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TECHNICAL DEVELOPMENT BRANCH

BRASH MANAGEMENT ON HABITAT RESTORATION SITES

REPORT PRODUCED FOR FACT

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FORUM FOR THE APPLICATION OF CONSERVATION TECHNIQUES

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BRASH MANAGEMENT ON HABITAT RESTORATION SITES

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Brash Management on Habitat Restoration Sites

1 INTRODUCTION

The rehabilitation of many degraded wildlife habitats (e.g. heaths, grasslands, woodlands and fen habitats) on sites where trees (both conifer and broadleaf) have seeded in or been planted requires not only the removal of timber products but also the removal or disposal of brash. This is so that preferred vegetation communities of favoured plant species can develop in appropriate conditions suitable for their establishment.

A large number of sites are currently being cleared for habitat restoration and some of these have given rise to ecological and environmental problems, as well as requiring considerable expenditure to finance machinery and operations. Problems have included: smothering, weed infestation and nutrient enrichment of developing flora by brash left on site; excessive smoke from burning; heavy wear and tear and maintenance of equipment; overall high energy usage for clearance works; and high costs of restoration.

Technical Development Branch (TDB) agreed to research this topic following discussions that arose within the Forum for the Application of Conservation Techniques FACT 4 (Sustainable woodlands) and FACT 7 (Environmental management) projects. This report reviews a range of methods currently available for managing brash where trees are felled as part of conventional timber harvesting, or as part of habitat restoration work. The report considers each technique from operational, ecological, environmental and economic viewpoints. Although the technique used on any particular site will necessarily be decided on local criteria this report seeks to provide information that can aid selection based on the above criteria.

2 SUMMARY AND CONCLUSIONS

This report reviews options for the management of brash both on and off the felling site. It then summarises information from questionnaires returned by site managers as to current methods employed in a series of histograms. All the 'on-site' and 'off-site' brash handling techniques are then reviewed. Advantages and disadvantages of each are considered related to operational, ecological, environmental and economic criteria. An appendix presents a definition of the forestry harvesting systems commonly employed within the UK, defining the system and stating the form in which brash is produced.

The technique used on any particular site will necessarily be decided according to local circumstances but some conclusions have been identified to help guide that decision and these are set out in Table 1. In working towards making a decision on technique choice the approach should consider the following points:

- Successful vegetation establishment, or recovery, will normally be aided by removal of brash from the site although this is dependent on the favoured light environment of the desired species and sufficiently low levels of browsing pressure to support establishment.
- Removal should be done by a technique that does not reduce, or make more difficult, the chance of successful rehabilitation with the desired species and vegetation community.
- Processing of timber and brash off-site will generally result in less disturbance to the surface vegetation and thereby aid recovery. (N.B. on some sites it is accepted that a degree of surface disturbance may actually aid re-colonisation or germination of desired species; such disturbance must be planned for and carefully managed, and does not serve as a justification to cause damage to the site).
- Removal of timber only (by timber merchants) whilst leaving brash on site, is likely to increase the costs of subsequent brash removal or disposal. (Follow up operations need to be costed into total cost estimates).
- Efforts made to extract timber and brash to ride-side in a saleable form to local markets e.g. wood fuel may (partly) offset habitat restoration costs.
- If using machines then consider the ground pressure of various options to avoid unnecessary disturbance to soil condition and soil water flows.
- Selection of a technique(s) needs to consider the related environmental footprint and may require completion of an environmental impact assessment.
- Ensure operations are carried out at a time of year or in weather conditions when ground conditions are at their optimum to reduce ground disturbance.
- Ensure all operations are carried out in a way that minimises any point source or diffuse pollution.
- Visit and observe similar operations on several other sites before settling on the best technique and plan of operations.

Table 1. Technique selections according to selected ecological / environmental / economic site management objectives

SITE OBJECTIVE	TECHNIQUES TO BE CONSIDERED		
	Acceptable techniques	**Possible techniques – (depending on how they are carried out and local circumstances)**	**Unacceptable techniques**
Require re-establishment of semi-natural vegetation communities in nutrient poor conditions. (i.e. need to remove arisings)	- all whole tree felling and removal (5.1 & 5.5) - all brash removal techniques. (5.2 & 5.5)	- dead hedging (5.3) - heaps / windrows (5.3) - chipping (5.5) - burning (5.5)	- brash left on site (5.3) - spreading by excavator (5.3) - forestry mulchers (5.3) - fell to waste (5.4) - chemical thin (5.4) - ring bark (5.4)
As above but soils are wet with poor load bearing. Also bogs and fens with even less load bearing capability	- by hand; portable winch; cable extraction; mini-forwarders (5.1) - manual; ATVs (5.2) but depending on site	As above + - horse extraction (5.1)	As above and also: - direct chipping; forest harvesters (5.1) - brash bailing; forest harvesters - all other methods
Require re-establishment of semi-natural vegetation communities whilst trying to avoid 'weed' establishment. (i.e. includes removal of arisings that will shelter weed establishment)	- all whole tree felling and removal (5.1 & 5.5) - all brash removal techniques (5.2 & 5.5) - chemical thin (5.4) - ring bark (5.4)	- chipping (5.5) - burning (5.5) - forestry mulchers (5.3)	- dead hedging (5.3) - heaps / windrows (5.3) - brash left on site (5.3) - spreading by excavator (5.3) - fell to waste (5.4)
Minimise air pollution	- horse; winch; cable way (5.1) - manual (5.2) - brash left; dead hedging; heaps/windrows (5.3) - fell to waste; chemical thin; ring bark (5.4)	- burning when dry (5.3)	- burning when wet (5.3) - all techniques involving large machines (i.e. due to exhaust emissions)
Minimise risk of diffuse ground water pollution on site	- all whole tree and brash removal techniques (5.1, 5.2 and 5.5.)		- all 5.3 techniques where brash left on site. - all 'alternative' techniques 5.4. (Due to decay products)
Minimise use of herbicides	- all except chemical thinning		- chemical thinning (5.4)
Maximisation of marketable produce	- all whole tree extraction techniques (5.1). - composting; chipping; fuel wood (5.4)	- all brash extraction techniques (5.2)	- all techniques leaving brash on site (5.3 & 5.4.)
Maximisation of alternative uses of material	- chipping (5.1) - brash bailing (5.2) - brash mats used to assist extraction operations on bogs. - dead hedging; left as fallen for browse protection (5.3) - composting, chipping, fuel wood (5.5)	- all whole tree and brash removal techniques (5.1, 5.2 and 5.5.) but depending on after processing	- burning (5.3) -fell to waste; chemical thin; ring bark (5.4)
Minimising operational costs	- by hand (5.1); manual (5.2) if by volunteers! - brash left (5.3) - fell to waste; ring barking (5.4)	- whole tree extraction to save second brash removal operation. (5.1) - all other techniques depending on local circumstances	- cable way; helicopter (5.1) - all techniques that require operation to remove brash after timber removed (5.2)
Minimising capital costs	- all non mechanised techniques	- other small equipment / machine techniques depending on local circumstances	- large scale forestry machines (5.1)

3 BRASH MANAGEMENT

During the course of felling and thinning operations, as part of either conventional forest management or as part of habitat restoration, tree felling will yield a quantity of timber and in addition a quantity of residual brash. Within the

context of this report the term brash has been taken to be the branch and crown wood, including leaves and needles, that is separate from the main utilisable stem component of the harvested tree crop. This residual material, usually left on site following the felling of the standing crop is also referred to as 'lop and top', 'slash' or forest residue. Brash may be left on site to break down, so releasing nutrients onto the site – this may be regarded as a positive or negative influence. Alternatively brash may be removed from the site either because the presence of brash conflicts with the management objectives or because there is a specific use or market to which the brash can be put. For example where site objectives allow it may be possible to generate revenue from brash (e.g. as a fuel source for electricity generation) or as a useful material in managing forest harvesting or habitat restoration (e.g. for extraction rack construction).

This report reviews the methods currently available for managing brash in terms of extraction and/or subsequent processing. Methods of brash management are reviewed in the context of their suitability to restoration of sites. The focus of this report concerns methods of extraction and subsequent treatment of brash. Additionally for the range of brash extraction and management techniques employed the advantages and disadvantages of each are given.

4 CURRENT METHODS EMPLOYED TO MANAGE BRASH

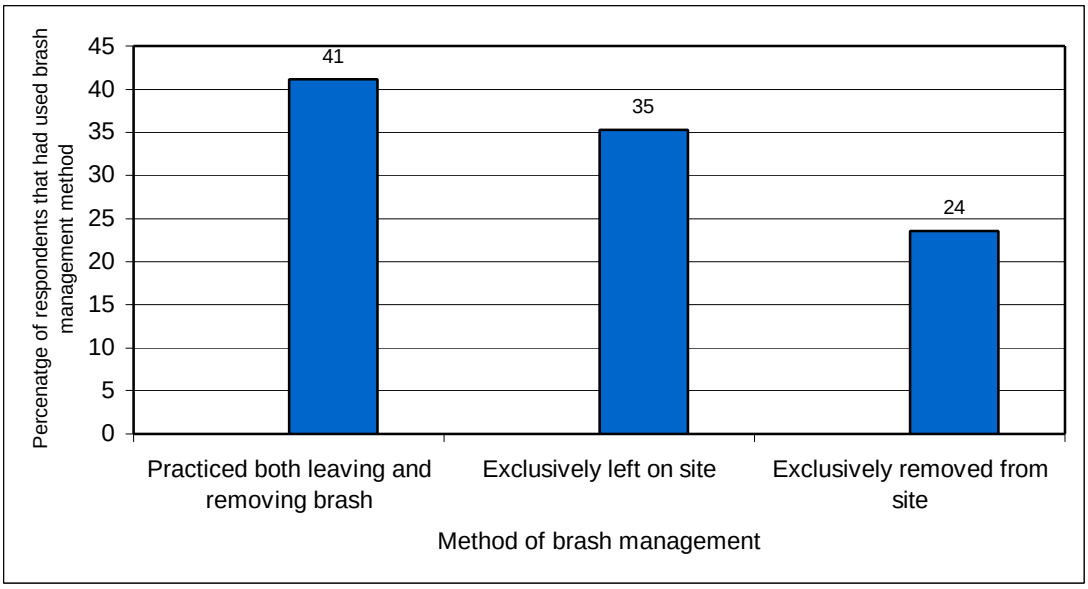
Brash may either be removed from the site separately from the timber, or at the same time as the timber through the use of whole tree harvesting systems. Additionally, brash from felling can be either managed on the felling site or extracted and then dealt with off-site.

As part of this study a number of representatives from various nature conservation and land management organisations took part in a questionnaire in order to survey which techniques of managing brash are currently being used as part of habitat restoration projects. The questionnaire was dispatched to representatives from within English Nature, Woodland Trust, RSPB, National Trust, Worcester Wildlife Trust, Prior and Rickets Consultants and English Nature from which 17 responses were received from a broad range of organisations across the UK. The results showed that brash was being actively managed both on and off site using a number of different techniques, incorporating varying levels of mechanical sophistication. Where brash is left on site it is most commonly heaped and where removed from site the brash is most commonly burnt. However, neither heaping nor burning off site are methods that exploit the potential of brash as a product with commercial value and have ecological and environmental consequences on the site.

A review has been made of the current nature of brash management practised by managers in relation to habitat restoration projects. There follows a series of charts illustrating the questionnaire results received from managers and a discussion of the trends observed.

For the methods of brash management included in charts 1 – 5 some managers had carried out more than one technique of extraction over sites at different times during their management.

Chart 1 Methods of brash management used by questionnaire respondents



The vast majority of questionnaire respondents had actively managed brash, either on the felling site or removed off site, as part of habitat restoration schemes. Chart 1 shows the proportion of brash management methods employed by managers. Almost a quarter of respondents exclusively removed brash from their sites indicating that they regard high input brash management as an important operation on habitat restoration sites.

Chart 2 Method of extraction employed by respondents where brash is removed from site.

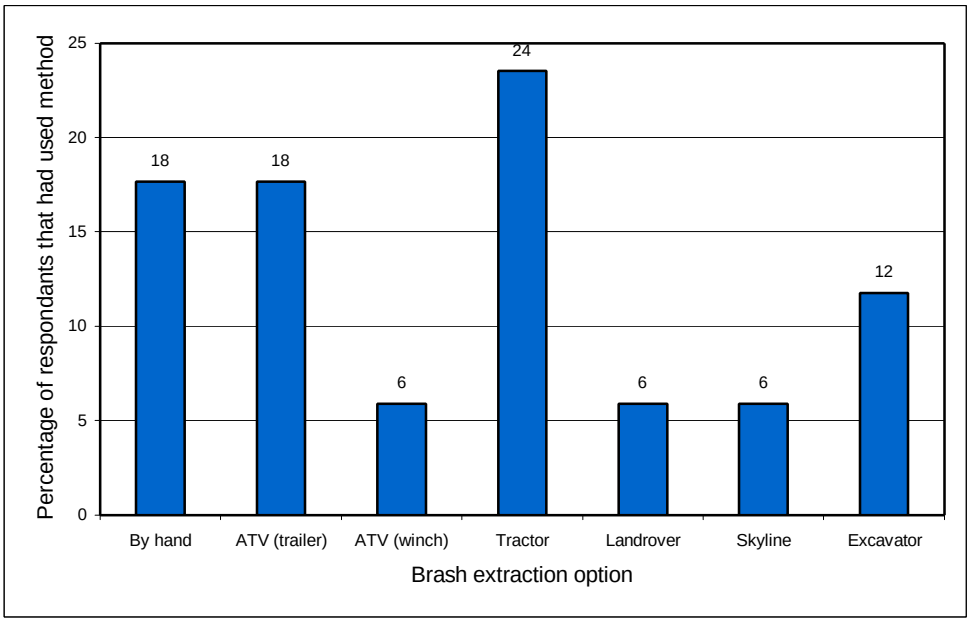
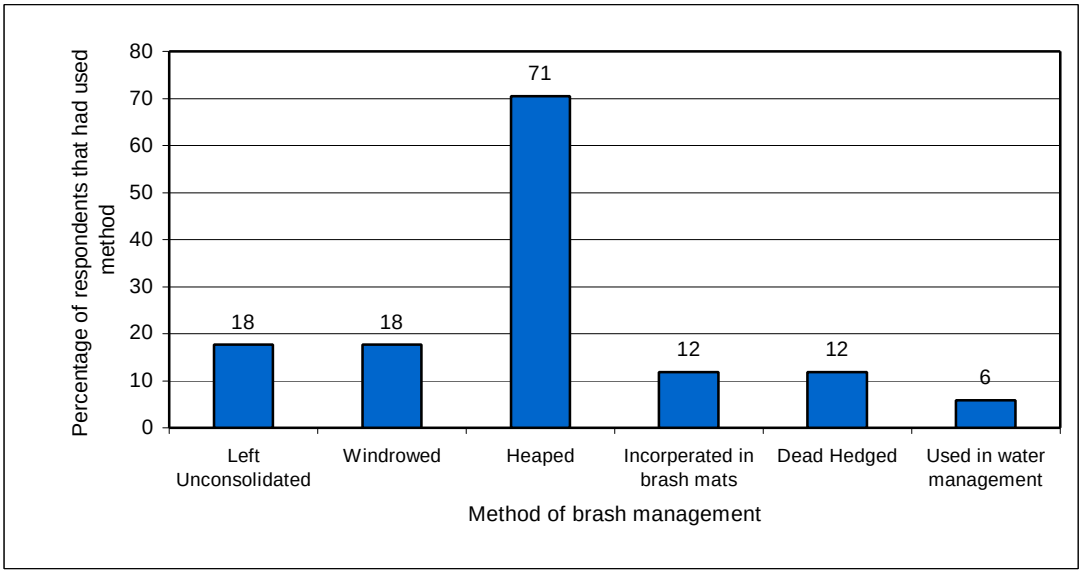


Chart 2 shows that where management involved the removal of brash from the felling site a broad range of extraction methods were used, ranging from simple hand extraction to highly mechanised means.

The most common method of brash extraction was by Tractor and trailer, using a variety of grab and loader attachments to bulk handle the brash. Hand extraction and extraction by ATV were also commonly used where brash was removed from wet and soft ground sites. These are relatively low ground impact means of brash removal and indicate the desire of managers to preserve the condition of the surface vegetation on areas where brash is removed. Some of these low impact methods are described in the FACT Practical Solutions Handbook (Bacon *et al.* 2001).

Of those methods used by the managers questioned three 'low impact' methods had been used, '*extraction by hand', 'extraction by ATV'* and '*extraction by skyline'* (skyline used for whole tree extraction).

Chart 3 Treatments used for managing brash by respondents where brash is left on site.

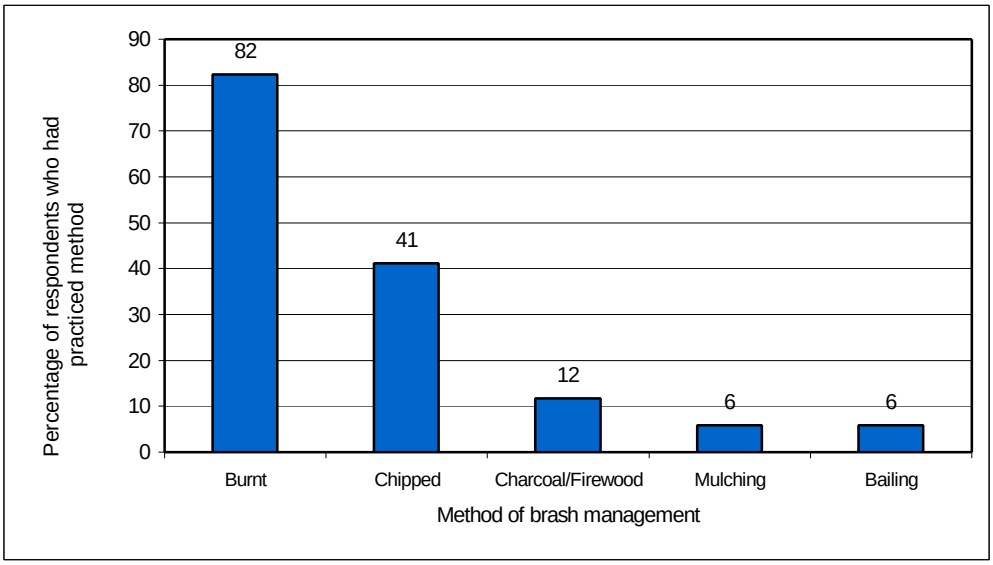


Respondents to the questionnaire reported that where the chosen method of brash management was to leave brash on site, in the majority of cases brash was consolidated into heaps. Aside from this very little management of brash was carried out where left on site. Heaping brash is a low input means of management whereby with basic machinery brash can be consolidated into piles to break down. Heaping concentrates brash, removing its physical presence which may hamper growth of desired plant species, while at the same time imposing less access restrictions on a site than windrowing.

Note that in Chart 3 where the method is given as 'Used in water management' this involved placing brash into water bodies to create a structural support for bog moss to colonise. Brash can also be successfully used to form dams to flood areas of wetland habitat restoration, subject to an appropriate environmental impact assessment and consultation with the Environment Agency.

The consequences of using brash to manage the water regime on site must be carefully considered. Any such measures need to be carefully monitored regarding the effects on waterways in terms of water movement and effects on upstream flow and also the effect of brash breakdown on the watercourse, the implications to neighbouring landowners must also be carefully considered. The Environment Agency and Local Water Authority should be consulted for further advice regarding the implications of using brash in watercourse management.

Chart 4 Methods of brash management employed by respondents following removal from site.

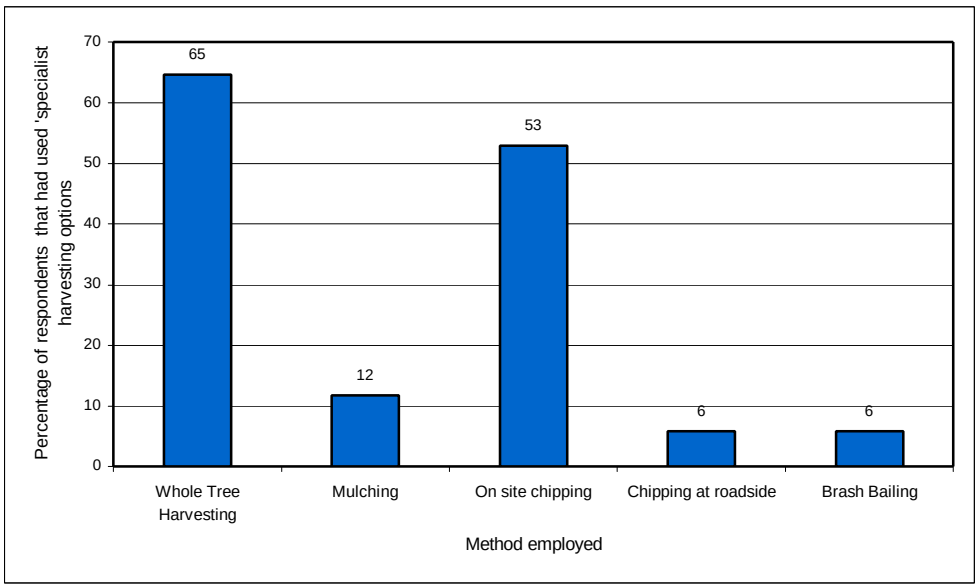


The most common means of managing brash subsequent to its removal as shown in Chart 4 was burning. Burning is a low input, low-tech method of disposing of brash, although careful supervision of the burning is necessary. Burning does not however capitalise on the potential value of the brash as a resource. The widespread use of brash burning indicates that either managers are not appreciating the potential value of brash as a product or, most likely that the markets for brash are poor and do not justify the management input needed to market the material.

Further research will be required to identify the reason behind the current, apparent under-exploitation of brash as a marketable product. It is possible that this is due to managers of wildlife sites giving the highest priority to habitat and ecological objectives, which in turn leaves very little time and resources available for deriving revenue from brash. Another factor is that many sites are small and/or remote and with difficult access so transporting of products to a market outlet is not easily achievable or economically viable.

Note: The legal constraints of burning as a method of brash disposal must be considered by managers (see section 6.5).

Chart 5 Range of harvesting operations employed by questionnaire respondents.



Two thirds of managers surveyed had used whole tree harvesting as a means of extracting produce, subsequently processing brash off site once the trees have been extracted.

5 REVIEW OF MANAGEMENT TECHNIQUES

This section deals with the suitability of brash management options for a given range of habitat restoration types for example restoration of grassland, heath, bog, fen and ancient woodland sites. Also included are a series of tables that detail the advantages and disadvantages of each option. Within these tables numerous methods of brash removal and subsequent management are presented together with extraction methods used in whole tree extraction, whereby the brash and timber components of the tree are extracted as one. Methods of extracting timber are considered outwith the scope of this report (see Appendix 1 for a broad classification of extraction systems commonly operated within the UK).

5.1 Methods of Removing brash from site as part of a whole tree felling operation.

- By hand

On some very sensitive sites staff or volunteers can carry out saplings, small trees or sections of trees for processing on less sensitive ground nearby, therefore resulting in low ground impact. The use of temporary movable boardwalks can reduce ground pressure still further.

- Horse extraction of whole trees

Conventionally horse extraction is operated under a pole-length extraction system whereby the main stem is skidded (dragged) or forwarded (carried), having been firstly snedd (branches removed) at stump. However, there is potential to practice whole tree extraction by horse. Horse extraction is generally low impact, but under wet ground conditions and in localised areas on key routes, erosion of the ground surface may occur. Restricting the time of year in which the extraction is carried out will reduce this risk i.e. outwith the wetter periods of the year. The availability of skilled horse teams, able to carry out such extraction may limit the use of horse extraction for habitat restoration.

- Portable winch

This technique is limited to short distance extraction due to winch capacity and the length of wire rope (typically 40m), but may be adequate for small areas of felling (particularly on steep slopes) where access is restricted. The load weight of the produce to be extracted must be matched to the capacity of the winch. TDB and English Nature also developed a winched sledging trailer for extraction on steep slopes or boggy ground (Jones 2001).

- Cable-way extraction

With High-lead cable extraction whole trees can be extracted from site with little or no ground disturbance, therefore the method is well suited to fragile site types such as bog and fenland. Where the cost of cable extraction can be justified in the interest of safeguarding the site this can be a useful technique.

- Direct chipping

This method has restrictions and is not suitable for sensitive sites due to the high ground pressure of the machine and is therefore unlikely to be suited to the low ground bearing conditions associated with bog and fen sites unless operated on mats. Tracked chippers are now available which have a *reduced* ground pressure thereby extending the suitability of this form of machinery to more sensitive sites (Bacon 2001), however a thorough site assessment is necessary to determine suitability.

- ATV/ Mini-forwarders

In recent years the development of mini-forwarders e.g. Vimek Minimaster (see Plate 1), Vimek 606D Mini-forwarder, Alstor, Norsjo Mekaniska Scorpion 1205 Mini-forwarder have enabled trees in loads, between 1 and 3 tonnes to be extracted to ride-side. These employ low horsepower engines (c 20hp), to prevent sinking on boggy vegetation (Bacon 1996).

Plate 1. Mini Forwarder Extraction of whole trees from a bog habitat restoration site by a Vimek Minimaster

All terrain vehicle (ATV) extraction of whole trees offers similar advantages to mini-forwarders although generally load sizes are smaller and operator ergonomics may not be to such a high standard, ATV extraction machinery is also generally more widely available than specialised mini-forwarders.

- Large-scale forest harvesting machine removal

Whole tree extraction with conventional forest machinery can cause ground disturbance to habitat restoration sites. Even with high floatation tyres, compaction and rutting of the ground surface may be difficult to avoid. The use of semi-permanent tracks such as corduroy roads and 'thatching' extraction racks with materials including brash will reduce ground disturbance with large-scale forest machinery, but can be expensive. For ancient woodland sites, a regular, geometric access rack network imposed on the wood may be undesirable, so small-scale forest machinery with low ground pressure that can gain access between the standing trees should be considered as an alternative.

- Helicopter

This provides a means of extracting whole trees with low ground impact and is appropriate for the most sensitive of sites, but the high cost (typically around £700 per hour for the helicopter alone) is likely to mean that only where no alternative extraction option exists should helicopter extraction be considered.

Table 2. Advantages and disadvantages of removing brash from site using whole tree felling

Technique	Advantages	Disadvantages	Indicative Costs
By Hand	• Low ground impact on sensitive terrain	• Labour intensive and physically tiring • Suitable for small light weight saplings/ tree sections only • Not suitable for long distances • Extreme caution is necessary to ensure that material handled does not exceed manual handling limits and that those involved have an understanding of manual handling limits, correct practice and ergonomics • Ergonomics of lifting and carrying brash must be carefully managed, to prevent harm to those involved	Volunteer support costs only
Horse Extraction of Whole Trees	• Offers a means to extract trees as part of a whole tree extraction system, without a reliance on mechanisation • Relatively low impact to the site, although level of ground disturbance will vary with individual site characteristics	• Limited in terms of the maximum tree size that can be handled • Hooves can cause local disturbance of sensitive soils on vulnerable habitat types • Limited availability of skilled labour able to carry out such work	£ 15 - £21/m^3 (indicative only- based on well presented pole-length extraction) (Dewar 1993)
Portable Winch	• This method of extraction exerts low levels of ground pressure • Operates well over steep sites.	• The limited length of wire rope contained within the portable winch constrains the distance over which timber can be extracted to approximately 40m. • Unless pared with other extraction equipment this method necessitates manual handling of produce prior to chokering and before subsequent conversion and stacking. • The dragging effect of skidding may be detrimental on some vulnerable sites.	£33.50/m^3 (Indicative figure only – based on timber extraction – no evaluation data for whole tree extraction) (Wyatt 1993).
Cable Extraction	• Timber extraction is possible with very low ground impact. Depending on the cable system used (Sky-line or High-lead) material is either transported partially or fully off the ground. Ground disturbance is only experienced from dragging rather than compaction	• Expensive to set-up for operation and will require skilled, specialist operators • Not economic for small volumes of produce and brash • Ground disturbance from dragging on sensitive sites	£30.00/m^3 – Includes cost of felling, extracting and roadside processing of whole trees (Drake-Brockman 1997)
ATV/ Mini-forwarders	• Low ground pressure allowing access on low load bearing terrain • Faster extraction method than by hand. • Enables extraction, processing or sale of material from boggy ground that would otherwise have no use	• Extraction of loads of only 1 – 3 tonnes at a time • Some compaction of surface sphagnum lawns though normally recovers	£7/m^3 based on Alstor extraction of crown wood over 200m, slope 25 – 45% (Anon 1999)
Direct chipping – "Terrain Chipping" of whole trees by mobile chipping machine, or, Integrated as on-site extraction and chipping of all the above ground tree components	• Provides a means of chipping the branch and stemwood in one operation to produce a uniform chip product • Ideally suited to chip production, maximising all the above ground components of the tree, i.e. for biomass production • Brash is chipped as soon as felled therefore material is still wet requiring less energy to chip than air dried brash	• Unit costs of chip production can be high • The weight of large-scale forest extraction machinery may impact on the habitat or bogging of the machine on fragile, wet soil types may occur, reducing outputs • Any chipped material left on site will breakdown to give a nutrient release on site which may promote undesirable vegetation	Tractor & trailer: £48.00/ tonne @ 30% moisture content. Purpose built Terrain chipper: £94/ tonne @ 30% moisture content. (Hall 2003)
Large-scale forest harvesting machine removal e.g.: Tractor based skidder and Grapple skidder	• Suited to whole tree extraction of a range of tree sizes. Small tree sizes can be economically skidded provided product accumulation is undertaken, as well as large tree sizes • Scale of economy minimises costs – large load sizes mean that bulk handling of brash is possible and therefore fewer trips from the felling site to the stacking site have to be made • Well suited to long distance transport	• The weight of large-scale forest extraction machinery may impact on the habitat or a bogging of the machine on fragile, wet soil types may occur, reducing outputs • The high costs of large scale machines means that for smaller felling volumes the costs of extraction will be high	None available, as no evaluation work for whole tree extraction carried out to date

Helicopter	• No ground disturbance to the site from extraction machinery • Able to cope with the largest of tree sizes provided that extraction is carried out with a suitably specified machine	• High expense of helicopter hire usually will result in a net cost of the extraction operation • Will require some accumulation of loads for smaller tree sizes which is time consuming and will have manual handling implications for operators • Requires very careful co-ordination of accumulated products with extraction. Loads should be prepared for uptake in pace with the helicopter, thus ensuring that the machine is fully utilised and experiences no idle waiting time • Any time that the machine is not actively involved with extraction will impact on the economics of the operation, heavily influencing the cost of extracting the produce • Use is very much subject to weather conditions • Down draught, air turbulence and noise disturbance may be a problem on sensitive sites	£50 plus per m^3 (based on pole extraction with a standing charge for helicopter hire of £700/ hour) (Saunders 2002)

Note that for all methods that involve whole tree extraction there must be adequate processing space at roadside, and the process will require careful organisation to sort timber and reside products.

5.2 Methods of removing brash independently from the timber component

Note that where brash is removed from the site at which it is produced it is likely that a waste management licence will be required for its disposal. Advice regarding requirements for obtaining waste management licences for the treatment of brash should be sought from the Environment Agency in England and Wales and from the Scottish Environment Protection Agency in Scotland (See section 6.5).

- Manual extraction

Provides a low impact method of extraction, suited to volunteers removing small volumes of produce over short distances; localised erosion (of the ground surface) may be a problem on wet sites such as bogs and fens. Laying down temporary, artificial floatation (i.e. walkways) will reduce the effect of trampling under foot.

- ATV/ Mini-forwarder extraction

Small-scale extraction machinery offers the potential for low impact extraction (low ground pressure) on sensitive sites and offers a versatile management option offering a range of management techniques for dealing with brash.

- Brash bailing with forwarder extraction

Provides a means of efficient bulk handling of brash in a consolidated form. However, due to the degree of mechanisation involved and the consequent ground impact this method will only be suitable on more robust load-bearing soils. Restricting work to the drier periods of the year is likely to reduce the effect of ground disturbance on vulnerable sites. Plate 2 shows the process of brash bailing on a clear felling site.

- Large scale forest harvesting machine

Methods of bulk handling brash should be considered, in terms of making the extraction economical. By increasing bulk handing capacity by using large-scale machines the impact of such equipment may degrade the site. Even with high floatation tyres some disturbance of the ground surface in terms of compaction and rutting may be difficult to avoid and therefore may not be suitable on sensitive sites.

The use of semi-permanent tracks such as corduroy roads and thatching extraction racks with materials including brash will reduce ground impact in terms of soil disturbance with large-scale forest machinery. For ancient woodland sites a regular, geometric access rack network imposed on the wood may be undesirable, so small-scale forest machinery with low ground pressure that can gain access between the standing trees should be considered as an alternative.

Plate 2. Bailing brash for fuel wood burning. Well-presented brash aids the process. Note the ground impact of the machine, typical for large-scale forest machinery

Table 3. Advantages and disadvantages of removing brash separately from the timber component

Technique	Advantages	Disadvantages	Indicative Costs
Manual Extraction	• Does not require any specialise equipment, so reduces overall equipment investment • Little or no impact on the ground surface, especially if floatation is aided with temporary walkways • Can be a valuable option when coupled with a mechanised method of extraction – manual extraction can be carried out over the most vulnerable areas, with mechanised extraction over longer distances to an accumulation point over load bearing ground	• Severe manual handling implications, especially with larger branches and crowns which may have to be further cut by chainsaw to enable them to be manhandled • With a small team of workers only small quantities can be effectively extracted over relatively short distances • Not suited to long distance extraction	Not possible to give indicative costs for this operation due to the varied nature of contract/ volunteer labour and the manual handling conditions involved
ATV/ Mini-forwarder Extraction	• Ground compaction and disturbance are reduced compared to larger-scale machinery • Usable on very sensitive sites where heavier equipment would bog down	• On very fragile habitat types frequent passes may cause compaction of vegetation, although this normally recovers • Not well suited to extracting over very long distances • Torque force, exerted through the wheels of high geared equipment can result in disturbance of the ground surface	£7/m^3 (Indicative only – based on forwarding shortwood over 380m extraction distance) (Wyatt 1993). Comparable figures for brash unavailable
Brash Baling with Forwarder Extraction	• Allows bulk handling of brash in the form of bails that can be easily manoeuvred and transported as a single bulk unit, rather than unconsolidated lose material, which is less suited to bulk handling by machine grab	• Uses specialised machinery the availability of which may be limited especially for small quantities of brash • The weight of large-scale forest extraction machinery may result in ground disturbance over the habitat or a bogging of the machine on fragile, wet soil types, reducing outputs	Bailer hire cost = £75 per hour (minimum 20 hour charge) (Lavery 2002) Equals a cost of £6 per tonne of bailed brash, (excluding bail extraction costs)
Large-scale forest harvesting machine removal E.g.: Forwarder with wire reinforced bunk to support brash, Tractor and trailer	• Large load sizes mean that bulk handling of brash is possible and therefore fewer trips from the felling site to the stacking site have to be made • Well suited to long distance transport • Loading by machine grab allows for efficient bulk handling of brash	• May result in disturbance to fragile soils and site types • May be an expensive option to transport a machine to site for small quantities of brash as part of a small-scale habitat restoration project • Little experience of using this technique for brash extraction	Approximately £4.50 per tonne based on 250m extraction distance and average load size of 8.3 tonnes per standard hour (Brockman 1996)

5.3 Methods of managing brash left on site

- Brash left on site at point of felling

Leaving brash to decay on site will mean that the site will receive the nutrient flush associated with brash breakdown. The light regime below the brash will be different to a site devoid of brash, certainly in the early stages of brash breakdown and may have a bearing on the plant species that develop. This can be crucial where seeking to promote a particular habitat type. Practical experience indicates that if brash is left on site, a few months after felling has taken place grasses (e.g. *Molinia* and *Deschampsia*) may grow up through the brash making it difficult to handle and chip.

Mature felled tops containing mature seed-bearing cones may create a seed source from which natural regeneration will develop. If the aim is to clear the site of tree cover then the development of natural regeneration may be undesirable, and subsequent interventions to remove natural regeneration will be necessary, with an associated cost implication. If the aim of felling is to remove a non-native tree species e.g. from an ancient woodland site, then removing this seed source may be essential and leaving brash may be inappropriate to meet the stated management objectives.

- Dead hedging

Dead hedging is the practice of constructing a 'wall' of brash that will act to exclude predatory browsing animals from access to a stand. This is a useful means of disposing of brash and offers a degree of protection against deer. It may be a useful technique in ancient woodland sites, provided sufficient volume of suitable brash can be accumulated to form the hedges. If dead hedging is carried out manually then the ground impact on the site will be low, but if mechanised transport of brash is used, then fragile sites may experience ground disturbance.

- Accumulate into heaps/ windrows

This is a well-established technique for managing brash where left on site. On grassland and heathland sites the likelihood of windrows and heaps providing a habitat for rabbits and other pest species should be considered as should the consequences for the site and adjacent areas. Access to the felled area for subsequent management may be compromised where windrows are formed and where this is likely to be the case, breaks in the windrows can be incorporated to allow machines to negotiate the obstacle created. As with any system that results in brash being left on site, the likelihood and consequences of mature cones providing a seed source for natural regeneration following felling must be considered if the objective of felling is to remove trees from the site. Equipment options for accumulating brash must be balanced with the sensitivity of the habitat type. Large-scale bulk handling machinery suitable for heaping brash will be constrained on bog and fen sites.

- Spreading by excavator

This technique involves scattering brash over the site, and does not therefore remove the physical presence of brash and the breakdown and associated release of nutrients remains the same. This technique involves the use of large-scale machinery for spreading brash, which restricts its suitability for fragile sites. Spreading brash has been briefly evaluated as a means of dealing with very coarse, woody brash, but the technique offered little benefit for subsequent management. It is possible that with very coarse brash this treatment may even serve to hamper subsequent management operations and access to the site.

- Chipping

Chipping on site removes the physical accumulation of brash, which may hamper the growth of desired plant species. The effects of shading on the ground surface must be considered if chipping takes place. Chip piles can act as a dense mulch which may have a positive or a negative influence in achieving the desired habitat type depending upon the soil acidity levels, plant species present and their shade tolerance. Habitat restoration will invariably seek to promote certain plant species. The light regime created following the management of brash must be considered and the effects of light intensity on desired species as well as on competing weed species. Dry brash is harder to chip than fresh material, so chipping is best carried out in close succession with the felling operation (Webb and Burlton 2000).

- Burning

Burning on site may be carried out on a cleared patch of exposed earth, or may be on raised sheets of corrugated iron to protect the ground surface on vulnerable sites especially if on peat soils. This disposes of the bulk volume of brash although weeds may subsequently invade the fire site. Burning is a useful means of brash disposal if management objectives specify physical disposal is necessary and there is no obvious market for the brash. Burning may not be desirable in high recreation areas and during dry periods of the year on dry sites such as heathland and grassland where there is a risk of fire spreading.

Managers should be cautious of burning where standing trees will remain, especially pole stage crops, due to the risk of the fungus *Rhizina undulata* developing. This fungus is dependent on soil conditioning by heating to temperatures of approximately 40°C and therefore develops around the edges of fire sites causing root disease and subsequent group tree dying.

Plate 3. Heathland restoration site where burning has been used to dispose of brash, subsequently Rosebay Willowherb (*Epilobium Angustifolium)* has colonised the areas where burning was carried out as a possible consequence of the burning on site

There is a current requirement under the UK Woodland Assurance Standard (UKWAS) that burning of brash should only be carried out 'only where there is a demonstrable management benefit, after full consideration' (UKWAS Steering Group 2000). If brash is burned then the location and density of fire sites must be carefully planned and some lop and top should be left as unburned habitat, except where this will result in pest or disease problems (UKWAS Steering Group 2000).

For further information regarding the burning of brash refer to Jones, B. (2002) Burning Forest Residues. Forestry Commission Technical Note, Forestry Commission Edinburgh.

- Forestry mulchers

Any brash treatment method applied to a site must take into consideration the knock-on effect on the habitat itself and the ground flora. Management techniques such as mulching have been developed in recent years particularly on heath rehabilitation schemes to mulch brash, grind stumps and leave a seed bed that is suitable for germination of heath plants, achieving three operations in one. This is a highly aggressive technique and needs testing for suitability on each site (Bacon 1999).

On sites where rare plant species are present the aggressive ground impact resulting from mulching the site will render these methods unsuitable; the opportunity created for invasive weed species to colonise a site must also be considered. Where habitat restoration aims to promote a particular vegetation type, an aggressive treatment such as mulching may not therefore be best placed to meet this objective.

- Tractor mounted roller

This process breaks up the brash physically, increasing the rate of breakdown (rotting). The brash remains on the felling site during break-down and consequently the nutrient release still takes place which may be detrimental if management objectives are to maintain a relatively nutrient deficient habitat type in the interest of promoting a given vegetation type. As with mulching, the aggressive effect of using a roller on a site regarding the impact on the vegetation present must be carefully managed.

Table 4. Advantages and disadvantages of managing brash on site

Technique	Advantages	Disadvantages	Indicative Costs
Leave brash on site with no treatment	• No cost of brash removal or treatment incurred • No site disturbance incurred through brash extraction • Nutrient flush from decaying brash is maintained (see also disadvantage)	• No revenue can be generated from the utilisation of brash as a product • Shading of the ground from brash laying on the ground surface can promote establishment of shade tolerant weed species • If breakdown is slow, can impede access for future management operations • Nutrient enrichment as decay occurs • Loss of the aesthetic appeal of the site • Risk from vandalism (principally arson) if large quantities of material are left on site	No cost of brash management incurred but may increase subsequent management costs
Dead Hedging	• Achieves both goals of partially clearing the site of brash and providing protection against deer • The technique is demanding in terms of labour requirement and is not as reliable as a correctly specified fence as a means of guaranteed deer exclusion	• Should not be relied upon as a long-term deer proof barrier • The use of dead hedging may be an advantage in ancient woodland sites where fencing is considered visually unappealing or conflicts with wildlife management i.e. preventing bird strikes • May encourage the development of weeds and brambles	Cost of construction = £4.50 - £5.00 per lineal m at approximately 2m high (Anon 2002)
Accumulate brash, either into heaps or windrows	• Shading effect on ground surface is minimised by consolidating brash into specific areas	• Can provide a habitat for species such as rabbits, which may conflict with management objectives • May encourage the development of weeds and brambles • Nutrient enrichment as decay occurs	Continuous Windrow: £129 per ha Intermittent Windrow: £81 per ha (Drake-Brockman 1999)
Excavator – spreading brash: large-scale forest tracked excavator	• The nutrient flush resulting from brash breakdown is maintained, however the physical barrier of the brash on site is removed.	• Can cause access problems to subsequent management operations, particularly if brash is coarse and therefore requires a long time to break down. • Nutrient enrichment as decay occurs. • May encourage the development of weeds and brambles.	£100 - £200 per ha. (Output likely to be 0.1–0.2ha per hour with a machine charge of £20 per hour) (Hall 2003).
Chip brash on site	• No cost of transporting brash off site • Option to collect in bags or hopper for removal • low ground pressure option offered in the form of new Tracked Chippers or on mats	• Transporting heavy chipping equipment onto the site may result in ground impact over the habitat	£40.50/m^3 Based on cost of chipping solid branchwood (Jones 1997)
Burn brash on site	• No cost of transporting brash off site. • Removes most of the nutrient release from decaying brash	• Requires some accumulation of brash prior to burning • Risk of fire spreading if not properly managed and controlled • The process is slow and therefore expensive due to the lengthy periods of management supervision necessary • Bare ground created may be vulnerable to weed species establishment, rather than the desired vegetation type colonising, see plate 3 • Air pollution issues • Smoke is undesirable near to inhabited areas • Results in a quantity of ash that must be dealt with • Should only be carried out in line with UKWAS where there is a demonstrable management benefit after full consideration. (UKWAS Steering Group 2000)	£103 per ha (Mylope 2002)
Mulcher: Mounted on large-scale forestry tractor	• Mulching brash aims to reduce the physical barrier that brash presents and increase the rate of breakdown • The scale of the machinery allows efficient treatment of large areas • Opportunity to mulch brash, grind stumps and create seedbed in one operation on suitable soil types	• Methods such as mulching have proven valuable for restocking sites however, their use for habitat restoration may be unsuitable due to the aggressive effect on the ground cover • The weight of large-scale forestry machinery may result in ground disturbance to the habitat or a bogging of the machine on fragile, wet soil types, reducing outputs • Stony sites may be problematical to mulchers due to the aggressive effect on the equipment	Flail Mulcher: whole site = £680-£1000 per ha (Mylope 2002) (excluding transport to site)
Roller: Mounted on large-scale forestry tractor	• Breaks brash down physically to aid natural decay and degrading of brash	• May be unsuitable due to the aggressive effect on the ground cover • The weight of large-scale forestry machinery may result in ground disturbance to the habitat or a bogging of the machine on fragile, wet soil types, reducing outputs	Roller £542 per ha (Mylope 2002) (excluding transport to site)

5.4 Alternative habitat restoration methods

- Fell to waste

As an alternative to extracting brash trees may be felled to waste, where neither the timber or brash are extracted from site, but are instead left on site. Provided leaving timber on site is in agreement with the management objectives, then the practice of felling to waste can be a useful technique, if for example, the cost of extracting the produce is greater than the value thereof.

- Chemical thin

The practice of packing of herbicide into incisions made around the lower trunk of trees. Provides an efficient, low labour demanding means of disposing of trees which contributes a component of standing deadwood to the site, providing associated wildlife benefits. (N.B. Injection techniques (e.g. Eco-plug) are not currently licensed for use in the UK and should therefore not be used).

- Ring barking

Ring barking using handbills or chain saws to cut the bark around the base of the tree causing it to die provides a chemical free method of disposing of standing trees. As this method does not rely on the use of chemicals it may prove more attractive for sensitive habitat restoration sites than chemical thinning in light of current legislation and industry standards (e.g. UK Woodland Assurance Standard UKWAS). A wide strip of bark needs to be removed or the method can fail, it should be noted also that it can take up to one to two years for the tree to die.

Table 5. Alternative methods of managing brash

Technique	Advantages	Disadvantages	Indicative Costs
Fell to waste	• Management costs are minimised where the cost of extraction is greater than the value of the produce • Small tree sizes can be whole-tree chipped to reduce the visual effect on the site, the impediment to access and the breakdown of the felled trees	• Leaving whole trees on site may be visually unattractive • The physical barrier created as a result of leaving timber on site may impede future management access • Cost of revenue of timber forgone	Fell and debranch: £500 per ha (Webb 2000)
Chemical thin	• Chemical treatment of standing trees eliminates cost of felling and extraction in areas where acceptable • Cheaper means of disposing of afforested stands when compared to alternatives such as manual felling	• Dead trees remain standing, therefore may not be appropriate for certain habitat restoration situations due to light regime in the shade of the standing stems (this may be a positive aspect for species which will be favoured through a gradual change in light regime • Most suitable as a means of thinning, effect of whole stand treatment would be visually unattractive • Relies on the use of chemical herbicides; current policy dictates a desire to reduce the use of such chemicals • If the area is to be used for public recreation the safety issue of standing deadwood should be considered regarding windblow/ snap and bow breakage	£300 - £400 per ha (with contracted labour) (Thompson 2002)
Ring barking	• A non-chemical method of killing standing trees where acceptable • Reduces shade effect of needles or leaves with minimal disturbance to allow ground vegetation to develop	• some species may take 1 – 3 years to die in which time they may increase their seed production which can lead to natural regeneration in the vicinity (e.g. pines, sycamore) • If the area is to be used for public recreation the safety issue of standing deadwood should be considered regarding windblow/ snap and bow breakage • Dead trees remain standing, therefore may not be appropriate for certain habitat restoration situations due to light regime in the shade of the standing stems	£1200/ ha based on 2000 tree/ha £900/ ha based on 1500 tree/ha (Based on chainsaw operator cost of £12 per hour. Ring barking 20 trees per hour) (Bacon 2003)

5.5 Brash taken off site for treatment

Note that where brash is removed from the site at which it is produced it is likely that a waste management licence will be required for its disposal. Advice regarding requirements for obtaining waste management licences for the treatment of brash should be sought from the Environment Agency in England and Wales and from the Scottish Environment Protection Agency in Scotland (See section 6.5).

- Composting

If brash is removed from the site for subsequent composting the effect is a physical one which consequently influences the light regime. The nutrient flush that is characteristically released as a result of brash breakdown will also be prevented and both these aspects have the potential to influence the plant species composition on a given habitat type. Prior to any such treatment taking place, the Environment Agency or SEPA should be contacted to ensure that any planned composting does not impede the Waste Management Licensing Regulations.

- Chipping

Chipping removes the physical accumulation of brash on the felling site, which may otherwise hamper the growth of desired plant species.

- Burning

Burning off site will reduce the potential risk of fire spreading to adjacent vegetation when burning on site. As with burning on site this is a useful means of brash disposal if management objectives specify physical disposal of the brash is necessary but no market exists. Burning should be avoided where standing trees are adjacent to the burning sites, especially pole stage crops due to the risk of the fungus *Rhizina undulata* developing (see section 5.3) and the risk of fire spread and heat damage to the cambium of the tree. Note that the UK Woodland Assurance Standard states that as with burning brash on the felling site this should be carried out only 'where there is a demonstrable management benefit, after full consideration' (UKWAS Steering Group 2000).

- Fuel wood

Generally involves an accumulation of brash and extraction from the site with large-scale extraction machinery in order that a fuel wood resource can be exploited economically. Site types vulnerable to ground impact from large-scale machinery (i.e. low load bearing bogs and fens) should therefore be avoided unless extraction can be enabled by low ground impact machinery at a reasonable cost.

Table 6. Methods of managing brash off site

Technique	Advantages	Disadvantages	Indicative Costs
Composting	• In combination with other biomass arising materials brash could be converted into a valuable fertiliser	• Little practical experience has been gathered using this technique but composting centres are under development • cost of transport to composting centres	None available as no evaluation work attempted to date
Chip brash off the felling site once extracted	• Chipping equipment does not have to be transported onto site reducing ground disturbance • Chipping, if performed off the felling site allows for easier bulk handling of the resulting chip and a product that can be effectively transported in a bulk container • Can form a saleable product e.g. for fuel-wood, mulches or for animal bedding	• Must be coupled with extraction machinery that can extract brash from the felled area in bulk that may in turn impact on the site in terms of ground disturbance • Requires careful paring of extraction machinery to output of chipper • Dry brash is harder to chip than fresh material and therefore chipping is best carried out in close succession with the felling operation (Webb and Burlton 2000) • If there is considerable time between felling and chipping of the brash then the air-drying of the chip can increase the energy requirement to chip the brash	£40.50/m^3 Based on cost of chipping solid brashwood (Jones 1997)
Burn brash off site once extracted	• Burning is concentrated at a centralised point and therefore reduces risk of fire spreading to the felling site	• Forgoes any value that could have been achieved if the brash were disposed of as a marketable product • This method involves the burning of brash purely as a means of disposal, no benefit is gained from the burning in terms of harnessing the energy released • Risk of fire spreading if fire is not properly managed and controlled • The process is slow and therefore expensive • Emission of pollution products • Smoke is undesirable near to inhabited areas • Results in a quantity of ash that must be dealt with • As material is removed from site for burning it is likely that a waste management licence will be required for the operation	Heaping with excavator and burning £1000 - £1500 per ha (Holms 2002)
Fuel wood	• Brash is burned off site in a facility that allows electrical and/or heat energy to be generated	• Unless the costs of extraction and haulage are kept at a minimum then the cost of producing energy in this way is not a viable option	Disc chipper £9.00m^3 solid wood. Drum and Screw chipper £6.50 - £7.50m^3 solid wood (Hall 2003)

6. ADDITIONAL CONSIDERATIONS FOR THE MANAGEMENT OF BRASH

6.1 Suitability of brash management techniques to thinning and clear felling

Where there is a desire to rid the site of tree cover, habitat restoration projects will require clear felling of standing crops, alternatively, the aim may be to thin out an undesirable proportion of the tree cover where species mixes are present. Habitat restoration over Plantations on Ancient Woodland Sites (PAWS) may require a selective thinning of undesirable trees species. It should be noted that when considering management methods that involve leaving brash on site, this is likely to be more appropriate when restoring a woodland site than when restoring an open habitat.

Where thinning is carried out the smaller volumes of brash produced compared with clear felling may influence the economics of brash management. Table 7 shows the suitability of brash management methods for thinning and clear felling.

Table 7 is constructed on the assumption that, *in general* where a clear felling operation is carried out larger volumes of brash will be produced compared to a thinning.

Table 7. Suitability of brash management techniques on thinning and clear felling sites

(The statements in this table governing method suitability to thinning and clear felling should be read in conjunction with the advantages and disadvantages in tables 1-6 before deciding on method selected).

Method of Brash Management	Suitability for Thinning	Suitability for Clear felling
• **Brash Removal as part of whole tree felling**		
By hand	If volume produced by thinning is small then this method will be appropriate provided that piece sizes are not beyond manual handling limits	If volume produced by felling is large may not be suitable
Horse extraction	Suitable if volume produced justifies the cost of extraction	Suitable if volume produced justifies the cost of extraction
Portable winch	Well suited to small volumes for short-distance extraction over sloping ground	Large volumes may render this method unsuitable due to small unit load sizes
Cable-way extraction	Likely to be hampered if trying to extract through a standing crop	Larger volume more likely to justify the high set-up costs
Direct Chipping	Large-scale machine access to site may be restricted by width of racks	Suitable
ATV/ Mini-forwarders	Suitable if volume produced justifies the cost of extraction. Scale of machinery is well suited to access down narrow rackways	Large volumes and tree sizes may make this method unsuitable due to small load capacity
Large-scale forest harvesting machine removal	Large-scale machine access to site may be restricted by width of racks	Suitable
Helicopter	Small volumes may not justify the use of the method. Access to material may be impeded.	The typically larger volumes associated with clear felling are more likely to justify high expense
• **Methods of removing brash independently from the timber component**		
Manual extraction	Suited to small volumes of brash	If large volumes produced may be unsuitable
ATV/ Mini-forwarder extraction	Suitable if volume produced justifies the cost of extraction. Scale of machinery is well suited to access down narrow rackways	Large volumes and tree sizes may make this method unsuitable due to small load capacity
Brash bailing with forwarder extraction	Large-scale machine access to site may be restricted by width of racks.	Suitable
Large scale forest harvesting machine	Large-scale machine access to site may be restricted by width of racks	Suitable
• **Methods of managing brash left on site**		
Brash left on site at point of felling	Suitable	Large volumes of brash created may mean shading prevents growth of desired plant species
Dead hedging	Suitable	Suitable
Accumulate into heaps/ windrows	Unsuitable within a standing crop	Suitable
Spreading by excavator	Unsuitable within a standing crop	Suitable
Chipping	Suitable – size and power of chipper must be appropriate to deal with quantity of brash	Suitable – size and power of chipper should be appropriate to deal with quantity of brash
Burning	Suitable – but see risks of burning near standing trees in section 5.3	If large volumes produced, may not be the most desirable method due to large scale of burning required
Forestry mulchers	Unlikely that access will be possible within the standing crop	Suitable
Tractor mounted roller	Unlikely that access will be possible within the standing crop	Suitable
• **Alternative habitat restoration methods**		
Fell to waste	Suitable	Suitable, although important to consider visual impact of large areas of dead trees
Chemical thin	Suitable	Suitable, although important to consider visual impact of large areas of dead trees
Ring barking	Suitable	Suitable, although important to consider visual impact of large areas of dead trees
Compost on site	Suitable	Suitable
• **Brash taken off site for treatment**		
Composting	Suitable	Suitable
Chipping	Suitable – size and power of chipper must be appropriate to deal with quantity of brash	Suitable – size and power of chipper should be appropriate to deal with quantity of brash
Burning	Suitable – but see risks of burning near standing trees in section 5.3	If large volumes are produced, may not be the most desirable method due to large scale of burning required
Fuel wood	Will only be justifiable, economically where sufficient volume of brash is produced	Will only be justifiable, economically, where sufficient volume of brash is produced

6.2 Site planning

Minimising vehicle movement over a site will reduce ground damage exerted by any extraction machinery involved in managing brash from a felling site. Accumulation of brash close to access racks at the time of felling and processing of the standing crop will reduce the need for vehicles to travel over the site and consequently reduce disturbance to the underlying vegetation and soil.

6.3 Effects of ground disturbance on the site

If using mechanised means of extracting whole trees or brash following felling some ground disturbance over the ground where extraction takes place may be unavoidable. Such disturbance includes compaction of the soil as a result of the weight of extraction machinery, and rutting where equipment causes a deformation in the physical profile of the ground. The effects of skidding are likely to be the most disturbing factor to vulnerable sites owing to the aggressive effect that the dragging action has on the soil surface. Ground disturbance resulting from brash management may not necessarily have a negative effect on the habitat restoration of the site.

The negative effects of disturbing the ground include the risk of exposing the soil to erosion and subsequent overland flow of sediment into waterways, disturbance of fragile vegetation and consequent impacts on fauna that utilises the vegetation type. Access to the site for future management operations may be hampered if severe rutting occurs. Compaction of the soil surface may prevent plant growth.

Ground disturbance of an appropriate kind can assist in preparing a seedbed for developing pants and to promote germination from the seed bank providing that this disturbance is undertaken to meet a stated objective which requires it.

6.4 Health and safety

Care must be taken when carrying out management operations over habitat restoration sites during any of the outlined methods of brash management included in this report. Where ground conditions are uneven caution must be taken when traversing the site and all machinery should be fitted with the appropriate safety structures including ROPS (Roll Over Protection System), OPS (Operator Protection System) and FOPS (Falling Object Project System) where required by health and safety legislation.

A full risk assessment should be carried out ***before*** any work is undertaken.

Currently appropriate safety advice to be adhered to when carrying out any brash management operation is contained within the Arboriculture and Forestry Advisory Group (AFAG) Guides.

6.5 Legal responsibilities when disposing of brash

There may be legal requirements that must be followed when disposing of biomass-arisings. These must be taken into consideration when planning the disposal of brash; this applies particularly to burning brash on site for purposes other than energy recovery. A waste management licence may be required or alternatively you may register the burning activity as being exempt from licensing controls under paragraph 30 of Schedule 3 of the Waste Management Licensing Regulations 1994, as amended, as long as what you are doing complies with the criteria specified in these Regulations. Burning brash may qualify for exemption from licensing if:

- The material burned consists of wood, bark or other *plant* matter.
- The material 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.
- The quantity of brash burnt does not exceed 10 tonnes in any 24-hour period.
- Burning takes place on the site where it is produced.
- The material destined for burning is produced by the establishment carrying out the burning (and is not therefore disposed of on behalf of a third party).

Brash *can* be stored in situ on the land where it is to be burned for a period prior to burning. Exemption from the requirement to dispose of waste under a waste management licence *must* be registered with the Environment Agency (EA) or the Scottish Environment Protection Agency (SEPA).

In addition, it is a requirement that the waste is disposed of 'without endangering human health and without using processes or methods which could harm the environment and in particular without:

(i) risk to water, air, soil, plants or animals; or
(ii) causing nuisance through noise or odours; or
(iii) adversely affecting the countryside or places of special interest

It is recommended that local authorities be consulted when burning operations are planned. It is important also to consider the constraints associated with burning with regard to the proximity of fires to public roads, public places and airfields. Public health also has to be considered when fires may be a nuisance. Local police and local authority environment officers should be contacted for advice (Jones 2002).

For further details of the legal responsibilities relating to brash disposal including burning consult your local Environment Agency office, details of which can be obtained from EA General Enquiries Tel: 0845 9333 111. For enquiries related to Scotland contact the local (SEPA) area office details of which can be found at the following URL: http://www.sepa.org.uk/contact/index.htm.

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APPENDIX 1 DEFINITION OF FORESTRY EXTRACTION SYSTEMS

In the UK the five commonly practised systems of timber extraction can be defined by the way in which the produce is extracted from site thus:

- **Shortwood**

Involves felling, delimbing and crosscutting of the tree at stump where upon the brash is discarded and only the saleable products including wood fuel are handled. The technique is suitable to all tree sizes. Minimising the number of products cut will reduce the time taken for sorting at roadside. The preferred method of extraction is forwarder, subject to ground conditions.

Nature of Brash Resulting from System

Brash is separated from the timber products at stump and usually accumulated by forwarder grab and placed into key extraction routes to aid machine floatation. This can lead to contamination of brash with soil if attempts to extract the brash are made after felling. If brash is accumulated on key extraction routes, this consolidates brash, and can aid collection following harvesting providing soil contamination is low. The brash can then be exploited as a product e.g. for fuel wood.

- **Pole-length**

This technique combines a three-phase operation involving felling and delimbing, extraction to roadside and cross-cutting of various products e.g. saw log, pulp and woodfuel. Conversion of products may take place at roadside or at the mill.

Nature of Brash Resulting from System

As with Shortwood extraction the main stem is snedded and the top removed at stump. Brash is therefore dispersed throughout the site.

- **Part-pole**

A variation of the Pole-length system whereby the sawlog component of the tree is removed at stump and extracted separately aiding product sorting, and providing efficient delivery of sawlogs to the customer during periods of high demand. Pulp and small roundwood can be extracted at a later stage. Outputs may be reduced using this method if product density is low resulting in correspondingly small load sizes.

Nature of Brash Resulting from System

Accumulated at stump.

- **Whole Tree**

All the above ground components of the tree are extracted off the felling site, resulting in no crown and branch wood residues being left in the forest, which increases the volume of harvestable produce from the tree.

Nature of Brash Resulting from System

Once at roadside the tree may be delimbed whereupon brash can be conveniently accumulated, for subsequent treatment (burning, chipping or bailing) or the whole tree including the main stem and branchwood may be directly chipped at roadside.

- **Terrain Chipping**

The chipper is used in the wood, directly chipping the whole tree, poles or shortwood into a hopper. The chips are blown into a trailer and subsequently dispatched into containers for road haulage. Terrain chippers may be self-contained units mounted onto a forwarder base unit with integral grab to allow mobility through the stand or simple independent mobile units.

Nature of Brash Resulting from System

All aboveground components of the tree are chipped and extracted from the felling site.