weather conditions. Usually, the width of the clearing will not be less than one half the height of the tallest tree which supplies the fuel. The typical width of a fireline is 10 feet.

Principle 2

Clean all fireline to mineral soil for all or part of width (see Figure 6). Cleaning a fireline to mineral soil prevents the fire from spreading through fuel across the fireline, particularly dead roots. However, constructing fireline to mineral soil may not be practical in some types of fuel.

Figure 6
Fireline Cleaned to Mineral Soil



Principle 3

Remove low hanging limbs from trees on both sides of the fireline to prevent the fire from spreading across the line (see Figure 7).

Figure 7
Low Hanging Limbs Spreading Fire Across Fireline

Module 3 : Forest Fire Suppression

This module will introduce participants to the basic concepts of forest fires. It will place specific focus on:

3.1 Effects of Weather and Topography on Forest Fire Behaviour

3.2 Forest Fire Suppression Strategies

Objectives

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

- Describe the impact that weather and topography have on forest fire behaviour.
- List the elements of a Fire Extinction Triangle.
- Describe and demonstrate the various methods of attacking a forest fire.
- List and demonstrate three forest fire suppression techniques and describe their uses.

What is fire suppression?

Suppression means all the procedures which start on, or after the alarm is made of a fire. The main objective of the suppression activities is to extinguish the fire.

An essential part of forest fire suppression is the detection of the fire. The occurrence of a forest fire must be observed and reported as soon as possible in order to start the suppression activities while the fire is small. A certain part of the detection will be done by people who are living and working in the area, by travellers passing through the area, or by aircraft passing over the area. Although this general detection is effective in small sections of a forested area, a specific system of detection for the fire danger season must be planned and organised. This is referred to as "organised detection". The main methods of organised fire detection activities are:

A. Ground patrolling;
B. Lookout towers, points and stations; and
C. Air patrols and satellite.

A and B are more applicable in the Jamaican context.

A combination of these methods may be the most appropriate and the most effective.

Ground patrolling

Ground patrolling can be carried out by using forest rangers, park rangers or community members, some of whom may be designated as fire wardens. These individuals can travel by foot or via a motorcycle or pickup.

Fixed lookout stations

Fixed locations can be fire lookout towers, or lookout points. Lookout towers are appropriate on flat terrain. Lookout points are normally built on the top of high hills, with an effective range of approximately 30-40 km around the tower or point. There are a number of factors that have a strong influence on the visibility, such as time of day, haze or smoke, and the position of the sun.

3.1 Effects of Weather and Topography on Forest Fire Behaviour

Fire behaviour is one of the most important aspects of forest fires because almost all actions taken to manage a fire depend on how it "behaves." Success in pre-suppression planning and actual suppression of wildfires is directly related to how well fire managers understand and are able to predict fire behaviour. The safety of all firefighting personnel also depends on this knowledge.

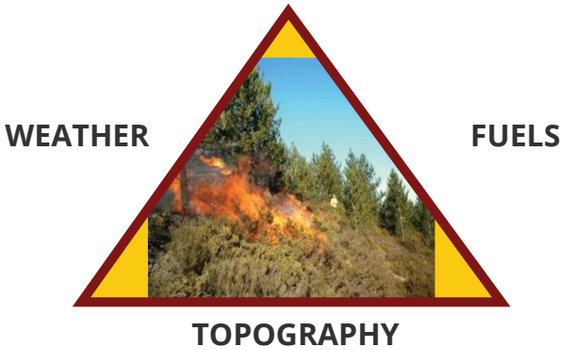
A wildfire behaves according to the environment in which it is burning. This environment consists of various elements of fuels, topography and weather. These elements and their reactions with one another, and the fire itself, determine the behaviour of fire. Fire behaviour is, therefore, defined as the manner in which fuel ignites, flame develops, and fire spreads as determined by the interaction of weather, topography and fuel. This is referred to as the forest fire environment. The focus on this module will be on the first two of these elements as fuel was already discussed in Module 1.

There are many elements under each of the three major components of the fire's environment that affect how a fire behaves. A change in any one of these elements will cause a change in the behaviour of the fire--and this change can be very abrupt and rapid.

Fire Behaviour

The manner in which fuel ignites, flame develops, and fire spreads as determined by the interaction of weather, topography and fuel.

Figure 8
Forest Fire Environment Triangle



Weather

Weather plays a major role in the birth, growth and death of a forest fire. Drought conditions lead to extremely favourable conditions for forest fires, and winds aid a forest fire's progress; weather can spur the fire to move faster and engulf more land. It can also make the job of fighting the fire even more difficult. Therefore, firefighters conducting fire suppression must monitor the weather at all times to make safe and effective firefighting decisions.

Weather

Short-term variations in the atmosphere.

There are three weather ingredients that can affect wildfires:

Temperature

Wind

Moisture

Temperature

Air temperature

Air temperature is the degree of heat or cold of the air.

In a forest environment, direct sunlight and hot temperatures can preheat fuels and bring them closer to their ignition point, whereas cooler temperatures have the opposite effect (remember - heat is one of the three pillars of the fire triangle). The sticks, trees and underbrush on the ground receive radiant heat from the sun, which heats and dries potential fuels. For this reason, forest fires tend to rage in the afternoon, when temperatures are at their hottest.

Wind

Wind probably has the biggest impact on a wildfire's behaviour. It is also the most unpredictable factor and the most variable in both time and location. Winds supply the fire with additional oxygen, further dry tpotential fuel and push the fire across the land at a faster rate. Winds also have the potential to carry sparks and firebrands ahead of the main fire causing spot fires. Also, bending flames result in the preheating of fuels ahead of the fire.

Wind

The horizontal movement of air relative to the surface of the earth.

Moisture

While wind can help the fire to spread, moisture works against the fire. Moisture, in the form of humidity and precipitation, can slow the fire down and reduce its intensity. Potential fuels can be hard to ignite if they have high levels of moisture, because the moisture absorbs the fire's heat. When the humidity is low, meaning that there is a low amount of water vapour in the air, wildfires are more likely to start. The higher the humidity, the less likely the fuel is to dry and ignite.

Topography

Topography is the arrangement of the earth's surface including relief (how high or low a place is) and the position of its natural and made features. Slope, aspect, elevation, other topographic features influence fire spread (how fast a fire moves in feet per hour).

Topography

The arrangement of the earth's surface including its relief (how high or low a place is) and the position of its natural and man-made features.

Slope

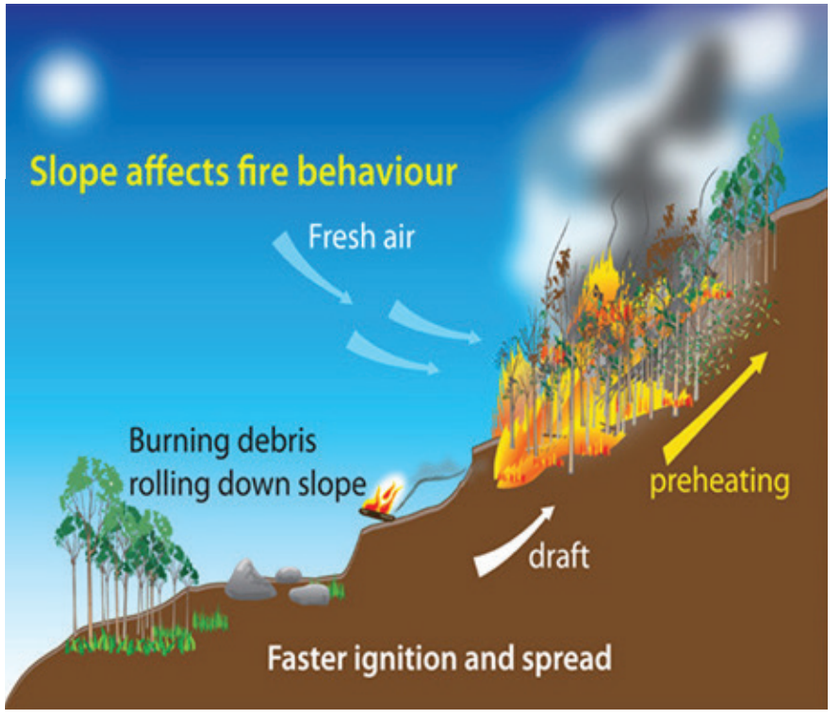
This is the amount or degree of incline of a hillside. Fires tend to spread faster up a slope than down one. The steeper the slope, the faster the fire burns. This is because the fuels above the fire are brought into closer contact with the upward moving flames. Convection and radiant heat help the fuel catch fire more easily. As heat rises in front of the fire, it preheats more effectively and dries upslope fuels, making for more rapid burning.

Slope

The amount or degree of incline of a hillside.

Another concern about steep slopes is the possibility of burning material down the hill and igniting fuel below the main fire.

Figure 9
Effect of a Slope on Forest Fire



(Source: https://ir.library.oregonstate.edu/xmlui/bitstream/handle/... /pnw618zappendixb.pdf)

The position of the fire in relation to the topography is, therefore, a major factor in the resulting fire behaviour. A fire on level ground is primarily influenced by fuels and wind. A fire which starts near the bottom of a slope during normal upslope daytime wind conditions will normally spread faster and has more area to spread upslope than a fire that starts near the top of the slope.

Aspect

This is defined as the direction of the slope in relation to the sun. It affects how much solar radiation a site receives and also the vegetation type. South slopes receive much higher solar radiation and are warmer, so fuels tend to dry out sooner and more thoroughly during the fire season. In contrast, north slopes have more vegetation and hence heavier fuel loads. North slopes are cooler and more shaded, thus delaying the drying of fuels long into the fire season.

Wind

The direction of the slope in relation to the sun.

Elevation

Elevation

The height of the terrain above sea level.

Elevation is the height of the terrain above sea level. It affects fire behaviour by influencing the amount and timing of rainfall, as well as exposure to prevailing wind. Elevation also affects the seasonal drying of fuel. In lower elevations, fuels tend to dry out earlier in the year because of higher temperatures and lower rainfall. The opposite is true for fuels at higher elevations.

Other Topographic Features

Barriers

A barrier is any obstruction to the spread of fire, typically an area or strip lacking any flammable fuel. Barriers to fire include may things, both natural and man-made:

Natural barriers:

- Rivers
- Lakes
- Rocks

Fuels which have a high moisture content do not burn as well as others in the same area.

Man-made barriers:

- Roads
- Highways
- Reservoirs
- Firelines constructed by fire resources

3.2 Forest Fire Suppression Strategies

The Extinction Process

There are three basic methods which can be used to extinguish a fire. This can be achieved by:

Starving

The limitation of fuel, that is, separating the fuel to prevent combustion or remove fuel during fireline construction.

This can also be accomplished by backfiring which is a technique employed to burn an area of vegetation in front of the fire, thereby creating a wide area devoid of vegetation.

Cooling

The reduction of heat by applying water, dirt, retardant or a combination.

Smothering

The limitation of oxygen by suffocating the fire with dirt or water or with the use of a fire-beater.

The smothering technique is most commonly used when firefighters are overhauling the last remnants of a forest fire.

Picture 6
Use of fire beater to smother fire

Figure 10
Triangle of Fire Extinction

Methods of Attack

Forest fires can advance and change directions quickly. Given their unpredictability, they present a very hazardous environment for firefighters. For these reasons, it is important that any firefighting response matches the conditions present at the fire. Therefore, the strategies used to control a forest fire depend on the rate of spread, intensity, spotting potential, size, type of available resources, and other factors.

Suppression action(s) may include direct attack or indirect attack or a combination of both strtegies.

Direct Attack

Direct attack is any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from not burned fuel. This includes the work of fire personnel applying water or fire retardant directly to the burning fuel. For most agencies, the objective is to make a fireline around all fire meant to be suppressed.

Direct Attack

Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from not burned fuel.

Such an attack is used when fire perimeter is burning at low intensity and fuels are light, allowing for safe operation at the fire's edge. Control efforts, including line construction, are done at the fire perimeter, which becomes the control line.

Direct attack is used mostly on ground or surface fuels, such as grass, brush, duff, underground fires, or on flanks or rear of large fires. It is also used in the later stages of a large fire, and on any fire where the burning intensity, heat, and smoke are too much for the fire fighters to work on the fire edge.

An approach against the wind at the fire front is the most effective, but because of the difficulty in predicting the speed at which the fire is spreading, it is not without risks. A direct attack is also dangerous to firefighters because they must work in smoke and heat close to the fire. Such an attack has the advantage of accomplishing quick containment of a fire but it can only be applied at low flame heights.

Indirect Attack

Preparatory suppression tactics used a distance away from the oncoming fire are considered indirect. Firelines may be built in this manner as well. Fuel reduction, back-burning and wetting unburnt fuels are examples. This method may allow for more effective planning. It may allow for more ideally placed firelines in lighter fuels using natural barriers to fire and for safer firefighter working conditions in less smoke filled and cooler areas.

In this method of attack, the fuel is separated from the path of the approaching fire. This technique is usually applied on high-intensity fires where fire fighters cannot approach the front of the fire due to heat and/or smoke conditions.

With the indirect method, the line is located some distances from the fire's edge. How far it is located from the fire is of prime importance. All the factors of fire behaviour must be used in making the decision. Since the intervening material must be burnt out, the line must be located where it will be effective when the fire reaches it. The intervening area must be kept as small as possible so that no more is burnt than is necessary, otherwise the fire can build up enough to jump the line. The right location can only be decided by experience and judgement.

Parallel Attack

This type of attack is a method of fire suppression in which a fireline is constructed approximately parallel to, and just far enough from the fire edge to enable workers and equipment to work effectively, though the fireline may be shortened by cutting across unburned fingers. The distance away from the fire edge will depend on the fuel, the intensity of the fire and the topography. In some cases, the line can be built along one flank. The unburned fuel is usually burned out as the line moves alongside the fire but can burn out with the main fire as long as there is no threat to the fireline. This type of attack has a number of advantages such as reduced heat and smoke exposure, line can be placed in lighter fuels and lines are often straighter and shorter.

Appendix

Forest Fire Emergency Contact Information

Jamaica Fire Brigade	
Address	Contact Information
85 Hagley Park Road, Kingston 10, Jamaica W.I. (HQ)	**Tel:** (876) 922-0027; (876) 967-0550 **Emergency:** 110 **Email:** area1@cwjamaica.com **Website:** www.jfb.gov.jm

Forestry Department	
Address	Contact Information
173 Constant Spring Road, Kingston 8 Jamaica W.I. (HQ)	**Tel:** (876) 618-3205 | (876) 924-2667/8 **Toll Free:** 1(888) FORESTS (367-3787) **Email:** fdinfo@forestry.gov.jm **Website:** www.forestry.gov.jm

Office of Disaster Preparedness and Emergency Management	
Address	**Contact Information**
2-4 Haining Road, Kingston 5 Jamaica W.I. (HQ)	**Tel:** (876) 906-9674 **Toll Free:** 1 (888) 225-5637 **Email:** odpem@cwjamaica.com **Website:** www.odpem.org.jm

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