

Table 7.2 Target vegetation, herbicide, timing and application amounts.

<i>Vegetation type</i>	<i>Herbicide</i>	<i>Pre/Post-planting</i>	<i>Time</i>	<i>Amount (litres/ha)</i>
Bracken	asulam	Pre-plant Post-plant	June/July July	8 5
	glyphosate	Pre-plant	July/Aug. of prev. yr.	3
Bramble	glyphosate	Pre-plant Post-plant (cowl)	July-Oct. May-Oct.	3 3
	triclopyr	Pre-plant Post-plant	July-Dec. Aug.-Dec.	5 3
Furze	triclopyr	Pre-plant Post-plant	Feb.-Oct. Aug.-Dec.	5 3
Grasses	atrazine	Pre-plant Post-plant	Jan.-March Jan.-March	12-14 12-14
	glyphosate	Pre-plant	Jan.-March	3
	propyzamide	Post-plant	Oct.-Jan.	3.75
	terbuthylazine	Pre-plant Post-plant	Jan.-March April-June	12-14 12-16
Grass/ Broadleaf weeds	glyphosate	Pre-plant Post-plant (cowl)	June of prev. yr. April-June	3 3
	Grass/ Light rush	atrazine	Pre-plant Post-plant	Jan.-March Jan.-March
glyphosate		Pre-plant	Jan.-March	3
terbuthylazine		Pre-plant Post-plant	Jan.-March April-June	12-14 12-16
Heavy rush	glyphosate	Pre-plant Post-plant (cowl)	June-Sept. June-Sept.	3 3
	Rhododendron/ Laurel	glyphosate	Pre-plant Post-plant (cowl)	June-Sept. June-Sept.
Scrub/ Woody weeds		glyphosate	Pre-plant Post-plant (cowl)	June-Aug. June-Aug.
	triclopyr	Pre-plant	June-Aug.	3
	imazapyr	Pre-plant	June-Aug.	2

7.11 ADVERSE IMPACTS

- **Failure to follow manufacturer instructions**
- **Failure to adhere to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of herbicides and the maintenance of application equipment, resulting in operator exposure and contamination of aquatic zones and other environmental damage**
- **Failure to notify local inhabitants and relevant authorities of operation**
- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Failure to implement relevant operational measures relating to aquatic zones and important habitats/biodiversity issues, with subsequent damage**
- **Incorrect formulation, application or calibration, causing crop or soil damage**
- **Damage due to species intolerance**
- **Surplus waste material and containers left onsite**
- **Poor, incomplete records of operations and associated expenditure**

7.12 BEST PRACTICE

- **Follow manufacturer instructions**
- **Be aware of legal requirements**
- **Strict adherence to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of herbicides and the maintenance of application equipment**
- **Display notices during application to alert members of the public to operation-in-progress**
- **Notify relevant authorities immediately of accidental damage to aquatic zones**
- **Match herbicide to vegetation, species and site**
- **Follow formulation, application and calibration rules**
- **Collect and remove all surplus material and containers during and after the operation for safe off-site disposal**
- **Adhere to workplace safety requirements**
- **Implement relevant operational measures relating to aquatic zones and important habitats/biodiversity issues**
- **Maintain the necessary buffer zones in relation to aquatic zones**
- **Employ suitably trained, qualified and experienced operators**
- **Keep a complete record of operations and associated expenditure**

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8. FOREST PESTS AND DISEASES

Trees can suffer from pest and disease attack at different stages of their development. Apart from endemic problems, there is a significant threat from exotic forest pests and diseases. Mammals can also cause considerable damage.

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8.1 KEY FACTORS

- Levels of pest risk in Ireland
- European Union regulations and national legislation
- Implementation measures
- Protective measures
- Use of chemicals
- Insects
- Diseases
- Mammal damage
- Safety and the environment

8.2 OBJECTIVES

- To protect trees from damage by insects, diseases and mammals.
- To exclude exotic pests and diseases.
- To comply with pest and disease regulations.
- Pest management.
- To ensure safe and environmentally acceptable protection measures.

8.3 THREATS FROM EXOTIC PESTS AND DISEASES

Irish forests are recognised under the European Union Plant Health Directive 77/93/EEC as being among the healthiest in Europe, with relatively few serious forest pests or diseases. This is mainly due to Ireland's island status, the relative newness of the forest estate, and the enforcement of forest plant health regulations.

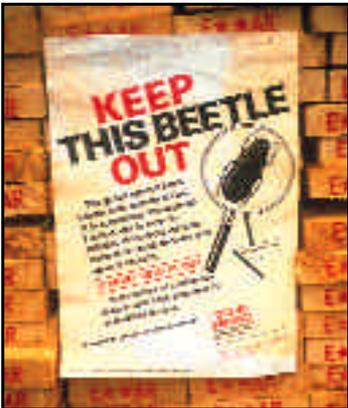
However, the species composition of Ireland's largely 'man-made' forests, which are comprised mainly of exotic conifers, makes them inherently susceptible to introduced harmful organisms. The growing movement between countries of forest plants and wood products (e.g. logs, sawn timber, pallets, packing wood and ship's dunnage) increases the risk of potentially very damaging forest pests and diseases spreading to Ireland.

Forest Service policy is to maintain a healthy forest environment by ensuring good management, identifying risks and maintaining a sustained commitment to measures which prevent the entry and establishment of destructive forest pests and diseases.

8.3.1 Policy implementation

Forest Service implementation measures include:

- Implementation of the forestry aspects of the EU Plant Health Directive and national legislation.
- Ongoing surveys and monitoring of the national forest estate for injurious pests and diseases.
- Registration and ongoing inspection of sawmills, forest nurseries and Christmas tree farms in relation to the implementation of the Plant Passport regime within the EU, and monitoring the movement of wood and forest plants from other Member States under this scheme.
- Registration of importers of wood and forest plants from non-EU countries, and monitoring and inspecting these imports on behalf of Ireland and the other Member States in the context of the Internal Market.
- Issuing of Phytosanitary Certificates for exports to non-EU countries.
- Liaison with the Department of Agriculture, Food and Rural Development, the Customs Authorities and with the European and Mediterranean Plant Protection Organisation (EPPO).
- The provision of assistance and advice on forest plant health regulations to growers, other government departments, trade associations, growers organisations and other interested bodies.
- Processing of identification and advisory queries from members of the public and private forest owners regarding insect pests and diseases of trees and forests.
- Implementation of the Forestry Plant Health Contingency Plan, if and when required.



Bark beetles and other exotic pests and diseases pose a major threat to Irish forests, and the inspection and control of imported plants and wood products are essential in maintaining the excellent health status of the national forest estate.



Some longhorn beetles are significant forest pests. One genus, *Monochamus*, can act as a carrier for pine wood nematode, which may cause a serious wilt disease.

8.3.2 Plant health legislation

Relevant EU legislation is represented by the Council Directive 77/93/EEC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. The European Communities (Introduction of Organisms Harmful to Plants or Plant Products) (Prohibition) Regulations, 1980, as amended, transpose Council Directive 77/93/EEC into national legislation.

8.3.2.1 Background

Border phytosanitary controls are in place to ensure that plants or their products which are being imported satisfy the plant health standards applicable to the importing country. With the completion in 1993 of the Internal Market and the abolition of border controls between Member States, the rules for production and marketing in the phytosanitary field are now the same throughout the EU, irrespective of whether the plants or their products are to be moved within the Member State or into other Member States.

Council Directive 77/93/EEC, commonly referred to as the Plant Health Directive, establishes harmonised phytosanitary regulations relating to trade between EU Member States. This Directive also covers the phytosanitary regulatory provisions relating to the importation of plants and plant products of non-EU origin.

8.3.2.2 Wood, forest plants and Christmas trees originating within the EU

To ensure that circulating plants and plant products are free from quarantine pests and diseases present within in the EU, the plant health regime places the emphasis on control at the place of production. The Member State in which the plants and plant products are produced is responsible for ensuring that they meet the plant health requirements of the receiving Member State.

Plant Passport: To certify freedom from quarantine pests and diseases, a Plant Passport, which replaces the former Phytosanitary Certificate between the Member States, must accompany certain species of plants and plant products. These plants or plant products must be inspected at the place of production. For example, *Sorbus aucuparia* plants must be accompanied by a Plant Passport confirming that the plants originate in areas recognised as been free of fireblight disease (*Erwinia amylovora*). In certain circumstances, a Replacement Passport may be required, e.g. where consignments of plants which have already received passports are subdivided.

Registration: Any producer of wood, forest plants and Christmas trees requiring a Plant Passport must be registered. Importers into the EU of certain forest plants and wood products must also be registered. The producer or importer is subject to certain obligations such as a requirement to keep records of all plants or plant products which have been purchased or sold or which are under production.

Protected Zones: Special arrangements are necessary to take account of differing pest and disease situations and differing crop and growing conditions within the EU. As a consequence, Protected Zones exposed to particular plant health risks are defined and accorded special status. The borders of these zones and the type of special protective measures are specified in each case. Accordingly, special requirements are laid down where certain plants and plant products are moving into or within the Protected Zone. Such material must be accompanied by a special Plant Passport (ZP Plant Passport). For example, a valid ZP Plant Passport must accompany plants of *Pinus* moving within Ireland or moving into Ireland from other Member States, confirming that the plants have been produced in registered nurseries and that the area of production is free from Brunchorstia disease (*Gremmeniella abietina*).

The following information is required on a Plant Passport:

- the title "EEC Plant Passport";
- indication of Member State code;
- indication of responsible official body or its distinguishing code;
- registration number;
- individual serial, week or batch number;
- botanical name;

- quantity;
- the distinctive marking 'ZP' for the territorial validity of the passport and where appropriate, the name of the Protected Zone for which the product is qualified;
- the distinctive marking 'RP' for a Replacement Passport and where appropriate, the code for the original registered producer or importer;
- in the case of third country products, the name of the country of origin or consignor country.

8.3.2.3 Importation of wood, forest plants and Christmas trees from outside the EU

Many of the injurious pests and diseases indigenous in third countries do not exist within the EU. Certain listed harmful organisms could be introduced on contaminated plants and could then become established, with serious economic and environmental consequences.

Under the Internal Market regime within the EU, once material is imported from a non-EU country, it can then circulate freely throughout the EU. The Member State where the material is imported is therefore responsible for protecting the other Member States, by ensuring that the plant material complies with the regulations and is free from harmful organisms.

In relation to importation, three types of material can be distinguished:

1. *Material which is prohibited:* Particular plant and plant products originating in certain regions of the world are banned. For example, *Castanea* and *Quercus* plants with leaves and originating from non-European countries are prohibited in all Member States.
2. *Material for which importation is allowed on presentation of a Phytosanitary Certificate and subject to a plant health inspection:* This is the established system for international trade under the International Plant Protection Convention (IPPC). The Phytosanitary Certificate is supplied by the authorities in the exporting country to ensure that the exported material conforms with the EU phytosanitary requirements. Compliance with the requirements of the Plant Health Directive is checked at the point of entry on behalf of the EU. The plants or plant products can then circulate freely within the EU accompanied by a Plant Passport. Special requirements are also laid down for some of these plants and plant products. For example, all conifer wood originating in North America must be heat-treated to 56°C for 30 minutes.
3. *Material whose importation is not subject to specific phytosanitary regulations:* For example, most tropical timbers.

8.3.2.4 Exports to non-EU countries

Many types of plants and plant products must be accompanied by a Phytosanitary Certificate before moving in international trade. It is the responsibility of the exporter to comply with the phytosanitary requirements of the country of destination. As described above, a Phytosanitary Certificate is issued by the national plant protection service (i.e. the Forest Service of the Department of the Marine and Natural Resources, for forest plants and plant products) under the rules of the IPPC. The plants or plant products are inspected and certified as being free from quarantine pests and in conformity with the current phytosanitary requirements of the importing country.

8.3.2.5 Implementation of plant health legislation

The Forest Service of the Department of the Marine and Natural Resources is responsible for implementing the forestry aspects of plant health legislation, i.e. the provisions relating to forest nurseries, sawmills, Christmas tree producers and importers of controlled forest plants and products. The Department of Agriculture, Food and Rural Development has overall statutory responsibility for plant health.

8.3.2.6 Procedures for plant health registration

Forest nursery producers, Christmas tree producers, sawmills and importers involved in the movement of controlled plants and plant products should apply in the first instance to the Forest Service for an application form.

The main controlled forest plant species are spruce, pine, fir, larch, Douglas fir, poplar, rowan, Spanish chestnut, oak and cherry. The main wood species controlled are conifer wood, oak, Spanish chestnut, maple, plane and poplar. Other species may also be covered.

On receipt of a completed application form, a unique registration number will be allocated. Following an inspection and provided that all necessary conditions are complied with, formal registration approval and permission to issue Plant Passports will be issued. The main conditions of registration are as follows:

1. Immediate notification to the Forest Service of any unusual pests or diseases.
2. Maintenance of an updated plan of the premises on which plants, plant products or other objects subject to plant health controls are grown, produced, stored, kept or used.
3. Submission to the Forest Service of samples of the Plant Passports actually used.
4. Maintenance of records, with a view to having complete information available to the Forest Service on plants, plant products or other objects purchased for storage or planting on the premises, under production or dispatched to others, and to keep related documents for at least one year.
5. Being available personally or designating another person technically experienced in plant production and related plant health matters, to liaise with the Forest Service.
6. To carry out visual observations as necessary, at appropriate times and in a manner laid down in guideline instructions which may be given from time to time by the Forest Service.
7. Ensuring access to the site for persons entitled to act for the Forest Service, particularly for inspection and/or sampling purposes, and to the records referred to above, and other related documents.
8. Regarding imports from non-EU countries, giving adequate advance written notification of the proposed landing of each consignment subject to control.
9. Otherwise co-operating with the Forest Service.



Butt rot caused by *Heterobasidion annosum* can result in considerable degrade in timber.

8.4 THREATS FROM ENDEMIC PESTS AND DISEASES

Endemic pests and diseases can become aggressive and epidemic if ecological circumstances change. Harmful insect and fungal activity may be triggered by forest management activities such as clearfelling. Natural disasters such as windthrow and fires provide ideal breeding material for damaging pests, with potentially serious consequences. To guard against the build-up of such pests, it is important to practice forest sanitation measures, e.g. to rapidly recover windthrown material before degrade commences.

8.4.1 Diseases

The principal forest disease which occurs in Ireland is *Heterobasidion annosum* (commonly referred to as 'Fomes'), a fungus which causes root and butt rot. The fungus spreads through root contacts between colonised stumps and living trees, causing serious decay. The marketable volume of timber can be greatly reduced, and infected trees are liable to windthrow.

Where the crop is healthy, the retention of some deadwood is beneficial for biodiversity (see FOREST BIODIVERSITY GUIDELINES).

8.4.2 Insect pests

The principal forest insect pest which occurs in Ireland is the large pine weevil (*Hylobius abietis*). Adult weevils pose a major threat to reforestation by feeding on the bark and underlying tissue of newly planted trees. Routine protective measures are essential if reforestation is to be successful. Other significant insect pests include green spruce aphid (*Elatobium abietinum*), pine shoot moth (*Rhyacionia buoliana*), pine beauty moth (*Panolis flammea*) and European pine sawfly (*Neodiprion sertifer*).



Larvae of the buff-tip moth causing defoliation.



The bank vole, which occurs in south western counties, can cause damage to young plantations.

8.5 MAMMAL DAMAGE

Grazing by wild or domesticated animals is a significant cause of damage in young plantations. Rabbits, hares, deer, cattle, goats and sheep inflict damage to varying degrees. The introduced grey squirrel can cause serious damage to young broadleaf stands, particularly sycamore. The bank vole causes damage to young trees, but is currently confined to the south-west region.

8.6 PROTECTION

The protection of Ireland's forest estate against the threat posed by endemic pests and diseases is dealt with on a day-to-day basis by integrated pest management. Pesticides are not normally applied, apart from their limited use in forest nurseries and for the control of large pine weevil.

8.6.1 Chemical control of large pine weevil

The permethrin-based product Permasect has been approved for forestry use in Ireland. Permethrin is a pyrethroid insecticide. It is mainly applied by directed spraying onto the main stem of newly planted trees.

8.6.1.1 Safety and environmental procedures

All safety and environmental precautions and procedures relating to the preparation, transport, storage and application of herbicides also apply to pesticides (see SECTION 7: VEGETATION MANAGEMENT and FORESTRY AND WATER QUALITY GUIDELINES).

8.6.2 Protection against *Heterobasidion annosum*

Stump treatment at felling with a solution of urea is currently the best method of preventing infection. It is a general condition of a felling license that conifer stumps are treated in accordance with the general practice of good forestry. The correct mixing rate is 1 kg of fertiliser grade urea, 5 litres of water and one bottle of dye. The urea solution may be applied to run-off either manually by brush and bucket, or by harvesting machine heads fitted with a special applicator. Stumps should be treated immediately after cutting. Although urea is not regarded as a pesticide, it should be prepared and securely stored under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone (see FORESTRY AND WATER QUALITY GUIDELINES). Gloves should be worn when mixing and applying the solution.

8.7 PROTECTION AGAINST MAMMALS

Exclusion by appropriate fencing is the most effective protection against rabbits, hares, deer, cattle, goats and sheep. With the increased rabbit population, rabbit fencing is often required. Sheep fencing is often standard (see SECTION 5: SITE PREPARATION FOR AFFORESTATION). Deer fencing is required for broadleaves and conifer species such as Douglas fir in areas where deer populations are high. Bank vole requires ground cover, so the removal or suppression of vegetation may significantly reduce the incidence of damage. Grey squirrel damage is difficult to control, but methods include selective poisoning, shooting, trapping and drey removal. Native red squirrel populations should be encouraged.

8.8 ADVERSE IMPACTS

- Breach of relevant EU Council Directives
- Introduction of serious forest pests and diseases, with consequential damage to forest estate
- No or incomplete documentation
- Risks resulting from ignorance of plant health regulations
- Failure or delay in adopting appropriate measures
- Crop damage due to incorrect timing or method of application
- Failure to adhere to the relevant safety and environmental procedures

relating to the preparation, storage, transport and application of pesticides and the maintenance of application equipment, resulting in operator exposure and contamination of aquatic zones and other environmental damage

- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones**
- **Mammal damage arising from poorly maintained fencing**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Poor, incomplete records of operations and associated expenditure**

8.9 BEST PRACTICE

- **Be aware of and observe plant health regulations**
- **Report unusual insect pests and diseases**
- **Apply appropriate measures at the right time and under the appropriate conditions**
- **Strict adherence to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of pesticides and the maintenance of application equipment**
- **Implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues and other environmental factors**
- **Notify relevant authorities immediately of accidental damage to aquatic zones**
- **Keep up-to-date with newer and safer formulations**
- **Maintain fences to protect against mammals, controlling vegetation in the case of bank voles**
- **Monitor for mammal pests**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**
- **Keep a complete record of operations and associated expenditure**

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9. FOREST MAINTENANCE

Forests continue to require attention throughout their early development, from establishment through to the stage where a satisfactory crop begins to form.

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9.1 KEY FACTORS

- **Crop condition**
- **Damage and likely causes: nutrition, pests and diseases, weather, vegetation and fire**
- **Other risks and dangers**
- **Ameliorative action**
- **Safety and the environment**
- **Restocking**
- **Plans and records**

9.2 OBJECTIVES

- **To ensure the successful development of the forest crop to maturity.**
- **To monitor and remedy adverse impacts.**
- **To maintain stocking levels.**

9.3 FOREST CONDITION

Newly planted forest crops require several years to become well-established. During this time, it is essential that the crop is monitored to ensure that the conditions necessary for establishment and survival are met, and to safeguard against unforeseen problems. In grant-aided plantations, satisfactory establishment must be certified before the full amount is paid.

9.3.1 Survival and growth

There should be an adequate number of live, healthy trees in place to ensure that a forest crop of good quality can be established. Normally, 90% of the original stocking is required.

9.3.2 Nutritional difficulties

Reduced needle strength, chlorosis, yellowing, fall-off in growth and death may all indicate nutritional difficulties. Needle and soil samples may need to be taken for analysis by a qualified laboratory. Nutritional problems can usually be rectified by phosphorus or potassium application. Nitrogen may also be deficient, although this will not normally be noticeable within the first four years. An undiscovered marl layer may also result in stagnation or death. If marl is suspected, testing should be carried out immediately in order to determine future prospects for the plantation. This can be done using the 10% solution hydrochloric acid test or by referring soil material to a qualified laboratory for analysis.

9.3.3 Pests and diseases

Defoliation, shoot damage, bark damage and dieback can be caused by a number of pests. Ireland's main forest pests, with associated damage in parentheses, include: aphid (needle cast); large pine weevil (bark pitting and stripping); bank voles (ring barking); rabbits and hares (shoots cut back); and other grazing animals, e.g. deer, trespassing stock (general reduction in plant numbers).

With the exception of wild cherry, which is prone to bacterial canker, stem and heart rot, fungal and bacterial diseases do not represent a major problem in young forests.

In general, pesticides are not usually applied. Some spraying to reduce large pine weevil attack may be carried out, necessitating the relevant safety and environmental precautions (see SECTION 8: FOREST PESTS AND DISEASES and FORESTRY AND WATER QUALITY GUIDELINES). The main protection from grazing animals is appropriate and well-maintained fencing. Bank voles thrive near brash or hedgerow vegetation. Associated damage usually occurs too late in the rotation to undertake restocking. The resulting depleted stocking will necessitate pruning in order to maintain stem quality.

Unusual pests or diseases should be reported to the local Forest Service Forestry Inspector.

9.3.4 Weather

The most common weather-related cause of damage during the early years of the rotation is frost damage, particularly late spring or autumn frosts. Frost damage usually occurs in low-lying areas where cold air drainage is poor, particularly in the Midlands. The danger of frost damage can usually be foreseen and minimised through proper species selection (see SECTION 4: SPECIES SELECTION). Replacement of frost-induced mortalities should be carried out using frost resistant species.

9.3.5 Vegetation

During early crop development, it may become apparent that the initial vegetation management was inadequate. Further weed control may be required, particularly with broadleaves which should always remain visible above the vegetation level.

Trampling to control vegetation may occasionally be necessary. If herbicides are used, follow all safety and environmental precautions and procedures relating to their preparation, transport, storage and application (see SECTION 7: VEGETATION MANAGEMENT and FORESTRY AND WATER QUALITY GUIDELINES).

9.3.6 Fire

Young plantations are particularly vulnerable to fire, especially during late spring/early summer as dead ground vegetation cover built up during the previous season begins to dry out. Details on firebreaks and reservoirs are given in SECTION 5: SITE PREPARATION FOR AFFORESTATION. Ensure firebreaks are maintained and kept free of vegetation. Identify areas of the forest at greatest risk, and follow local meteorological information to identify particularly risky periods. A fire plan should also be in place as part of the overall management plan, listing contact telephone numbers of the local fire authorities and detailing a plan of action to be implemented in the event of fire. Public warning signs and notices on the 'do's and don'ts' of fire prevention may be appropriate for use in high risk areas, although these can actually incite individuals to deliberately light fires as an act of vandalism.

There is a particular responsibility to ensure that important habitats are not put at risk from fire through management neglect.

9.4 OTHER MAINTENANCE

9.4.1 Drains and sediment traps

Drains and sediment traps should be kept fully functional. While much of this work can be done manually, machines may be needed for certain tasks, e.g. to realign drains.

9.4.2 Fences, gates and stiles

Proper fencing is crucial to prevent damage from trespassing animals. Gaps in the fenceline should be repaired, and stiles and gates maintained and kept in a safe condition.

9.5 ENVIRONMENTAL ASPECTS

As long as the plantation has been established in accordance with best forest practice, there are few potential environmental dangers associated with this stage of crop development up until the commencement of thinning. Issues which may arise relate to failure to maintain and empty out sediment traps (leading to sedimentation entering aquatic zones), and poor fire prevention management. Full adherence to safety and environmental precautions and procedures is required if fertilisers, herbicides and pesticides are being used, in order to avoid associated potential risk to the environment (see SECTION 5: SITE PREPARATION FOR AFFORESTATION, SECTION 7: VEGETATION MANAGEMENT, SECTION 8: FOREST PESTS AND DISEASES and FORESTRY AND WATER QUALITY GUIDELINES).



Young forests are particularly vulnerable to fire, and a detailed fire plan should be in place to facilitate the swift deployment of control measures.



Ensure all fencelines are secure against grazing animals throughout the forest's vulnerable establishment and early development stage.

9.6 MAINTENANCE CONTRACTS AND CERTIFICATION

In the case of maintenance contracts and certification assessments, suitably qualified forestry advisors should be employed. Insurance should also be considered.

9.7 MONITORING FOREST HEALTH

Irish forests enjoy a relatively disease-free status, primarily due to the degree of natural protection afforded by Ireland's island status. Plant health regulations are strictly enforced by the Forest Service to protect against imported pests. However, forest owners and managers should be vigilant for signs of health deterioration throughout the rotation. Persistent and/or extensive discoloration of the foliage should be noted. Any unusual pests or diseases should be reported to the Forest Service. While periodic fluctuations in canopy health occur through aphid attack, unusually extended defoliation should be noted.

As part of the European Union Scheme on the Protection of Forests against Atmospheric Pollution, sample forest plots located throughout the country are closely monitored for crown condition and for soil and needle nutrient levels. Trends are monitored and reported on annually by the EU, with exceptional deterioration in forest condition brought to public attention. Pest and disease surveys are carried out by the Forest Service, and forest owners are requested to co-operate fully with their implementation.

9.8 MANAGEMENT PLANS

While management plans are mandatory for grant-aided plantations 10 ha or greater in area, the development of a forest plan on establishment is strongly recommended for all plantations (see SECTION 17: FOREST PLANNING). Along with appropriate maps and statements on objectives and constraints, such plans should incorporate site and management information, including:

- *pre-planting details*, e.g. site features, rights-of-way, aquatic zones, archaeological sites, important habitats and other sensitive areas, under- and overground utility lines;
- *development details*, e.g. stands and compartments, species, ground preparation and drainage patterns, roads, reservoirs and other open spaces;
- *other information*, e.g. forest yield estimate, provenance details, annual operations and costs, cost and income records per management unit, contracts, mandates and certification, fire plan.

Forest management companies are now designing computer-based plans and planning tools to suit forests of all sizes. Good records are essential.

9.9 RESTOCKING

If failure occurs, restocking is vital to ensure the development of a viable crop. Restocking is mandatory for the purpose of grant aid, as understocked areas will produce low quality timber of little or no value. Restocked areas require stronger plants than those used during the initial planting. Manual or chemical vegetation control may also be required, with strict adherence to all safety and environmental precautions if herbicides are used.

Restocking may be impossible in some areas due to some intractable problem which is either new or overlooked during planting, e.g. the localised presence of undetected marl. In such cases, the area may serve as an open space within the plantation.

9.10 ADVERSE IMPACTS

- **Crop failure due to nutritional deficiencies**
- **Inadequate or wrongly prescribed fertiliser application**
- **Incorrectly timed fertilising, fertilising during unsuitable weather, or excessive fertiliser application, with subsequent run-off into aquatic zones**
- **Careless storage or improperly sited storage areas for fertilisers, leading to contamination of aquatic zones**

- **Crop failure due to weeds, pests or diseases**
- **Frost damage due to poor species selection**
- **Inadequate fire precautions**
- **Inadequate control using herbicides and pesticides**
- **Failure to adhere to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of herbicides and pesticides and the maintenance of application equipment, resulting in operator exposure and contamination of aquatic zones and other environmental damage**
- **Poorly maintained sediment traps and damaged or poorly maintained drains, leading to sediment entering aquatic zone**
- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones**
- **Fences and gates damaged and unsafe, leading to grazing and accidents**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Poor, incomplete records of operations and associated expenditure**

9.11 BEST PRACTICE

- **Regular inspection**
- **Assess for fertiliser requirements**
- **Identify the correct fertiliser and application rate**
- **Apply fertilisers at the correct time and during suitable weather conditions**
- **Store fertilisers at least 50 m from the nearest aquatic zone**
- **Assess for weeds, pests and diseases**
- **Strict adherence to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of herbicides and pesticides and the maintenance of application equipment**
- **Maintain sediment traps and drains**
- **Notify relevant authorities immediately of accidental damage to aquatic zones**
- **Develop a fire plan**
- **Maintain gates, stiles and fences**
- **Assess stocking levels and undertake restocking, if necessary**
- **Implement management plan and keep records**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**
- **Keep a complete record of operations and associated expenditure**

9.12 REFERENCE MATERIAL

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10. TENDING

Tending encompasses a number of forest operations which take place between establishment and first thinning with the aim of improving final crop quality in terms of tree form and wood quality. Brashing, intended to render the crop accessible, is also included.

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10.1 KEY FACTORS

- **Suitability of crop for improvement**
- **Correct time for treatment**
- **Benefits of pruning conifers**
- **Benefits of shaping broadleaves**
- **Other interventions**
- **Tools and machinery**
- **Safety aspects**
- **Crop health**
- **Records**

10.2 OBJECTIVES

- **To improve crop quality.**
- **To achieve maximum potential value.**

10.3 CROP SUITABILITY

Intervention after the crop has become satisfactorily established can be costly. It is therefore important that such decisions are made with a view to maximising benefit to the crop, and that the cost of intervention will be justified later by the associated increase in timber quality and revenue. Tending ensures that crops are capable of being brought on to a significantly higher quality by thinning.

10.4 PRUNING CONIFERS

The objective of pruning is to confine the knotty core so as to allow the maximum increment of knot-free and higher value timber on final crop trees. Pruning involves the removal of persistent dead and lower live branches which would otherwise weaken and degrade subsequent timber increment. During pruning, it is vital to leave the branch collar intact. This will enable the rapid closure of the wound by the expanding stem, reducing the risk of infection and eliminating degrade in timber subsequently laid down at that point.

10.4.1 Conditions necessary for pruning

- There should be enough trees of good stem quality to produce a final crop.
- Crop growth should be vigorous. Pruning should not be undertaken on low yield sites where slow growth will limit the production of knot-free timber.
- Trees with a very high degree of branching or large branch size should be avoided.
- Pruning should be confined to stands not susceptible to windthrow or disease.
- Trees should have the capacity to increase diameter to approximately 2.5 times their pruned core. The timing, type of thinning and rotation must therefore be considered.
- Pruning of spruce should in general be confined to higher yield classes to achieve a quality impact.

10.4.2 Operational details

Pruning normally takes place at or after first thinning (see SECTION 11: SILVICULTURE AND THINNING), when access is considerably easier. Between 200-400 stems/ha are normally selected as final crop trees, and these individuals receive treatment. While pruning height can vary, a height of 3-6 m achieved in two lifts is normal. Green branches accounting for up to 45% of the live crown (between the lowest live branch/whorl and the tip) can be removed without risk to growth potential. Preferred species for pruning are high yield class Douglas fir, spruce and pine.

10.4.3 Pruning equipment

- *Manual pruning saw:* Available in a variety of makes. They have precision ground teeth which are either non-hard pointed (to enable future sharpening) or hard-pointed (for longer life). Knives can also be attached to cut smaller branches, and extension poles fitted for longer reach.
- *By-pass lopper:* Designed for cutting live wood. It has thick, short and deep counter blades to deal with strong branches.

- *By-pass top pruner*: Can be fitted to extensions for higher reach into the crown, and is operated by rope or handle.
- *Powered pruner*: Operate using a two-stroke engine connected to the cutting head through a drive shaft, and is shoulder-harnessed.
- *Light weight chainsaw*: Used for heavy branches and brashing.
- *Hydraulic secateurs*: Capable of cutting branches up to 40 cm in diameter.
- *Tree monkey*: Automatic ground controlled pruning machine which ascends and prunes the stem. Impractical for small-scale operations or species with ascending or wiry branches.

10.4.4 Safety in pruning

Manual pruning is not considered to be a particularly dangerous operation. As such, special ancillary clothes or equipment are generally not required. However, hard hats are advisable for high pruning operations.

The use of power cutting tools and saws for pruning (particularly chainsaws used for the removal of large branches) requires strict adherence to safety procedures. Manufacturer safety instructions should be observed and guidelines on start-up, use and maintenance adhered to. Other considerations are as follows:

- operators should be fully trained and experienced;
- operators should be protected against noise and vibration;
- purpose-designed protective wear should be used, including safety helmets, visors and ear muffs, protective jackets, trousers and gloves, and steel toe-capped boots;
- the operation should be managed professionally.

10.4.5 Environmental aspects

Environmental implications are somewhat limited. Store fuel under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. Prevent brush and debris generated by the operation from entering aquatic zones. See FORESTRY AND WATER QUALITY GUIDELINES.

10.5 FORMATIVE SHAPING OF BROADLEAVES

Formative shaping is carried out early in the rotation to counteract heavy branching, forking and apical damage in broadleaf species. Its aim is to ensure an adequate number of straight, good quality and apically-dominant stems for eventual final crop selection. The operation is normally carried out using secateurs or loppers, concentrating on apical training and the removal of disproportionately large side branches.



Inspect broadleaf crops early in the rotation to assess the need for formative shaping. Shaping is often required to eliminate heavy branches and forking and to secure a single quality stem.

10.5.1 Crop condition

- There should be enough individual trees of potentially good quality to benefit from the treatment.
- Large branches over 3 cm in diameter should not have already developed.

10.5.2 Timing

Shaping is species-related, but generally commences when the trees are between 1.0-1.6 m in height and is applied each year, as required, until the crop reaches 3.0 m or more. Particular attention is needed during the first few years, especially on fertile sites where vigorous growth takes place. Commence shaping as soon as possible, as it becomes harder to induce quality stems as the trees become older.

Shaping is best carried out in June. By this time, any frost-induced bud damage or forking will have become apparent and the lignification of new growth will not yet have taken place. Shaping at this time also focuses the season's growth on selected quality shoots, as opposed to spreading it over shoots which may end up being removed later in the year. Shaping in autumn can also expose the fresh wounds to a greater risk of infection.

10.5.3 Other operational aspects

Emphasis should be given to achieving a dominant leading shoot. The majority of competing shoots are removed to eliminate forking. In removing branches, the branch collar should remain intact in order to facilitate wound closure. Disproportionately large branches lower down the stem should also be removed at the same time. Not more than 60% of the foliage should be removed in any single year.

10.6 PRUNING BROADLEAVES

Pruning in broadleaves is aimed at reducing branching in order to produce knot-free timber. This operation should not be necessary in crops which received effective formative shaping and which are subject to a carefully controlled thinning regime which discourages branch formation.

Pruning should be confined to crops where straight stems have been achieved but are threatened by large quality-degrading branch formation. The operation should be done before branch size exceeds 5 cm in diameter. As with formative shaping, autumn pruning should be avoided due to the risk of infection. Large branches may occasionally be removed from mature trees for safety reasons. Pruning in most cases will require the use of a long handled saw.

10.7 RESPACING

Respacing or non-commercial thinning may be carried out in densely stocked areas of natural regeneration, to remove badly formed trees at an early stage, or to capitalise on growth where there is a risk to crop stability from future thinning.

10.7.1 Natural regeneration

Under certain conditions, natural regeneration can give rise to a great number of young seedlings on a site. For example, up to 50,000 trees/ha can result following the clearfell of Sitka spruce on mineral sites. This growth may be suitable for adoption as a subsequent crop. If so, the first step is usually to reduce stems to a manageable number, using a brush cutter.

10.7.2 Later respacing

Later respacing can take place in high density stands of both conifer and broadleaf crops, and can be seen as a non-commercial pre-thinning. Any decision to respace should be based on a careful cost/benefit analysis. The operation is normally carried out at late thicket stage, usually using a light chainsaw. It may also be accompanied by a single lift of green pruning.

10.7.3 Safety and environmental aspects

The use of power cutting tools and chainsaws for respacing requires strict adherence to safety procedures, and all operators must be fully trained and experienced. Safety and environmental aspects are as for pruning (see SECTION 10.4.4).

10.8 BRASHING

Brashing in itself is not an ameliorative operation. Its main function is to render thicket stage crops accessible for measurement or inspection purposes. The need for brashing has declined somewhat in recent times, primarily due to the mechanisation of thinning operations, the incorporation of measuring systems on harvest heads, and the questionable cost efficiency of intensive measuring in low value crops. However, it is still important for forest owners to have access to their plantations, e.g. to inspect growth, to check drains. Brashing is usually carried out with a light chainsaw.

The use of chainsaws for brashing requires strict adherence to safety procedures, and all operators must be fully trained and experienced. Safety and environmental aspects are as for pruning (see SECTION 10.4.4).

10.9 RECORDS

Records should be kept of all ameliorative treatments, timing and intensity of operations, and associated costs, in order to enable crops to be certified as being of high quality. This is particularly important in pruned conifers, where mature standing trees may not otherwise be certifiable as having received the treatment.

10.10 ADVERSE IMPACTS

- **Stocking problems ignored**
- **Extensive knotty core in conifers due to failure to prune or delayed pruning**
- **Commercial viability threatened due to improper pruning decisions**
- **Loss of growth due to excessive pruning**
- **Quality improvement of broadleaves not achieved through failure to shape or incorrect shaping**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Improperly sited storage areas for fuel, leading to contamination of aquatic zones**
- **Brash and debris entering aquatic zones**
- **Poor, incomplete records of operations and associated expenditure**

10.11 BEST PRACTICE

- **Ensure crop is in a condition to benefit from pruning**
- **Evaluate economics of pruning operation to confirm net benefit to final crop value**
- **Prune on time**
- **Shape broadleaves on time, repeating as necessary**
- **Employ suitably trained, qualified and experienced operators, particularly in relation to chainsaw operations**
- **Adhere to workplace safety requirements**
- **Locate fuel storage areas at least 50 m from the nearest aquatic zone**
- **Keep brash and debris out of aquatic zones**
- **Keep a complete record of operations and associated expenditure**

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11. SILVICULTURE AND THINNING

Thinnings are undertaken to concentrate growth onto the best quality and most vigorous trees as the crop matures. Thinnings also provide a source of intermediate production and income from the forest. As the operation is now largely mechanised, a high level of control is needed to ensure benefits to the forest and to avoid site damage.

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11.1 KEY FACTORS

- Suitability of crop
- Time of thinning
- Type of thinning
- Intensity
- Risks
- Felling methods
- Extraction methods
- Machine suitability to site
- Safety
- Crop hygiene
- Thinning operations and the environment
- Impact of extraction tracks and roads

11.2 CROP MANAGEMENT AND SILVICULTURE

11.2.1 Objectives

At establishment, forest crops are more densely stocked than available growing space would allow. In naturally regenerated crops, large numbers of seedlings and young trees die out, with only the strongest surviving. In managed crops, thinning removes suppressed, diseased and damaged trees and trees of poorer quality, thereby 'releasing' selected trees for further growth in timber volume.

In even aged and pure crops, the objective is to achieve an even stand of good quality vigorous stems without losing out on total potential timber yield. Due to the greater variety in mixed stands and broadleaf crops, the focus here is on retaining straight stems and avoiding forking, epicormic branching, fluting, buttressing or other quality defects.

11.2.2 Light

Different species have different light requirements. As crop vigour is a function of crown health, final crop trees can be kept vigorous by gearing thinning to these requirements. Table 11.1 outlines the light requirements of the main forest species in Ireland.

Species	Light requirement
Beech, <i>Abies</i> spp., western hemlock, western red cedar	Low
<i>Picea</i> spp., Douglas fir	Relatively low
<i>Pinus</i> spp., sycamore, <i>Quercus</i> spp.	High
Ash, <i>Larix</i> spp., cherry, poplar	Very high

Table 11.1 Light requirements of the main forest species in Ireland.

11.2.3 Suitable crops

Most crops benefit from thinning. However, particular site conditions or the current state of the crop may present risks which outweigh advantages. These factors include:

- site (soil, location) inherently unstable;
- poor drainage/persistent waterlogging;
- unsuitable cultivation used at establishment (usually mould board ploughing);
- stands 'drawn up' or etiolated due to delayed first thinning;
- stands damaged or diseased;
- inaccessibility, e.g. severe slopes.

In some cases, the operation may be financially prohibitive without the possibility of recovering expenditure over the rotation. Thinning very small woodlands may be of marginal value. A by-product of thinning is the development of a more open stand capable of supporting a wider diversity of ground vegetation and enhanced biodiversity.

11.2.4 Thinning control

Thinning control is exercised through the manipulation of the time of first thinning, thinning interval and thinning weight. Decisions regarding thinning control, weight, interval and type are aided by book- and computer-based tabular guides and models which assume different initial stocking levels and productivity.

11.2.4.1 Time of first thinning

The point at which a forest crop reaches maturity will depend on site and species. The indicators for any intervention are usually the crop's top height (height of the dominant trees is usually not affected by treatment) and its development stage in terms of inter-tree competition.

First thinning in conifers takes place a few years after canopy closure, usually when a top height of approximately 10 m is reached. At this stage, thinnings are usually saleable as pulp or pallet material. Earlier intervention may mean that first thinnings may not be developed enough to be saleable.

Time of first thinnings is of crucial importance as it largely determines the ultimate quality of the crop. It is carried out at a stage when canopy openings do not incur serious risks of windthrow. However, maximum site damage can occur at this time, if the operation is not carried out carefully.

11.2.4.2 Thinning intensity

In even aged crops, thinning intensity is regarded as the proportion of the crop volume removed over the rotation. It can be represented as a percentage of the maximum mean annual increment (yield class) removed. The thinning intensity can be calculated for any species if the yield class is known. Yield class in turn can be calculated from the height of dominant trees at a given age.

The removal of 70% of the yield class each year from first thinning on is known as the marginal thinning intensity. This is estimated to be the maximum annual amount which can be removed without reducing the crop's cumulative volume production.

11.2.4.3 Type of thinning

The type of thinning generally refers to the way in which trees to be thinned are selected. A number of types are described:

- *Low thinning*: A form of selective thinning involving the removal of dead, suppressed and poorly formed trees in the lower canopy.
- *Intermediate thinning*: A form of selective thinning involving the removal of suppressed and sub-dominant trees and the breaking-up of groups of dominants and co-dominants to create an even distribution of final crop trees.
- *Line thinning*: Systematic removal of trees along designated lines, normally following original planting rows. Closely related are: row and selective thinning (usually refers to first thinning where rows are removed to enable machine extraction, followed by a selective thinning of the remaining crop); and chevron thinning (similar to row and selective, with lines directed at an acute angle from the main rack to suit skyline extraction).
- *Crown thinning*: The removal of trees competing with selected dominants, including other dominants of poor form.

In the past, the choice of thinning and extraction methods often depended on how difficult the operation was in relation to the value of the crop. For example, a high value broadleaf crop could justify high manual input in selecting, marking, felling and extraction. Conversely, cost saving is an important factor in low value crops. Modern felling and extraction equipment allows a combination of systematic (to open up racks) and selective thinning (to improve the crop at safe intensities) at the first thinning stage. The more uniform the crop, the more flexibility there is in locating racks.

Thinning and extraction both become easier later on as the crop is opened up, with trees becoming bigger and crowns lengthening.

11.2.4.4 *Weight and interval of thinnings*

Weight describes the amount of timber thinned at one time related to yield class. Removals tend to be about 25% of the standing volume per unit area, representing a rather higher proportion of trees. Interval is the time between individual thinning operations.

11.2.4.5 *Uneven aged, mixed and broadleaf crops*

Thinning prescriptions are less easily quantified in uneven aged, mixed and broadleaf crops, due to the variation in age and species. However, each component can be calculated if the yield class is known. The approach becomes more subjective as complexity increases, and conditions relating to individual trees must be taken into account.

11.3 PLANNING THE THINNING OPERATION

Although thinning is a silvicultural operation, it involves the felling and extraction of timber over rough terrain and along forest roads. It should be undertaken within the context of a forest plan.

11.3.1 Strategic planning

Strategic planning involves decisions at forest and estate level and is necessary to avoid piecemeal development. Strategic planning is initiated at the time of afforestation and reforestation and will encompass the following factors:

- terrain classification to indicate sensitive areas;
- the identification of geographic features and management boundaries;
- road networks;
- the selection of management regimes, allocating thinning and final felling systems to different sites;
- schedules of harvesting operations, with consideration given to potential site impacts;
- broad decisions on harvesting methods and equipment.

11.3.2 Tactical planning

Tactical planning is intended to support operations in each harvest area. Stands are normally identified by species and yield class, so each stage of forest development is known. Allocation for thinning is made prior to the operation and should be detailed in a harvest plan. This plan includes a description of the operation and measures to minimise environmental disturbance (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES). The plan is best represented and recorded on a map accompanied by a short written description.

Identify all relevant environmental issues. Identify if the area to be harvested lies within or contains:

- an area identified as being environmentally sensitive in a County Development Plan;
- a part or whole of a Special Area of Conservation (SAC), Special Protection Area (SPA) or proposed Natural Heritage Area (pNHA);
- aquatic zones (see FORESTRY AND WATER QUALITY GUIDELINES);
- archaeological sites and monuments (see FORESTRY AND ARCHAEOLOGY GUIDELINES);
- important habitats retained for biodiversity purposes (see FOREST BIODIVERSITY GUIDELINES).

Liaise with the following for practical advice where important environmental issues are anticipated:

- the relevant Regional Fisheries Board;
- the relevant Local Authority;
- National Parks and Wildlife of Dúchas The Heritage Service;
- the National Monuments and Historic Properties Service of Dúchas The Heritage Service;
- other relevant bodies, non-government organisations and the local community.

Inspect the area and prepare a map (Ordnance Survey 6 inch scale is usually appropriate) which includes the following:

- The boundaries of the harvest area.

- The environmental features of the area, including all aquatic zones, archaeological sites and monuments, and important habitats.
- Additional features which may present difficulties or require particular attention when harvesting, e.g. landscape considerations (see FORESTRY AND THE LANDSCAPE GUIDELINES), dwellings and associated buildings, overhead and underground utility lines (electricity, gas, telephone and water), public and private water supplies, rights-of-way.
- The location of buffer and exclusion zones within the thinning area (as stipulated by FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES), within which operations will be prohibited or restricted.
- The existing and planned road network and associated structures such as landings, turntables and bridges.
- The location of areas of potentially high erosion risk.
- The location of machine maintenance, refuelling and repair areas and storage areas for fuel, motor oil, lubricants and chemicals. These must be on dry, elevated sites at least 50 m from the nearest aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.
- Felling and extraction machine routes. Plan these so that they avoid all buffer and exclusion zones and, where possible, difficult terrain conditions. The length of extraction routes should be minimised, particularly on steep slopes.

The plan should also address the following:

- legal requirements, e.g. felling licence;
- intended weight of thinning and cycle;
- felling system and felling machine type to be used, related to site and terrain class;
- extraction system and extraction machine type to be used, related to site and terrain class;
- rack layout to meet machine route requirements;
- likely risks, e.g. windthrow;
- timing/weather constraints on operational schedule;
- the need for ancillary structures, e.g. temporary bridges, sediment traps, rafts for boggy ground;
- a contingency plan for emergencies.

While there can be some degree of flexibility in the choice of options, the aim must be to combine systems and machine types to achieve the most effective and site-friendly operation.

11.3.2.1 Terrain classification

Terrain can be classified on the basis of three factors: ground conditions (soil bearing capacity); ground roughness (the presence of obstacles which impede machine operation, e.g. boulders); and slope. The terrain class is depicted as the scoring of these factors in the above sequence. Table 11.2 outlines the scoring of each factor, and Table 11.3 (overleaf) lists the machine operations most suited to each terrain class.

Table 11.2 Terrain classification scoring.

Ground condition	Ground roughness	Slope
Good (1)	Even (1)	Gentle (<8°) (1)
Average (2)	Uneven (2)	Intermediate (8°-14°)(2)
Poor (3)	Rough (3)	Steep (>14°) (3)Very
poor (4)		

11.4 FELLING

Thinning involves the felling and removal of trees from existing immature or semi-mature stands. The operation is complex and involves important considerations relating to crop health, site/environmental protection and operator safety.

11.4.1 Objectives

- Ensuring the safety of operators and other personnel.
- Minimising damage to the retained crop.
- Avoiding damage to the soil and to aquatic zones and other sensitive areas.
- Maximising conversion value.
- Facilitating extraction.

Table 11.3 Machine operations most suited to each terrain class.

1.1.1	2.1.1 Forwarder, Skidder, Horse	3.1.1	4.1.1 Tracked Forwarder
1.1.2	2.1.2 Forwarder, Skidder, Horse	3.1.2	4.1.2 Forwarder, Tracked Forwarder, Cable
1.1.3	2.1.3 Forwarder, Skidder, Horse	3.1.3	4.1.3 Cable
1.2.1	2.2.1 Forwarder, Skidder, Horse	3.2.1	4.2.1 Tracked Forwarder
1.2.2 Forwarder, Horse	2.2.2 Forwarder, Tracked Forwarder	3.2.2	4.2.2 Tracked Forwarder, Cable
1.2.3	2.2.3 Chained Forwarder, Cable	3.2.3	4.2.3 Cable
1.3.1	2.3.1 Forwarder, Cable	3.3.1	4.3.1 Tracked Forwarder, Cable
1.3.2 Forwarder, Cable	2.3.2 Forwarder, Tracked Forwarder, Cable	3.3.2	4.3.2 Cable
1.3.3	2.3.3 Cable	3.3.3	4.3.3

11.4.2 Legal issues

Thinning is subject to the Forestry Act 1946. As such, general and limited felling licences must be sought. A general felling licence is normally issued where an actual harvest plan has been submitted. A limited licence is issued where special considerations or constraints arise.

11.4.3 Safety procedures

- Operator safety must be a priority at all times. Guidelines, rules and safety instructions must be strictly observed.
- A written risk assessment should be carried out by the forest owner, manager or contractor.
- Employ suitably trained, qualified and experienced operators.
- Equipment should be properly used and maintained.
- There should be a clear understanding among all operators of the thinning system to be imposed and tree categories to be removed.
- Directional felling should be understood and used in relation to terrain.
- All operators involved in felling and extraction must carry adequate insurance.
- Contractors should have an up-to-date safety statement.

11.4.4 Methods

The following methods of felling are currently employed:

- full motor manual (chainsaw operator);
- motor manual and machine processing;
- harvesting head mounted on wheeled machine;
- harvesting head mounted on tracked machine.

11.4.4.1 Motor manual

This method has been used for over half a century and is still the norm in many countries. It has been replaced to a large extent in Ireland by machine operation, although it is still practised by some operators in conjunction with cable, horse, forwarder and skidder extraction. Chainsaws are also used in 'tidying up' operations, for small woodlots and for large, difficult-to-handle trees.

Motor manual felling is a very dangerous operation and strict rules must be observed. Trees are large objects and can fall with alarming unpredictability. Operators must be well-trained and equipped with a clear understanding of how trees are felled, trimmed and jointed.

Safety requirements particularly relevant to motor manual felling are as follows:

- operators must have completed a recognised course (e.g. Coillte Training Centre, Mountrath) covering the use and maintenance of the chainsaw, and first aid;
- purpose-designed protective wear must be used, including safety helmets, visors and ear muffs, protective jackets, trousers and gloves, and steel toe-capped boots;
- operators must be issued with ancillary equipment (jacks, levers, air cushions, grapples, etc.) to improve efficiency and to avoid risk of injury;
- chainsaw operators must never work alone;
- the operation must be managed professionally.

11.4.4.2 Machine felling

Processors: These machines delimb and joint logs only, with felling carried out motor manually. Processors are not usually used in thinning, as the operation is labour intensive and cumbersome. However, they do have some application in cable extraction operations.

Thinning machines: Several types are currently in use:

- System-built machines (four- to eight-wheeled) with high ground clearance, narrow profiles and low ground pressure, are suited to working within stands. However, they are expensive.
- Harvesting heads mounted on the chassis of lighter forwarders are also used. They have the advantage of high ground clearance. The harvesting head comprises saws, grapples and delimiters.
- Harvesting heads on excavator bases are another type of thinning machine. However, very few are actually suited to the task, due to their low ground clearance, weight and aggressive tracking which causes site damage. Their width can also damage trees, necessitating wider forest tracks. Due to these factors, the use of such machines for thinning purposes is usually discouraged.

It is important that the weight and size of the harvesting machine are considered in deciding its suitability for early thinnings, as crop damage can be caused by larger machines. The suitability of machines weighing 14-16,000 kg or more for first thinnings is questionable.

If used, harvesting heads should have a built-in urea applicator.

Mechanised thinning is safer and ergonomically more attractive than motor manual thinning. The main safety advantages are that the operator works in a protected area and is comfortable. Log handling is also more controlled. The main safety considerations relate to: keeping the defined risk zone of the machine free of onlookers; the slope at which the machine is operating; and procedures regarding damaged cutters, jammed logs and repairs. Machine operators should also be equipped with helmets and steel toe-capped boots, together with a climbing harness where boom repairs are to be carried out onsite.

Motor manual operators employed to 'tidy up' following a machine thinning operation must be trained and competent, and must observe all safety rules.

11.4.4.3 Site factors and thinning machines

Carefully handled machine thinning and extraction may cause less site disturbance than motor manual and machine extraction. The thinning machine operator should lay down a thick brush mat as the operation progresses through the forest. This provides a protective surface for forwarders to travel over, thereby avoiding soil damage and sedimentation, and damage to the roots of retained stems. See FORESTRY AND WATER QUALITY GUIDELINES and FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES.

Operators must ensure that aquatic buffer zones and associated watercourses are kept free of felled material.

Care must be taken where fuel is stored and machines are serviced. Securely store all fuel and machine oils under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. All maintenance and refuelling operations and machine repairs (if required and practical) should be carried out at least 50 m from the nearest aquatic zone on a dry, elevated site. Spent oil must be collected and retained for correct off-site disposal. Remove all containers from the site and dispose of carefully. Do not, under any circumstances, discharge fuel or machine oil into an aquatic zone. The relevant Local Authority must be informed promptly of any accidental fuel or machine oil spillage which threatens an aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.

11.5 PROCESSING

Trees are debranched and jointed (cut into smaller lengths) after they are felled. Motor manual debranching requires considerable experience and skill, and experienced and trained operators should be employed. Bunching - the piling of logs for extraction - requires skill and the application of ergonomic methods. Strain on operators should be minimised. Processing is most commonly carried out using a customised thinning machine or a standard machine fitted with a suitable head. Bunched material should be presented and located in a way which facilitates subsequent extraction.

11.6 EXTRACTION OF THINNINGS

Economic and site-friendly extraction is a crucial component of the thinning operation.

11.6.1 Extraction methods

There are a variety of extraction methods available to suit site conditions and the scale and economics of the operation. As with felling, operators must be trained and skilled in the particular method and associated techniques to overcome difficult situations, e.g. the recovery of material jammed or fallen into drains or hollows. Safety features relating to each method must be observed. Maintenance and debugging equipment, fuel and some spare parts should be carried on site.

Operators should be made aware of the degree of off-road haulage, loading and unloading conditions.

During the planning of extraction, ensure that sensitive areas (e.g. aquatic buffer zones, archaeology exclusion zones, retained habitats, young crops) are avoided. See FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES, FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES and FOREST BIODIVERSITY GUIDELINES.

11.6.1.1 Horse extraction

Historically, virtually all thinnings from Irish forests were extracted by horse. This method is still used occasionally for difficult sites and small woodlots, and for removing individual trees. If properly carried out, it is suitable for environmentally sensitive sites over which horses can travel.

Advantages: Horse extraction is regarded as being site friendly, with minimal soil compaction and damage to retained trees. Difficult locations and tree manipulation can be handled relatively easily. The operation is also popular with the public.

Disadvantages: Skill in handling and managing the animals is essential. Certain insects frighten horses, causing them to behave unpredictably, and handlers must be able to understand this behaviour and be prepared for it. Horse extraction can occasionally result in debarking and site damage if the same route is used continually. The operation is expensive, but costs may be offset against reduced environmental damage.

Operational guidelines: Use trained animals only. Understanding the animal, the use of properly designed harnesses, and good maintenance and care during the operation are all needed for effective extraction.

11.6.1.2 Skidding

Skidding by tractor was the standard operation for many years. This method is still widely used in Europe and is used here for full pole extraction, e.g. transmission poles. While a variety of tractors can be used, large, modified, four-wheel drive machines are most common. These are fitted with a logging plate, double drum winch and choking equipment to haul in logs.

Advantages: Small scale operations affordable to small woodland owners are possible. Machines are light weight and cause little damage on good sites. Awkward, large or badly shaped trees can be easily handled. Machines tend to be more efficient in later thinnings when the crop has been opened up.

Disadvantages: Rutting and 'bog down' can occur on soft ground, due to the small number of wheels and higher ground pressure. This can cause soil damage and sedimentation. Ground clearance is low. The operation is also very weather dependent. Tractors can be dangerous to use on steep slopes. Potentially hazardous manual handling is involved in the winch/chain/choking system for drawing the logs to the vehicle. Productivity is also limited with this method. Skidding is not ergonomically efficient.

Operational guidelines: Operators should be familiar with the ground conditions and avoid soft sites. Machines should be kept in good condition. Cabs should be strengthened to afford driver protection.

11.6.1.3 Forwarding

Forwarding is the most common form of extraction used in Western Europe, and is the most frequently used in Ireland. The forwarder evolved from Scandinavian forest operations as a custom-built forest extraction machine. Forwarders come in a variety of makes and sizes. Six- to eight-wheeled machines (usually the latter) weighing approximately 10 tonnes (6-7 tonne load) are most suitable for thinning operations. If properly maintained, forwarders can last well after their depreciation life. Therefore, a wide range of machines and designs are in use, from agricultural tractors and older reconditioned models to sophisticated state-of-the-art machines.

Advantages: The forwarder is specifically designed for timber extraction, and purpose-built thinning models are available. The machine can operate in poor visibility as it is well-equipped with lights. A range of equipment to deal with soft ground can be acquired with the basic machine e.g. balloon tyres, chains and tracks. The machine is ergonomically designed, providing a safe, comfortable environment for the operator. It can travel on fairly steep slopes and over rough ground. It can remove substantial loads and provide clean logs. A good operation combining forwarding with machine felling can minimise the potential for site damage.

Disadvantages: Light weight tracked forwarders suitable for very soft ground have not kept pace with the development of standard machines, as they are deemed to be uneconomical. The selection of an unsuitable machine (too heavy or too wide) will result in soil damage and upper tree debarking, the latter caused as the load sways. Soil damage can also be caused by heavy tracks and chains or by continuous passage over one route or at exit points from the forest. Debagging can cause site and drain damage.

Operational guidelines: A good extraction plan which reduces travel over the same route is necessary for efficiency and site protection. Extraction racks should be well-furnished with brash mats. Sensitive sites should be avoided. If required, equipment necessary for soft ground conditions should be fitted. Debagging equipment should be carried, as well as a minimum number of spare parts. Operators must be fully trained and experienced. Machines must not be used incorrectly, e.g. use of the crane to debag. Extended off-road haulage distances should be avoided.



Used in conjunction with adequate brash mats, custom-built forwarders offer a site-friendly method of extracting thinnings from the forest.

11.6.1.4 Clambunk extraction

Clambunks are a variation on the forwarder theme, except that the bogey used to carry the jointed logs is replaced by a large grapple which can bunch together a number of full length poles. In general, the same conditions as those for forwarder extraction apply. This system is not frequently used in Ireland.

11.6.1.5 Cable extraction

Cable extraction is a tried-and-tested method commonly used in hilly and mountainous areas. Japan, USA, Austria and Norway have all developed cable extraction to a high level. In Ireland, cable extraction is used in Co. Wicklow and on steep slopes in the south and west of the country. There are two types of cable extraction: the high lead (where lift is achieved by the resistance of a brake and clutch); and the skyline (where lift is achieved by a static taut wire, with a carriage riding along the cable). A tower and winch are employed to haul the material to a landing bay. Managing cables can be very dangerous and operators must be experienced and trained in the system. As cables can be hidden by debris, good team work and great care must be observed by all personnel on the site, especially those felling and choking the material. Operators must be fully equipped with safety clothing. Effective radio communication between personnel is also essential.

Advantages: The method is flexible, capable of handling all types of material, is ideal for steep slopes and causes no or minimal ground damage. Capital investment is also relatively low. The system is less likely to impact on sensitive sites.

Disadvantages: Cable extraction often requires a yarding area to accumulate logs, usually situated at a roadside. It is a two-person operation and is generally dependent on the weather. It requires a considerable amount of ancillary equipment and can be dangerous. Set-up time is high and output generally low.

Operational guidelines: The operation must be carefully planned, with suitably spaced racks and suitable spar and support trees clearly identified. Operators must be trained and experienced in the system. There should be adequate room at the yarding site for stacking. If whole trees (i.e. stems including tops and branches) are extracted, possible impact on the site nutrient status should be evaluated.

11.7 SUMMARY OF FOREST/SITE THINNING IMPACTS

While thinning usually benefits stand value, the operation can expose the forest to a number of risks.

11.7.1 Wind risk

A number of factors will predispose forest stands to wind damage. Many of these are associated with thinning:

- Delayed thinning puts the crop at serious risk. It results in the movement of the trees' centres of gravity upwards, as the severe competition between individual trees reduces crown size in relation to stem length. Whenever thinning is eventually carried out, the sudden exposure to the wind can cause breakage and uprooting within the stand. Windthrow can 'creep' throughout the stand until it meets a windfirm edge.
- Thinning inherently unstable sites with high watertables, impeded drainage and restricted rooting depth can result in uprooting and windthrow when crowns are disturbed. Reduced or restricted thinning may be possible, but risk increases with height.
- Cultivation at establishment may be a contributing factor when stands are opened up. Mould board ploughing combined with row thinning can result in extensive windthrow. Although the risk is less on a dry site, experience has prompted the virtual cessation of mould board ploughing as a cultivation method.
- Excessive openings for roads, entrances and turning points for machines increase wind risk in areas prone to windthrow, and also reduce production.

11.7.2 Damage to trees

Careless machine use will cause additional damage to retained trees. Heavy forwarder types and wide machines cause butt and root damage. Stem debarking will occur if racks are too narrow or if the load sways due to uneven ground conditions.



Immediate urea application to the cut stump is essential to avoid the infection of retained trees with *Heterobasidion annosum*, and subsequent butt rot.

11.7.3 Disease

Manual felling operations should include urea application to stumps immediately after felling. Felling machines should also be fitted with effective applicators. Failure to treat stumps may result in infection by butt rot (*Heterobasidion annosum*), leading to timber loss and instability among retained stems later in the rotation. As a chemical, prepare and securely store urea under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone.

11.7.4 Soil damage

The continuous use of the same track and the deployment of unsuitable machines and ancillary equipment (e.g. chains, tracks) will cause soil rutting and compaction, as will a poorly designed operation which fails to leave enough brash to cover extraction racks. Extraction racks should always avoid boggy areas and adequate brash cover should be readily available.

It is essential that the site operation is planned and that the crop is suitable for thinning without incurring undue risk to forest health and stability. The thinning method, machine type and equipment should suit the site, crop development stage and species, and all operators and supervisors should be trained and experienced.

11.7.5 Aquatic zones and other sensitive areas

Thinning and extraction operations near aquatic zones may cause sediment, branches and other material to fall or to be washed into the water. These operations can also damage archaeological sites, disturb wildlife and disrupt the landscape. In order to avoid or minimise such adverse impacts, all thinning and extraction must be carried out in accordance with the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and with relevant measures set out in the FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FOREST BIODIVERSITY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES. Some of the relevant measures are as follows:

- In general, exclude all operations from buffer and exclusion zones stipulated for aquatic zones and archaeological sites. The outer perimeter of these zones should be marked clearly with a perimeter fence, brightly coloured paint marks on trees, or brightly coloured tape. Machines should not enter these zones during felling or extraction. Fell trees away from these zones, and ensure that logs are presented in a way which avoids extraction machines entering these zones. Do not pile logs within these zones. If present (due to the absence of guidelines at the time of planting) and where crop stability allows, trees should be removed from these areas at thinning. This operation must be carried out with extreme care. Other open spaces in relation to public roads, dwellings, habitats, etc. can also be created at this time.
- Create and maintain dense, fresh brash mats on all machine routes, to avoid soil damage, erosion and sedimentation. In all cases, brash mats should be renewed before they become too worn.
- Prevent the accumulation of brash, logs and debris in drains and aquatic zones. Minimise the number of water crossings. The installation of heavy duty plastic culverts with a protective brash cover is preferable to logs for drain crossings. Remove all temporary water crossings as operations progress.
- Ensure that important wildlife habitats retained for biodiversity purposes are protected. Plan operations with due regard to the breeding and nesting seasons of important species, and associated features such as badger setts and heronries. Some deadwood should also be left *in situ* after thinning, in the form of standing dead stems or naturally fallen trunks, or as logs deliberately left behind on the forest floor.
- Any unrecorded archaeological site or artefact discovered during the operation must be left undisturbed and the relevant authorities (the National Monuments and Historic Properties Service, the National Museum of Ireland and the Garda Síochána) notified immediately. A minimum exclusion zone of 20 m must be created until the site of the find has been investigated.
- On sites which have a high risk of soil erosion or with soils of low bearing capacity, consider suspending mechanised operations during and immediately after periods of particularly heavy rainfall.
- Prepare and securely store all fuel, machine oils and urea under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. All maintenance and refuelling operations and machine repairs (if required and practical) should be carried out at least 50 m from the nearest aquatic zone on a dry, elevated site. Ensure that all



Create and maintain dense, fresh brash mats on all machine routes, to protect soil during thinning and extraction operations.



hazardous compounds are removed from the site for correct disposal. All containers, spent oil, machine parts and refuse generated by the operation should also be removed.

- All operators should have contact telephone numbers onsite for all relevant agencies (Local Authorities, Regional Fisheries Boards, Dúchas The Heritage Service, National Museum of Ireland, Garda Síochána, etc.) in case of accidental damage to aquatic zones, archaeological sites, important wildlife habitats and other environmental features.

11.8 EXTRACTION ROADS

11.8.1 Density and construction

General roads issues are dealt with in SECTION 14: FOREST ROADS. Within the overall forest road requirements, harvest roads have an important function in the thinning operation.

While some access roads may already be in place in larger forest blocks, these may not reach all those stands to be thinned. Any new forest roads which are required should be completed, with adequate time to 'settle in', prior to thinning. Road design plans should include loading bays, turntables, culverts, etc. Road density varies from forest to forest, but is usually approximately 20 linear m/ha, with distances apart of about 500 m. Separate parking areas for operators' cars and vans should also be provided.

See SECTION 14: FOREST ROADS for details on environmental impacts associated with forest road construction.

11.9 MEASUREMENT OF THINNINGS

Estimates of volume and tree size distribution are usually made by the owner prior to thinning. This is done by taking sample plots or diagonals and sample trees, using full or partial tariff systems which calculate tree volumes through diameter at breast height and length. While timber measurement is technically not part of the harvesting operation, it may require inspection paths, brashing and the felling of sample trees.

Measurement is normally carried out: pre-harvest, for the purpose of valuation decision making in relation to harvesting; and post-harvest, for the purpose of definitive quantification of material sold. The following measurement methods are associated with thinning (these are usually less intensive than those required for more valuable final crop material):

- volume/weight measurement;
- weight measurement;
- oven dry bark-free tonne measurement;
- volume weight measured with reduced stratification.

Modern harvesting machines incorporate computerised measuring equipment which operate as logs are felled and jointed. Lengths and diameters are measured, compiled and tabulated. The measurement and control system must be regularly maintained and calibrated. These systems enable the cutting of logs to required specifications, and calculate volume per assortment class for payment purposes. Reliability is essential.

The recently published *Timber Measurement Manual* (see reference list) describes sampling procedures, measurement types and equipment in great detail, and should be consulted. In all cases, species composition, sampling levels and procedures adopted should be clearly indicated to avoid dispute over the amount of produce.

11.10 FELLED MATERIAL

The measurement of thinnings for valuation purposes is carried out manually before felling or mechanically during felling, using measurement systems installed in modern harvesting heads.

Certain species, e.g. *Pinus* spp., should be removed quickly from the site in order to avoid the development of blue stain degrade.

11.11 ADVERSE IMPACTS

- Poor planning, leading to badly situated or inadequate roads and tracks
- Lack of consultation with relevant authorities, interest groups and the local community
- Thinning prescribed for unsuitable crops and sites, leading to windthrow
- Delayed thinning, leading to windthrow
- Thinning too heavy, leading to increment loss and windthrow
- Wrong felling system selected
- Felling and extraction machines unsuited to the site, leading to crop, soil and machine damage
- Inadequate brash mats, leading to soil damage and sedimentation
- Excessive haulage distances to roads, leading to inefficiency and site damage
- Pile up of debris at landing sites
- Failure to implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors, with subsequent damage
- Failure to notify relevant authorities immediately of accidental damage to aquatic zones and archaeological sites
- Site and environmental damage due to poor timing and failure to curtail operations in adverse weather conditions
- Sediment entering aquatic zones
- Brash and debris in aquatic zones
- Crop damage due to poor extraction
- Disease due to lack of stump treatment
- Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements
- Members of the public entering the work area, with risk of injury
- Improperly sited maintenance, refuelling and storage areas, leading to contamination of aquatic zones with fuel and machine oils
- Poorly organised timber removals, leading to waste, damage and degrade
- Poor, incomplete records of operations and associated expenditure

11.12 BEST PRACTICE

- Consider thinning operations during early planning stage
- Consult with relevant authorities, interest groups and the local community
- Prepare a thinning, felling and extraction plan, including a written risk assessment
- Prepare a contingency plan for emergencies
- Assess suitability of crop for thinning
- Ensure adequate forest road density to avoid long off-road haulage distances, using an optimal road spacing model
- Ensure adequate tracks, bridges and culverts
- Minimise stream crossings, providing temporary structures if unavoidable
- Thin on time
- Ensure appropriate thinning intensity for species and yield class
- Avoid creating excessive openings in the forest canopy
- Avoid extraction through young forests
- Select the most appropriate felling and extraction machinery
- Ensure a site-friendly operation with adequate brash mats to avoid soil and crop damage
- Schedule operations in sensitive areas to avoid periods of adverse weather
- Implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors
- Maintain the necessary buffer and exclusion zones in relation to aquatic zones and archaeological sites
- Notify relevant authorities immediately of accidental damage to aquatic zones or archaeological sites
- Employ suitably trained, qualified and experienced operators
- Adhere to workplace and machine safety requirements
- Exclude non-involved personnel from the site
- Exclude members of the public from the site, placing warning signs of operation-in-progress

- **Ensure urea is applied to all stumps immediately after cutting**
- **Ensure adequate landing areas for logs, controlling piling at cable yarding areas**
- **Locate refuelling, maintenance and storage areas at least 50 m from the nearest aquatic zone**
- **Select an appropriate measurement system and keep clear records**
- **Ensure good timber removal scheduling, with all timber removed promptly**
- **Remove all rubbish, empty containers, machine parts, etc. during and after the operation for safe off-site disposal**
- **Keep a complete record of operations and associated expenditure**

11.13 REFERENCE MATERIAL

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12. FINAL HARVESTING

Harvesting the mature trees is the final operation of the forest rotation. While many of the operational elements are similar to those for thinning, the environmental impacts are far greater. Due to the large number of even aged stands and Ireland's windy climate which constrains uneven aged management, the usual practice in this country is to clearfell or remove all trees from the site. Sites permitting, 'standards' are occasionally left to bridge the gap between felling and the establishment of the subsequent crop, usually for amenity, regeneration or conservation purposes. As the proportion of broadleaf woodlands and forest diversity increases, a trend towards more continuous cover forestry is likely.

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- 12.14 TIMBER MEASUREMENT
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- 12.16 BEST PRACTICE
- 12.17 REFERENCE MATERIAL

12.1 KEY FACTORS

- Choice of rotation length
- Planning the harvesting operation
- Contingency planning for emergencies
- Consultation process
- Legal issues
- Site considerations, including access and terrain
- Choice of felling and extraction machinery
- Size and structure of felling coupes
- Considerations arising in selection felling
- Felling system
- Operational checklists
- Environmental safeguards in relation to soil, sensitive areas (e.g. aquatic zones, archaeological sites, wildlife habitats) and the landscape
- Materials storage and machine servicing
- Safety measures
- Roads and associated features (e.g. landings, entrances, water crossings)
- Loading and transport
- Site rehabilitation

12.2 FELLING POLICIES

Next to planting new forests, felling the crop at the end of the rotation can have the greatest potential adverse impact on the site and the environment. A planned and strategic approach to this operation is therefore essential.

12.2.1 Rotation policies

In Ireland, it is generally accepted that rotation lengths should be geared towards ensuring that the regional and national growth potential is not reduced and that each forest stand is managed to achieve its maximum production potential.

In Ireland, where there has been a continuous and substantial annual increase in the forest area, only the most exploitative policies will place national forest increment at risk. The issue therefore focuses on the general principle of rotation of maximum mean annual increment (MMAI) in relation to site and species, to achieve consistent and sustained yield. The age of MMAI is achieved when current annual increment equals average mean annual increment.

Minor modifications to the rotation of MMAI can also achieve satisfactory financial yield. For supply and market reasons, it has been customary in Ireland to adhere to rotations of MMAI minus 30% for Norway spruce and lodgepole pine, and MMAI minus 20% for Sitka spruce. However, this should not be taken as a mandatory prescription. Rotation lengths in Irish forests vary from 35 years for fast growing conifers to over 80 years for most broadleaves.

Exceptions to normal practice usually involve the replacement of unsuccessful stands with a more productive crop, and the early felling of stands susceptible to windthrow in order to avoid technical problems and to minimise financial loss. Considerations such as landscape, conservation, seed potential and the preservation of unique stands, may determine that rotations of MMAI are exceeded or that individual trees are preserved. The desire to achieve large sizes in broadleaves in order to maximise quality timber may also involve extending rotations. To enhance biodiversity, owners should consider the retention of some stands and trees beyond commercial maturity (see FOREST BIODIVERSITY GUIDELINES).

The introduction of alternatives to clearfelling, e.g. selection felling, coppicing and group felling, will require well-informed consideration of species, site factors and growth patterns (see SECTION 16: BIODIVERSITY AND SPECIALISED WOODLANDS).

12.2.2 The law

Felling is controlled by the issue of general or limited felling licences under the Forestry Act 1946.

A *general felling licence* is a licence to practice forestry which may be granted to landowners who are carrying out a systematic scheme of felling and reforestation. A general felling licence may be granted for a specific period in lieu of the lodgement of felling notices and the issuing of limited felling licences. It can be granted without a felling notice.

A *limited felling licence* is issued for a specific felling operation. Notice of intention to fell must be given to the Garda Síochána. Specified trees can be felled 21 days after lodgement, unless a prohibition order has been issued. Following inspection, a limited felling licence may be issued which may require certain replanting or other conditions to be met.

Felling licences also apply to thinning, although these do not affect the area under forest cover and do not carry a reforestation obligation. Felling licences are not required within urban areas or where Local Authorities require tree removal.

Details of crops to be felled must be sent to the Forest Service, including the number of trees and the size of the felling coupe. General licences will normally be issued within the context of an overall plan, and limited licences for individual trees, specific lots or where environmental or other sensitive issues arise. The Forestry Act 1946 is currently being amended to cater for the legal implications of sustainable forest management.

12.3 PLANNING CLEARFELLS

The clearfell operation should be handled within a comprehensive forest estate or catchment plan. This will provide a suitable context to ensure that operational control is in place, environmental risks are reduced, economically viable felling policies are followed and that costs are minimised.

Forest owners should have on-hand an inventory or estate record which identifies areas by species, age, yield class and location. Details of when and where thinnings and final fellings will be carried out should also be contained within a long-range forest management plan. This plan should also include maps so that the location and extent of proposed fellings can be easily identified. This information will be required to assess any potential adverse environmental impacts and to arrive at long-term management decisions regarding reforestation, and for the purpose of obtaining a felling licence. Modern information technology means that, for large scale forest owners, records can be kept in the form of geographical information systems (GIS) which incorporate maps and associated data together with financial and management models to determine when interventions should be made to optimise production and return. For small forest owners, paper-based records should include maps and stand/compartments details.

12.3.1 Objectives of planning

- Optimise timber production.
- Avoid or minimise adverse environmental impacts.
- Recognise specific interests and local needs.
- Ensure an efficient and cost-effective operation.
- Provide efficient and safe access.
- Control costs.
- Avoid scheduling problems.
- Provide flexibility.
- Identify safety hazards in advance.
- Protect operator health and safety.

12.3.2 Strategic and tactical planning

Preparing for final felling incorporates both strategic and tactical planning. Strategic planning is a long-term process involving the consideration of a number of factors at the forest estate level:

- forest types, rotation lengths, management/final felling systems (e.g. clearfell, shelterwood, selection felling);

- anticipated difficulties relating to windthrow (based on windthrow hazard classification), terrain (based on terrain classification - see SECTION 11.3.2.1), and associated management and operational constraints;
- protected and sensitive areas (e.g. Special Areas of Conservation, aquatic zones, archaeological sites, important habitats);
- landscape considerations;
- operation time frame;
- coupe size and felling/reforestation schedule;
- existing forest roads, additional access requirements and optimum extraction routes;
- road design standards;
- production estimates;
- suitable harvest and extraction systems and machines, based on predicted stand characteristics, environmental issues, future market projections, forest road networks and likely machine availability and costs;
- likely requirements regarding machinery, operators and materials;
- likely income/expenditure flow;
- maps, data and prescriptions.

Tactical planning is more short term in nature and is intended to support operations in each harvest area. It includes a description of the operation and measures to minimise environmental disturbance. The development of a tactical harvest plan, which involves the identification of relevant environmental issues and consultation with the relevant authorities and local community are detailed in SECTION 11.3.2 and in the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES. Additional considerations include the following:

- details of intended operations;
- specific crop information, e.g. species, volume, value;
- product information, size categories;
- operation timing and scheduling;
- contractor details and conditions, e.g. permitted extraction load sizes, methods of payment;
- specific equipment to be used and constraints identified;
- safety codes and checklists;
- outline site restoration procedures to be undertaken at the completion of operations.

A contingency plan should also be in place to cover harvesting. As part of contingency planning, include non-sensitive areas within the felling coupe(s) where harvesting may continue if it has to be postponed in sensitive areas, due to particularly adverse weather conditions, soils with high erosion risk or low bearing capacity, or accidents involving environmental damage.

12.3.3 Organisation

Felling operations may be carried out directly by the owner using his/her own staff or contractors, or by standing sale to purchasers. The operation requires professional management and effective communication between owner/management and the contractors. Clear instructions should be given.

12.3.4 Checklists

It is advisable to prepare a checklist before the operation commences. This should include:

- site access;
- safety issues;
- risk assessment;
- emergency plans;
- crop details;
- services on site;
- data on slope and impacts;
- ground roughness and obstacles;
- bearing capacity;
- felling systems to be used;
- other factors influencing the operation, e.g. type of material to be extracted;
- harvest tree details, tree height, diameters;
- details on roads, bridges, etc.;
- working time restrictions.



The careful selection of felling coupe size and shape will minimise the landscape impact of felling while creating opportunities to introduce age structure diversity within the forest.

12.4 FELLING COUPES

The size of felling coupes for final harvesting are determined by many competing factors. These include the stability of surrounding forest crops, location and topography, environmental issues such as water quality and the landscape, and various commercial and silvicultural constraints. The following factors should inform the decision regarding the appropriate size of felling coupes (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES):

- Smaller felling coupes tend to promote water quality, with greater care and planning needed as the coupe size increases (see FORESTRY AND WATER QUALITY GUIDELINES).
- Smaller felling coupes also tend to promote biodiversity (see FOREST BIODIVERSITY GUIDELINES).
- Select coupe sizes which reflect the landscape type and scale (see FORESTRY AND THE LANDSCAPE GUIDELINES). Skylines in particular need to be treated on a large scale, with the forest either left standing or cleared fully to reveal the shape of the underlying landform. Landscape issues also favour asymmetric and irregularly shaped coupes which follow landform, with edges diagonal to the contour, rising in hollows and descending on spurs.

Adjoining felling coupes harvested in a short time scale are likely to have a cumulative impact on the environment. In large, even-aged stands, phased felling and reforestation will minimise this cumulative effect and will ensure that succeeding rotations do not inherit the same undesirable structure. Staggered felling/reforestation also benefits biodiversity and the landscape by introducing structural and age diversity (see FOREST BIODIVERSITY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES).

In Ireland, a general distinction is made between coupes under 25 ha (which can be recommended for a general felling licence) and coupes over 25 ha (which can be recommended for a limited felling licence). When felling coupes are extended, consideration should be given to scheduling clearfells so that adjoining reforestation areas are well established. Other issues to be considered are wind risk on adjoining stands and potential edge effects, particularly with Norway spruce.

Large felling coupes over 25 ha may be acceptable on flat terrain or valley bottoms where visual impact is minimised. Felling in very sensitive landscape areas should be limited to 5-15 ha. While broad guidelines on coupe size are to be considered, size limits should not be absolute but relate to the size of the forest or water catchment unit. In the latter case, the coupe size will influence the likelihood of nutrient pollution. This would be an important issue if a catchment contributes to a drinking water supply.

Acceptable coupe size will be reviewed periodically by the Forest Service.

12.5 HARVEST ROADS

SECTION 14: FOREST ROADS and FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES deal with forest roading issues and associated environmental considerations in detail. However, several important considerations relate specifically to clearfelling.

As with thinning, adequate access and roading are crucial for efficient felling programmes. Most of the roading required for final felling will usually already be in place if the area received thinnings in the past. In long established forests, a good road network is likely. Forest roads and accompanying drains must be in good repair prior to commencement of final felling, given the high levels of use during the operation and the increased level of run-off over the site resulting from canopy removal and the subsequent decrease in rainfall interception. As with thinning operations, road design should balance the operational need for roading, landing bays, turning areas and parking, with the need to minimise expenditure and loss in stocked area, and environmental considerations relating to aquatic zones, landscape, etc. Road lengths are related to the type of harvest and extraction systems and machines selected. For example, forwarding and cable extraction both require less roading compared to skidding. Road spacing models may be useful in this context.



12.6 FELLING

As outlined in SECTION 11: SILVICULTURE AND THINNING, mechanical felling is now the norm in Irish forests. Some motor manual operations are still carried out, mainly on smaller areas and in difficult terrain and crop conditions.

12.6.1 Objectives

- Maximise volume/value conversion.
- Ensure operator safety.
- Facilitate efficient extraction.
- Minimise site and soil damage and disturbance of aquatic zones, archaeological sites, wildlife habitats and other sensitive areas.
- Achieve a cost-effective operation.

12.6.2 General rules

- Operator safety must be ensured at all stages of the operation.
- Operators must be suitably trained, qualified and experienced.
- The operation must be managed professionally.
- All machinery and equipment should be properly used and maintained.
- The site should be kept clear of non-operational personnel and members of the public.
- The site should be adequately signposted.
- Damage to sensitive areas (e.g. aquatic zones, archaeological sites, wildlife habitats) must be avoided by adherence to measures stipulated in relevant guidelines (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES, FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FOREST BIODIVERSITY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES). Consult with the relevant authority before the operation if in any doubt as to how best to treat a sensitive area.

12.6.2.1 Motor manual felling

Motor manual felling is usually carried out alongside cable and skidder extraction, for small forest holdings and for difficult or large material. As described in SECTION 11: SILVICULTURE AND THINNING, the operation is potentially dangerous and operators must be suitably trained, qualified and experienced in chainsaw operation, and fully equipped with protective gear, well-maintained saws and ancillary safety equipment. Chainsaw operators must never work alone.

Directional felling is a technique which maximises safety and allows for efficient loading for extraction. The operation must be carefully planned for each group of trees in order to facilitate safe and easy delimiting. Several types are described:

- *Face felling*: Felling along a face usually against the prevailing wind direction. Trees are felled in parallel onto an open space.
- *Strip felling*: Diagonal felling into a bunching zone for easy extraction, enabling trees to be swung, rocked or pivoted into position.
- *Bench felling*: A bench tree is felled to facilitate the delimiting, cross-cutting and movement of trees subsequently felled.
- *Contour felling*: A system designed for cable extraction to prevent trees rolling downhill.

12.6.2.2 Machine felling

Dedicated felling machines are of the same general design as thinning machines, but are usually more powerful and heavier. Excavator type machines are frequently used in clearfell situations, as damage to the remaining standing crop is not a factor. The main types of harvesting machines are as follows:

- *Processors*: Processors delimit and cross-cut only, and are usually used in conjunction with motor manual and cable systems. Processors have largely been replaced by system-built harvesters or by excavators and forwarders fitted with a harvesting head.
- *Harvesters*: System-built machines comprising a base fitted with a crane and harvesting head. Harvesters used for final felling are invariably wider, heavier and of greater ground pressure than those used for thinnings, due to the larger material and the less sensitive site requirements. Tree handling capacity is up to 60 cm dbh.

System-built harvesters are specifically designed to handle larger material on clearfell sites.



Some excavators can be fitted with harvesting heads and used as harvesting machines.

- *Harvesting heads mounted on excavator units:* A variety of excavators are equipped with certain hydraulic systems which make them suitable for conversion into felling machines. These are the least expensive type of felling machine available, but tracks can be damaged by stumps and boulders. Ground clearance and slopes can also pose difficulties.
- *Harvesting heads mounted on forwarders:* Again similar to those used for thinning, but the larger felling heads required necessitate the use of heavier base machines.

12.6.3 Felling and site factors

Felling can have a major adverse impact on the site. Clearfelling, which involves the removal of the entire crop, can result in considerable build-up of debris and soil disturbance. Canopy removal increases run-off from the site, increasing the risk of sediment, debris and harmful chemicals entering nearby aquatic zones. Aquatic zones, archaeological sites and wildlife habitats can also be directly disturbed. Meanwhile, the presence of 'lop and top' can create a negative visual impact.

A number of low impact harvesting techniques can be used to reduce the potential for adverse environmental impacts, as detailed in the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and with relevant measures set out in the FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FOREST BIODIVERSITY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES:

- Ensure that all personnel, particularly machine operators, are aware of the harvesting plan (including the contingency plan), environmental issues relating to the site, and the outer perimeter of all buffer and exclusion zones.
- Install all necessary ancillary structures (e.g. additional drainage, sediment traps, log steps, aquatic zone crossings, corduroy strips) before harvesting commences or, where appropriate, as harvesting progresses. Maintain these features throughout the operation.
- As most clearfelling is carried out using machines, it is vital that machine selection is based on site conditions. Excavator-based harvesters are frequently used in clearfelling, but can cause problems on slopes and soft sites or where rocks or tall stumps are frequent.
- Exclude all operations from buffer and exclusion zones stipulated for aquatic zones and archaeological sites. The outer perimeter of these zones should be marked clearly with a perimeter fence, brightly coloured paint marks on trees, or brightly coloured tape. Machines should not enter these zones during felling or extraction. Fell trees away from these zones, and ensure that logs are presented in a way which prevents extraction machines from having to enter these zones. Do not pile logs within these zones.
- Create and maintain dense, fresh brash mats on all machine routes, to avoid soil damage, erosion and sedimentation. Concentrate brash on primary routes and at the junction of the extraction path and landing site. Where the soil bearing capacity is low, specify prompt extraction to ensure that fresh brash is available for extraction machinery. In all cases, brash mats should be renewed when they become heavily used and worn.
- Prevent the accumulation of brash, logs and debris in drains and aquatic zones.
- Avoid crossing aquatic zones. If unavoidable, suitable temporary structures should be used. Remove all temporary crossings as operations progress.
- Directional felling and secure stacking should be used to prevent material from rolling down slopes.
- Ensure that important wildlife habitats retained for biodiversity purposes are protected during harvesting. Plan operations with due regard to the breeding and nesting seasons of important species, and associated features such as badger setts and heronries. If possible and where wind firmness and landscape considerations allow, retain some stems to grow on to old age, ideally scattered throughout the site. Some deadwood should also be left *in situ* after felling, in the form of standing dead stems or naturally fallen trunks, or as logs deliberately left behind on the forest floor.
- Any unrecorded archaeological site or artefact discovered during the operation must be left undisturbed and the relevant authorities (the National Monuments and Historic Properties Service, the National Museum of Ireland and the Garda Síochána) notified immediately. A minimum exclusion zone of 20 m must be created until the site of the find has been investigated.
- On sites which have a high risk of soil erosion or with soils of low bearing capacity, consider suspending mechanised operations during and immediately after periods of particularly heavy rainfall.

- Prepare and securely store all fuel and machine oils under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. All maintenance and refuelling operations and machine repairs (if required and practical) should be carried out at least 50 m from the nearest aquatic zone on a dry, elevated site. All containers, spent oil, machine parts and refuse generated by the operation should be removed from the site for correct disposal. Leakages during machine operations should be attended to immediately.
- All operators should have contact telephone numbers onsite for all relevant agencies (Local Authorities, Regional Fisheries Boards, Dúchas The Heritage Service, National Museum of Ireland, Garda Síochána, etc.) in case of accidental damage to aquatic zones, archaeological sites, important wildlife habitats and other environmental features.
- The passage of ground haul extraction on forest roads should be confined to unladen traffic gaining access to or exiting from the harvesting site. No forwarding or ground haulage operations should take place on either forest or public road surfaces. There should be no carrying over of soil or debris onto public roads. Keep exiting roadside drains and culverts free of all logs, debris and obstructions.
- Where harvesting operations adjoin public roads, appropriate warning signs should be in place to alert the public. Warning signs should also be placed within the forest, particularly if it is used for recreation.
- Undertake appropriate site rehabilitation and restoration on completion of fellings and extraction operations.

12.6.4 Windthrow

In Ireland, up to 30% of the annual harvest can comprise windthrown material. As well as resulting in a badly disturbed site littered with shattered and uprooted stems, windthrow results in timber which can be dangerous and difficult to harvest. Machine harvesting is highly recommended for these sites, as the material can be dealt with more efficiently and with a greater degree of operator safety. Most harvesters can fell, joint and delimb difficult material, pushing stumps back in place as the operation proceeds.

In addition to the standard safety precautions, chainsaw operators working on windthrown sites require clear instructions on the techniques required to deal with timber which is jammed, hung-up and under stress. Only trained, qualified and experienced operators should be used.

Material blown across drains and aquatic zones should be removed.

12.7 EXTRACTION

Once felled, trees must be moved from the cutting site to a landing or roadside, where they are consolidated into larger loads for transport from the forest. If not already jointed, they will be processed into logs at this stage.

Regardless of the type of logging system used, the operation can be difficult and will impact on the site. Clearfelling, or final harvest and extraction, usually requires larger and heavier machines than those used for thinning.

12.7.1 Objectives

- To optimise productivity.
- To ensure the safety of all operators.
- To minimise soil disturbance.
- To minimise impact on aquatic zones, archaeological sites, wildlife habitats and other sensitive areas.
- To minimise damage to remaining trees (if any).
- To minimise visual impact.
- To avoid deterioration of logs.
- To facilitate transport from the forest.



Windthrow results in timber which can be both difficult and dangerous to harvest.

12.7.2 Extraction methods

Extraction methods for final felling are similar to those used for thinning (see SECTION 11: SILVICULTURE AND THINNING), except that horse extraction is rarely used.

12.7.2.1 Skidding

Skidding is sometimes used for larger tree length material or in small-scale operations. High powered four-wheel drive tractors fitted with double drum winches and choker cables are used. Farm tractors are occasionally used for smaller material and where ground conditions allow.

Advantages: Highly manoeuvrable, suitable for small-scale operations and can handle large, difficult or poorly shaped trees. It is a one-person operation and equipment is relatively inexpensive. The load can be dropped to ease extraction difficulties.

Disadvantages: Dependent on the weather and 'bogging down' can frequently occur, although high flotation tyres and chains will help. Skidding can be dangerous under wet conditions and where slopes are severe. Skid trails tend to be heavily used, leading to soil compaction and erosion. No skidding should be undertaken on roads. In all cases, short extraction distances are required.

Operational guidelines: Skidders should operate from skid trails to minimise site damage. Restrict work during wet weather conditions and on sites with soil of low bearing capacity. Operators must be trained, experienced and properly equipped. Chokers should be used efficiently to maximise log extraction and to reduce damage. Skid trails should be of minimum width and angled across the slope. Uphill skidding is preferable to downhill skidding, as it tends to disperse run-off water and reduce the degree of soil disturbance. Avoid crossing drains and aquatic zones, unless adequate structures are installed.

12.7.2.2 Forwarding

Forwarders used for clearfell extraction operations tend to be larger than those used for thinning extraction, normally between 12-14 tonnes, six- to eight-wheeled and over 2.5 m in width. Forwarding is the most common form of clearfell extraction used in Ireland.

Advantages: Easy to load, ergonomically designed and safer than skidders. Forwarders are complementary to felling machines, with better weight distribution resulting in less soil disturbance. Efficient extraction distance is greater than that of skidding, thereby reducing road density requirements. Material extracted by forwarders is usually shortwood, leading to reduced landing area requirements and the option to land at roadside. Forwarders without chains and tracks can drive on roads. They are easy to manoeuvre and deliver clean logs.

Disadvantages: Forwarders have few disadvantages in relation to skidders. Forwarders are more expensive, and can cause soil compaction. Bogging down requires time-consuming unloading, and stability can change with load size. Certain crops, site types and products will rule out the use of forwarders, e.g. very large trees, steep slopes, very soft terrain, requirements for full length produce. Heavy loads and continuous use of tracks, particularly at entrance and exit points to trails, will cause rutting, although this can be reduced by using flotation tyres and tracks, and brush matting.

Operational guidelines: Logs should be uniform and well-presented. Extraction trails need to be of better quality than those used in skidding operations. To minimise the risk of tipping, extraction should be carried out up and down slopes. The use of brush mats reduces soil and site disturbance. Drainage ditches and cross drains may be required to divert water from tracks. Machines should be adequately equipped with flotation tyres, tracks and chains. Log mats or reusable pipes should be used for crossing drains.

12.7.2.3 Clambunk extraction

This is a variation on the forwarder/skidder theme specifically intended for full pole extraction. Poles are clasped by a large grapple mounted on a forwarder base, and are then skidded out. Site damage is usually less than that caused by skidders, as a large portion of each pole is lifted clear of the ground. Apply operational guidelines specified for both skidders and forwarders.



Forwarding is the most common method of clearfell extraction used in Ireland.

12.7.2.4 Cable extraction

Cable extraction is confined to steep slopes or to very soft ground conditions. A skyline system involving a static wire and carriage held up by support trees is usually used. Anchor trees and guy lines are used to keep the tower and support trees upright. A high degree of site planning and preparation is required.

Advantages: The system suits steep slopes and wet or unstable sites. Ground disturbance is minimal. It is capable of handling a variety of log material, including whole tree harvesting. Equipment is relatively inexpensive.

Disadvantages: The operation requires a high degree of organisation and is labour intensive. Motor manual felling may be involved. Processing at the landing site is often required, necessitating further space. The operation is dangerous, e.g. site debris can hide cables. Setting up is time consuming and support trees have to be carefully selected. The acquisition of up-to-date equipment of a scale suitable for Irish operations has been slow. Many of the machine models now in circulation are old or reconditioned. Cable extraction is a highly skilled operation requiring effective teamwork.

Operational guidelines: Cable extraction must be carefully planned using trained and experienced personnel. Staff should have completed and passed a recognised training course (e.g. Coillte Mountrath Training Centre). Cables must be kept clear and handled carefully. Well-rooted and stable support and anchor trees must be carefully selected. Workers should be in clear communication with each other at all times. The site should be kept clear of non-involved personnel. Cabling across aquatic zones should be avoided. If unavoidable, full suspension systems should be used. Adequate roading and landing bays should be provided.

12.8 WHOLE TREE HARVESTING

In recent years, tops, branches and needles have been identified as useful forest by-products for mulch and energy. Cable systems are particularly suitable for whole tree harvesting, although systems involving skidding to a loading bay and subsequent processing by chipper are also feasible. Onsite chipping also facilitates economic transport. Adequate room should be allowed for temporary storage, processing and chipping. Forwarder-mounted chippers can gain deeper access into the harvesting area and avoid the need for whole tree extraction.

Expert advice should be sought before considering whole tree harvesting, as soil impoverishment through the loss of nutrients and organic matter may occur on some site types.

12.9 EXTRACTION - ENVIRONMENTAL IMPACTS

Clearfell extraction operations can cause considerable site disturbances. Measures should be taken to minimise this disturbance at all stages of the operation (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and relevant measures set out in the FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FOREST BIODIVERSITY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES):

- Exclude all extraction machinery from buffer and exclusion zones stipulated for aquatic zones and archaeological sites, and from important wildlife habitats retained for biodiversity purposes. Schedule operations to minimise disturbance to important wildlife species.
- Create and maintain dense, fresh brash mats on all machine routes, to avoid soil damage, erosion and sedimentation. In all cases, brash mats should be renewed before they become too worn.
- Load sizes specified in the harvest plan or recommended by manufacturers should not be exceeded. Overloading will damage extraction machinery, will increase the risk and severity of soil compaction and rutting, and may lead to machine instability.
- Prevent the accumulation of brash, logs and debris in drains and aquatic zones. Avoid crossing aquatic zones. If unavoidable, suitable temporary structures should be used. Remove all temporary crossings as operations progress.
- On sites which have a high risk of soil erosion or with soils of low bearing capacity, consider suspending mechanised operations during and immediately after periods of particularly heavy rainfall.
- All operators should have contact telephone numbers onsite for all relevant agencies (Local Authorities, Regional Fisheries Boards, Dúchas The Heritage Service, National Museum of Ireland, Garda Síochána, etc.) in case of accidental damage to aquatic zones, archaeological sites, important wildlife habitats and other environmental features.



Brash mats protect the soil during machine passage. Mats which become worn during operations (above) must be renewed.



Loading areas should be carefully laid out and managed in order to facilitate effective collection for haulage.

12.10 LOADING

Clearfell operations involve the presentation of large volumes of timber at landing sites for transport from the forest to the processing facility. These sites represent the end-point for many machine journeys, both extraction machinery and timber haulage trucks. They are also often used for the delivery and storage of fuels, machine oils, spare parts and other material. Furthermore, jointing, trimming and piling may also be carried out at these sites. Due to these operations and inherent risks relating to pollution and sedimentation, loading areas should be located where they will not adversely impact on aquatic zones.

Loads should be carefully staked, labelled and signposted. Access roads and loading areas should be kept in good condition, with adequate space allowed for turning. Trucks should be checked before departure to ensure that loads are secure and that tyres and brakes are in good condition. Tyre pressures should be checked in relation to load and road conditions.

After the completion of operations, landing sites may need to be treated for compaction.

12.11 SCHEDULING REMOVALS

Forest owners and managers should ensure that arrangements with purchasers are in place to facilitate the orderly removal of timber produce from the forest, with maximum efficiency and minimum disturbance to the local community. All timber extracted from the forest should be removed from loading bays. Certain species, e.g. *Pinus* spp., should be removed promptly in order to avoid the development of 'blue stain' and other degradations.

12.12 SERVICING

Harvesting and extraction requires the use of heavy machinery, with associated maintenance, refuelling and repair. Potential adverse impacts of these operations must be considered, particularly the contamination of aquatic zones with fuel and motor oils.

All maintenance and refuelling operations and machine repairs (if required and practical) should be carried out at least 50 m from the nearest aquatic zone on a dry, elevated site. Prepare and securely store all fuel and machine oils under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. Ensure that all hazardous compounds are removed from the site for correct disposal. All containers, spent oil, machine parts and refuse generated by the operation should also be removed. The relevant Local Authority and Regional Fisheries Board must be notified immediately of accidental spillages which threaten aquatic zones.

12.13 SITE REHABILITATION

A clearfell operation involves a greater degree of disturbance than most other forest operations. This can be reduced by implementing appropriate site restoration measures (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES):

- Harvesting debris and sediment should be removed from drains, sediment traps and culverts. Drains damaged during the course of operations should also be repaired.
- All temporary structures, such as log bridges and corduroy rafts, should be removed immediately after use.
- Immediately after operations, implement water control and soil amelioration treatments on major extraction routes. These may include the creation of diversion channels across wheel ruts where there is a risk of erosion, or ripping in heavily compacted areas.
- Road surfaces should be restored and reshaped as necessary to prevent erosion and sedimentation.
- Ensure that all hazardous compounds are removed from the site for correct disposal. All containers, machine parts and refuse generated by the operation should also be removed.

Post-harvest sites are often untidy in appearance, and can remain so for several years. Some of the most intrusive impacts can be mitigated by rolling, mulching or burying brush, re-seeding entrances, planting species such as larch or broadleaves close to gates, entrances and roads, and by ensuring that gates and fences are repaired. Hedgerows, individual stems and areas of natural regeneration should also be retained to improve site appearance. See FORESTRY AND THE LANDSCAPE GUIDELINES.

Carefully timed felling operations can minimise some of the adverse impacts. For example, felling during late spring/early summer will enable the site to green over rapidly, while also avoiding periods of heavy rainfall. Reforestation should be undertaken as soon as possible after harvesting, to aid site restoration and appearance.

12.14 TIMBER MEASUREMENT

General timber measurement considerations for thinning operations, as described in SECTION 11: SILVICULTURE AND THINNING, also apply to final felling. However, a greater intensity of measurement is required, given the material's higher value. Methods associated with the clearfelling of mature crops are as follows:

- volume/weight measurement;
- tariff measurement;
- abbreviated tariff measurement;
- oven-dry bark free tonne measurement;

- volume/weight measurement with reduced stratification;
- conventions for whole tree measurement for valuable mature broadleaves.

The recently published *Timber Measurement Manual* (see reference list) should be consulted.

Computerised measurement systems incorporated into harvesting heads and used to calculate volume per assortment class for payment purposes must be regularly maintained and calibrated, as reliability is essential.

12.15 ADVERSE IMPACTS

- **Poor records**
- **Failure to clearly identify harvesting areas**
- **Poor planning, leading to badly situated or inadequate roads and tracks**
- **Poor planning, leading to the selection of unsuitable systems**
- **Lack of consultation with relevant authorities, interest groups and the local community**
- **Legal procedures ignored**
- **Felling coupes too large**
- **Risk of windthrow in adjoining areas**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Members of the public entering the work area, with risk of injury**
- **Felling and extraction machines unsuited to the site and material, leading to crop, soil and machine damage**
- **Excessive haulage distances to roads, leading to inefficiency and site damage**
- **Damage to the site and extraction machines due to overloading**
- **Site impoverishment due to whole tree harvesting**
- **Inadequate brush mats, leading to soil damage and sedimentation**
- **Machine damage to drains**
- **Failure to implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors, with subsequent damage**
- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones and archaeological sites**
- **Site and environmental damage due to poor timing and failure to curtail operations in adverse weather conditions**
- **Sediment entering aquatic zones**
- **Brush and debris in aquatic zones**
- **Rutting and compaction through the overuse of tracks**
- **Landscape adversely affected by extent and nature of felling operation**
- **Improperly sited maintenance, refuelling and storage areas, leading to contamination of aquatic zones with fuel and machine oils**
- **Overuse of site for extraction and loading**
- **Pile up of debris at landing sites**
- **Damage to trucks due to poor forest road condition**
- **Poorly organised timber removals, leading to waste, damage and degrade**
- **Debris not spread or windrowed, creating unsightly site**
- **Inadequate site rehabilitation, including unsightly margins and entrances**
- **Delays in reforestation, thereby extending the period of poor visual impact**
- **Poor, incomplete records of operations and associated expenditure**

12.16 BEST PRACTICE

- **Keep good stand records**
- **Consult with relevant authorities, interest groups and the local community**
- **Follow legal requirements**
- **Prepare adequate harvesting plans, including a written risk assessment**
- **Prepare a contingency plan for emergencies**
- **Select the best silvicultural and financial felling rotation**
- **Base assortments on market trends, to maximise productivity**
- **Select the most appropriate felling and extraction machinery**
- **Ensure adequate forest road density, to avoid long off-road haulage distances**

- **Ensure adequate tracks, bridges and culverts**
- **Minimise stream crossings, providing temporary structures if unavoidable**
- **Design coupes to minimise negative landscape impact**
- **Ensure a site-friendly operation with adequate brash mats to avoid soil damage**
- **Schedule operations in sensitive areas to avoid periods of adverse weather**
- **Implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors**
- **Maintain the necessary buffer and exclusion zones in relation to aquatic zones and archaeological sites**
- **Notify relevant authorities immediately of accidental damage to aquatic zones or archaeological sites**
- **Avoid using high ground pressure machinery on sensitive sites**
- **Avoid soil degradation, seeking expert advice if whole tree harvesting**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace and machine safety requirements**
- **Keep non-involved personnel off-site**
- **Exclude members of the public from the site, placing warning signs on all approach routes**
- **Ensure adequate storage areas for logs**
- **Control piling at cable yarding areas**
- **Avoid using extraction machinery on forest roads**
- **Locate refuelling, maintenance and storage areas at least 50 m from the nearest aquatic zone**
- **Select an appropriate measurement system and keep clear records**
- **Remove all rubbish, empty containers, machine parts, etc. during and after the operation for safe off-site disposal**
- **Keep a complete record of operations and associated expenditure**
- **Ensure good timber removal scheduling, with all timber removed promptly**
- **Rehabilitate badly disturbed areas, landing bays, entrances, tracks, etc.**
- **Repair roads**
- **Reforest as soon as possible, considering diverse species at entrances and along margins**

12.17 REFERENCE MATERIAL

Anon. 1987. Operational Directive 3/87: Code of Practice for Harvesting (Revised). Forest Service, Department of Energy, Dublin 2.

Anon. 1990. Forest Operations Manual - Getting It Right First Time. Coillte Teoranta - The Irish Forestry Board, Leeson Lane, Dublin 2.

Anon. 1999. Guidelines on Preparing Your Safety Statement and Carrying Out Risk Assessments. Health and Safety Authority, 10 Hogan Place, Dublin 2.

Anon. 2000. Guidelines for Forest Harvesting and the Environment. Report prepared for the Forest Service, Department of the Marine and Natural Resources. Purser Tarleton Russell Ltd., Forest Industry Consultancy & Research, 36 Fitzwilliam Square, Dublin 2.

Anon. Various Safety Guides produced by the Forestry and Arboriculture Safety and Training Council, 231 Corstorphine Road, Edinburgh, EH12 7AT, Scotland.

Dykstra, D.P. and Heinrich, R. 1996. FAO Model Code of Forest Harvesting Practice. Food and Agriculture Organisation of the United Nations, Rome.

Purser, P. 2000. Timber Measurement Manual: Standard Procedures for the Measurement of Round Timber for Sale Purposes in Ireland. COFORD, National Council for Forest Research and Development, Agriculture Building, University College Dublin, Belfield, Dublin 4. Available from the Forest Service.

Vaughan, L., Visser, R. and Smith, M. 1993. New Zealand Forest Code of Practice. 2nd Edition. New Zealand Logging Industry Research Organisation (LIRO), PO Box 147, Rotorua, New Zealand.

Whelan, D. and Cummins, T. 1996. Woodland Establishment and Management for the Timber Grower. Irish Timber Growers Association, 84 Merrion Square, Dublin 2.



13. TRANSPORT

The most common form of log transport from the forest to the processing facility is by articulated truck or truck and trailer. There may be intermediate stages where severe weight restrictions limit the size of the vehicle or, in the case of pulpwood, where logs are brought to a depot for further transport by rail.

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13.1 KEY FACTORS

- Legal constraints
- Local restrictions
- Forest and public road standards
- Loading bays, turnings and entrances
- Storage of fuel and lubricants
- Operational and public safety
- Scheduling

13.2 OBJECTIVES

- Ensure safety of workers and the public.
- Avoid damage to transport infrastructure, including roads and bridges.
- Minimise pollution and spillage.
- Deliver logs economically and without loss of volume or quality.

13.3 LEGAL ISSUES

Log transport is subject to legal maximum weight restrictions relating to truck design under the Road Traffic Acts 1933-1997 and the Road Transport Act 1999. Forest and transport managers should ensure that these limits are observed. Local Authorities can impose restrictions if country road conditions warrant. Permission from Local Authorities must also be sought when opening new entrances or widening existing entrances, and special conditions may be imposed. There are stacking restrictions in the vicinity of public roads. Penalties will be imposed for the pollution of aquatic zones.

13.4 PLANNING PROCESS

Harvest plans should take into account transport demands on forest roads and the condition of local public roads. Road design should also take into account transport demands resulting from forestry activity within a locality.

Road surfaces, bridges, culverts, loading areas and turning bays will all need to meet required standards for truck usage in the forest. Regarding public roads, road width and surface, acute bends, narrow bridges and entrances, and roadside dwellings must be considered in relation to the type of truck used, the load weight and the scheduling of daily arrivals and departures.

13.5 CONSULTATION

It is crucial to consult with Local Authorities regarding intended logging operations and their transport implications. Adequate consultation can overcome opposition to operations by securing agreement on scheduling, one-way systems, load size and the use and maintenance of entrances.

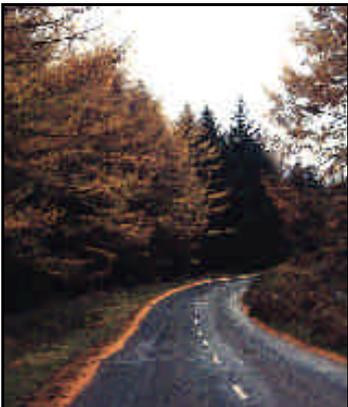
Co-operation between forest owner/manager and Local Authorities on repairs and minor works on public roads may facilitate a logging transport operation and secure public acceptance.

Consultation with local residents may be necessary to overcome concerns about transport disruption and additional traffic congestion.

13.6 IMPACTS

Roadside timber and loading bays should be kept tidy and loads made secure to avoid loss of material and debris. From an environmental perspective, the transport of logs from the landing to the processing facility is a relatively low impact operation. However, some risk may arise through damage to infrastructure by overloading or the use of unsuitable vehicles, such as debris or sedimentation from roads or bridges entering aquatic zones. Fuel leaks may also cause pollution.

Tyre pressure should be adjusted to reduce wear and tear on roads. Mud flaps should be fitted to catch mud, grit and stones thrown up from the wheels, in order to reduce danger and inconvenience for other road users.



Ensure that all timber haulage operations and schedules take account of the condition of local public roads and minimise disruption and inconvenience to the local community and to other road users.

Fuel and machine oil spillage should be avoided.

Forest roads should be maintained and road conditions within and outside the forest monitored. Forest road damage should be reported and repaired. Local Authorities should be notified of damage to public roads. Entrances should be kept clear of brash and mud.

Schedules should aim to minimise local traffic congestion and disruption.

An effective recording system should be in place to note truck details and loads leaving the forest.

13.7 ADVERSE IMPACTS

- **Legal penalties on consignor or haulier due to overloading**
- **Infrastructural damage due to overloading, unsuitable vehicles or poor truck design**
- **Debris from poorly secured loads or careless loading**
- **Loss of volume and value arising from poor loading practice**
- **Pollution arising from fuel leakage**
- **Dirt and debris at entrances**
- **Lack of consultation with Local Authority and the local community, leading to local opposition, e.g. due to poor scheduling**
- **Local Authority penalties for road damage**
- **Unscheduled and unrecorded removals**
- **Accidents to operators and members of the public, due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Poor, incomplete records of operations**

13.8 BEST PRACTICE

- **Work to a code of practice on road timber haulage**
- **Consult with Local Authority and the local community**
- **Good planning and scheduling**
- **Ensure that forest and public road networks are adequate**
- **Upgrade and ensure good surfacing throughout the forest road system**
- **Ensure that appropriate trucks and combinations are used**
- **Monitor and repair damage**
- **Ensure orderly loading and secure loads**
- **Limit payment to legal loads**
- **Tailor operations to road bearing capacity, e.g. halt during heavy rain**
- **Ensure correct tyre pressure**
- **Avoid disrupting the local community, e.g. schedule journeys to avoid early morning traffic**
- **Use road signs**
- **Fit mud flaps**
- **Keep entrances clear**
- **Encourage driver courtesy to other road users**
- **Ensure a good docket and control system**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**
- **Keep a complete record of operations and associated expenditure**

13.9 REFERENCE MATERIAL

- Anon. 1997. Guidelines for Weights and Dimensions of Mechanically Propelled Vehicles and Trailers. Leaflet No. 1. Department of the Environment, Custom House, Dublin 1.
- Dykstra, D.P. and Heinrich, R. 1996. FAO Model Code of Forest Harvesting Practice. Food and Agriculture Organisation of the United Nations, Rome.
- Vaughan, L., Visser, R. and Smith, M. 1993. New Zealand Forest Code of Practice. 2nd Edition. New Zealand Logging Industry Research Organisation (LIRO), PO Box 147, Rotorua, New Zealand.



14. FOREST ROADS

Forest roads feature in many operations and have been referred to in other sections of the CODE OF BEST FOREST PRACTICE. This section focuses on particular issues which arise during their construction, maintenance and use.

Larger forests usually require a minimum road network for access and development. Forests over 10 ha in area normally require harvest roads for timber extraction. In most cases, harvesting tracks adequately cater for areas less than 10 ha.

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14.1 KEY FACTORS

- **Planning requirements**
- **Forest size**
- **Harvest road requirement**
- **Consultation**
- **Availability of material**
- **Topography**
- **Geology**
- **Anticipated usage**
- **Construction and water quality**
- **River/stream crossings**
- **Other sensitive areas**
- **Landscape considerations**
- **Entrances**
- **Maintenance**
- **Monitoring**
- **Compliance with safety regulations during construction**

14.2 OBJECTIVES

- **To provide safe low-cost access to the forest.**
- **To serve management and harvesting needs.**
- **To provide maintenance plans for existing roads.**
- **To minimise soil disturbance and erosion during construction and use.**
- **To minimise road and landing areas consistent with good design.**
- **To utilise natural drainage patterns.**
- **To avoid sensitive areas.**
- **To minimise landscape disturbance.**
- **To ensure safety for both operators and members of the public.**
- **To provide benefit to the local community, where feasible.**

14.3 PLANNING

Careful planning will substantially reduce the road density required within a forest, while also minimising adverse environmental impacts.

Road planning must be complete before construction takes place. Planning at an early stage of the forest rotation would be desirable, as environmental features are usually more readily identifiable before canopy closure. However, this may conflict with the need to await technological or market developments.

The following outlines planning procedures for developing an efficient forest road network with minimal environmental disturbance (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES).

Identify all relevant environmental issues. Identify if the area to be roaded lies within or contains:

- an area identified as being environmentally sensitive in a County Development Plan;
- a part or whole of a Special Area of Conservation (SAC), Special Protection Area (SPA) or proposed Natural Heritage Area (pNHA);
- aquatic zones (see FORESTRY AND WATER QUALITY GUIDELINES);
- archaeological sites and monuments (see FORESTRY AND ARCHAEOLOGY GUIDELINES);
- important habitats retained for biodiversity purposes (see FOREST BIODIVERSITY GUIDELINES).

The construction of all forest roads creates access into areas previously isolated. The construction of roads for access and development of new forests will have an immediate visible impact and will cause substantial new site disturbance. It is therefore necessary to liaise with the following for practical advice, particularly where important environmental issues are involved:

- the relevant Regional Fisheries Board;
- the relevant Local Authority;
- National Parks and Wildlife of Dúchas The Heritage Service;

- the National Monuments and Historic Properties Service of Dúchas The Heritage Service;
- other relevant bodies, non-government organisations and the local community.

New forest roads and the recommissioning of existing forest roads will entail new pressure on public roads. This impact should be evaluated at the planning stage, with discussions initiated with both the Local Authority and the local community. This will avoid confrontation later on during the forest cycle. Where sensitive issues arise, agreed monitoring procedures may be necessary to enable corrective measures to be implemented and to reassure concerned parties.

Inspect the area and prepare a map (Ordnance Survey 6 inch scale is usually appropriate) which includes the following:

- The boundaries of the forest to be roaded, together with directions and distances to the nearest public road.
- Main public access route(s) and any existing forest road and track network, including associated structures such as landings, turntables and bridges.
- The environmental features of the area, including all aquatic zones, archaeological sites and monuments, and important habitats.
- Additional features which may present difficulties or require particular attention when developing a road network, e.g. awkward bends and restricted bridges, landscape considerations, dwellings and associated buildings, overhead and underground utility lines (electricity, gas, telephone and water), public and private water supplies, rights-of-way.
- The location of buffer and exclusion zones within the area (as stipulated by FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES), within which operations will be prohibited or restricted.
- Areas unsuitable for roading, due to, for example, potentially high erosion risk or difficult terrain.
- The location of machine maintenance, refuelling and repair areas and storage areas for fuel, machine oils and chemicals. These must be on dry, elevated sites at least 50 m from the nearest aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.
- The location of any gravel source within the forest intended for use for road construction.

Determine the appropriate spacing and density for the road network. The extent of forest roads will depend on factors such as the size and shape of the forest, maintenance requirements, expected volume, current and potential value of the crop, the harvesting systems and machinery to be used, and the nature of the terrain. Road design standards should be based on: the bearing capacity of the public road access routes; anticipated axle loads; traffic intensities; and environmental considerations. Subjecting a forest road to axle loads greater than those for which it was designed can lead to severe damage, greatly reducing the life of the road and creating the potential for serious environmental disturbance and community upset. Planning should take into account the existing road network and allow for maintenance and upgrading. The cost of ensuring that existing roads remain serviceable can outweigh the investment needed and the disturbance created by a new road system.

Plan the route of forest roads and the location of landings and turntables to minimise the potential for site and environmental disturbance. During road positioning, consider the following:

- Routes should avoid archaeological sites and important habitats. Their encroachment in or near wet or unstable areas, areas of high erosion risk and with soils of low bearing capacity, should be minimised.
- Roads should be located at least 50 m from aquatic zones, where possible. Road layout should aim to direct off-road traffic away from aquatic zones. If there is no other option but to cross an aquatic zone, construct an appropriate bridge or culvert, identifying suitable crossing points on the road plan.
- Maintenance costs and erosion problems tend to increase greatly with steeper inclines. The gradient of roads should therefore be kept to a minimum, restricted where possible to short stretches of steep road which are considered necessary to reduce overall impacts.
- The layout of the road network should be designed with appropriate variation in curves and gradient to reflect landform. Routes should be unobtrusive and cross skylines at the lowest practical point. Landing bays and turntables should also be unobtrusive. See FORESTRY AND THE LANDSCAPE GUIDELINES.



- Landings and turntables should be located on stable, well-drained sites at least 20 m from the nearest aquatic zone. Avoid locating them on prominent spurs or ridges.
- Where possible, roads should follow the natural contours of the terrain. Position roads to minimise the need for cutting and filling.
- Avoid stands which show signs of instability.

All aspects of forest roading, from initial surveying to later maintenance requirements, should be assessed by qualified and experienced engineering staff. Appropriate design specifications for both new or upgraded roads should be used. Although practice varies, road widths should be at least adequate to allow safe and efficient haulage. Good quality material should be specified for the construction and maintenance of forest roads.

14.4 ACCESS/DEVELOPMENT ROADS

During initial forest development, some roading will be required for access, transportation of material and inspection purposes.

14.4.1 Road density

Roading will usually be necessary in situations where the distance from the entrance to the furthest corner of the forest is greater than 500 m and where there are no existing roads or metalled tracks. An access/development road density of 7 linear m/ha is deemed acceptable to qualify for grant aid. Unnecessary road construction should be avoided at this stage, as the cost will have to be borne by the owner over most of the rotation.

14.4.2 Construction

Construction in the early stages of forest development can potentially have a major adverse impact, both visually and in terms of soil and water disturbance. Natural features and breaks should be followed and embankments camouflaged. Construction should be kept away from all rivers and streams, where possible. The relevant Regional Fisheries Board must be consulted if construction within 50 m of an aquatic zone is proposed.

The construction of fords, culverts and bridges must be managed with care to avoid the creation of barriers to fish passage, to minimise disturbance to stream beds and to prevent run-off into the aquatic zone. The construction of fords, culverts and bridges is detailed in SECTION 5.4.1 and the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FORESTRY AND WATER QUALITY GUIDELINES. Sediment traps are required at intervals along long roadside drains.

Prior planning and adherence to the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FORESTRY AND WATER QUALITY GUIDELINES will ensure that disturbance to sensitive areas (aquatic zones, archaeological sites, retained wildlife habitats) is avoided and that unstable ground and difficult terrain are circumvented.

Access and development road construction is governed by the Safety, Health and Welfare at Work (Construction) Regulations 1995.

14.4.3 Entrances

In the interest of both operator and public safety, adequate bellmouth entrances should be constructed at all sites adjoining public roads. Local Authorities must be consulted if new entrances (i.e. entrances in addition to existing gates and tracks) are proposed or if old entrances are to be widened. Forest entrances off public roads should be sensitively designed and constructed, and well-maintained.

14.5 HARVEST ROADS

14.5.1 Density

The optimal harvest road density for one rotation under Irish conditions is 20 linear m/ha, or approximately 100 linear m/1,000 m³ of extracted timber. Forwarder and cable systems are the most economical forms of extraction in relation to road density, but



Decisions on the final forest road density, layout and design will be influenced by the extraction system(s) used and the requirements of road haulage vehicles.

hauls greater than 300 m should be minimised. Skidder extraction typically requires two to three times the road density needed for forwarder and cable systems. The location and spacing of roads is critical for cable extraction.

Adequate provision must be made for landing and turning bays, in order to accommodate harvesting/extraction machinery and road haulage trucks.

14.5.2 Construction

Harvest roads provide access to the forest at production stage, i.e. from first thinnings onwards. Road design should take into account the spatial and temporal pattern of harvesting to be followed. Construction should be completed well in advance of the harvesting operation, to allow the road to dry out and settle. As most of the extraction roads will have been completed before final felling, the visual impact of the roading operation will be less than that arising from the construction of access/development roads at establishment. However, other impacts relating to sedimentation, sensitive areas, river/stream crossings, erosion on slopes, etc., are equally significant.

Harvest road construction is governed by the Safety, Health and Welfare at Work (Construction) Regulations 1995.

14.6 ROAD CONSTRUCTION - SITE ISSUES

Each stage of forest road construction has implications for water quality. This section contains detailed information on low impact road construction techniques which can be used to reduce the potential for adverse environmental disturbance from road and track construction. A primary consideration is to keep sedimentation and run-off from roads from entering aquatic zones, both during road construction, maintenance and use.

- Minimise the total area of disturbance which results from road construction. The total length and average width of the road network should be the minimum required for efficient and safe transportation.
- Wherever possible, carry out road formation and construction from April to October - the period when ground conditions tend to be drier. Where there is a risk of severe erosion occurring, construction should be suspended during periods of high rainfall.
- Where the intended route of a road must pass through waterlogged or impervious soils, these areas should be drained before construction commences. This will stabilise the road bed and reduce the danger of failure during construction and use.
- Cut-off drains should be constructed to a flat gradient at least 5 m back from the upper edge of the road formation, to avoid erosion.
- Ensure that roadside drains do not intercept large volumes of run-off from higher ground.
- Roadside drains must never discharge directly into aquatic zones. As with all drainage channels, they must taper out before entering the buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. Where necessary, install sediment traps at the end of the drainage channels to the outside of the buffer zone.
- Adhere to drainage measures set out in FORESTRY AND WATER QUALITY GUIDELINES.
- The outer perimeter of all buffer and exclusion zones (see FORESTRY AND WATER QUALITY GUIDELINES and FORESTRY AND ARCHAEOLOGY GUIDELINES) should be marked clearly with a perimeter fence, brightly coloured paint marks on trees or brightly coloured tape. Machines should not enter these zones during roading operations, except where it is unavoidable.
- Crossings over rivers and streams should be minimised. Where unavoidable, bridges and culverts should be used. SECTION 5.4.1 details important considerations regarding planning, consultation, construction and maintenance of crossings aimed at minimising any adverse impact on water quality, fish and other aquatic life.
- Spoil heaps generated during construction should be deposited on stable areas away from aquatic zones. They should be levelled out where possible, or breached at 20 m intervals and seeded to encourage greening over and stabilisation.
- All maintenance and refuelling operations and machine repairs (if required and practical) should be carried out at least 50 m from the nearest aquatic zone on a dry, elevated site. Prepare and securely store all fuel and machine oils under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone. Material used for road and crossing construction should also be stored at least 50 m from the nearest

aquatic zone. All containers, spent oil, machine parts and refuse generated by the operation should be removed from the site for correct disposal.

- The relevant Local Authority and Regional Fisheries Board must be notified immediately of spillages or other accidents during construction which threaten aquatic zones.
- Metalliferous or sulphide-rich material for road construction must not be used within 50 m of an aquatic zone. Any water flowing off such a surface should be directed onto vegetated soil and not allowed to flow directly into an aquatic zone.
- Gravel must not be removed from aquatic zones. Gravel may be removed from an aquatic buffer zone only after consultation with the Regional Fisheries Board and fishery owner. Any water discharging from a quarry or gravel source must pass through a sediment trap before entering the buffer zone.
- Any unrecorded archaeological site or artefact discovered during roading operations must be left undisturbed and the relevant authorities (the National Museum of Ireland, the Garda Síochána and National Monuments and Historic Properties Service) notified immediately. A minimum exclusion zone of 20 m must be created until the site of the find has been investigated. See FORESTRY AND ARCHAEOLOGY GUIDELINES.
- All roads should be allowed to consolidate, dry out and settle before use, so that they do not become rutted from traffic.
- Maintain all roadside embankments and cuttings and encourage their revegetation (e.g. grass, willow), in order to improve stability and to improve their visual appearance.
- The condition of roads, drains and culverts should be assessed prior to and immediately after harvesting and transport operations. Photographic evidence gathered at this stage may assist in any subsequent disputes.
- Roadside drains and sediment traps should be routinely inspected and maintained during construction.
- All operators should have contact telephone numbers onsite for all relevant agencies (Local Authorities, Regional Fisheries Boards, Dúchas The Heritage Service, National Museum of Ireland, Garda Síochána, etc.) in case of accidental damage to aquatic zones, archaeological sites, important wildlife habitats and other environmental features.

14.7 MAINTENANCE

Routine inspection and the necessary maintenance of road surfaces and associated crossings, drains and sediment traps are essential to ensure the working condition of the forest road network, to maximise its operational lifetime, and to avoiding adverse environmental impacts such as the entry of run-off into aquatic zones. This is particularly important for roads in continuous use. It may be appropriate to close off some secondary forest roads until they are required again. Roads and drains constructed prior to the issuing of environmental guidelines require particular attention.

Sediment traps should be regularly inspected and cleaned out. This should be carried out between May and September in order to avoid fish spawning seasons. Harvesting debris should be regularly removed from roadside drains, sediment traps and culverts to avoid blockages and washouts, particularly after extended periods of heavy rainfall.

14.8 TEMPORARY STRUCTURES

During thinning and final felling, it is often necessary to install temporary machine crossings over aquatic zones and drains and across wet areas of the site, e.g. heavy duty plastic pipes, log culverts, corduroy mats. The need for such crossings should be minimised through the careful layout of harvesting and extraction routes, given the potential impact on water quality through disturbance and sedimentation. Where unavoidable, these structures should be carefully installed and maintained, and removed immediately as the operation progresses to other areas of the forest. Many of the measures regarding the planning and construction of permanent crossings also apply, e.g. minimise disruption to the bank, bed and adjacent buffer zone, ensure that all crossings are at right angles to the flow, avoid steep approaches to the crossing (see SECTION 5.4.1).

14.9 SAFETY

The following legislation applies to forest road construction:

- Safety, Health and Welfare at Work Act 1989;
- Safety, Health and Welfare at Work (General Application) Regulations 1993;
- Safety, Health and Welfare at Work (Construction) Regulations 1995.

All road construction and maintenance operations should be professionally managed, employing suitably trained and experienced operators. Particularly dangerous operations such as rock blasting are sometimes necessary, necessitating specific consultation with the relevant authorities. Members of the public should be excluded from the work area, with adequate warning signs placed on all approach routes.

14.10 ADVERSE IMPACTS

- **Lack of consultation with relevant authorities, interest groups and the local community**
- **High costs due to poor planning and design**
- **Loss of crop production due to excessive roading and landing areas**
- **Disruption to public roads due to poorly designed entrances**
- **Poor visual impact on slopes**
- **Reduced slope stability**
- **Erosion, with sediment entering aquatic zones**
- **Impaired water quality and restricted fish passage due to poorly designed crossings**
- **Future safety risks due to poor design**
- **Shortened road lifetime due to poor maintenance**
- **Failure to implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors, with subsequent damage**
- **Improperly sited maintenance, refuelling and storage areas, leading to contamination of aquatic zones**
- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones and archaeological sites**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements during construction**
- **Poor, incomplete records of operations and associated expenditure**

14.11 BEST PRACTICE

- **Consult with relevant authorities, interest groups and the local community**
- **Good design with appropriate density**
- **Implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors**
- **Maintain the necessary buffer and exclusion zones in relation to aquatic zones and archaeological sites**
- **Notify relevant authorities immediately of accidental damage to aquatic zones or archaeological sites**
- **Employ competent engineering staff**
- **Employ suitably trained, qualified and experienced operators**
- **Minimise the area of disturbance**
- **Avoid wet and unstable sites, and sites prone to erosion**
- **Utilise ridge tops, where possible**
- **Keep gradient low, where possible**
- **Ensure entrances from public roads are properly designed**
- **Avoid construction before, during and after wet conditions**
- **Reseed unstable spoil**
- **Minimise and balance cutting and filling**
- **Allow the road to settle and dry out before use**
- **Ensure adequate drainage and run-off control, installing sediment traps, if required**
- **Proper design for bridges and culverts to allow unhindered fish passage**

- **Correct slopes and angles for water crossings**
- **Keep roads away from aquatic zones, where possible**
- **Keep spoil and residues out of aquatic zones**
- **Adequate monitoring and maintenance, particularly of old roads and drains constructed prior to the issuing of environmental guidelines**
- **Adhere to workplace safety requirements for operators during both construction and use**
- **Locate refuelling, maintenance and storage areas at least 50 m from the nearest aquatic zone**
- **Keep a complete record of operations and associated expenditure**

14.12 REFERENCE MATERIAL

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15. REFORESTATION AND WOODLAND IMPROVEMENT

Although site conditions may be difficult when a crop has been removed, many features, such as roads, bridges and drains, are already in place for the next rotation. Reforestation represents an opportunity to improve the forest in terms of species diversity, production and cultivation. Reforestation also provides a unique opportunity to enhance the forest's biodiversity and landscape functions and to establish aquatic buffer and archaeological exclusion zones which may have been absent in the previous rotation.

The initial appearance of a reforested area is likely to be untidy, but this negative impact can be minimised by care in handling brash and by diversifying species in strategic locations. Entrances can also be redesigned at this time.

The improvement of other woodlands, particularly degraded broadleaf areas, will also increase productivity and enhance appearance.

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15.1 KEY FACTORS

- **Reforestation obligations**
- **Planning the replacement crop**
- **Scheduling reforestation**
- **Ground conditions after harvesting - rocks, roots and stumps**
- **Other features - remains of previous woodland**
- **Species selection - diversity, stocking**
- **Site preparation, waterlogging, rehabilitating drains**
- **Cultivation equipment**
- **Landscape, biodiversity, aquatic and archaeological considerations**
- **Protection against large pine weevil and deer**
- **Weed control**
- **Rehabilitation of old woodlands**

15.2 REFORESTATION

In general, forest owners are legally obliged to reforest felled areas.

15.2.1 Objectives

- **To establish a viable crop.**
- **To achieve improvements in terms of species diversity, forest design and stocking.**
- **To maintain and improve the protection of aquatic zones, archaeological sites and wildlife habitats.**
- **To maintain forest soil stability.**
- **To maintain the forest infrastructure.**

15.2.2 Choice of species

Overall site and species suitability is described in SECTION 3: NEW PLANTING SITES and SECTION 4: SPECIES SELECTION.

In many cases reforestation will be replacing the first rotation produced on the site. In Ireland, the first rotation is very likely to have been Sitka spruce or lodgepole pine on poor soils.

Reforestation represents an opportunity to increase the range of species on the site in the light of experience gained during the previous rotation. While it is important for the forest owner and manager to maximise returns by selecting the most productive species, it is likely that site differences will allow some increase of diversity without severely impacting on production. For example, larch can be introduced on drier patches within a wet site, thereby increasing species diversity. Overall, species diversity will improve the forest's biodiversity, landscape and amenity functions, as well as expanding its product range. Allowing small areas of scrub to develop also enhances biodiversity.

Apart from scattered groups of suitable trees, previously stocked areas adjoining aquatic zones must be left unplanted during reforestation. The width and treatment of the protective buffer zone is detailed in the FORESTRY AND WATER QUALITY GUIDELINES. Exclusion zones around archaeological sites and monuments set down in the FORESTRY AND ARCHAEOLOGY GUIDELINES must also be adhered to at reforestation. Important habitats should also be identified for retention at reforestation, along with other measures to enhance biodiversity e.g. retention of older trees and deadwood (see FOREST BIODIVERSITY GUIDELINES).

A greater diversity of species can be achieved along road edges where the presence of spoil creates more fertile conditions. Larch and less site-demanding broadleaf species, particularly of native provenances, can be used to mitigate the visual impacts of harvesting near public roads and entrances (see FORESTRY AND THE LANDSCAPE GUIDELINES).

A commitment to species diversity implies the introduction of a wider range of conifers on drier sites previously planted with Sitka spruce, and more broadleaves on the better conifer sites which might have been previously planted with larch, Douglas fir or Norway spruce.

15.2.3 Cultivation

A good harvesting operation will leave low stumps 5-10 cm in height. Stumps need not be removed for reforestation purposes, but the presence of brush may give rise to certain practical difficulties. This can be managed by burning the material or by piling it into rows (windrowing). Burning is not often recommended as it can reduce soil fertility. It can also give rise to group dying of conifers (*Rhizina undulata*), which becomes evident as the trees mature.

Care must be taken when windrowing in order to avoid removing the topsoil during the operation. Windrowing may not be advisable for shallow infertile soils.

Excavating may be required to open up drains and to carry out mounding. Windthrown areas may require special attention, as uprooting causes disruption to drains and waterlogging.

As with afforestation, ground preparation and drainage during reforestation can have serious implications on water quality and fisheries. Although old drainage systems may be more stable, sediment traps should be installed where necessary and the direct entry of collected water into aquatic zones avoided at all times. See SECTION 5: SITE PREPARATION FOR AFFORESTATION. Adhere to FORESTRY AND WATER QUALITY GUIDELINES at all times.

15.2.4 Plant stocking

In general, stocking is as for afforestation (see SECTION 6: PLANTING). Areas under windrows should be compensated for by changes in plant alignment.

Tree shelters may be needed for difficult conditions, for example, where heavy vegetation competition or browsing threatens survival.

Natural regeneration occurs fairly frequently after clearfelling and can be managed for reforestation purposes. Sitka spruce and lodgepole pine have both adapted well to Irish conditions and are capable of undergoing profuse natural regeneration. Very dense stocking can develop and these areas should be well respaced before they become strongly established (1 m in height). Various methods include clearing saws or chemical treatment. Vigorous and well-formed trees should be selected. Natural regeneration can be patchy and inter-planting will probably be necessary. Many broadleaf species regenerate naturally. Old ash sites can regenerate profusely.

15.2.5 Cultivation machinery

The presence of features remaining from the previous crop, such as drains, old cultivation and stumps, may create problems for machinery use. For example, low ground clearance excavators may have to operate at a slower speed in order to avoid damage. Custom-built rippers and scarifiers, often equipped with accessories to accumulate brush material, may be suitable, particularly on dry sites. Attention should be given to the correct type and dimensions of excavator buckets.

15.2.6 Protection

15.2.6.1 Exotic pests

The conditions required by the European Union Plant Health Directive (Council Directive 77/93/EEC) also apply to planting stock used for reforestation purposes (see SECTION 8: FOREST PESTS AND DISEASES).

15.2.6.2 Large pine weevil and other endemic pests

Stumps left after felling provide ideal breeding material for the large pine weevil (*Hylobius abietis*) (see SECTION 8: FOREST PESTS AND DISEASES). General treatment involves post-planting spraying. The permethrin-based product Permasect has been approved for forestry use in Ireland. Permethrin is a pyrethroid insecticide. It is applied mainly by directed spraying onto the main stem of newly planted trees. Careful application and strict adherence to manufacturer instructions and FORESTRY AND WATER QUALITY GUIDELINES are required to minimise any risk to the operator and the environment.



Large pine weevil poses a severe threat to newly planted trees on reforestation sites.

Other pests, such as aphids and shoot damaging insects also occur (see SECTION 8: FOREST PESTS AND DISEASES).

15.2.6.3 Diseases

Butt rot (*Heterobasidion annosum*) can cause serious damage to conifers during the subsequent rotation, particularly if stump treatment is inadequate at harvesting (see SECTION 8: FOREST PESTS AND DISEASES for protective treatment).

15.2.6.4 Mammals

Reforested areas are often quite susceptible to trespass and grazing, particularly by deer. The risk of damage from browsing is high wherever Sitka spruce is replaced with any other species. In many areas, the establishment of species other than Sitka spruce will not be possible without expensive protection, including fencing. Bank voles also find shelter on clearfell sites. These are to be found mainly in the south-east of the country, but are spreading. Domestic animals are less likely to cause damage, as the rough ground conditions make the site less accessible. However, it is necessary to take the precaution of providing adequate fencing to keep stock out. Grey squirrel will constitute a threat to developing broadleaf plantations. Poisoned bait can be used but not where red squirrels are present. Trapping or shooting may also be used. Effective control is confined to spring/early summer.

See SECTION 5: SITE PREPARATION FOR AFFORESTATION and SECTION 8: FOREST PESTS AND DISEASES for further details on controlling trespass and browsing.

15.2.7 Weed control

Vegetation is usually vigorous on reforested sites. In general, apply measures detailed in SECTION 7: VEGETATION MANAGEMENT. Predominant vegetation on reforestation sites includes bramble, furze, grass, broadleaf weeds and naturally regenerating broadleaf species. Common herbicides include asulam, glyphosate, triclopyr and terbuthylazine, applied as outlined in SECTION 7: VEGETATION MANAGEMENT. A balance should be kept between competition control and the contribution of vegetation to site biodiversity.

15.2.8 Storage and use of chemicals

All safety and environmental precautions and procedures relating to the preparation, transport and application of herbicides and pesticides (as described in SECTION 7: VEGETATION MANAGEMENT and set out in the FORESTRY AND WATER QUALITY GUIDELINES) must be followed. All chemicals should be securely stored on a sheltered, dry and elevated site at least 50 m from the nearest aquatic zone.

15.2.9 Sensitive sites

Site disturbance during felling and reforestation may make sensitive areas such as aquatic zones, archaeological sites and retained habitats difficult to locate or identify. The location of such features should be included in the harvesting plan, with associated protective buffer and exclusion zones clearly marked on the ground during operations (see FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FOREST BIODIVERSITY GUIDELINES and FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES). As described earlier, use the opportunity presented by felling and reforestation to introduce protective aquatic buffer and archaeological exclusion zones which may have been absent during the previous rotation.

15.2.10 Landscape

Felling and reforestation provides an opportunity for better landscaping in large forest blocks. Interest groups should be consulted well in advance of planting and proposed changes made clear through maps, models or computer-generated images. Measures may include changing boundaries and species, leaving pockets or corridors, and incorporating unplanted river valleys, hedgerows or broadleaf trees in the forest landscape. In large forest areas, reforestation programmes should be scheduled to complement other landscape features. See FORESTRY AND THE LANDSCAPE GUIDELINES. Biodiversity enhancement can also occur in tandem, especially where groups of broadleaves or small pockets of scrub are retained from one rotation to the next (see FOREST BIODIVERSITY GUIDELINES).

15.2.11 Maintenance and tending

Maintenance and tending operations specified for afforestation are also relevant to reforestation (see SECTION 9: FOREST MAINTENANCE and SECTION 10: TENDING). As previously described, deer fencing may be necessary to a greater degree if species diversity is increased. Crop development needs to be monitored for vitality and condition and evidence of disease or pests.

15.2.12 Access, roads and bridges

The question of additional infrastructure will not be as crucial for reforestation and the subsequent rotation as it is for the first rotation. For example, a road system will already have been constructed during the establishment, thinning and felling of the first rotation. However, due to wear and tear at harvesting, repairs and maintenance will be necessary. Additional improvements, e.g. turning points, stabilisation and landscape measures, can also be carried out at reforestation. As outlined in SECTION 14: FOREST ROADS and stipulated in the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FORESTRY AND WATER QUALITY GUIDELINES, care must be taken to avoid damage to aquatic zones and sensitive sites during roadworks.

15.2.13 Signage

Notices should be placed near entrances from adjoining public roads, to indicate that felled areas have been reforested. This measure helps to reduce public disquiet relating to harvesting operations. Irish language notices should be used where appropriate.

15.3 WOODLAND IMPROVEMENT

Woodland improvement usually refers to rehabilitating older forest areas which have been degraded through neglect, or increasing and extending the range of forest uses through the provision of additional amenities.

15.3.1 Degraded woodland

Improvement in degraded woodland can be achieved through the creation of sensitive felling/replanting coupes, respacing, thinning and pruning. Natural regeneration can be encouraged where gaps have occurred through windthrow. Some minor soil and site improvement work may be necessary.

Tracks and walking and riding paths can be opened up. Signage and some public facilities can be introduced if recreation is to be a function. Open spaces can be enhanced and local wildlife habitats developed and protected.

15.3.2 Remnant woodland and individual trees

Depending on the potential of the remaining trees, remnant woodland cover left after storms, exploitation or neglect can be felled and reforested or allowed to regenerate, while holding on to those remaining trees with some potential. Natural regeneration may be feasible for smaller areas, provided there is some seed tree potential. Patches of remnant woodland can be incorporated as features which add variety to the forest as a whole.

15.3.3 Hedgerows and single trees

Hedgerows are a major feature of the Irish landscape and are important as wildlife corridors for both flora and fauna. Unless specific measures are deployed, the conversion of farmland to forestry can result in the loss of these important features. Hedgerows, particularly those along major boundaries and public roads, should be retained as important habitats within the forest (see FOREST BIODIVERSITY GUIDELINES). With careful selection and attention during hedgerow maintenance, single hedgerow trees can be allowed to develop into valuable commercial stems.

Single or small groups of trees located on open spaces both within the forest and between the forest edge and the property boundary can enhance the amenity value, landscape and biodiversity of the forest. See FORESTRY AND THE LANDSCAPE GUIDELINES,



Degraded woodland can be improved through the creation of several small scale felling/replanting coupes. Through gradual expansion, these coupes eventually merge together to rejuvenate the entire woodland canopy.

FORESTRY AND WATER QUALITY GUIDELINES and FOREST BIODIVERSITY GUIDELINES for further details.

15.3.3.1 *Dangerous roadside trees*

It should be noted that forest owners have a responsibility to take all reasonable steps to ensure roadside trees on their lands do not pose a hazard, as they can be held liable if, due to negligence, injury or death is caused. See *Guidelines on the Recognition of Dangerous Trees*, available from the Forest Service.

15.4 ADVERSE IMPACTS

- **Felling and reforestation take place without any consultation with relevant authorities, interest groups and the local community**
- **Failure to avail of opportunities presented by reforestation to diversify species**
- **Failure to avail of biodiversity and landscape opportunities**
- **Areas neglected or operations delayed, leading to reforestation difficulties**
- **Unsuitable cultivation equipment used**
- **Poor site conditions after cultivation**
- **Improperly sited maintenance, refuelling and storage areas, leading to contamination of aquatic zones with fuel and machine oils**
- **Failure to implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors, with subsequent damage**
- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones and archaeological sites**
- **Severe weed competition**
- **Large pine weevil infestation**
- **Failure to adhere to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of herbicides and pesticides and the maintenance of application equipment, resulting in operator exposure and contamination of aquatic zones and other environmental damage**
- **Deer damage**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Roading neglected**
- **Opportunities to improve woodland missed**
- **Poor, incomplete records of operations and associated expenditure**

15.5 BEST PRACTICE

- **Consult with relevant authorities, interest groups and the local community, particularly for large areas**
- **Good reforestation plan**
- **Avail of opportunities to diversify species**
- **Avail of biodiversity and landscape opportunities**
- **Effective brush management**
- **Select appropriate cultivation machinery**
- **Implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors**
- **Maintain the necessary buffer and exclusion zones in relation to aquatic zones and archaeological sites**
- **Notify relevant authorities immediately of accidental damage to aquatic zones**
- **Locate refuelling, maintenance and storage areas at least 50 m from the**

nearest aquatic zone

- **Ensure adequate vegetation management and pest control**
- **Strict adherence to the relevant safety and environmental procedures relating to the preparation, storage, transport and application of herbicides and pesticides and the maintenance of application equipment**
- **Adequate fencing, particularly against deer**
- **Adequate maintenance of young forest and roads**
- **Improve degraded woodland**
- **Extend woodland uses**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**
- **Keep a complete record of operations and associated expenditure**

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16. BIODIVERSITY AND SPECIALISED WOODLANDS

Numerous measures can be implemented to enhance the biodiversity function of Ireland's production forests. Protective measures are also needed for forests located in nationally designated conservation areas.

Specific activities are required for the management of forests for non-wood products, and also for specialised forests such as riparian and urban woodland and short rotation crops.

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16.1 KEY FACTORS

- Increasing biodiversity in all forests
- Categories of Irish forests
- Management strategies for biodiversity in Irish forests
- Management opportunities in native and semi-natural woodland
- Habitat protection
- Management of urban woodland
- Management of forests for other non-wood functions
- Operational issues in intensively managed short rotation forests
- Specialised forestry considerations

16.2 OBJECTIVES

- To extend the understanding and application of biodiversity principles.
- To ensure the status of other non-wood functions.
- To ensure the protection, management and regeneration of native and semi-natural woodlands and their associated habitats.
- To identify and apply best practice for urban and amenity woodland management.
- To minimise the environmental impacts of intensive management practice in short rotation forests.

16.3 BIODIVERSITY

Biodiversity describes the variability among living organisms and the ecosystems of which they are part. Three conceptual levels of biodiversity are recognised: ecosystem; species; and genetic. Biodiversity issues are fully dealt with in the GUIDELINES FOR FOREST BIODIVERSITY and supporting literature, and are summarised here in the context of non-wood forest functions.

Forest owners and managers should be aware of the legislation impacting on the use of land for forestry. These include: the European Union Habitats Directive (Council Directive 92/43/EEC) and Birds Directive (Council Directive 79/409/EEC) and associated Special Areas of Conservation (SACs) and Special Protection Areas (SPAs); the proposed Natural Heritage Areas (pNHAs) identified by Dúchas The Heritage Service; guidelines on the Pan-European Landscape Diversity Strategy; and the Wildlife Act 1976 and the Wildlife (Amendment) Bill 1999.

16.3.1 Biodiversity and Irish forests

Irish forests can be classified as follows:

- native woodland forming the following broad categories: acidophilous oak (mainly sessile) forest; mixed pedunculate oak/ash forest with hazel; and wetland/riparian woodland comprising alder, ash, birch and willow (these can again be subdivided, depending on species distribution and dominance);
- semi-natural forests - predominantly broadleaf, although some include conifers;
- coniferous forests planted during the 1900s;
- grant-aided young forests, both conifer and broadleaf, planted since 1990.

In some cases, the replacement of non-forest habitats with forests may reduce biodiversity, at least on a temporary basis. However, in most situations, the change enhances biodiversity, particularly from an agricultural landuse.

16.3.2 Species

Ireland's native forests comprise sessile and pedunculate oak, common ash, elm, birch species, alder, holly, rowan, willow, aspen, cherry and also yew and juniper, with associated shrub and ground layers comprising various grass, sedge, moss and fern species. Semi-natural forests have a high proportion of native species, with some non-natives such as beech, lime, sycamore, chestnut and conifers such as silver fir.

16.3.3 Planning and managing for biodiversity

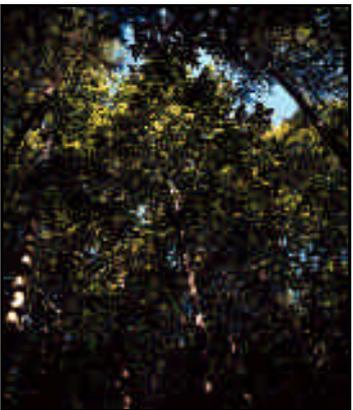
Managers should make provisions for maintaining and enhancing biodiversity in both new and existing forests. Biodiversity considerations should be incorporated into all forest development, harvesting, roading and maintenance plans, with periodic reviews



The treecreeper is one of many bird species closely associated with trees and woodlands in Ireland.



Incorporate existing pockets of broadleaf woodland (above) and other important wildlife habitats into the site development plan.



A diverse, multi-layered canopy creates a greater range of habitats within the forest.



Deadwood left on the forest floor enhances biodiversity opportunities.

to take account of new species arrivals, new research findings and other changing circumstances. While sustainable forest management practices will, as a whole, benefit biodiversity, the following measures are emphasised (see FOREST BIODIVERSITY GUIDELINES):

- The site's location adjacent to or within SACs, SPAs or pNHAs should be taken into account during the site development plan, with Dúchas The Heritage Service consulted on how best to plan the forest in relation to these areas.
- Identify and incorporate local biodiversity factors into the site development plan, including locally important habitats (e.g. hedgerows, pockets of scrub and native woodland, ponds, peaty hollows, rocky outcrops, etc.) and species of particular interest.
- Adhere to FORESTRY AND WATER QUALITY GUIDELINES regarding the protection of aquatic zones and associated wildlife.
- Species diversity contributes to the habitat value and biodiversity of a forest. Mixtures can include native and non-native broadleaves and conifers, and must be silviculturally compatible.
- Favour broadleaf species as much as possible, where appropriate to site conditions. In conifer forests, plant broadleaves in swathes (particularly along external and internal margins) and not as single stems within the canopy.
- Where possible, select native tree species suited to the site and geographical location, ideally using local or Irish provenances.
- If non-native species are being used, include at least two species in the mix. In all cases, the dominant species should account for no more than 80% of the mix.
- If possible, use natural regeneration of native and other desirable species on the site, particularly along the forest edge.
- Where possible, retain existing hedgerows, areas of low-lying scrub, pockets of native broadleaf cover and individual old trees to form wildlife corridors between forest patches.
- Encourage age diversity within the forest, where size permits. This may be achieved over time in even-aged forests through the staggered felling/replanting of coupes, or on new sites through staggered planting of adjacent coupes at different time intervals.
- Different tree species occupy different storeys within the forest canopy. Select species to encourage the development of a multi-storey canopy, in order to provide structural diversity. However, ensure species compatibility.
- Old trees are important in forest biodiversity, as they provide a range of additional habitats. Retain some stems to grow on to old age, ideally scattered throughout the forest.
- Some deadwood should be left *in situ* after both thinning and final harvesting. Deadwood can be left in the form of standing dead stems or naturally fallen trunks (if present), or as logs deliberately left behind on the forest floor.
- Proactively manage open spaces enforced by management operational requirements or by the FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES and FORESTRY AND THE LANDSCAPE GUIDELINES, with a view to capitalising on their biodiversity potential.
- Retain and proactively manage locally important habitats present on the site, as identified in the site development plan, to conserve and enhance these habitats and to facilitate the development of associated native flora and fauna. If necessary, information on suitable management approaches for retained habitats can be obtained from relevant organisations and agencies.
- Minimise the use of chemicals such as herbicides and pesticides. Carefully assess the need for application, and apply only when necessary. Adhere strictly to manufacturer instructions and FORESTRY AND WATER QUALITY GUIDELINES at all times.
- It is essential to protect against deer in areas where natural regeneration is being encouraged.
- Control exotic woody species such as rhododendron and laurel throughout the rotation, as these suppress the native shrub and ground layers.
- During all forest operations, avoid soil damage and minimise general site disturbance. Follow correct procedures for all machine operations throughout the rotation. In all cases, adhere to FORESTRY AND WATER QUALITY GUIDELINES and FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES.
- Plan all forest operations with due regard to the breeding and nesting seasons of important species, and associated features such as badger setts and heronries.
- Ensure that all hazardous material and general litter are removed from the site for correct disposal.

16.3.4 Regeneration

Appropriate stocking is essential whenever attempting to regenerate native or semi-natural woodlands. Forms of continuous cover management may be appropriate where site conditions allow. Young woodlands are extremely vulnerable to grazing, and protective fencing is essential for the establishment of broadleaf and diverse forests.

16.4 OTHER NON-WOOD FUNCTIONS

16.4.1 Recreation and amenity

Increased access to all forests has resulted in a high level of forest visits in Ireland. Activities such as walking, orienteering, pony trekking and cycling are commonplace, and the value of forests in providing a recreational and cultural environment, particularly for urban dwellers, is now an important function. Large numbers of people visit public forests and increasingly, private owners are opening up woodlands as part of wider commercial enterprises.

16.4.2 Carbon storage

In the context of the ongoing debate over climate change, the capacity of forests to sink greenhouse gases has come into sharp focus in recent times. Ireland's significant current economic growth highlights the issue of surplus emissions. All forests store carbon for lengthy periods, both short- (as biomass production) and long-term (through soil changes over long rotations). Forest owners have a valuable national resource and carbon storage potential should be included where possible in forest inventories.

16.4.3 Non-wood products

As public affluence increases, the demand for traditional products from the forest is growing. Foliage and Christmas trees are now significant seasonal markets. More emphasis is being placed on seed from indigenous sources, and this in itself represents another form of non-wood produce. The use of forest biomass grown on a short rotation as fuel has been slow to develop in Ireland, but is likely to grow in line with emerging trends towards renewable resources.

The gathering of fruit, nuts and mushrooms in forests, particularly common in Nordic countries, has not reached commercial development in Ireland. However, this sector may develop in line with a higher profile forest culture.

All of these non-wood products require specific planning and operational approaches to be adopted by forest owners and managers. A forest devoted to a specialised product will have its own schedule of operations governing establishment, management and harvesting. The successful production of non-wood material within forests grown primarily for commercial timber production will require changes in conventional forest practices and operations, and specific plans will be necessary.



Rhododendron (above) and laurel suppress ground vegetation and must be removed from areas where natural regeneration is being encouraged.

16.5 SPECIALISED FORESTS

16.5.1 Conserved native and semi-natural forests

Conserved native and semi-natural forests refer to areas within SACs. They have a high importance as gene and ecosystem resources in the national effort to conserve biodiversity. They are regulated by European and national legislation through the EU Habitats Directive and Regulation SS 94/1997, which provides the national statutory framework. Contravention of this legislation is an offence.

Many important native and semi-natural woodlands have been identified as SACs, with oak, ash, hazel, birch and alder representing the main species. Approximately 6,000 ha are owned by Dúchas as nature reserves, but considerable areas are under private ownership.

Forest management can be permitted in these areas, if the primary objective is to maintain a favourable conservation status.

Fencing to exclude browsing and to allow natural regeneration is required in many

areas due to the high grazing pressure from sheep and deer. Removal of unwanted species such as rhododendron will require specific operations to be carried out. Selected overmature stems are often removed to create gaps for natural regeneration. The use of chemicals should be avoided or kept to a minimum, with strict control over forest machinery.

A high degree of consultation is necessary between owners, managers and the relevant forest and heritage authorities.

16.5.2 Other woodlands of conservation value

Other woodlands of conservation value relate to areas not currently protected by legislation but which fall within pNHAs or which may be given a statutory basis under the forthcoming changes to the Wildlife Act.

Dúchas estimates that approximately 30,000 ha of woodland could fall within this framework, within which conservation will form a key objective for management alongside with timber production. This category may include native broadleaves, beech, sycamore and other naturalised broadleaves, along with 5,000 ha of conifers.

These areas exist within both the public and private forest estate. As with woodlands within SACs, their management will depend on a high degree of co-operation. Distinct approaches may be needed for establishment and harvesting operations, selection of species and rotation policies.

16.5.3 Riparian woodlands

Riparian woodlands perform an important role as the meeting point between two ecosystems: terrestrial and freshwater. Their increasingly recognised benefits arise through the ability of these woodlands to provide variable shade and shelter for fish and other aquatic life. They stabilise river banks and maintain nutrient balance through the modest input of organic matter. Riparian woodlands act as a physical buffer between the aquatic zone and the commercial forest cover, have a high amenity value and fit in well with landform. Natural riparian tree species are relatively abundant in Ireland and include birch, alder, willow, rowan, oak and ash.

FORESTRY AND WATER QUALITY GUIDELINES stipulate the introduction and maintenance of protective buffer zones adjoining aquatic zones. While buffer zones are to remain largely unplanted, the establishment of groups of riparian tree species, either through planting or the encouragement of natural regeneration, is permitted. These groups form components of a riparian woodland ecosystem. It is important to note that riparian woodland can extend beyond the required buffer zone to enclose a wider area of the forest.

The preferred management of riparian woodlands is to encourage natural regeneration by reducing grazing levels. The use of heavy machinery or chemicals is discouraged and may be forbidden altogether, depending on the distance from the aquatic zone (see FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FORESTRY AND WATER QUALITY GUIDELINES). Some motor manual felling and extraction by low ground pressure machinery may be desirable to introduce appropriate levels of cover. Exotic colonising species such as laurel and rhododendron should be removed. Planting may be necessary in some situations, for example, where seed sources for natural regeneration are inadequate or where the site is subjected to severe livestock grazing pressure.

16.5.4 Urban woodlands

The urban forest comprises the entire tree population within an urban area, from street trees and garden trees to trees in public parks and areas of urban woodland. Urban woodlands in particular offer a large range of social, environmental and economic benefits, are capable of absorbing a large number of visitors, and provide an ideal opportunity to demonstrate good forest practice to the urban population. Urban woodlands, and the urban forest resource as a whole, are becoming increasingly recognised as a vital component of the urban infrastructure essential in underpinning the quality of life and the environment in towns and cities.

In other European countries, the management of urban woodlands is largely based on



Urban woodlands represent an invaluable resource and refuge for urban dwellers, but a specific management approach is required to take account of factors associated with their location within towns and cities.

traditional forestry in terms of providing a sustainable canopy cover and hence, the continuous production of associated benefits to users and the wider urban population. Long-term planning and regular management, backed up with secure funding and based on a high degree of co-ordination and consultation between all relevant professionals and the local community, are essential ingredients for successful urban woodland development.

Management must consider practicalities specific to woodland development in the urban environment. These include: vandalism and unintentional damage; safety and security of both users and adjacent residents; inappropriate uses such as mountain biking and horse grazing; 'fly-tipping' and general litter control; intense usage levels and the incorporation of existing 'natural desire lines'; the need to cater for a wide range of activities; and site conditions problematic for tree growth (e.g. former landfill sites, compacted soil, building debris). Careful attention is also required to minimise conflict with existing urban infrastructural features and related factors (e.g. overhead and underground utilities, planning objectives and proposed developments) and to maximise opportunities for integration (e.g. linkages with existing pedestrian or cycle routes).

16.5.5 Small scale coppice woodlands

The number of small scale coppice woodlands of native species is increasing. The potential of areas traditionally defined as 'scrub' is now beginning to be realised, e.g. craft-based enterprises, joinery, wood turning, charcoal, basket making. A wide range of traditional low-impact management crafts are involved. Such areas can be established and managed either as discrete woodlands or as components of larger woodlands.

16.5.6 Seed stands

Some stands are reserved for seed selection. Stands of scheduled species approved by the EU are listed and catalogued as required under EU Council Directive 66/404/EEC on the marketing of forest reproductive material. These will have been selected for required genotype and phenotype characteristics. For commonly planted species, the most cost-effective method of collection is from trees felled during thinnings or at clearfell, on the basis that these operations take place during seed years. For less common, long rotation species and broadleaves, other methods may be necessary, including climbing and ground collection. Natural regeneration from conifer standards, where adequate seed following a mast year is left to regenerate on a clearfell site, is rarely practised in Ireland. The practice is more common with broadleaves. The Forest Service must be notified of the intention to fell seed stands. See SECTION 1: FOREST REPRODUCTIVE MATERIAL.

16.5.7 Short rotation crops

Short rotations are usually understood as being less than ten years. Short rotation forestry is considered part of the overall forest sector, although it overlaps with agriculture to some extent. Apart from some common operational difficulties, short rotation forest crops are generally managed quite differently from timber producing forests. Felling licences may not be required for some short rotation crops.

16.5.7.1 Short rotation biomass forestry

Short rotation biomass forestry usually involves growing willow or poplar from clones or cutting over a 5-7 year rotation, specifically for the production of fuel.

Biomass forests require fertile soil. Stems are planted at wide spacing in order to encourage rapid stem and shoot growth and to facilitate harvesting. Issues requiring particular attention include stocking levels, the amount of fertiliser required, and weed and pest control.

The size and bulk of the harvested material and the lack of a well-developed root mat to support machinery will warrant specialised harvesting systems. Adherence to environmental controls applied to farming will be required where cropping takes place at regular intervals.

Short rotation biomass forestry is a specialised activity. A volume of specific literature is available to those involved and can be obtained through the Agriculture and Forestry

Biomass Network (AFB-NETT), which supports biomass energy in the EU.

16.5.7.2 Christmas trees

Christmas tree farms are similar to nurseries and involve the growing of young conifers under intensive management.

As with nurseries, strict controls on the use and storage of chemicals and fertilisers are required (see SECTION 2: NURSERY PRACTICE). Depots, buildings and structures, together with roads, entrances and loading bays, should be well-maintained and in accordance with Local Authority requirements.

Christmas tree farms are subject to the requirements of the EU Plant Health Directive 77/93/EEC (see SECTION 8: FOREST PESTS AND DISEASES).

16.6 ADVERSE IMPACTS

- **Biodiversity considerations ignored**
- **Misinterpretation of biodiversity issues**
- **Lack of consultation with relevant authorities and interest groups**
- **Damage to retained habitats, including native and semi-natural woodland, through forest operations**
- **Failure to avail of biodiversity opportunities**
- **Damage through woodland neglect**
- **Difficulties in securing natural regeneration**
- **Problems in urban woodlands, such as vandalism, safety and litter**
- **Damage to seed stands or research areas due to forest operations**
- **Environmental aspects of specialised forests overlooked**
- **Impacts of intensive short rotation management, such as ground damage and nutrient loss**

16.7 BEST PRACTICE

- **Ensure understanding of biodiversity values, principles and objectives**
- **Identify features of native and semi-natural woodland**
- **Ensure that existing habitats, including native and semi-natural woodlands, are protected**
- **Recognise biodiversity issues and opportunities in plantation forests**
- **Consult with relevant authorities, interest groups and the local community**
- **Undertake appropriate levels of management**
- **Create suitable conditions for natural regeneration of desirable species**
- **Apply appropriate level of control and management in urban woodlands**
- **Ensure protection of forests assigned specialised objectives**
- **Ensure adequate control of short rotation forest management in relation to fertilisers, chemicals and harvesting**
- **Extend woodland uses**

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17. FOREST PLANNING

Managing a forest is a long term process and is subject to a range of influences. All forestry enterprises - from small woodlands to substantial forest areas - require some level of planning in order to anticipate and manage operational, production and environmental policies and objectives.

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17.1 KEY FACTORS

- Plans in a national context
- Plans in a regional context
- Forest management plans
- Strategic issues
- Tactical issues
- Operational issues
- Aids to planning
- Records

17.2 OBJECTIVES

- To facilitate the orderly establishment, development and management of forests.
- To facilitate forest management processes in the context of competing interests.
- To schedule forest operations in an optimal way.
- To arrive at the best operational solutions.
- To measure achievement against objectives.
- To ensure good records and communication.

17.3 NATIONAL PLANS

National forest planning is undertaken under governmental and sectoral policies and strategies. In Ireland, national forest strategy is expressed in detail in *Growing for the Future: A Strategic Plan for the Development of the Forestry Sector in Ireland*. For national plans to be effective, broad agreement must be reached across the various interests, particularly at government levels and within European Union policies.

The impact of national planning on the forest owner and manager is limited to obligations arising through national or EU legislation and international agreements, participation in periodic surveys, and uptake of grant-aided schemes.

National plans can have major impacts on how forest practice will be encouraged or constrained. It is therefore advisable for the forest owner and manager to be aware of where his/her particular enterprise fits in with the overall national forest context.

17.4 REGIONAL PLANS

All counties have individual Development Plans. Local Authorities are directed by the Department of the Environment and Local Government to include forestry in regional indicative strategies within these plans. These will involve issues which impact on forestry, such as country roads, planning considerations, water and landscape. Various levels of consultation will be necessary. Forest owners may be expected to submit details of intended developments and operations. Currently, Local Authorities must be notified of intended afforestation greater than 25 ha in area. Planning permission involving environmental impact assessment is mandatory on areas in excess of 70 ha.

Regional planning issues will arise with the larger and more widespread forest companies who own or manage forests across the country, but are unlikely with smaller or farm forestry enterprises.

In the case of large forest companies, different approaches may be needed on a regional basis for activities such as planting, roading and access, and policies relating to landscape, wildlife and the environment. Co-operative initiatives between forest owners may be useful.

Forest owners and managers should consult with the Forest Service, Dúchas The Heritage Service, Local Authorities, Regional Fisheries Boards, environmental organisations and farmer groups, to keep aware of potential opportunities and constraints.

17.5 FOREST PLANS

For developments greater than 10 ha in area, it is advisable to prepare and update a forest plan. This is mandatory for grant purposes. The following should be encompassed:

- ownership details;
- records (activities, materials, costs) of past operations;
- schedules of further operations;
- maps indicating property and management units, site and stand details, and special features;
- inventory information from which forecasts can be made.

Forest plans have strategic, tactical and operational components. These can in turn be broken down into establishment, management, harvesting and roading elements.

17.5.1 Strategic planning

This presents a broad focus on how the resources of an estate or forest district are to be utilised. Its main components are:

- identifying the important forest values, environmental, economic and social;
- consultation processes with relevant agencies and groups;
- measures stipulated by the various environmental guidelines (FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FORESTRY AND THE LANDSCAPE GUIDELINES, FOREST BIODIVERSITY GUIDELINES and FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES) and relevant to the site;
- information needed for environmental impact assessments, if required;
- maps on a forest/estate scale (1:10,000-1:50,000) indicating geographical features, terrain types and soils, management units by species or age, protected or special areas, roads, crossings and bays, and site structures such as buildings, transmission lines, etc.;
- identification of problem areas and likely impacts;
- management regimes allocated to areas, including schedule of operations consistent with these and with environmental and social constraints, appropriate equipment and machines, and growing stock inventories.

17.5.2 Tactical planning

Tactical planning converts strategic plans into a series of management plans for the estate/forest in a shorter timeframe of 1-2 years. Values identified at the strategic level are recognised and considered in the context of technical feasibility and costs. The main components are:

- liaison procedures with agencies and groups;
- description of operations to be undertaken;
- measures stipulated in the various environmental guidelines and relevant to the site;
- large scale maps covering the area of operations and indicating local geographic features, management area boundaries, terrain classification zones, road networks associated with operations, protected and special areas, and required buffering of aquatic zones, archaeology features and habitats;
- crop details;
- management goals for crops;
- schedule of operations;
- necessary equipment;
- protective measures for the site.

17.5.3 Operational planning

Depending on how extensive the operation is and the area involved, the orderly achievement of forest operations also requires a degree of planning. Tactical planning can, if required, be broken down to the decisions involving specific operations, indicating time schedules, materials and other resources, with the capacity to review decisions in the light of new information on, for example, costs, resources and constraints. Also include measures stipulated in the various environmental guidelines and relevant to the site and the operations in hand.

17.5.4 Breakdown by operations

The main forest activities can be treated specifically within the different planning processes. These normally break down into establishment/management, harvesting and roads, as dealt with in relevant sections of the CODE OF BEST FOREST PRACTICE.

17.5.4.1 Establishment and management plans

These are formulated when new forest areas are developed or at reforestation. They include:

- location of access roads and rights-of-way;
- location of public utility lines crossing the site (e.g. electricity, telephone, water);
- drainage systems and waterflow;
- environmental site features and treatment, as stipulated by the relevant environmental guidelines;
- species selection;
- safe storage areas.

17.5.4.2 Harvest plans

These will be formulated well in advance of thinning or clearfelling once the production cycles have been identified. They include:

- schedule of stands to be harvested;
- details of stands to be harvested;
- terrain classification;
- existing road structure;
- existing and proposed road network and temporary structures;
- protected and sensitive areas and their treatment;
- extraction direction;
- machine/site suitability;
- safe storage areas.

See FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES for further details.

17.5.4.3 Roding

Specific elements should include:

- terrain features, geology, soils and topography;
- protected and sensitive sites and their treatment;
- other site features, including buildings and utility lines;
- road spacing and density;
- road design related to proposed traffic;
- bridges and other river crossings;
- safe storage areas.

See FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES for further details.

17.6 AIDS TO FOREST PLANNING

Paper records should be sufficient for owners with small forest areas, provided they are complete and kept up-to-date.

Most records can be stored on personal computers. While electronic map storage can be somewhat costly, particularly for smaller forest owners, this may be overcome by access to a management company which can provide the planning service.

The use of geographic information systems (GIS) in Irish forestry has increased rapidly in recent years. With appropriate software, forest maps can be stored on most of today's computers within a GIS framework. Maps can then be associated with data sets relating to the particular area, e.g. crop composition, site details, operations completed or to be undertaken, ownership and financial information. Maps can also be overlaid with other existing information, such as roads, fisheries, catchments, areas of scientific and conservation interest, archaeological sites, etc., to identify opportunities and constraints. Some of this information can be acquired free of charge, while some must be leased or purchased. For example, OS maps are the property of the Ordnance

Survey and must be purchased. Furthermore, their use is permitted only under certain conditions, with constraints on copying and sharing. Independently surveyed map information may be available with less constraints.

Silvicultural, species and growth models can also be incorporated into forest plans to provide production forecasts. Setting up a GIS-based and user-friendly management plan may require professional assistance.

17.7 FOREST INVENTORY AND PLANNING SYSTEM

The Forest Service has commissioned a Forest Inventory and Planning System (FIPS) to facilitate the national assembly, exchange and processing of forest area based information. This facility will be available to the forestry sector and to other interested agencies and individuals involved in planning or control activities.

The system has a number of key components:

- a forest classification system;
- species type and development categories;
- forest maps indicating location and composition of all forest areas;
- production forecast capacity (national);
- stand inventory information (regional);
- functions to support Forest Service activities (including grants and felling licences);
- information input and change capacity with forest owners/managers and land management agencies using other hard- and software.

A forest soils survey and a landscape reclassification are also being assembled as part of FIPS.

17.8 ADVERSE IMPACTS

- **Absence of or poor records**
- **No baseline information**
- **Poor monitoring**
- **Poor production and financial decisions**
- **Forest operations not co-ordinated with other interests**
- **Unsatisfactory audits**
- **Difficulties with relevant authorities**
- **Difficulties arising out of poor planning decisions**
- **Expense in amending practices**
- **Danger of arbitrary constraints**

17.9 BEST PRACTICE

- **Ensure clear records**
- **Ensure clear schedules**
- **Allow for flexibility in forest plans**
- **Easy access to material for consultation**
- **Information to avoid operational risks**
- **Information to avoid environmental risks**
- **Optimise management decisions**
- **Optimise financial decisions**
- **Ensure compatibility of forest planning with other planning processes**
- **Set up user-friendly system with maximum use of available data**

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18. TRAINING, COMPETENCE AND INFORMATION

In a changing forestry environment, forest owners, managers and operators need access to professional services, advice, assessment, training and information to ensure that forest practice conforms to quality standards and adapts to continuous improvement.

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18.1 KEY FACTORS

- **Quality of advice**
- **Quality of management**
- **Technical skills**
- **Competence in related activities**
- **Farm forestry needs**
- **Quality of professional courses**
- **Quality of training**
- **Assuring professional and technical competence**
- **Need for consultation**
- **Need for information**
- **Need for technology transfer of research results**

18.2 OBJECTIVES

- **To ensure a high quality level of advice, management and control in forest practice.**
- **To ensure the quality and relevance of forestry courses.**
- **To ensure availability of the most recent information for forest activities.**

18.3 ADVISORY SERVICES

A range of advisory services are on offer to forest owners, ranging from ways to maximise landuse options to advice on site, species, establishment and management techniques. Owners need advice on rotation lengths, harvesting, timber measurements and sales, and also on the environmental and business aspects of their operations.

It is essential that reliable advice is sought from individual organisations or groups properly qualified and experienced, whether this relates to the forest, environmental, business or engineering aspects of the overall forest enterprise. Entrants into farm forestry in particular will need a high quality of service to embark on this unfamiliar landuse. In all cases, owners should ensure that advisors are listed and approved.

18.4 FOREST MANAGEMENT

New and existing forest owners must have access to reliable management services or have reached a competent level of skill through training. Many courses have been organised by the Forest Service and Teagasc to familiarise farmers with the practical requirements of plantation forestry.

Forest owners should ensure that the management services they employ comprise qualified and experienced personnel.

Modern forest management requires skills associated with ancillary activities, e.g. environmental resource management, biodiversity and conservation, archaeology, engineering, timber valuation, marketing and sales. Suitably qualified professionals should be employed or consulted with in these areas.

18.5 RESEARCH

Forest practice requires research input to deal with contemporary and emerging problems. New constraints and requirements are presented by environmental priorities, such as aquatic zone protection and managing for biodiversity. Replacements for chemicals no longer approved are frequently required, while harvesting and extraction constantly require new approaches and systems to enhance efficiency and to minimise soil damage.

In Ireland, the National Council for Forest Research and Development (COFORD) has established links between scientists and practitioners. Forest owners and managers should keep themselves up-to-date with contemporary research developments, sourcing information through publications and seminars.

18.6 PROFESSIONAL EDUCATION

Professional education in forestry is provided at the National University of Ireland, University College Dublin (UCD). The University of Limerick provides a Bachelor of Technology Degree in Wood Science and Technology, while the Mayo/Galway and Waterford Institutes of Technology offer diploma level courses in forestry.

The Society of Irish Foresters has an approved process for its technical membership and can make available information on courses, consultancy services and ethical practice.

18.7 TECHNICAL TRAINING

The Coillte Training Centre in Mountrath, Co. Laois, provides Forest Service funded training in forest practice for supervisors and operators in the use of chemicals and harvesting machinery (including chainsaws), and will undertake other occasional courses depending on demand. Training modules in forest practice are given in Ballyhaise Agricultural College and provide basic knowledge to farm forest owners.

A number of training colleges in the United Kingdom, such as Newton Rigg, Cumbria, are also recognised as providing courses suitable for Irish conditions.

18.8 FARM FORESTRY

The need for supporting farm forestry was recognised by the National Farm Forestry Forum, established by the Forest Service. From this arose training modules organised by the Forest Service and Teagasc, with field days and demonstrations to provide additional support. The emphasis is on the technical and administrative aspects of grant-aided forestry.

Foresters, forest owners and farming organisations also provide support through seminars and field days. The main organisers are the Society of Irish Foresters, the Irish Timber Growers Association, the Irish Farmers Association and the co-operatives. Forest owners and new entrants to forestry should make themselves aware of the availability of Forest Service support appropriate to their needs.

Ireland's Strategic Plan for Forestry, as outlined in *Growing for the Future*, outlines the desirable criteria for good farm forest management as being:

- attendance at farming courses on plantation management;
- regular professional assessment;
- long-term management contracts;
- personal experience of forest management.

18.9 CONSULTATION

In modern Irish forestry, forest owners and managers need to consult with landuse interests more than ever before. This requires information on who represents the various interests. Owners of larger forest properties should familiarise themselves with the local representatives of the relevant statutory bodies, together with local groups and community representatives.

Communications skills needed to deal with complex landuse and operational issues should be developed individually or through the relevant owner, manager or contractor organisation.

18.10 APPRAISAL AND COMPLIANCE IN FOREST PRACTICE

Demands from the public and from customers for quality goods and services and for environmentally acceptable processes have led to various certification schemes which place increasing responsibility on producers to ensure acceptable practice.

Forest practitioners must ensure that the complexities of their area of work in relation to environmental, social and economic values are understood. Competencies in self-assessment, evaluation and consultation must be acquired through training, information transfer and advice.



The development of farm forestry among individuals new to the sector emphasises the need for guidance which is relevant to their scale of operation and which will ensure that such woodlands remain viable.

Major forestry companies can acquire this competence within their management systems and through the networks they create. Smaller companies and large forest owners will need to hire in these competencies, supplemented by individual training and access to current information. Smaller forest owners should ensure competency through their relevant professional and trade associations or through co-operatives, in order to keep as up-to-date as possible with current developments.

Necessary information includes:

- changes in national law;
- European Union regulations;
- national regulations, guidelines and standards;
- grants, premiums and associated procedures;
- commitments arising out of international forestry or environmental agreements;
- criteria and indicators for sustainable forest management accepted through international agreements;
- information on available forest certification schemes;
- acceptable self-assessment procedures;
- developments in forest research.

As instruments of the IRISH NATIONAL FOREST STANDARD, the Forest Service environmental guidelines (FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FORESTRY AND THE LANDSCAPE GUIDELINES, FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FOREST BIODIVERSITY GUIDELINES) and CODE OF BEST FOREST PRACTICE are designed to facilitate the above process.

18.11 ADVERSE IMPACTS

- **Poor quality forestry advice**
- **Poor quality forest management**
- **Poor quality forest operation due to lack of training**
- **Lack of skills in ancillary areas**
- **Lack of environmental advice and management**
- **Untrained and unqualified personnel**
- **Unapproved courses**
- **Poor or no forest practice assessment**
- **Poor information flow**
- **Poor consultation process**
- **Poor awareness of various certification schemes**

18.12 BEST PRACTICE

- **Ensure advisors are qualified**
- **Ensure managers are professionally trained**
- **Ensure operators and supervisors are trained**
- **Avail of qualified ancillary expertise**
- **Approved courses only supported**
- **New entrants (farm foresters in particular) to avail of training and to be provided with necessary support services**
- **Continuous education and training**
- **Ensure access to information**
- **Ensure access to research findings**
- **Full awareness of forest practice assessment requirements**
- **Develop consultation skills**
- **Awareness of certification schemes**

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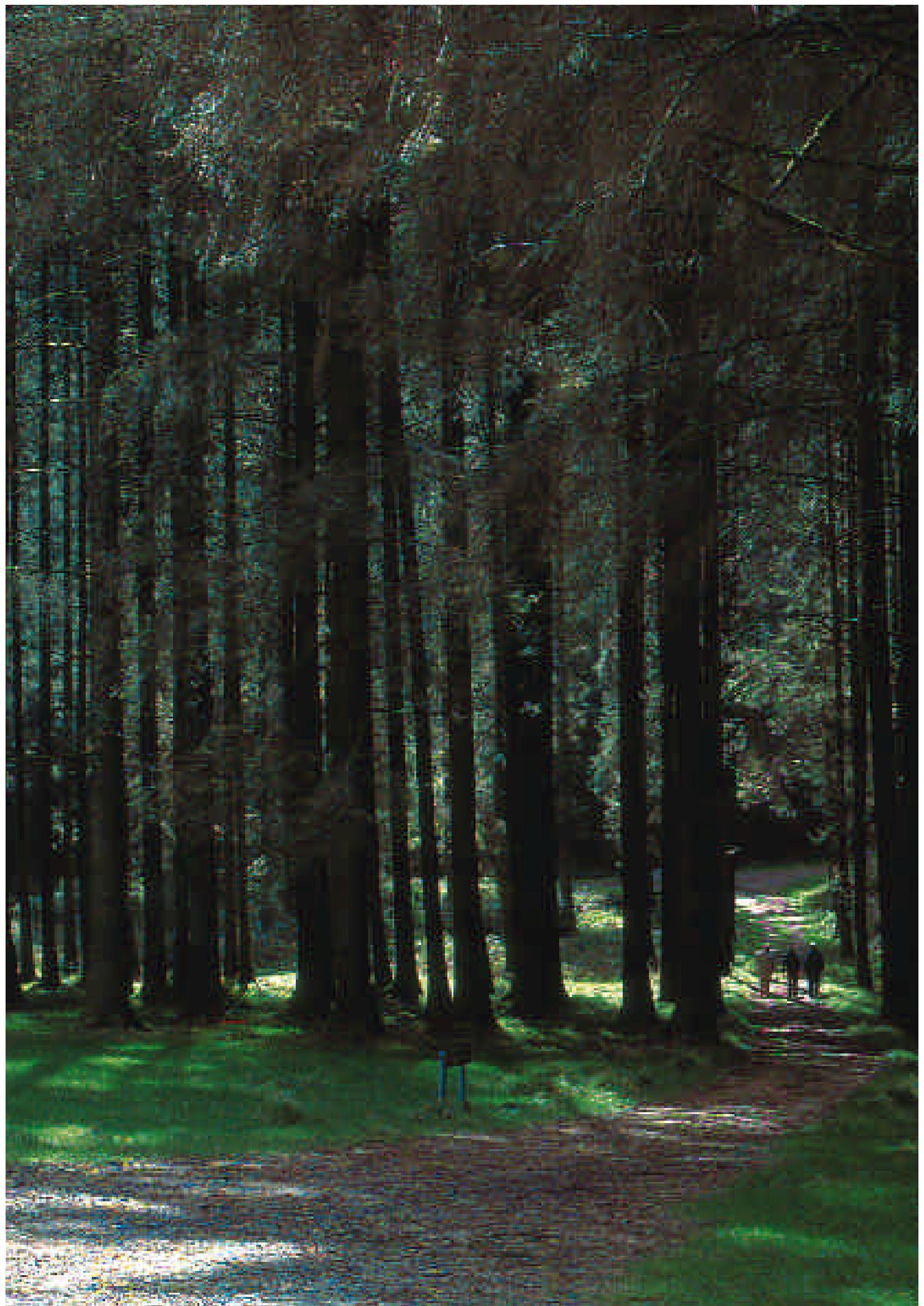
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Glossary

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Abiotic influences: impact of non-living agents such as wind and frost.

Aquatic zone: a permanent or seasonal river, stream or lake shown on an Ordnance Survey 6 inch map.

Base status: nutrient status.

Biodiversity: the variety of ecosystems and living organisms (species), including genetic variation within species.

Biofuels: fuels derived from organic materials by biological processes.

Biotic influence: impact of living organisms.

Brush mat: a layer of cut branches set down to prevent or reduce ground damage by harvesting machines.

Broadleaves: broadleaf trees and woodlands. Most of Ireland's broadleaves are deciduous.

Bryophyte: a division of the plant kingdom containing small, rootless non-vascular plants such as mosses.

Carbon cycles: processes involved in the recycling of carbon in the earth's ecosystem.

Carbon sequestration: the process by which carbon dioxide is removed from the atmosphere and stored as carbon.

Certification scheme: a market-oriented scheme used to certify that forests are managed on a sustainable basis.

Clearfelling coupe: area over which the entire forest crop is felled.

Clones: group of individuals derived originally from a single individual by vegetative propagation.

Code of Best Forest Practice: a tool to support the sustainable management of forestry through the use of best operational practice.

COFORD: The National Council for Forest Research and Development.

Conifers: coniferous trees and woodlands.

Continuous cover: continuous cover forest management which involves the use of selective harvesting and natural regeneration to promote uneven aged forest stands and a continuous tree cover more typical of natural forests. Continuous cover implies a continuous input of management effort, at a low level, and a continuous flow of wood and other forest products.

Criteria: category of conditions or processes which describe sustainable forest management at a conceptual level by defining its essential elements.

Drainage: an operation to remove excess water from an area in a controlled fashion. In woodlands, drains are almost always open, unlined channels.

Ecosystem: a community of plants and animals (including humans) interacting with each other and the forces of nature. Balanced ecosystems are stable when considered over the long term (hundreds of years, in the case of woodland).

Environmental guidelines: water quality, archaeology, landscape, biodiversity and harvesting guidelines of the Forest Service.

Eutrophication: the process of nutrient enrichment in water ecosystems.

Farm forestry: forestry practiced by farmers or involving plantations as part of the farm holding.

Forest biomass: total forest organic material including stems, leaves and roots.

Forest property: an area of forest estate.

Forest reproductive material: seeds, plants or clones used for forestry purposes.

Forest vitality: the ability of the forest to endure and perform its functions.

Forestry: the management of predominantly tree covered land (woodland), whether in large tracts (generally called forests) or smaller units (known by a variety of terms such as woods, copses and shelterbelts).

Germ plasm bank: plantation concerned with the conservation of hereditary genetic material.

GIS: geographic information system, a multi-layer computer-based system for efficient input, storage, analysis and retrieval of geographic and land attribute data.

Greenhouse gas emissions: greenhouse gases such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), which are released or emitted into the atmosphere as a by-product of natural and industrial processes. These emissions are regulated by the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC).

Hydrology: the study of water relationships.

Indicators: these provide a basis for assessing actual forest conditions by measuring sustainable forest management in relation to one aspect of a criterion.

Kyoto Protocol: the Kyoto Protocol of the UNFCCC sets targets for the atmospheric release of greenhouse gases.

Life cycle analysis: the process of tracking energy inputs into, and the use and rate of decay of, wood products.

Medium density fibreboard (MDF): a reconstituted wood panelboard of medium density made by bonding wood fibres.

Mycorrhizae: beneficial soil fungi associated with tree roots.

National Inventory: detailed listing of standing wood volume in the national forest estate, usually involving ground survey and remote sensing.

Oriented strand board (OSB): reconstituted wood panelboard made by bonding wood strands, arranged in layers at right angles to one another.

Pathogens: organisms capable of causing disease.

pH: hydrogen ion concentration, a measure of acidity or alkalinity.

Protected habitats or species: areas and organisms protected by the EU Birds and Habitats Directives.

Provenance: location of trees from which seed or cuttings is collected. Designation of Regions of Provenance under the forest reproductive materials regulations is used to help nurseries and growers select suitable material. The term is sometimes confused with 'origin', which is the original natural genetic source.

Reconstitution: replanting damaged or failed plantations.

Recreation (forest): activity or experience of visitor's own choice within a woodland setting. (Facilities may sometimes be provided and charges levied for their use.)

Red Data Book: comprises catalogues listing species which are rare or in danger of becoming extinct nationally or locally.

Reforestation: regeneration (usually by planting) of an area from which a stand of trees has been felled.

Ridelines: permanent, unsurfaced access routes through a forest, usually laid out for administration purposes.

Riparian: associated with river banks.

Sedimentation: the process whereby soil particles are transported by surface water flow (water flowing above ground) into aquatic zones.

Semi-natural woodland: woodland composed of mainly locally native trees and shrubs which derive from natural seedfall or coppice rather than from planting.

Sensitive catchment: an area which, due to its geology and soils, is sensitive to influences which cause water acidification.

Shaping: cutting of branches of broadleaf trees to encourage stem straightness.

Silviculture: the science of growing and managing forests.

Special Areas of Conservation (SACs): areas of significance for the conservation of special habitats which have been designated under the EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (commonly referred to as the Habitats Directive).

Special Protection Areas (SPAs): areas of significance for the conservation of special habitats which are important for birds and have been designated under the EU Council Directive 79/409/EEC on the conservation of wild birds (commonly referred to as the Birds Directive).

Stakeholder: any individual or group which maintains an active interest in an organisation's operations.

Sustainable forest management: the stewardship and use of forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems. (From the Ministerial Conference on the Protection of Forests in Europe, Helsinki, 1993.)

Thinning: removal of trees in a stand to redistribute volume and to improve form over the remaining crop.