FORESTRY PRACTICE GUIDE

WHOLE-TREE HARVESTING

A Guide to Good Practice

The Forestry Authority
A part of the Forestry Commission

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A Guide to Good Practice

T. Nisbet, J. Dutch and A. Moffat

Forestry Commission Research Agency

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Enquiries relating to this publication should be addressed to:

Forestry Practice
Forestry Commission
231 Corstorphine Road
Edinburgh
EH12 7AT

Tel: 0131-334 0303
Fax: 0131-316 4344

Cover Picture: a clambunk skidder felling and extracting timber. FOREST LIFE picture library: 0131-334 0303

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INTRODUCTION

The purpose of this guide is to describe the potential impacts of whole-tree harvesting (WTH) upon the forest ecosystem, to consider the likely risks on different sites and to make recommendations for managers faced with different harvesting options. The aim is to provide operational guidance to managers. Because our knowledge of this subject is still developing (Proe *et al*., in prep), these recommendations may need to be revised over the course of time and further advice on specific sites may need to be obtained from the Forestry Commission Research Agency.

Whole-tree harvesting can be defined as the removal of most branches and needles from a harvesting site in addition to the stem wood that is removed in conventional harvesting. The stump is left *in situ*.

WHOLE-TREE HARVESTING IN BRITAIN

Traditionally, WTH has been little used in British forestry, but, in the last decade, the interest in this type of harvesting has increased for a number of reasons. These include:

a. when using cable crane, the reduced cost and greater safety of WTH on steep ground. The whole tree is extracted to the roadside where de-limbing can occur on level ground using modern timber processing machinery;

b. the limited amount of brash present after clearfelling with WTH so that subsequent restocking is *perceived* to be easier, quicker and cheaper;

c. the possibility of removing the woody residues from the site for marketing as fuel, fibre or as a mulch;

d. the ability to respond to changes in timber product specification resulting in improved margins and reduced timber stocks at roadside;

e. better use of the forest road system;

f. improved visual appearance of harvested sites.

Two systems of WTH are currently employed in British forestry: one-stage working where the whole tree is removed from the site in a single operation; and two-stage working involving the conventional harvesting (CH) of stem wood followed by a subsequent operation to harvest residues.

Cable crane and skidder working are one-stage systems. Cable cranes are ropeway systems where timber is extracted by means of moving cables, powered by a stationary winch. The trees are normally carried partially or wholly clear of the ground. Because of the relatively high cost of extraction, the use of cable cranes is normally confined to the most difficult sites, in particular to forests on steep ground in northern and western Britain.

Skidders are tractors which extract the tree from the felling site by lifting the butt end up from the ground and pulling the tree with the crown dragging along the ground. At the present time, clambunk skidders are the machines most often employed in this type of WTH.

Two-stage systems involve forwarder working on CH sites and are therefore without the attendant benefits described in (a), (d) and (e) above.

We estimate that some 10 per cent of current clearfelling programmes in Forest Enterprise are being achieved through WTH, of which 60% is by cable crane working and 40% is by skidder working. So far, very little WTH is carried out by forwarder working.

IMPACTS ON THE ENVIRONMENT AND TREE GROWTH

Harvesting systems should aim to minimise damage, a policy advocated in the Helsinki Guidelines (Ministry of Agriculture and Forestry, Finland 1993) and reinforced by the recent Government statement on *Sustainable Forestry* (UK Government, 1994). The environmental standards for harvesting practice are covered by existing guidelines (e.g. Forests and Water Guidelines (1993), Forest Landscape Design Guidelines (1994) & Forest and Soil Conservation Guidelines (FC, in prep)). The use of WTH poses particular hazards to sensitive sites of which the forest manager should be aware, because serious damage can be caused to the forest environment which is not compatible with sustainable forest management.

WTH presents a number of threats to the forest environment over and above those associated with CH. There are six principal ones.

1. Soil physical damage, erosion and siltation of watercourses.

With the exception of cable crane working, WTH requires more material to be removed from the site and hence more site traffic. An added problem is the consequent reduction in the use of brash mats in skidder working. Harvesting operations are therefore more likely to cause serious soil compaction, rutting and erosion, leading to increased siltation and turbidity in local watercourses. Soil damage can be costly and impractical or impossible to rectify, with potentially deleterious consequences for future site productivity (FC, in prep.). Impacts on watercourses can include damage to fish spawning gravels, restrictions to fish movement and the pollution of water supplies.

2. Impoverished soil fertility and associated silvicultural implications

Branch and foliage material have much higher nutrient concentrations than stem wood. Their removal through WTH represents a considerably greater drain on the nutrient capital of a site than occurs in CH. On average, nitrogen and phosphate losses can exceed those in CH by a factor of around 2 to 3, while for the base cations potassium, calcium, magnesium and sodium, losses are between 1.5 and 2 times higher. Such losses are a cause for concern over the ability to sustain site productivity in the long-term, especially in acid soils of inherently low fertility (Carey, 1980). However, in general, plantation forestry practices have not been found to threaten long-term sustainability (Evans, 1990).

WTH has been shown to result in reduced tree growth in second rotation Sitka spruce compared to where brash was retained (Proe & Dutch, 1994; Dutch,1995). This is thought to be due partly to a reduction in site fertility and partly to the loss of physical shelter provided by the brash. Therefore as the exposure of a given site increases, WTH may have an increasingly adverse effect on tree growth.

Brash has also been shown to be a very effective mulch, suppressing weed growth for several years after felling. The effect is most important on fertile sites where WTH may result in additional weeding requirements.

3. Acidification

The greater removal of base cations through removing whole trees can be a significant drain on the buffer capacity of forest soils. Modelling studies predict that within acid sensitive areas this will lead to severe soil and stream water acidification over several harvesting cycles. The sites most at risk are those lying within critical loads exceedance map squares for UK freshwaters (Forests and Water Guidelines, 1993). However, the authors believe that the current models do not adequately address a number of important “sinks” for acidity in forest stands. These include: enhanced atmospheric inputs of base cations by a forest scavenging effect, additions of base cations via rock phosphate fertiliser applications, and the effect of cultivation and harvesting practices on soil weathering rates. It is estimated that such sinks could help to compensate for the additional acid load due to WTH on some sites. Further research is being undertaken to quantify these sinks and validate existing models.

4. Freshwater eutrophication

There is a reduced risk of nutrients leaching to drainage waters from ground that is WTH compared to CH. This is due to the removal of the foliage and branch material in the former, which form an important source of leachable nutrients. On the other hand, there is some concern about the concentrated organic leachate that can drain from roadside brash stores associated with WTH. This nutrient rich and strongly coloured leachate is potentially highly polluting, causing unacceptable fungal growths and deoxygenation in local streams and tainting of water supplies.

5. Degraded landscape

WTH can provide both positive and negative effects on the landscape compared to CH. The cleaner site and faster rate of revegetation reduce the visual impact of the felled site, but worn extraction routes and roadside brash stores can be very unsightly.

6. Degraded habitat

The main threat to wildlife habitat derives from the removal of coarse woody debris from WTH sites. Coarse woody debris forms an important habitat, provides shelter and cover from predators and is a valuable substrate for invertebrates and fungi.

RECOMMENDATIONS ON SITE SUITABILITY

In view of the serious threats that WTH can pose to the forest environment, the sensitivity of any site must be considered at the early planning stage. Within critical loads exceedance squares WTH should be avoided as a precaution until research clarifies the risk of increasing surface water acidification. However, for sites with steep slopes, cable crane working with WTH maybe the only practical option.

For the majority of sites it should be possible to reduce the impact of WTH operations to an acceptable level with good planning and management, including the use of appropriate machinery and equipment (FC, 1996a, b, c, d, e). This will require a detailed prescription for the site with particular attention to terrain and soil type, time and scale of harvesting, the use of protective measures, siting of brash stores and alternative options for CH working should weather conditions prevent WTH. As with CH, liaison with the local water regulatory authority and water undertaker in public water supply catchments, the identification of private water supplies, provision of roadside facilities, the need for advanced engineering work, careful location of main haul routes, and adequate timber dispatch arrangements all need to be addressed before harvesting operations start.

Since the one and two stage systems of WTH differ in their propensity to damage a site, each method of working is dealt with individually below. However, all methods require the same attention to the siting of brash stores and consideration of wildlife habitat, and therefore recommendations on these aspects are given under separate headings.

Cable crane (skyline) working with WTH

This method of harvesting poses the least threat to the forest environment and is appropriate to most steep sites. The absence of ground traffic minimises the risk of soil damage, which is limited to the disturbance caused by the trailing of tree tops during skyline extraction. The key point for action is to minimise the formation of worn trails by the repeated dragging of trees along the same routeway. There is a risk of these prominent trails becoming water channels, resulting in erosion and the entry of sediment to watercourses. Take care in skyline set-up to minimise dragging where possible, relocate the skyline away from areas that start to erode, provide brash to protect key areas and dig offlets to reduce water flowing down any damaged areas.

Soils on steep slopes generally have a moderate or high nutrient status and WTH is unlikely to lead to site infertility. The main exceptions are skeletal or ranker soils on rocky or unstable slopes, where the removal of whole trees is likely to present a high risk of nutritional problems in subsequent rotations. These soils are of limited productivity and may be vulnerable to acidification. Such sites are also prone to slope failure and erosion and may therefore be unsuitable for clearfelling. Tree crops are best left to stand indefinitely for their ecological value or be allowed to regenerate naturally following harvesting.

Skidder working with WTH

Skidder working presents the greatest risk of site damage and therefore particular care is required in assessing site suitability. The problems of ground damage and soil fertility may be assessed using information on soil types. Soil wetness and nutritional factors can be used to allocate soil types to broad categories of risk; low, medium and high.

Ground damage

Risk Category	Soil Types (see Pyatt,1982)
Low	Brown earths, Podzols, Rankers, Skeletal soils, Limestone soils and Littoral soils except Sand with shallow or very shallow water-table.
Medium	Shallow peaty soils (peat <45 cm deep), Surface-water gleys, Ground-water gleys and Ironpan soils.
High	Peatland soils (peat >45 cm deep), and Littoral soils with shallow or very shallow water-table.

In the context of ground damage, the *low risk category* indicates those soil groups which are likely to be safe for skidder working under “dry” site conditions. Operations should cease during, and for a time following, periods of very wet weather, when the risk of soil damage is high. Ground conditions should be assessed before operations are allowed to recommence. The use of some brash may be required to protect localised areas of soft ground.

Soils in the *medium risk category* are those that require restrictions to the timing of harvesting operations and the use of physical protective measures to prevent serious soil damage. Harvesting should be restricted to dry periods and adequate brash mats used to protect all main extraction routes. Areas of ground subject to regular traffic and manoeuvring, (e.g. close to roadside processing sites), are especially vulnerable and require thick brash mats.

- Check the softness of the ground using a hand held metal probe before operations commence and closely monitor progress for signs of soil damage.
- Suspend or re-organise operations if significant rutting (ruts deeper than 10 cm and longer than 5m in length) starts to occur or if turbid, sediment-laden water begins to enter local watercourses.
- Take remedial action on damaged areas, e.g. with the use of additional brash or piping, and reduce turbid water by digging offlets to direct water away from watercourses and if necessary construct sediment traps.

- Resort to appropriate conventional harvesting practices if skidder working continues to cause ground damage. This requires planning the sequence of extraction so that brash is available along any potential CH extraction route.

The *high risk category* comprises sites with very soft ground where skidder working is likely to result in unacceptable damage to soils and water quality. Choose alternative methods of harvesting that are more suited to dealing with such sensitive sites (see Forestry Commission, 1991).

Soil fertility

Risk Category	Soil Types (see Pyatt,1982)
Low	Brown earths, Surface-water gleys, Ground-water gleys, *Juncus* bogs.
High	Unflushed Peatland soils, *Molinia* bogs, Shallow peaty soils, Ironpan soils, Podzols, Littoral soils, Rankers and Skeletal soils.

Definition of the nutrient risk categories is more straightforward than the ground damage categories with low and high referring to the likelihood of encountering a deficiency in one or more nutrients in subsequent rotations. The nutrient status of soils in the *low risk category* is good and it is unlikely that WTH would affect the nutrition of the following crop. Soils in the *high risk category* are those where fertility is likely to be a limiting factor for tree growth and consequently, any additional removal of nutrients in WTH may increase the requirement for remedial fertilisation (of N, P or K) as the inherent fertility of the soil decreases.

Two-stage working (forwarder)

The secondary extraction of harvesting residues allows WTH to be extended to those soil groups where skidder working presents a high risk of ground damage. The stem wood on such sites can be carefully harvested by shortwood working using a forwarder, leaving much of the residue material in the form of brash mats to be subsequently removed. Harvesting of the latter can proceed by working backwards on the remaining brash mats, allowing the soil to be protected from the wheels or tracks. Secondary extraction can also increase the amount of residues harvestable from medium risk sites where skidder working requires the selective use of brash mats.

For secondary extraction to be effective, brash mats must be thick and well constructed. Sites with insufficient brash are unsuitable, while poorly managed extraction routes will result in recovery of low quality brash material and a high risk of rutting. The benefits to soil fertility of delaying the extraction of brash for a period of 3 to 6 months in order that the nutrient rich needles will be left on site must be balanced against the reduced bearing capacity of the dried brash mat.

A summary of the various options for harvesting different site types is given in Figure 1.

Siting of brash stores

Brash stores should be located on drier areas away from watercourses. This will encourage the retention of leachate within the soil and so reduce the risk of contaminating local stream waters. Prominent sites in the landscape should be avoided to reduce visual impact. Brash stores can last well over 5 years and need to be carefully designed in sensitive locations. The brash can be re-used in creating temporary roads, constructing lay-bys or strengthening brash mats on nearby sites.

Site conservation

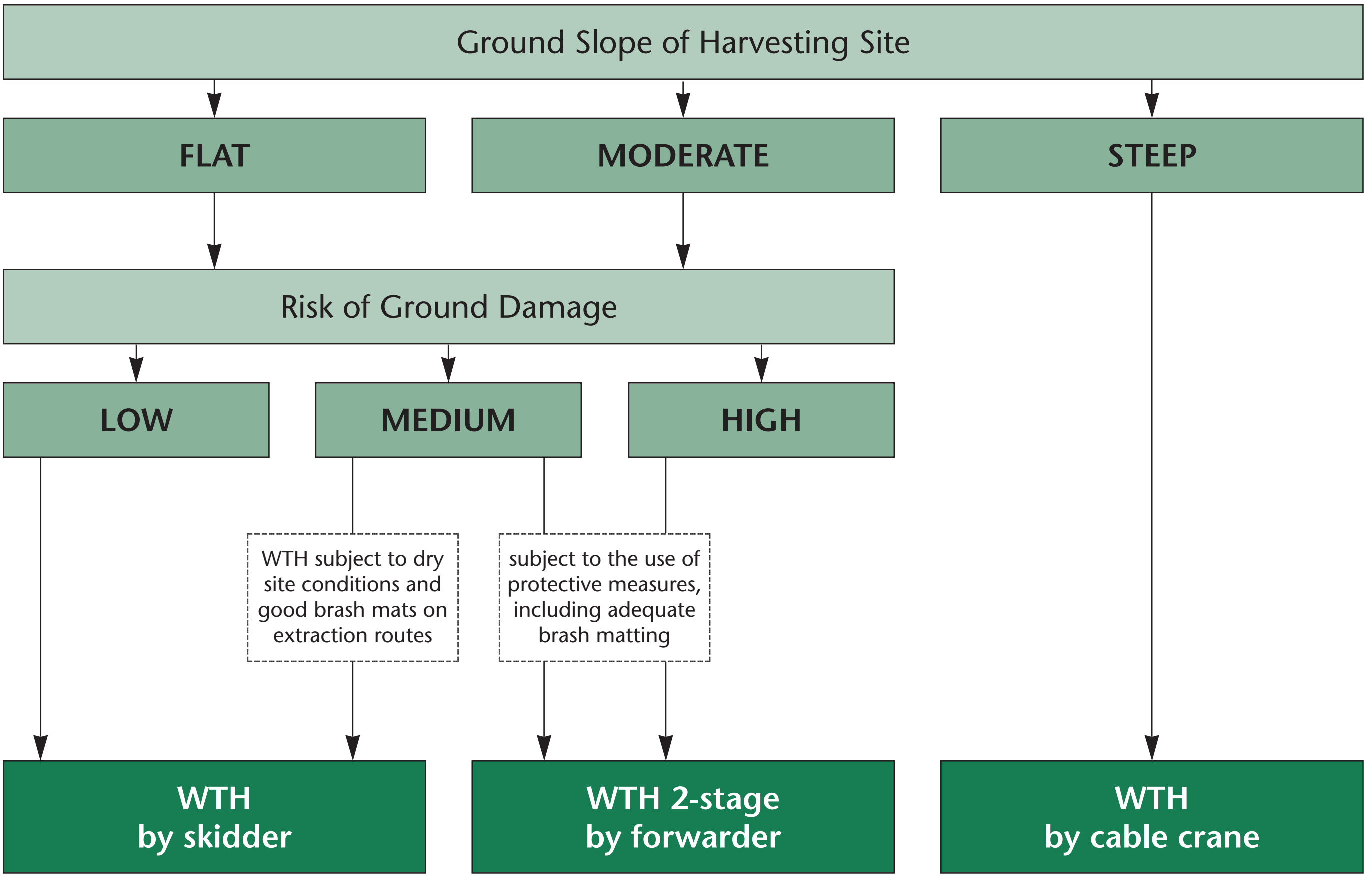
As with other types of harvesting, small areas of both live and dead trees can be left standing in suitable locations where this will benefit woodland ecology. WTH should be avoided on sites where brash forms an important habitat for key species.

FIGURE 1

Decision diagram indicating the type of whole-tree harvesting operation suitable for different sites.

WTH should be avoided:

- within critical loads exceedance squares except on steep sites necessarily extracted by cable crane (see page 4).
- on both high and low nutrient risk soils (see page 7) where soil fertility has been a limiting factor.



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NOTES

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Forestry Commission
231 Corstorphine Road
Edinburgh
EH12 7AT

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