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Burning Forest Residues

TECHNICAL NOTE

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SUMMARY

Burning forest residues is a traditional method of ground clearance following harvesting operations. Guidance is given on suitable types of cut material for burning, equipment to use, planning and techniques to ensure good management. The necessary legislation is specified. Environmental impacts, health and safety and atmospheric considerations are discussed and guidance is provided on good practice before, during and after burning.

This Technical Note is produced as a guide to the latest developments in burning forest residues and is the third in a series of three on forest fire control. The others are: *Planning controlled burning operations in forestry* and *Forest and moorland fire suppression*.

INTRODUCTION

Throughout the UK, the burning of forest residues has been a traditional method of ground clearance following a harvesting operation. Today the process is carried out mainly by private estates and woodland owners and only in a limited number of Forest Enterprise areas. The aim of this Technical Note is to provide forest and other land managers with information on the latest developments in burning forest residues and guidance on good burning practice.

Many reasons for burning have been cited, the most common being that it is a positive aid to vermin control, particularly rabbits, by removing cover and exposing burrows. Burning is also seen as being the most cost-effective way of dealing with unusable brash to give access for subsequent operations. In amenity areas such as picnic sites, cycle paths, walks and drives, burning may be used as part of a plan to improve visual appearance. Burning may also used to deal with residues from whole tree harvesting/processing operations, for disease control, to aid natural regeneration, for disposal of coppice, to reduce specific weeds and to aid land use conversion.

BURNING RESIDUES: TYPES AND METHODS

When burning residues (cut material), especially if the operation is mechanised and local conditions are taken into account, these fuel loads can be effectively controlled by using the appropriate methods and techniques.

Types of cut material

The following types of cut material are burnt in certain forest conditions:

- hardwood lop and top
- conifer brash
- rhododendron.

Hardwood lop and top cannot be used for machine flotation and traction during harvesting to the same extent as brash from conifers. Conifer brash is burnt on some small re-stock sites that do not justify the expense of transporting and using ground preparation machinery. Residues can also be burnt to improve access for other forest operations and to achieve target stocking densities.

Methods and equipment

The following should be considered when burning cut and stacked woody material:

- Minimise soil content in heaps by using methods and equipment that reduce soil disturbance.
- Allow cut material to dry to reduce smoke production.
- Ensure material is heaped and surrounded by adequate fire breaks/control lines.
- Check wind direction and strength.

Stacking techniques and machinery

Where residues are burnt as part of the harvesting process, machinery can be used to gather material that can improve burning control and efficiency. Residues should be accumulated using techniques that give minimum soil disturbance and using equipment such as front end loaders, bulldozers and forwarders that can gather and stack cut material.

Caution is required when pushing partially burnt material onto an established bed of embers; there is a risk to the operator and the machine and these need to be assessed. Machinery used on sites where burning takes place should be regularly cleaned so that belly plates and sump guards contain minimal quantities of combustible material. Fire extinguishers should be provided on machinery and their condition and ease of access checked. Machines should be used with due regard for the risk of fire during burning operations.

Smaller, more numerous piles are recommended rather than larger piles and windrows. It is easier to control fires in piles compared to windrows because piles are smaller, less restrictive to site access and surrounded by distinct brash free areas. Large fire breaks should be made at regular intervals in windrowed material.

Minimising soil damage and smoke creation

To reduce soil damage and promote efficient brash burning with the minimum of smoke creation, it is important to reduce the amount of soil incorporated into brash heaps. Brash should therefore be accumulated with equipment and techniques that give minimum soil disturbance. Lifting brash with long tined rakes or shaking soil from 'grappled' brash will reduce soil accumulation compared to indiscriminate bulldozing or bad grapple practice with soil pick-up. Good technique is especially essential where brash has been used to form extraction routes.

Where possible, brash should be loosely stacked into small piles when it is dry. Aerated stacks of dry material will burn more efficiently than wet piled material that is compacted during brash stacking. Fuel with high moisture contents and burning with poor oxygen supply (compaction and/or soil incorporation) produces more smoke in smouldering fires, which burn with reduced vigour. These fires burn at slower rates and smoke is not dispersed in hot updraughts from the fire. Burning drier material with minimum soil content will help to reduce smoke creation.

Burning heaped brash piles should take place in weather conditions that are safe and help to disperse smoke in the desired direction. Vigorous fires burning in air conditions that allow smoke to rise will disperse smoke more effectively than smouldering fires burning in temperature inversions where the air is calm, keeping smoke close to the ground. On some sites it will be a management constraint to plan burning on days where wind direction, weather and fuel conditions are suitable and where labour is available.

Some practitioners burn green material at the time of harvesting and this requires a well-established fire. Smoke management with fresh brash fires requires good planning and an understanding of all the constraints.

Wind direction and drifting

Wind conditions throughout the fire site and neighbouring fuel conditions should be monitored before and during burning. Embers from stacked fires can be carried in strong convectional updraughts from the fire and/or in the wind and spot fires can start if there is a suitable local fuel source (Murgatroyd, 2001). Burning should not take place where there is very dry fuel and strong winds. Fires can burn through dry upper and lower soil litter layers and into the soil (especially peat) in dry conditions.

The probable course of drifting smoke should be ascertained and its effect upon local inhabitants and services such as roads, railways and airfields considered. Burning drier, aerated brash in weather conditions that allow smoke to rise are examples of good smoke management practice.

LEGISLATION

The legislation relevant to burning residues is similar to that of controlled (prescribed) burning (see Murgatroyd, 2002). In addition however forest residues become classed as waste if they are to be burned on site. They are then covered by the Waste Management Licensing Regulations (1994) which are administered by the Scottish Environment Protection Agency (SEPA) and the Environment Agency (EA) in England and Wales.

It is an offence to burn waste on land in the open except under and in accordance with a Waste Management

Licence granted in terms of Sections 33 and 35 of the Environmental Protection Act. The offence described does not apply to the activities listed below provided they have been registered with SEPA (Scotland) and EA (England and Wales) before the activities take place. Notification can be by phone or, preferably, by letter.

The activities are:

1. Subject to sub-paragraph 2 below, burning waste on land in the open if:

   – the waste consists of wood, bark or other plant matter;

   – it is produced on land which is operational land of a railway, light railway, tramway, internal drainage board, the National Rivers Authority or which is a forest, woodland, park garden, verge, landscaped area, sports ground, recreation ground, churchyard or cemetery, or it is produced on land as a result of demolition work;

   – it is burned on land where it is produced and the total quantity burned in any period of 24 hours does not exceed 10 tonnes.

2. Sub-paragraph 1 above only applies to the burning of waste by an establishment or undertaking where the waste burned is the establishment's or undertaking's own waste.

3. The storage pending its burning, on the land where it is to be burned, of waste which is to be burned in compliance with any or all of the activities in sub-paragraph 1 above.

It is recommended that local authorities are consulted when burning operations are planned. Another constraint associated with burning is the proximity of fires to public roads, public places and airfields. Public health also has to be considered when fires may cause a nuisance. Local police and local authority environment officers should be contacted for advice.

Further reference to other relevant legislation can be found in *Planning controlled burning operation in forestry* (Murgatroyd, 2002), which includes Roads, Clean Air, Environmental Protection and Public Health. All parties involved in burning residues have responsibilities under the various Acts and Regulations concerning Health and Safety at Work.

CURRENT METHOD OF BURNING

The most common method of burning residues is to create piles at a density of between *c.* 10 and 20 per hectare (Figure 1), depending on the quantity of residue present. Current burning costs range between £160/ha and £250/ha and may be included as part of the overall cost of the harvesting operation.

Figure 1 Piles of brash prior to burning

ENVIRONMENTAL IMPACTS

Pathology

The most common threat to conifers after burning operations is the fungal pathogen *Rhizina undulata* (Forestry Commission, 1961). This fungus causes root rot of conifers, known as group dying, and affects all commercially grown conifers in the UK. The fruiting bodies of *R. undulata* can develop as soon as 15 weeks after burning. The spores can remain dormant and viable for up to 2 years until heat activates germination. *R. undulata* will only become established in burned areas if the spores are present in the soil prior to burning and live conifer roots are available. It is also thought that more acidic soils containing a peaty layer are good conditions for the mycelium to grow as the shallow rooting system offers many root contacts which allow the mycelium to spread rapidly from tree to tree.

Identification of *R. undulata* is difficult and is mainly through the presence of the fruiting body. This has a dull chestnut brown to black colour with tough flesh and an undulating surface, and a yellow to ochre undersurface with numerous branch-like rhizoids. Mature fruiting bodies can be up to 6 cm wide. Two or more may be joined

together giving the appearance of being much larger. They often develop above dying roots or burned wood in the soil.

Many areas of Europe, where group dying is prevalent, ban burning. It is thought that digging a trench (0.3 m deep x 0.3 m wide) will prevent the radial spread of the fungus. There have been cases in Canada where newly restocked sites have suffered deaths due to *R. undulata*, but this is not thought to occur in the UK. However, it would be prudent to assess areas prior to planting particularly if brash burning has taken place. Avoiding planting sites adjacent to the burned areas and stumps may also prevent the spread of the fungus. There are no known chemical or biological methods of control.

Soil

Burning of brash in piles can be described as a severe burn, characterised by a white ash layer left after the complete burn of all material. Burning brash in this way will destroy all organic matter to a depth of several centimetres and cause changes in the physical, chemical and biological properties of the upper layers of mineral soil. In organic soils such as peat there is a risk of ground fires developing which will be difficult to extinguish.

Silvicultural systems

The burning of forest residues lends itself to a clearfell/restock system. In other systems, such as continuous cover, fire could damage surrounding standing crops. Movement of machinery to pile heaps into this type of system may be expensive; hand piling of residues would also be expensive. Burning can be used to aid natural regeneration of tree species.

ATMOSPHERIC CONSIDERATIONS

Wind, temperature and rainfall are the most important elements to consider. These factors influence fuel moisture. Knowledge of the weather is the key to successful brash burning and is essential for proper management of smoke produced by burning.

Wind

Wind speeds are much stronger in open areas than they are in the forest. Therefore, from a smoke management perspective, the stronger the winds the better the dispersal, provided that there are no downwind, smoke-sensitive areas. Ground wind speeds of between 13 kph (8 mph) and 16 kph (10 mph) are ideal for good dispersion of smoke.

Wind direction may change substantially with height above ground level and it is these 'transport' winds that regulate the movement of the smoke column. Moderate wind speeds allow a convection column to develop that enables the smoke to dissipate into the atmosphere, where it quickly disperses with minimum impact on ground level air quality. Once the fire has died down and smoke production is from smouldering combustion, surface wind is necessary to ensure good smoke dispersion.

Temperature

High ambient air temperatures will draw up the heat produced from the fire, which in turn helps to disperse the smoke.

Rainfall

Rain affects both fuel and soil moisture and it is necessary to obtain information about local rainfall. Soil moisture is very important to reduce the effects of the fire on the chemical and physical properties of the soil. A period of rainfall followed by sunny skies, brisk winds and low humidity, will generally result in good burning conditions with adequate soil protection.

GOOD BURNING PRACTICE

Before burning

An assessment of areas that will be affected by the burning should be carried out in order to install control measures and maintain good relations with neighbours.

Brash should be arranged into small, aerated, soil-free piles, constructed when conditions are dry and with distinct fire breaks. The underlying soil should be checked to ensure that the risk of a ground fire is avoided. Where dense residues are present the number of piles should be sufficient to give a reasonable average pile size and adequate fire breaks.

Fire breaks should be clear of any combustible fuel, including fine branched material and substantial litter layers. The risk of embers creating spot fires in high hazard fuels such as *Molinia* and gorse should be considered. The risk of spot fires is also dependent on weather conditions. Piles should be created in areas where they do not present a hazard when burning.

Wind direction and speed should be checked to ensure dispersal of smoke away from sensitive areas and adjoining landowners, and the local fire brigade should be notified of the intention to burn. A traffic control system should be installed if visibility on public highways is likely to be reduced.

During burning

The ignition of the fire should take place as close to the centre of the pile as possible to aid the complete burning of the pile. A safe and efficient method of ignition using a less volatile fuel such as diesel must be identified. Poor ignition systems can lead to frustration, giving a tendency to use unsuitable or explosive fuels. Petrol in particular should never be used.

The weather and site conditions should be monitored to ensure that:

- smoke is dispersed in the desired direction;
- there is a low incidence of organic soil layer damage in wet or damp soil conditions;
- there is a low risk of embers creating spot fires.

At all times, the burning of brash should be under supervision to reduce the risk of loss of control due to changing conditions and injury to persons. A risk assessment should be made when leaving smouldering embers overnight. It should include neighbouring fuel loads, changing weather conditions and risk of injury to site visitors including children. If there is any doubt, embers should be extinguished. It may be difficult to defend a decision to allow embers to burn unattended, if fires spread or injuries occur. In one court case a contractor was found to be negligent when a child was injured by embers. The court concluded that the fire should have been extinguished and surrounded by some type of temporary fence or marker tape.

Good communications between team members is essential and the provision of plans, maps and an effective communication system, e.g. local radio network and mobile phones, is imperative to maintain control over the operation. All personnel involved in brash burning should wear the appropriate protective clothing.

An adequate fire suppression system should be available at all times to ensure good fire control. A low expansion foam system (Murgatroyd, 2001) is considered the most efficient as it can be used to lay foam traces and is effective for damping down operations (Figure 2). It can also be incorporated into most water based suppression systems.

In the absence of a low expansion foam system, plain water systems with good quality branches and nozzles with on/off controls, spray and jet patterns should be used. Synthetic foam concentrate should be available for mixing at the rate of 0.5 litre per 100 litres of water to reduce water surface tension for damping down operations.

Figure 2 Damping down with low expansion foam

After burning

The fire should be fully extinguished and all fire sites damped down. Where there is a risk of organic material such as peat continuing to burn periodic checks should made after the site is vacated.

CONCLUSIONS AND RECOMMENDATIONS

- Cut material (hardwood lop and top, conifer brash and rhododendron) can all be burnt following harvesting operations, particularly as an aid to vermin control and to allow access for subsequent forest operations.
- Residues should be heaped in many small piles rather than few large piles, with adequate windbreaks, using machinery and techniques to minimise soil disturbance and allow time to dry.
- Wind and fuel conditions should be assessed and monitored to avoid spot fires, reduce soil damage

and minimise effects of drifting smoke on local people and services.

- The legislation relevant to burning residues is covered by the Waste Management Licensing Regulations (1994), administered by SEPA in Scotland and EA in England and Wales.

- Several key environmental aspects need to be considered following burning:

  – In conifers, the fungal pathogen *Rhizina undulata* is a common threat, causing root rot (group dying); prevention includes avoiding planting sites close to burnt areas and digging a trench to stop radial spread.

  – Brash burning in piles affects the upper layers of all soils and incurs a risk of ground fires in peat.

  – In continuous cover silvicultural systems, fire can damage surrounding crops, but it can be used to aid natural regeneration of tree species.

- Wind, temperature and rainfall all influence fuel moisture. Checking weather conditions/forecasts is essential for proper management of smoke:

  – the stronger the winds, the better the dispersal;

  – high ambient air temperatures draw up heat and help smoke dispersal;

  – rainfall followed by sun and brisk winds results in good burning conditions and protects soil.

- Good burning practice involves three main stages:

  – Before burning: arrange pile sizes, inform neighbours and fire brigade, check firebreaks, install control measures, assess wind conditions.

  – During burning: ensure safe ignition, monitor weather and site conditions, reduce risk of loss of control, ensure good communication between the team, organise an adequate fire suppression system.

  – After burning: ensure that the fire is fully extinguished, damped down and rechecked (after the site is vacated).

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