



Code of Best Forest Practice – Ireland

ACKNOWLEDGEMENTS

The Forest Service would like to express its appreciation to all of those who took part in the consultation process involved in producing the CODE OF BEST FOREST PRACTICE – IRELAND, and to those who made submissions at various stages of its development.

CODE OF BEST FOREST PRACTICE – IRELAND

Published by:
Forest Service
Department of the Marine and Natural Resources
Leeson Lane
Dublin 2
Ireland

ISBN 0-9538874-1-3

Production: Magner Communications

Editorial Working Group: K.D. Collins (Forest Service), Dr. G. Gallagher (Forestry Consultant), Professor J.J. Gardiner (University College Dublin), Dr. E. Hendrick (COFORD) and D. McAree (Forest Service). Dr. G. Gallagher also assembled the material for the various forest operations described in the Code.

Photography: Forest Service (D. McAree, J. Connelly, G. Cahalane, E. Curran and K.D. Collins), COFORD, Coillte (Warner Corporate Photography), Department of Archaeology, N U I C, T. Cummins, A. McCormack and T. O'Leary, and Richard T. Mills

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Price IR£12.00 / €15.00

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FOREWORD



These are exciting and challenging times in Irish forestry, where the objective over the next 30 years is to expand the national forest estate from 9% to 17% of the land cover. This will undoubtedly have major economic, social and environmental implications for the country. As Minister of State with responsibility for forestry, I will be insisting that this development will be carried out within the principles of sustainable forest management (SFM). Following from the Third Ministerial Conference on the Protection of Forests in Europe, held in Lisbon in 1998, Ireland is committed, in perpetuity, to the sustainable management of all our forests. We are custodians of these forests and have a moral responsibility to pass them on to future generations in a much improved and environmentally enhanced form. With this in mind, it is an opportune time to launch my Department's IRISH NATIONAL FOREST STANDARD, CODE OF BEST FOREST PRACTICE and suite of five Environmental Guidelines.

The IRISH NATIONAL FOREST STANDARD outlines the criteria and indicators relating to the national implementation of SFM. Qualitative and quantitative measures are described, by which progress towards the practice of SFM will be monitored under Irish forest conditions.

I am particularly pleased that Ireland's CODE OF BEST FOREST PRACTICE is the first to be produced in Europe. This describes all forest operations and the appropriate manner in which they should be carried out to ensure the implementation of SFM.

The suite of five Environmental Guidelines relating to water quality, archaeology, landscape, biodiversity and harvesting, are the mechanisms by which the Forest Service will ensure that the environmental aspects of SFM are implemented. Adherence to the Guidelines is a condition of grant aid and felling licence approval.

The wide-ranging consultation process which took place involved public discussion, expert opinion and the input of sectoral interests including non-government organisations, and is strongly reflected in all of the documents.

These important publications are the result of many long hours of work by the contributors, Forest Service staff and all those who engaged in the consultation process. The implementation in the forest and at national level of the Standard, the Code and the Environmental Guidelines, together with effective monitoring and enforcement by the Forest Service, will ensure that all timber produced in Ireland is derived from sustainably managed forests.

A handwritten signature in black ink that reads "Hugh Byrne". The signature is written in a cursive, flowing style.

Hugh Byrne TD
Minister of State at the Department of the Marine and Natural Resources



INTRODUCTION

In 1996, the Government approved the Strategic Plan for the Development of the Forestry Sector in Ireland, set out in the document *Growing for the Future*. The overall aim of the strategy is "To develop forestry to a scale and in a manner which maximises its contribution to national economic and social well-being on a sustainable basis and which is compatible with the protection of the environment."

A framework for the implementation of sustainable forest management in Ireland is described in the IRISH NATIONAL FOREST STANDARD. It has a number of instruments including the CODE OF BEST FOREST PRACTICE, environmental guidelines relating to water quality, archaeology, landscape, harvesting and biodiversity, and the Forest Service inspection and monitoring systems, particularly in relation to grant-aided forestry.

The CODE OF BEST FOREST PRACTICE is designed to ensure that forest operations in Ireland are carried out in a way which meets high environmental, social and economic standards.

Certain features distinguish Irish forestry from forestry practised elsewhere in the world, and these features are reflected in the CODE OF BEST FOREST PRACTICE. The lack of native conifer species with any significant commercial potential has meant that introduced species from Continental Europe, North America and Japan predominate. These species have been grown here in Ireland for a considerable period amounting to several rotations, frequently undergo natural regeneration and have not succumbed to major pests or diseases.

The range of native broadleaf species with commercial potential is also somewhat limited, with oak, ash and, to a lesser extent, birch, alder, cherry and aspen, being capable of commercial development. Introduced broadleaves such as beech and sycamore can now be considered semi-natural.

Conifers suit a wide range of forest soils, from brown earths to peaty gleys and podsols. Broadleaves demand more fertile sites.

Ireland is a wet country traversed by streams and rivers, and this water resource is of major significance. In addition, Ireland has had an open landscape for centuries, and this factor has shaped cultural and social attitudes which must be respected in a period of change.

In Ireland, the establishment, management and harvesting of plantation forests for timber production dominate the forestry sector. The CODE OF BEST FOREST PRACTICE therefore focuses on the achievement of viable forests which conform to the principles of sustainable production and which are managed in a safe and environmentally acceptable manner respectful of society's expectations.

Forest products cover a range far wider than wood alone, e.g. carbon sequestration, biodiversity, water quality and recreation. Material products should be produced to high quality standards. Other products should also attain high objective quality.

Implicit in the CODE OF BEST FOREST PRACTICE is the assumption that these practices will be observed. An evaluation process is therefore necessary and this should be unambiguous and easy to implement.



BACKGROUND

THE NATIONAL FOREST

Ireland's forest area now comprises approximately 626,000 ha or 9% of the total land area. Most of this forest has been established since 1950, with significant increases in the rate of planting in the private sector since 1989. Broadleaf species account for approximately 20% of the forest estate, and national policy is to increase broadleaf planting to more than 20% of total annual afforestation (1).

Along with substantial additions to the forest area by planting, the thinning of semi-mature forests and felling at maturity are also increasing dramatically. Clearfelling is now approaching 6,000 ha/year.

These activities, together with ongoing maintenance operations throughout the rotation, emphasise the fact that forest operations are having an increasing economic, social and environmental impact.

DEVELOPING A CODE

In *Growing for the Future* (1), strong emphasis was placed on the quality of forest management. Under the relevant strategic actions, it was proposed to develop the existing code of procedure for self-assessment companies into a CODE OF BEST FOREST PRACTICE for the management of all forests over the full rotation.

The CODE OF BEST FOREST PRACTICE is one element in a series of initiatives supporting the IRISH NATIONAL FOREST STANDARD (2) designed to ensure that the development of the forestry sector in Ireland is undertaken on a sustainable basis. Existing guidelines on fisheries, archaeology and the landscape (3) (4) (5) are revised and updated (6) (7) (8) (9) (10) (11), and these are accompanied by new guidelines on harvesting and biodiversity (12) (13) (14) (15). The CODE OF BEST FOREST PRACTICE, together with these 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), will provide direction for forest managers, owners and operators.

THE INTERNATIONAL ENVIRONMENT

Awareness of the need for sustainable forestry is influencing forest management worldwide. In 1987, *Our Common Future*, the report of the Brundtland World Commission on Environment and Development, raised the concept of sustainable development to a practical level. The resulting United Nations General Assembly Resolution 44/228 established the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992 (16).

In 1992, the UN Food and Agriculture Organisation (FAO) formulated a definition of how sustainable development applied to forests. In Strasbourg, 1990, the Ministerial Conference on the Protection of Forests in Europe passed resolutions to protect Europe's forests. A second Ministerial Conference took place in Helsinki in 1993, passing resolutions on sustainable forest management and biodiversity. A third Ministerial Conference was held in Lisbon in 1998. The work of the InterGovernmental Panel on Forests, established at the UN Commission on Sustainable Development meeting in 1995, is also continuing (17).

THE LOCAL ENVIRONMENT

Local factors are also highlighting the urgent need for the development of this CODE OF BEST FOREST PRACTICE:

- The rate of planting achieved by the Forestry Operational Programme 1989-93 (18) and the Operational Programme for Agriculture, Rural Development and Forestry 1994-1999 (19) is bringing a considerable number of new forest owners and managers into the sector, creating a clear need for new direction and guidelines for forest development (20).
- As forest cover continues to grow, the consequence of poor practice will have an increasing impact on both the environment and production.

Forestry represents a growing landuse in Ireland, and private afforestation in recent years has contributed significantly to the current figure of 9% of the land area.



Forestry in Ireland must be carried out in a manner which accommodates fishing, environmental, landscape, planning and other interests.

- The consumer - from the timber purchaser to the recreational user and taxpayer - is demanding ever-higher standards in forestry, thereby ensuring that the issue of quality is a driving force in management. The move towards environmental certification of timber products (e.g. 21) is an example of this emerging influence on Irish forestry.
- Environmental, fishing and landscape interests and planning authorities are acutely aware of the impacts of forestry, particularly those associated with the establishment of plantation forests and the felling of forests in general. Biodiversity issues feature strongly in how management is judged. The Department of the Environment recently published a strategy for sustainable development in Ireland (22) which encompasses forestry development. The first national report by the Department of Arts, Heritage, Gaeltacht and the Islands on the implementation by Ireland of the UN Convention on Biological Diversity has also been published (23), as has a report by the Environmental Protection Agency (EPA) on the state of Ireland's environment at the turn of the Millennium (24).
- Economic factors require that commercial forests are managed prudently. While afforestation in Ireland is currently strongly supported by the European Union, the economics of Irish forestry are such that shortfalls in management can easily turn available forest into a financial failure.
- Forestry competes with a wide range of other landuses and schemes. As policy-makers have to consider the management implications of each possible use, the pressure from these alternative uses will be more difficult to resist unless forest management is governed by a code of best practice.
- European Union and State investment in Irish forestry has been substantial, and European and Irish taxpayers expect high quality establishment and management in return.
- The development of farm forestry and small scale forest ownership 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.
- Good forest management is a powerful way to demonstrate to the wider public the benefits of forestry, such as increased diversity, rural activity and employment, recreation, carbon sequestration and production. Through sound management, these benefits can be credibly presented to the public, thereby encouraging a wider understanding and acceptance of forestry as a landuse.

TRAINING AND COMPETENCE

Forestry has become more complex over the years. It now impacts on a wider stratum of people and environments than ever before, and is subject to a large range of social and environmental demands. As a result, the need for a wide range of professional and managerial skills has increased.

Qualified forestry personnel are essential for assessing, supervising and managing forests throughout their rotations, and as contractors to undertake forest operations. Other related activities require specialised technical and professional input from engineers, biologists, landscape architects and others, together with an expansion of planning, business and communication skills.

Farm forestry has special needs and farm forest owners require training modules specifically targeted at their particular level of involvement (20).

Also recognised is the growing need for approved professional and technical courses and opportunities for continued education, for expertise in assessment and auditing forest practice, and for skills in competency and certification.

The transfer of research findings to forest practice is essential in order to keep the sector up-to-date and innovative.

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Minister Hugh Byrne signing the Lisbon Resolution, 1998, committing Ireland to implementing sustainable forest management.

PRINCIPLES OF SUSTAINABLE FOREST MANAGEMENT

DEFINITIONS

Since the concept of sustainable development emerged on the international arena, its application to forestry has been defined on a number of occasions (1). The definitions have common features and all lead to the criteria adopted by contemporary codes of practice from around the world.

In 1991, the International Tropical Timber Organisation (ITTO) defined sustainable forest management as follows:

Sustainable forest management is the process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment.

In 1992, the United Nations Food and Agriculture Organisation (FAO) formulated a definition of how sustainable development applied to forests:

Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development (in the agricultural, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

A statement of principle for a global consensus on the management and sustainable development of all types of forest was agreed at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992:

Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual human needs of present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products. Appropriate measures should be taken to protect forests against harmful effects of pollution, including airborne pollution, fires, pests and diseases, in order to maintain their full multiple value.

Resolution I of the second Ministerial Conference on the Protection of Forests in Europe, held in Helsinki in 1993, laid down the following definition

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.

CRITERIA

Six pan-European criteria for sustainable forest management emerged following the Helsinki conference in 1993 (2) (3):

- C1 Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles.
- C2 Maintenance of forest ecosystem health and vitality.
- C3 Maintenance and encouragement of productive functions of forests (wood and non-wood).
- C4 Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems.
- C5 Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water).
- C6 Maintenance of other socio-economic and cultural functions and conditions

Guidelines for planning, management and practice accompany each criterion. They include: maintaining or increasing forest areas; prudent silvicultural practice; care in the use of chemicals; and care in harvesting. Broad issues are also dealt with, such as: diversification of forest products; sustained forest yield; conservation of ecosystems, landscape and heritage; species and genetic conservation; soil and water protection; enhancement of the multiple functions of forests; and the rights of ownership and the need for adequate consultation.

INDICATORS

Indicators used in the IRISH NATIONAL FOREST STANDARD (4) provide a way of assessing forest conditions in relation to the criteria for sustainable management. For each criterion, a qualitative indicator refers to policy, legislation and support measures. Indicators are described as follows:

- C1 The forest resource and land conversion; forest ecosystem carbon budgets; and forest industry carbon budgets.
- C2 Defoliation of forests; damage caused by biotic and abiotic agents; beneficial influence of biotic agents and ecosystem processes; and changes in physical and chemical properties of soils.
- C3 Productive capacity; competitiveness of forest industries; contribution to the national and local economy; and non-wood values.
- C4 Area and type of forest; habitat and species diversity; forest management; conservation of species and utilisation of native genetic resources; and diversity and landscape.
- C5 Protection of waters; and protection of soils.
- C6 The socio-economic and employment contribution of the forestry sector; public awareness and participation; forestry education, research and training; recreation and amenity values; cultural merit; and safety in the forest.

Within the indicators, measures describe how trends may be monitored. Impacts of each forest operation can be assessed by an appraisal procedure and regular monitoring of the forestry sector through official information systems.



Indicators used in the IRISH NATIONAL FOREST STANDARD provide a way of assessing forest condition in relation to the criteria for sustainable forest management. The six criteria relate to: the forest resource; forest health; productive capacity; biodiversity; soil and water; and socio-economic issues.



Under sustainable forest management, forest practice must be consistent with the safeguard and enhancement of the various environmental, economic and social values, from the protection of water quality to facilitating the particular needs of rural communities.

IMPLICATIONS FOR FOREST MANAGEMENT

The principles of establishing, managing, harvesting and replacing forests on a sustainable basis to meet environmental, economic, social and cultural needs have specific implications for forest management:

- The species planted should be suitable in terms of genetic quality, growth potential, suitability to site and wood quality. This also implies the inclusion of native species where feasible.
- The principle of diversity must be upheld, and the transfer of lands to forestry should ensure that overall species diversity is maintained or increased. It is widely recognised that a commercial forest will support a wide range of species and inter-species associations at various stages of its rotation.
- The establishment and management of forests should be undertaken in a way which ensures that the full value of the forest is achieved with the maximum efficiency and consistent with environmental protection.
- The principle of quality management leading to quality products should be implicit, so that the user requirements of the various forest customers are recognised and met.
- Forest practice must be associated with: a healthy environment and the need for water and soil quality; an archaeological, heritage and cultural presence; nature conservation; landscape conservation and enhancement; and recreational features. The particular needs of rural communities must also be respected.
- The health and vitality of forests must be protected and maintained, with management oriented towards pest control and good practice in relation to the avoidance or minimisation of fire and windthrow damage.
- Forest operations should not damage the viability of the forest.
- Forest practice must be backed by strong and ethically based professional, educational and training programmes. These will provide sound advice and will help to ensure that forest operations are carried out safely, efficiently and with minimal risk to the environment.
- The principles of transparency and a high level of communication between the forest authority, owners, managers, operators and users, are essential to ensure the successful implementation of the CODE OF BEST FOREST PRACTICE.

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IDENTIFICATION OF FOREST VALUES

SOCIETY'S NEEDS

Society's requirements from the forest have been focused in recent times and enshrine environmental, economic and social values. In order to plan and manage forest operations in a sustainable manner, it is necessary to identify these values and to place them in the context of management objectives which are ranked according to the required functions of the forest.

Since earliest times, forests have been seen as a source of material goods, shelter, wood and food, as well as cultural sustenance. Although not always observed in practice, the principles of sustainable management have guided forest owners and custodians for centuries.

Increased awareness of the forest's full potential, combined with the development of a more sophisticated approach to management, will allow a more complete fulfilment of society's wider needs.

MANAGEMENT OBJECTIVES

Forestry is an economic activity and most forests are established to supply timber. However, these forests also have the potential to deliver a wide range of goods and services, and the goal to produce timber can also accommodate other aspects of the forest's role.

The management of each forest, property or group of forests is supported by objectives which define and prioritise the various functions. For example, timber production will be a key function in most cases, but with water and soil protection high on the list. Biodiversity and landscape functions will usually feature among the objectives in relation to their importance in the composition and location of the forest. Recreational and cultural functions will depend on the broader demands of society in particular locations.

In certain forests, timber production may have a low, if any, priority, with conservation, protection and biodiversity taking precedence. For example, riparian woodlands have numerous functions relating to water quality, bank stabilisation and biodiversity.

The well-managed forest is a balanced mechanism. It produces a competitive renewable material - wood - at a low energy cost, mitigating the impact of greenhouse gases in the process. It creates the basis for both direct and downstream employment of special benefit in rural areas. The forest provides a wide range of habitats valuable for biodiversity throughout the rotation cycle, increasing diversity where it replaces tillage and intensive grazing. Native and semi-natural woodlands are among the most diverse habitats. The forest produces food, decorative material and other commodities, and can absorb large numbers of visitors. A well-designed forest also benefits the landscape and has considerable tourist potential.

TYPES OF VALUES

In order to plan and manage forest operations in a sustainable manner, it is necessary to identify certain forest values which need to be safeguarded. These values can be broadly classified as environmental, economic and social, with associated constituent values (see Table 1).

Table 1 Environmental, economic and social values.

<i>Environmental values</i>	<i>Economic values</i>	<i>Social values</i>
Soil Water quality Landscape Ecological and scientific values Cultural and archaeological values Biodiversity Forest protection and health	Sustained productivity Commercial viability	Rural development and farm forestry Amenity and recreation Safety Other community values



The protection of water quality involves adherence to the Forest Service FORESTRY AND WATER QUALITY GUIDELINES, dialogue with local fishery interests and continuous monitoring.

ENVIRONMENTAL VALUES

Soil

Soil values relate to erosion, compaction, stability and displacement, and levels of soil fertility.

Wet soils, particularly peats, can become badly compacted by machine passage. Machine slippage and rutting during thinning and clearfell operations also occur, adversely impacting on soil stability and tree growth (1). Soil displacement can occur at harvesting, with a consequent loss of organic matter and fertility (2). Further loss can occur from the burning of slash or its removal from poor soils.

Damage can be reduced by carefully planning and supervising forest operations and by using low ground pressure vehicles or wide tyres, tracks and chains. Controlling loads and distributing slash along extraction routes and at rack headlands also contribute to ground protection (3). Limiting clearfell coupe size and tight control on burning also maintain soil stability.

Soil protection also contributes to water quality. Forestry can be beneficial in this regard by reducing erosion and nutrient loss.

Water quality

Water values are concerned with protecting water quality, ecology and stability, and controlling onsite and downstream impacts. An aquatic zone is defined as a permanent or seasonal river, stream or lake shown on an Ordnance Survey 6 inch map.

Establishment, harvesting and road construction impact on the hydrology, chemistry and level of sedimentation in aquatic zones, through compaction by heavy machinery, soil displacement, increased run-off through drainage, and contamination with fertilisers, chemicals and fuel.

The Forest Service's *Forestry and Fisheries Guidelines* (4) have formed the basis for the protection of aquatic zones since 1992. While it is still too early to assess the full impact of these guidelines, they are acknowledged to be valuable in their recognition and treatment of sites sensitive to acidification where forests might be established (5). The guidelines have helped ensure that planting operations were planned to guard against damage to aquatic and riparian zones.

Clear guidelines relating to the entire forest cycle, including ground preparation, planting, fertiliser and chemical application, thinning, harvesting and roading, are given for both sensitive and non-sensitive areas. In the guidelines, sensitive areas are identified based on several criteria, e.g. base-poor geology, low water pH, location in salmon fishing and spawning areas. The guidelines identify numerous protective measures. These include: distance of ground preparation to aquatic zones; the need for cut-off drains and sediment traps; planting distances for both conifer and broadleaf species; timing, conditions and type of fertiliser application; storage and application of chemicals; limits on machine operations and refuelling; timing, construction and location of roads and bridges; and the protection of river gravel.

These guidelines have now been reviewed and updated (6) (7).

More extensive development of riparian-type forests will be needed in order to optimise conditions for both fish and forest. This may require modification of the current species choice (8) and planting disposition. Local identifiers will be needed to classify areas as being sensitive or non-sensitive. Further refinement of fertiliser application practices to determine optimum amounts and frequency of application will be needed. In addition, best practices regarding reforestation in catchment areas need to address species selection, ground preparation, planting and fertiliser and chemical usage.

Catchment areas need to be identified to enable forest planning and management in consultation with the relevant authorities, including the Regional Fisheries Boards and



Carefully planned and designed forests add greatly to Ireland's rural landscape.

Local Authorities. The use of such tools such as geographical information systems (GIS) and indicative forest strategies (IFS) will become part of this process.

Landscape

The Forest Service's *Forestry and the Landscape Guidelines*, published in 1992 (9), provide a sound basis for best forest practice in relation to the landscape. These guidelines have now been reviewed and updated (10), taking into account various forest development scenarios and the identification of particular landscape character types (11) (12).

How a forest will look and its composition relative to the landscape must be determined at the initial stage of development, with planting areas, species selection, location of ridelines, firebreaks and roads, etc. decided upon accordingly. These considerations add complexity to normal forest practice. Equally, sensitivity regarding shape, proportion, margin and other factors will also be required during the planning and management of the felling operation, particularly in light of the immediate and significant landscape impact involved. Reducing felling coupe size is becoming increasingly recognised as an important factor in controlling the impact of the operation.

Together, felling and reforestation offer an ideal window of opportunity to undertake major restructuring of an existing forest area, with a view to maximising its contribution to the landscape.

The Government's Strategic Plan specifies certain actions to be taken in grant-aided forestry (13). These are backed up in the section relating to forestry in the Department of the Environment's strategy for sustainable development in Ireland (14). Account must be taken of the limit of 70 ha for individual or add-on forestry developments, above which environmental impact assessments (EIAs) are required. The minimum distance between afforestation and dwellings or buildings is 60 m, unless the owner agrees to a closer set-back distance. The minimum distance between afforestation and public roads is 20 m for conifer species, and 10 m for broadleaf species. Local Authorities are entitled to evaluate forest developments over 25 ha in area, and any subsequent requirements must be accommodated.

Urban and Amenity Woodland Schemes (15) (16) place particular emphasis on landscape and variation.

In summary, landscape will impact on forest practice in relation to decisions regarding: whether or not to plant; species selection and diversity; the treatment of sensitive areas such as margins and ridges; the size and disposition of felling coupes and reforestation operations; and the position and treatment of roads, ridelines and open spaces.

Ecological and scientific values

Ecological and scientific values are concerned with conserving communities of rare or unusual fauna and flora, unique landforms and geology, and areas dedicated for research.

Forestry practice and conservation are not mutually exclusive. While most forests are managed within commercial objectives, the balance between these and conservation will depend on structure and composition, and where the forests are located in relation to heritage areas.

Ecological values assume different levels of priority, based on how forests are designated.

Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are protected by European Union and national legislation. Where these occur within or adjacent to forests, forest management activities must be undertaken in consultation and agreement with Dúchas The Heritage Service. In such cases, the protection of biodiversity and habitats will be a priority and this will determine the establishment of new forests or the management of existing forests.



Ireland's native woodlands represent an invaluable ecological and scientific resource.

The proposed Natural Heritage Areas (pNHAs) have been identified by National Parks and Wildlife of Dúchas as areas of value in the national effort to conserve biodiversity. They do not currently have a statutory basis but may be designated in a new Wildlife Act. They include native and semi-natural woodlands and other woodlands of conservation value. In such cases, conservation and commercial activity can be twin objectives.

Establishment and management must be subject to consultation and a co-operative approach by forest and conservation interests will be needed. All proposed grant-aided forestry with pNHAs are referred to Dúchas. Ecological values are also important in commercial forests, as they widen the range of benefits produced for both owners and society.

Identifying the location of SACs and SPAs in the context of forest development enables the management approach to be determined at an early stage. The location of these areas and pNHAs in relation to existing forests is also critical in ensuring the necessary protection. While this may result in some forestry developments being discouraged or forbidden, there are also numerous situations where existing forests are located near or within such areas or will be allowed under special conditions, probably on the basis of an EIA.

Situations where forest practices will be subject to conservation requirements include the following:

- private or publicly owned forests classified as SACs;
- forests or proposed forests bordering SACs or SPAs;
- other forests within SACs but not themselves classified as SACs;
- forests containing SACs;
- forests proposed for or existing within pNHAs.

Impacts on operations include possible limits on species selection and planting, ground cultivation, chemical usage, the extent of logging and the type and use of machines. The level of impact will depend on the nature, extent and importance of those habitats involved.

Ireland's indigenous forest area is small and is mainly confined to National Parks or nature reserves. The maintenance of riparian areas, scrub or relict forest is also important, as it contributes to biodiversity.

As forestry in Ireland relies to a great extent on afforestation of previously unplanted land, large scale projects greater than 70 ha in area are subject to planning permission and require an EIA. However, plantation forests have intrinsic value in meeting human requirements over and above primary products. They sequester CO₂ and provide a framework for associated habitats and ecosystems.

Designated forest research areas also need to be identified and protected against damage arising from forest operations.

Cultural and archaeological values

Ireland has been inhabited for almost 10,000 years. As a result, the country is rich in the physical remains of human activity. Many of these sites occur on forest land or lands likely to be developed for forestry. Types of monuments vary greatly and include ancient trackways, fortifications, ecclesiastical ruins, megalithic tombs, standing stones, earthwork mounds and cairns. Operational guidelines covering forestry and archaeology in operation since 1992 (17) have been reviewed and updated (18) (19).



Megalithic tombs and other valuable archaeological sites and monuments must be protected during all forest operations.

The National Monuments Acts and Amendments 1930-1994 provide for legal protection from unauthorised interference or damage to identified and newly discovered sites. Activities leading to disturbances are forbidden. The Record of Monuments and Places (RMP) is based on information previously recorded in the Sites and Monuments Record (SMR) and County Inventories. This contains an index and map of monuments and other archaeological features which are registered, and others likely to be of significance but not yet registered. All sites listed are protected under the National Monuments legislation.

In relation to forestry, Forest Service guidelines (19) clearly set out procedures to facilitate the identification and reporting of sites, and treatment during various forestry operations from the design stage through to harvesting.



Irish forests provide habitats for a diverse range of flora and fauna, including our native red squirrel.

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. Forests are complex ecosystems and important sources of biodiversity.

Resolution H2 of the Helsinki Ministerial Conference on the Protection of Forests in Europe introduced general guidelines for the conservation of biodiversity in European forests (20).

As described in *Growing for the Future*, Government policy supports diversity in forests on the following basis:

- monocultures are more vulnerable to attack by pests and disease;
- increased species diversity will broaden the range of processing options and value-added possibilities;
- variety contributes to landscape enhancement and creates further benefits in the areas of wildlife and recreation;
- broadleaves have high environmental value and can also provide the basis for high value-added end-uses.

Increased diversity will have an impact on forest practice. The high profile of Sitka spruce in Ireland has meant that forestry operations reflect the requirements of the species. Sitka spruce is relatively easy to grow, suitable for a wide range of sites, and is uniform under plantation conditions, with clearly defined growth rates and rotations. All of these factors enabled the standardisation of forest practice, although this does not imply that best practice was always the case.

Diversity introduces variation in best operational practice, depending on whether the crop is relatively easy to manage (e.g. conifers) or demands specific requirements (e.g. broadleaves, mixtures). Different approaches will be needed for:

- ground preparation;
- planting density;
- vegetation and pest control;
- early and later tending;
- crop management (thinning);
- optimum felling procedure.

Higher densities, more intensive vegetation management, species-specific pests and disease control, shaping and non-commercial thinning are all operations which will accompany a broadleaf planting programme. Riparian areas will also require special attention. Viable broadleaf and conifer/broadleaf mixtures will have to be planned for and brought to rotation in an optimal way. Douglas fir and some of the minor conifer species will be more demanding of management than spruce.

Diversity in an Irish context also implies that greater attention must be given to the origin and quality of forest reproductive material. The limited supply of home-produced seed means that material will need to be sourced from a wider spectrum of provenances in order to undertake the planting programme and to attain the level of diversity set out in *Growing for the Future*. Importing seed from unsuitable sources has very severe repercussions, particularly given that the impact often only becomes apparent later in the rotation when remedial action is impossible, e.g. poor growth form.

The planting of mixtures gives rise to particular operational challenges. Suitable species, proportions planted, differential growth rates and the likely final crop all require prior planning and continued attention.

Sustainable forest management also implies maintaining or increasing non-forest biodiversity, e.g. additional flora through the retention of existing habitats (e.g. hedgerows, scrub) and the treatment of open spaces and edges. Insect, bird and mammal diversity can all be enhanced through appropriate management practice and measures such as the retention of overmature trees and deadwood (e.g. 21). Riparian zones also contribute to fish and other aquatic life.



Port inspections play a crucial role in protecting Irish forests from exotic pests and diseases.

The new FOREST BIODIVERSITY GUIDELINES (22) focus on how best to conserve and enhance biodiversity in Irish forests, through appropriate planning, conservation and management.

Forest protection and health

Growing for the Future states that Government policy in relation to forest protection and health 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."

Risks to forests arise from already identified indigenous pests and diseases, and exotic pests and diseases against which Ireland's island status offers some protection. Other threats include fire, wind and air pollution.

European plant health regulations (23)(24) apply to the importation of forest plants. At a national and local level, protection against pests and diseases requires contingency planning, reporting, monitoring and timely intervention.

Fire damage can be minimised through preventative measures such as the introduction of firebreaks and strict controls on the burning of vegetation. Fire plans should also be prepared for the swift deployment of firefighting measures, should fire occur.

Forest management practices can reduce the risk of windthrow but cannot anticipate storm damage. Prompt harvesting of windthrown material will help to minimise the impact of damaging insects.

Irish forests are monitored regularly to evaluate potential changes associated with transboundary pollution and other world-wide environmental changes (25).

ECONOMIC VALUES

Sustained productivity

The principle of sustained yield has been identified with good forest management in countries with a long tradition of managed forests, particularly in Europe. The principle is based on an allowable cut whereby national forest growth is not, in the long-term, allowed to decline. In effect, the allowable cut determines the rate of clearfelling and maintains the growth base. The principles of sustained yield and allowable cut often form the basis of forest management in countries with significant and continuous forest cover. For example, Scandinavian countries embody these principles within laws and regulations relevant to forestry.

On the local forest and forest estate level, rotation lengths of maximum mean annual increment (MMAI) usually ensure that crops are grown to maturity and reach their full potential. A rotation based on the MMAI is usually close to the optimum financial rotation, thereby providing the woodland owner with a convenient criterion for sustained productivity (26). An important measure of productivity is the yield class or average annual volume production over the rotation of MMAI. Yield classes vary between species and site, with lower yield classes meaning longer rotations. Rotation length therefore responds to changes in species and site selection.

Felling can involve the removal of whole crops as they reach maturity, as is usually the case with conifer species. Felling can also involve the removal of older individual trees. This practice is sometimes undertaken in broadleaf or mixed forests, usually as single stems reach a high value.

The smaller the forest parcel is, the more sensitive it is to management practice. In Ireland, the increased number of small forest parcels associated with the growth of farm forestry will require particular attention if sustained productivity is to be approached or achieved (27).

In Ireland, the concept of sustained long-term productivity can be easily demonstrated in the context of the current planting programme. Ireland's forest base has grown

considerably over recent years and this is set to continue, given Government policy set out in *Growing for the Future*. However, any breaks in this planting programme would entail future discontinuities in timber supply, producing a serious knock-on effect on downstream activities.

The question of good forest practice in achieving sustained productivity is more likely to arise at a local level, where felling is controlled on a forest parcel, property, estate or catchment scale. Large companies with major forest holdings have obligations to implement felling programmes which do not cause dangerous fluctuations in timber supply or major environmental disruption.

Increasing diversity, including the use of broadleaves (including native species) and the development of mixed stands, will impact on felling as well as planting strategies, as will the allowances necessary for other forest uses, e.g. biodiversity, landscape, recreation.

Commercial viability



Careful financial analysis and good forest management are key factors in ensuring commercial viability.

A commercial crop is expected to pay for itself, with the value of the timber produced outweighing the cost of investing money over long periods in the necessary forest operations (28). Critical factors include: the vigour of the crop in producing volumes of wood; the quality and assortments of the material; the market price for the produce; the cost of the long-term investment in terms of land, establishment, maintenance and harvesting operations, and the cost of borrowing.

Commercial viability is closely linked to high yield, quality wood produce and interest rates favourable to long-term borrowing and investment. Grant aid significantly increases commercial viability as the money costs associated with borrowing over a long time period can be reduced or even eliminated.

The CODE OF BEST FOREST PRACTICE must ensure that the correct decisions are made regarding site and species selection and that all operations are carried out cost-effectively and with due regard to environmental protection and safety, with the overall intention of ensuring success in crop establishment, maintenance and harvesting.

The availability of grant aid should not be an excuse for poor investment or operational decisions.

SOCIAL VALUES

Rural development and farm forestry



Forestry represents an alternative landuse which facilitates rural development and enables farm enterprises to diversify.

Agriculture has traditionally been the mainstay of rural communities in Ireland. However, in the context of the Common Agriculture Policy reforms by the EU in the Operational Programme for Agriculture, Rural Development and Forestry 1994-1999 (29), forestry is recognised as an alternative landuse suited to rural development and enabling farm enterprises to diversify. The Economic and Social Research Institute (ESRI) has found that forestry has positive impacts on rural communities and has over time found increasing acceptance as a rural-based industry (30).

The Strategic Plan proposes to ensure the contribution of farm forestry to national afforestation by securing real benefits for farm and rural communities. In Ireland, the growth of farm forestry is a recent development which requires encouragement to enable it to compete with other farm enterprises and schemes. Forest practice will need to adapt to operations in small forest parcels which characterise farm forestry. Such changes also necessitate training initiatives for all involved.

New initiatives, such as farm forest co-operatives, forest farm partnerships and management agreements, can create mechanisms which facilitate the involvement of the farmer in forest enterprise.

A key objective of the Strategic Plan is to provide additional employment in the forestry sector. While direct employment will be limited, primarily due to efficiencies in operations, it is important where few alternative prospects exist. Indirect and downstream employment prospects are more significant.

Amenity and recreation

As set out in *Growing for the Future*, it is national policy to encourage the provision of public access to forests and the development of associated amenities, with due regard to owners' rights. The forest can provide for a wide range of recreational activities. These opportunities feature prominently among the criteria by which members of the public judge the value and benefits of forestry development.

There has been a general policy of open access to forests since the 1970s (31), and this is complemented by the provision of specific support schemes designed to encourage urban and amenity woodlands for public access and enjoyment (15) (16). Recent surveys suggest a very high level of forest visits (32).

The provision of recreational facilities impacts on forest management in areas such as general forest safety, species composition, the design and treatment of forest roads, open spaces, edges and entrances, and the notification and scheduling of forest operations. These activities must be understood in the context of public liability insurance requirements as expressed in the Occupiers Liability Act 1995.

Safety

Health and safety in forestry is the concern of all those involved, including forest owners, managers, supervisors, operators, recreational users and trespassers. The Safety, Health and Welfare at Work Act 1989 and the Safety, Health and Welfare at Work (General Application) Regulations 1993 place responsibilities on all involved in work activities, and set out a basis for managing health and safety in all workplaces (33). Companies and individuals may be prosecuted for non-compliance with the legislation.

Forest owners have legal responsibilities to ensure that the workplace and all articles and substances situated there are safe and free from health risk. This involves informing contractors of potential hazards, work agreements and monitoring.

Employers, self-employed and employees all have clear responsibility to ensure safe working practices for themselves and others.

The Safety, Health and Welfare at Work Act and its regulations lay down a basis for managing health and safety in the workplace (33). A leaflet outlining safety in forestry operations (34) has also been published.

Forest practice must ensure that operations do not endanger workers and others. The extensive nature of these activities in the forest context requires a high degree of attention. The use of heavy vehicles, manual machinery and chemicals all require experience and caution.

Other community values

Communities living close to forestry activities are particularly conscious of the associated benefits and risks. The care of the local environment, in the context of commercial activities, is of high concern to its inhabitants. The impact of forest operations on roads, rights-of-way, entrances, margins, aquatic zones and water schemes, and local sites of archaeological and cultural significance, is of particular concern to rural communities. Local landscape impacts, such as changes to the view from local dwellings due to felling or road construction, must be handled in harmony with the local community as well as on a regional or national basis. Forestry development in harmony with the local community creates a sense of ownership and mutual respect between the forest owners and other stakeholders, and this is ultimately beneficial to all.



Training is a key element in promoting operator safety in all forest operations.

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INTERNATIONAL CODES OF PRACTICE

INTRODUCTION

Many countries involved in commercial forestry have compiled or are in the process of compiling forest standards, codes and guidelines as a direct consequence of the issues arising from the debate on sustainable forest management. This section describes a number of these in order to illustrate the international context in which the Irish CODE OF BEST FOREST PRACTICE and associated 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) will operate. A sample is taken from countries where environmental conditions or the type of forestry practised show some similarities with Ireland.

AUSTRALIA

Australia's forest management system is administratively similar to that in Canada, where much of the forest is state-owned, and western USA, where forest management is conducted by the forest agencies rather than by industry. Australia has a substantial plantation resource, predominantly Monterey pine. Approximately 70% of plantation production takes place on public lands (1). Important contemporary influences on forestry practice include environmental issues, concern with economic performance, management quality and the National Forest Policy - a joint Commonwealth and state initiative designed to harmonise principles of forest use and to overcome difficulties between the two government levels regarding conservation issues. All of these factors are leading to the development of a harmonised approach to forestry practice and the development of codes of forest practice by each state.

A total of 15 state and national codes exist. These deal primarily with forest and logging practices but also cover the development of consistent nation-wide baseline standards for native forests. Australia is involved in two international codes covering the logging of indigenous forests and criteria and indicators for sustainable management of boreal and temperate forests.

Two states - Tasmania and Victoria - have in place specific legislation for their codes. Others impose control over forest practice through regulations under various forestry acts and contractual agreements for timber sales. Signatory states to the new National Forest Policy Statement are obliged to develop codes of forest practice covering both state and private forest operations.

Recent work on baseline environmental standards and performance indicators (relating to soils, water quality, flora and fauna, pests and diseases, and forest productivity) and the development of the National Forest Policy suggest that codes will evolve with increasing emphasis on principle and quantitative performance standards and a reduced emphasis on direct prescription.

FOREST PRACTICES CODE OF BRITISH COLUMBIA, CANADA

Recent changes in society's attitudes regarding environmental protection, biodiversity, recreation and other issues created considerable pressure on government to change forest practices in British Columbia, culminating in the recommendation by the BC Forest Resources Commission in 1992 for the establishment of a Forest Practices Code (2) (3). During its development, it was agreed that the Forest Practices Code should:

- be regarded as a component of a provincial commitment to protect and sustain the environment while ensuring a sustainable economy;
- recognise that the physical and biological capacity of the forest underpins the long-term sustainability of all its uses;
- be based on integrated resource management principles;
- link practices to resource management priorities in landuse plans;
- draw on the best of existing policies, practices and experiences and incorporate them into a single framework;
- provide minimum provincial standards for practice;

- provide a systematic and cost-effective process for public input in its development, implementation and revision;
- establish processes to develop locally relevant standards which improve upon provincial standards;
- provide a review and appeals process, and ensure public accountability.

The Forest Practices Code framework comprises:

- the Forest Practices Code of British Columbia Act;
- Forest Practices Regulations;
- Forest Practices Standards;
- Forest Practices Code Guidebooks.

The Forest Practices Code of British Columbia Act is the legal umbrella which establishes the Forest Practices Code, sets mandatory requirements for forest practice, provides stronger powers (including penalties) for enforcing better practice, and sets out obligations, public involvement and administrative arrangements. The Forest Practices Regulations lay out regulations governing activities such as strategic and operational planning, harvesting, silviculture, roading, management and recreation. The Forest Practices Standards allow for expansion on the regulations, where required, and are intended to provide flexibility to accommodate regional variation. The requirements specified in both the regulations and the standards are mandatory and legally enforceable. Forest Practices Code Guidebooks are part of the Forest Practices Code but are not a component of the legislation. They provide 'best management practice' recommendations on procedures, processes and results considered to be consistent with the requirements of legislation, but allow for professional judgement.

Also included is a Forest Practices Board (which acts as an independent public watchdog) and a Forest Appeals Commission (established to hear appeals of enforcement determinations).

The Forest Practices Code contains a planning framework comprising both strategic and operational components. Strategic planning identifies management objectives for resource management zones, landscape units and sensitive areas. Operational planning includes forest development plans, silvicultural prescriptions and logging plans. Forest development plans show how and where harvesting activities will be conducted over a broad area. Silvicultural prescriptions are site-specific and detail harvesting methods and the sequence of silvicultural treatments consistent with forest resource management objectives. Logging plans describe how harvesting operations are to be carried out onsite to ensure that site productivity is maintained and that all resource values are accommodated.

FAO MODEL CODE OF FOREST HARVESTING PRACTICE

In 1996, the UN Food and Agriculture Organisation (FAO) produced its Model Code of Forest Harvesting Practice to highlight the wide range of environmentally sound harvesting practices available to forest managers, particularly those requiring only a modest level of investment in training and technology (4). Contributions to the code were made by a wide range of international organisations (including the World Conservation Union (IUCN), the International Union of Forestry Research Organisations (IUFRO), the World Wide Fund for Nature (WWF) and the International Tropical Timber Organisation (ITTO)), national agencies and individuals. Although originating primarily from industrialised countries, the code is designed for general application in the context of a country's cultural and social framework.

In general, the code was designed to: enhance protection, sustainable management, conservation and rehabilitation; and to promote efficient utilisation and assessment to achieve full value of goods and services provided by forests and woodlands.

The FAO Model Code of Forest Harvesting Practice assumes that it is first necessary to know the practices which are technically and economically feasible and that it is possible to conduct harvesting consistent with sustainable forest management. It sets out descriptions, guiding principles, objectives and the consequences of bad practice, and details recommendations for planning, road engineering, cutting, extraction, loading, transport, harvest assessment and workforce.

Descriptions of practice are extensive, covering a wide range of biophysical, socio-economic and political conditions.

NEW ZEALAND FOREST CODE OF PRACTICE

The New Zealand Forest Code of Practice was first published in 1990 following consultation between the New Zealand Logging Industry Research Organisation (LIRO), the forest industry, territorial authorities and others. It was revised and updated in 1993. Its aim is "to plan, manage and carry out forestry operations in a sustainable manner" (5).

Approximately 1.4 million ha of New Zealand's 7.5 million ha of forest is exotic plantation forest, primarily highly productive Monterey pine. Approximately 99% of the country's timber volume comes from these exotic plantations.

In New Zealand environmental legislation, the Resource Management Act 1991 replaces all other resource and land, air and water related laws. Its aim is "to promote the sustainable management of natural and physical resources", with sustainability defined as "providing for social, economic and cultural well-being".

The Forest Code of Practice is designed as a practical document for environmental planning of operations and as a database on the forest operations themselves. Its objectives relate to the protection or maintenance of the following:

- soil and water values;
- scenic values;
- cultural values, incorporating traditional, historical and archaeological values and sites;
- recreational values;
- scientific and ecological values;
- forest health;
- site productivity;
- off-site impacts;
- safety;
- commercial values.

The code incorporates an environmental planning process, enabling inputs from District and Regional Councils, central government agencies, non-government organisations (NGOs), communities and individuals. During the process, important environmental values are identified for each site, operations having a potential adverse impact are identified, cost-effective low impact techniques are selected, compliance is checked and performance monitored.

The code is intended for use at the operational level, but states that environmental values should also be considered at the strategic and tactical levels. A planning framework is presented, based on the incorporation of three management constraints - ecological, economic and cultural - to minimise adverse impacts and to achieve acceptable standards. When these constraints are identified and combined, areas where development is unacceptable or where specific techniques are needed to minimise potential adverse impacts, are readily identified. Also included is a description of the use of geographical information systems (GIS) as a tool in the planning framework.

The code has an impact appraisal process based on rating systems and checklists.

The operations database containing information on forest practice can be used to select cost-effective low impact techniques. The database is divided into six sections: access; land preparation; establishment; tending; protection; and harvesting. Each is further broken down into relevant operations (e.g. stream crossings and access roading and tracking, in the case of access). Techniques available for each operation are presented, together with relevant machinery, potential adverse impacts and methods for their reduction. This database is designed to avoid or minimise adverse environmental impacts of operations. It provides the necessary information to achieve this in the form of non-prescriptive guidelines, with emphasis on implementing corrective measures to protect site values.

SWEDEN

Only 5% of the total productive forest land in Sweden is under state ownership, with private individuals and forest companies representing the major forest owners. The national authority responsible for the practical application of forest policy is the National Board of Forestry and its associated County Forestry Boards.

Family forest owners are represented by eight forest owners' associations formed to improve the financial yield of forestry among their members. This is done by co-ordinating the timber trade and by assisting with logging and silvicultural practices. The different associations co-operate in the Swedish Federation of Forest Owners. Forest companies are represented by the Swedish Forest Industries Association. Forestry and related nature conservation are promoted by the Swedish Forestry Association.

National forest policy enacted by the Swedish government in 1993 incorporates commitments made at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992 (6). Underlying this policy is the conviction that Swedish forests can supply renewable products on the principles of ecological cycles. Goals for both forest production and forest environment have been established, with the preservation of biodiversity forming a key element. Sweden's forest policy states that forest management will continue to be characterised by multiple uses, including hunting, produce such as wild mushrooms and berries, active silviculture and the traditional 'right of common access'. Forest owners and workers are responsible for obtaining the knowledge required to fulfil environmental standards when implementing various forest operations and measures.

Legislation has been in existence since 1903 requiring the planting and cultivation of new forests after logging. Current legislation contains provisions aimed at protecting key woodland habitats and forest types. Special regulations are in place covering approximately 4 million ha of low productivity woodland excluded from the productive forest land area, to ensure that the character of these woodlands remains unchanged. Other regulations set out requirements for the environmental assessment of new silvicultural methods or forest materials, and the maintenance of a gene bank to preserve the original genetic material of the country's tree species.

SOUTH AFRICAN HARVESTING CODE OF PRACTICE

A South African Harvesting Code of Practice is being developed along the lines of the New Zealand and British Columbia codes, directed principally at the country's 1.4 million ha of plantation forests. It provides guidelines on efficient harvesting to ensure long-term site productivity, taking into account the natural environment and safety. An auditing and compliance mechanism is also included (7).

TROPICAL COUNTRIES

Various codes and guidelines are being developed specifically for tropical forests (8) (9) (10). Consideration is given to planning and technical supervision of operations, with an emphasis on logging, roads, felling and extraction. Impacts on ecological values are emphasised. In some cases, legislation has been introduced. Less waste and greater community involvement in management are proposed. Regeneration with indigenous species and erosion control are proposed for logged sites.

UK FORESTRY STANDARD

The UK Forestry Standard (11) was developed specifically for forestry in the UK but in the context of global protocols for sustainable development. It was developed in the context of the international debate on sustainability through the UK Forestry Accord in 1996.

The standard outlines the UK regulatory framework, including policy, powers, instruments and mechanisms. It establishes a number of criteria and indicators associated with the standard requirements for forest management units in assessing the sustainable forest management. Criteria cover aspects such as soil, water and air pollution, timber production, safety, rural issues and conservation.

Good forest practice and the impact of forest operations on the environment and community are dealt with. The importance of woodland plans is also strongly emphasised.

Standard Notes (SN) identify management options and relate to:

- general forestry practice;
- creating new woodlands;
- creating new native woodlands;
- felling and reforestation;
- managing semi-natural woodlands;
- planting and managing small woodlands.

Particular features also apply to each of these options. For example, forest operations in SN1: General Forestry Practice includes cultivation and drainage, establishment and protection, harvesting and forest roads and tracks. The Standard Notes also deal with environmental issues, landscape and the integration of new woodlands. Planting, natural regeneration and colonisation in new native woodlands are also described, as are felling and reforestation plans, regeneration, grazing, species, genetic stock in semi-natural woodlands, and strategies for small woodlands.

An extensive publication index is given for cross-referencing purposes.

OREGON FOREST PRACTICE ACT, USA

Fourteen states within the USA have in place forest practice acts. Six of these can be regarded as being comprehensive, involving monitoring and enforcement (12).

The 1971, the Oregon Forest Practice Act resulted in the development of forest practice rules which set specified standards for reforestation and streamside buffer strips. These have been amended many times to deal with drainage, harvesting, herbicides, clearcuts, wildlife, wetlands and roads. A total of 24 major amendments were incorporated by 1993.

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LEGAL AND REGULATORY FRAMEWORK

REGULATORY FRAMEWORK

Forest operations and environmental protection are regulated by a number of acts of the Oireachtas and by various European Union Council Directives. Personnel involved in forest operations should be familiar with the legal requirements and their guidelines (1) (2). Aspects of forestry and the law have been abstracted and presented in a more accessible form in a number of publications (3) (4) (5) (6) (7) (8) (9). The following is intended as a guide only. Professional legal advice should be sought, where necessary.

IRISH LEGISLATION

Forestry Act 1946

This contains the main provisions for controlling tree felling:

- It is an offence to uproot or to cut down any tree, unless the owner has obtained permission in the form of a felling licence from the Forest Service.
- Application for a felling licence is made on a felling notice form, available from any Garda Síochána station.
- Prohibition orders can be served, prohibiting the felling of all or any of the trees specified in the felling notice.
- Limited felling licences allow applicants to fell approved trees and can be exercised over a period of two years. Replanting conditions may be attached.
- General felling licences can be exercised over a specified period.
- Felling licences are not required in certain circumstances, e.g. trees in a County Borough or an Urban District, trees within 100 feet of a building or permanent structure, trees excluded by local government and utilities legislation.

Forestry Act 1956

This facilitates compulsory purchase of commonages.

Forestry Act 1988

This establishes Coillte Teoranta and amends penalties relating to felling offences.

Local Government (Planning and Development) Acts 1963-1996

These provide for the protection and preservation of trees, and bring trees under planning control:

- Tree preservation orders (TPOs) can be issued to protect trees and woodland for amenity reasons. The permission of the planning authority is then required before any trees are lopped, topped or felled. TPOs do not apply to dangerous trees, and contravention of a preservation order is an offence.
- A planning authority can make a Special Amenity Area Order (SAAO) declaring an area to be one of special amenity on the grounds of its outstanding natural beauty, its recreational value or a need in the area for nature conservation. SAAOs can be useful in conserving woodlands. Conservation Orders can be made inside an SAAO, to protect specified flora and fauna.
- A planning authority may enter into a management agreement with a landowner to restrict or regulate the development or use of the land. This can be used to prevent or regulate the felling of a woodland or to encourage its management for recreational purposes.

Local Government (Water Pollution) Acts 1977-1990

These deal with the prevention of water pollution:

- it is an offence to cause the entry of polluting matter into waterways;
- Local Authorities are empowered to order remedial action in a specified manner;
- the accused is entitled to prove reasonable care;
- notification of accidental discharge is required;
- permission is granted to Local Authorities to issue bye-laws in relation to a specified activity.

Environmental Protection Agency Act 1992

This establishes the Environmental Protection Agency (EPA) and defines its various functions:

- the licensing and regulation of large/complex industry and other processes with significant polluting potential;
- the monitoring of environmental quality;
- advising public authorities in relation to environmental functions, and assisting Local Authorities in the performance of their environmental protection functions;
- the promotion of environmentally sound practices.

National Monuments Acts and Amendments 1930-1994

The above:

- protect archaeological sites, monuments and artefacts;
- create an offence to damage listed or newly discovered sites and monuments;
- places archaeological sites, monuments and artefacts under State ownership;
- registers sites and monuments and defined areas of protection.

Wildlife Act 1976

This is the principal national legislative instrument governing nature conservation in Ireland. Under the Act, it is an offence to burn vegetation growing within a mile of a forest. The Act also protects wild birds.

Roads Act 1993

This requires that all owners or occupiers of land must take reasonable steps to ensure that any trees on the property do not present a hazard or potential hazard to people using public roads. Local Authorities can require the owner or occupier to undertake appropriate action and may, without notice, take action to reduce or remove a tree which is an immediate and serious hazard.

Safety, Health and Welfare at Work Act 1989 and the Safety, Health and Welfare at Work (General Application) Regulations 1993

The aims of these are to:

- place general obligations regarding safety and health at work on employers, employees and on others;
- lay down a basis for managing health and safety in the workplace;
- ensure that employers and employees consult on safety and health matters;
- bring about a preventative approach to avoiding workplace accidents and ill health;
- empower the National Authority for Occupational Safety and Health, otherwise known as the Health and Safety Authority (HSA), with responsibility for promoting occupational safety and health and for the administration and enforcement of the relevant statutory provisions.

HSA guidelines relating to forest operations cover:

- the care and protection of humans, animals and beneficial plants, safeguarding the environment and guarding against water pollution in the use of herbicides;
- risk assessment planning, safety statements and rules for hazardous work;
- rules on equipment, risk zones, ground conditions and emergencies;
- rules for harmful substances with reference to instruction, handling, application and storage;
- advice on the use of clothing for and the maintenance of chainsaws;
- rules on tractors and mobile machines.

Safety, Health and Welfare at Work (Construction) Regulations 1995

These are relevant to construction projects such as forest roading, bridge construction, etc.

Occupiers Liability Act 1995

This places obligations on owners of forest land regarding the welfare of visitors and others.

Waste Management Act 1996 Litter Pollution Act 1997

Local Government (Planning Development) Regulations - Environmental Impact Assessment - Statutory Instrument No. 100 of 1996

European Communities (Environmental Impact Assessment) (Amendment) Regulations - Statutory Instrument No. 101 of 1996

Employment legislation

Relevant legislation covering employment issues include: the Minimum Notice and Terms of Employment Act 1973; the Unfair Dismissal Act; and the Employment Equality Act 1977.

Transport legislation

Relevant transport legislation includes: the Road Traffic Acts 1933-1997, which deal with load weights; and the Road Transport Act 1999, which introduces consignor liability for overloaded trucks.

Planning and Development Bill 1999

Wildlife (Amendment) Bill 1999

One of the main objectives of the Wildlife (Amendment) Bill 1999 is to provide for the establishment and protection of a national network of protected areas of both natural heritage and geological importance, to be known as Natural Heritage Areas (NHAs).

EU LEGISLATION

Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

Council Directive 92/43/EEC (commonly referred to as the Habitats Directive) provides for the establishment of an EU-wide network of Special Areas of Conservation (SACs). These are areas of significance for the conservation of special habitats.

Council Directive 79/409/EEC on the conservation of wild birds

Council Directive 79/409/EEC (commonly referred to as the Birds Directive) provides for the designation of Special Protection Areas (SPAs). These are areas of significance for the conservation of special habitats which are important for birds.

European Communities (Natural Habitats) Regulations 1997

These provide for the designation and protection of SACs and SPAs.

Council Directive 66/404/EEC on the marketing of forest reproductive material and Council Directive 71/161/EEC on external quality standards for forest reproductive material marketed within the Community

Council Directives 66/404/EEC and 71/161/EEC set out the requirements relating to genetic characters and external quality to be met by forest reproductive material before it can be marketed in the Community.

Council Directive 1999/105/EC on the marketing of forest reproductive material

The new Council Directive 1999/105/EC, which comes into force from 1 January, 2003, aims to update the legislation to take account of accessions of new Member States

since 1975, the Internal Market and scientific advances, including the availability of new material.

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

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

EU Environmental Impact Assessment (EIA) Directive 85/337/EEC

EU Environmental Impact Assessment (EIA) Directive 97/11/EEC

EU scheme on the protection of forests against atmospheric pollution (Council Regulation EEC 3528/86)

This establishes a series of observation plots and trials throughout Europe to assess the effect of atmospheric pollution on crown condition, defoliation, soil and other factors.

INTERNATIONAL PROTOCOLS

OECD Scheme for the Control of Forest Reproductive Material moving in International Trade

The current Organisation for Economic Co-operation and Development (OECD) Scheme covering forest reproductive material moving in international trade dates from 1974. It has been the subject of considerable revision in the last few years and a new updated scheme will be adopted by the OECD Council in the near future.

Protection of the World Cultural and Natural Heritage (1972)

United Nations Convention on Biological Diversity (1992)

Climate Change - UN Framework (1992)

Helsinki Protocols arising from the Ministerial Conference on the Protection of Forests in Europe, Helsinki, 1993

Lisbon Protocols arising from the Ministerial Conference on the Protection of Forests in Europe, Lisbon, 1998

Kyoto Protocol, 1997

This relates to the commitment to reduce greenhouse gas emissions under the United Nations Framework Convention on Climate Change (UNFCCC).

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USING THE CODE OF BEST FOREST PRACTICE

AIM

The aim of the CODE OF BEST FOREST PRACTICE is to complement on an operational level that of *Growing for the Future - A Strategic Plan for the Development of the Forestry Sector in Ireland* (1): "To develop forestry to a scale and in a manner which maximises its contribution to national economic and social well-being on a sustainable basis and which is compatible with the protection of the environment." Particular emphasis is placed on ensuring that the various environmental, economic and social forest values are recognised in the context of criteria for sustainable forest management, and that adverse impacts associated with particular forest operations can be monitored and avoided or remedied. As most forests in Ireland are managed on a commercial basis, a careful balance between measures to protect the environment and measures to maintain forest productivity will be necessary. However, these are not necessarily mutually exclusive.

OBJECTIVES

Specific operational objectives are as follows:

- To maintain forest productivity through good silvicultural practice.
- To protect and enhance aquatic zones and water quality.
- To protect and enhance forests and forest ecosystems.
- To protect and enhance biodiversity.
- To identify and protect heritage areas, archaeological sites and artefacts within forest sites.
- To identify and protect Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and proposed Natural Heritage Areas (pNHAs).
- To maintain and enhance visual amenities (private and public) and landscapes of importance.
- To minimise the impact of forest operations off-site, both on communities and the environment.
- To identify and develop recreational potential, and to carry out forest operations in a manner which is compatible with these activities.
- To maintain forest health and vitality through protection against pests and diseases.
- To ensure forest operations are carried out safely.
- To ensure forest operations do not damage forests.
- To provide meaningful and productive employment.
- To ensure that forest operations are efficient and cost-effective.
- To comply with legislation.

GRANT-AIDED FORESTRY PROGRAMMES

While the CODE OF BEST FOREST PRACTICE is designed to be used independently of how forest operations are financed, the control of grant-aided forestry in Ireland has brought an additional measure of regulation, particularly in relation to afforestation (2).

In most instances, application of the CODE OF BEST FOREST PRACTICE will be complementary to the adherence to the various guidelines for grant-aided forestry (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 its provisions have been derived to a significant extent from these guidelines in the areas where they apply. As the principles of sustainable forest management provide the framework for both the CODE OF BEST FOREST PRACTICE and the guidelines, forest operations which do not meet the standards required will not receive support. Specifications set out to qualify for grant-aided forestry are occasionally more stringent than silvicultural practice would normally require.

Species selection is directed towards target percentages of broadleaf species and conifers other than Sitka spruce. Some limitations are set on acceptable species for planting, and distinction is made between enclosed and improved land and unenclosed or unimproved land. With the exception of urban woodlands, grant aid may be constrained for land classified as non-agricultural.

Other requirements set by good silviculture and the environmental guidelines (such as minimum standards of fencing, stocking, roading and maintenance) would be as stringent as those set out in the CODE OF BEST FOREST PRACTICE.

USING THE CODE IN THE PLANNING FRAMEWORK

In a long-term activity such as forestry, which can create substantial and lasting change, good planning is essential to ensure that forest operations are undertaken with minimum impact. Planning is also essential for sustainable forest management in order to protect the environmental, economic and social values. Planning issues arise when land is first identified for afforestation (e.g. forest design, soil and water management) and continue throughout the forest cycle in relation to aspects such as harvesting, recreation, biodiversity and landscape. While the CODE OF BEST FOREST PRACTICE focuses on operational planning, strategic and tactical planning are also paramount (3):

Strategic: This applies to regions and issues of national importance, implying consultation at high levels.

Tactical: This relates to forest management plans and the extent to which forest operations take place over time with reference to resources and constraints.

Operational: This involves the selection of specific operational systems and the monitoring and review of operational decisions.

Figure 1 indicates the position of the CODE OF BEST FOREST PRACTICE and other tools within the planning framework for forestry.

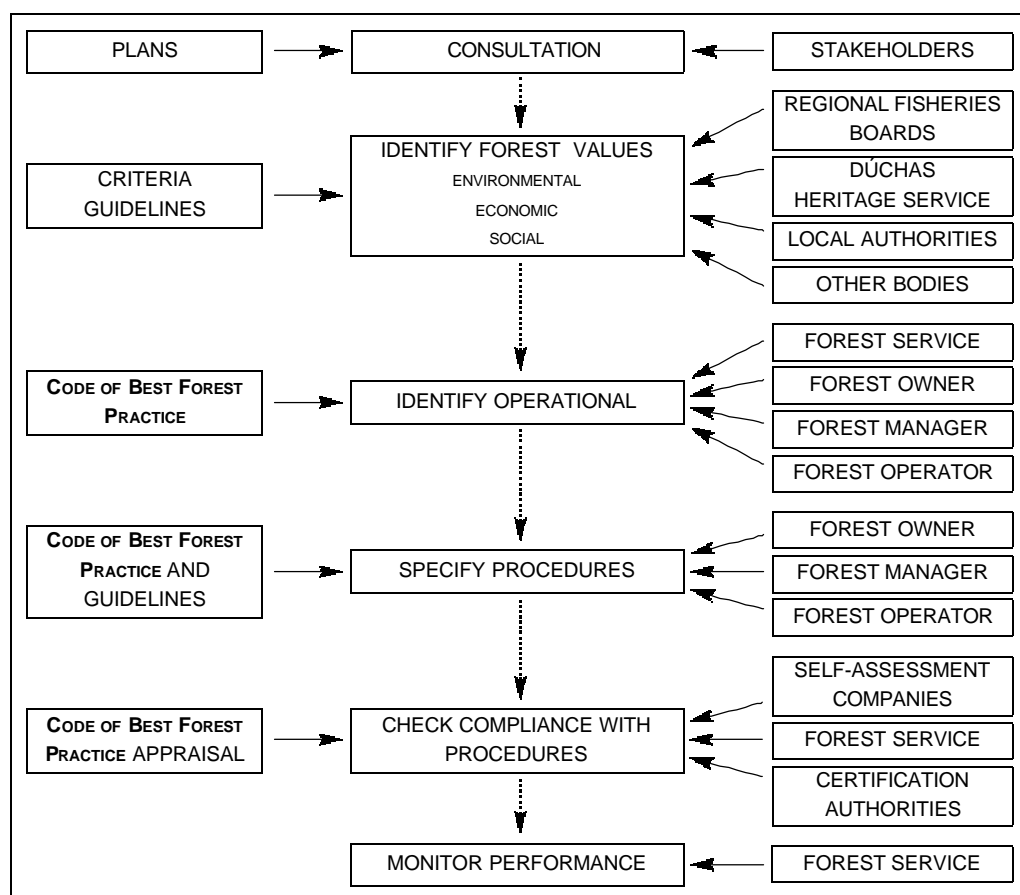


Figure 1 Planning framework for forestry.
Consultation

Consultation is inherent in good planning. There are many interests and well-defined representative bodies associated with Irish forestry. In addition to the forest owners themselves, they include local community groups, farming organisations, employer/employee organisations, Local Authorities, Dúchas The Heritage Service and Regional Fisheries Boards, county council planning and environmental interests,

environmental non-government organisations (NGOs), and sporting and recreational groups. The CODE OF BEST FOREST PRACTICE is designed to highlight those occasions and operational practices which require consultation at a stage early enough in the planning process to avoid or minimise difficulties. The early exchange of information is important in creating a climate of trust and transparency, and to allow sensible and practical solutions to be found where difficulties exist.

Consultation will be required at different stages in the process, well in advance where forest establishment and major operations are planned, and often on an ongoing basis where operations can vary, due to natural causes or management decisions.



Dialogue and exchange of information are important in creating a climate of trust and transparency.

Identifying forest values

The second stage in the planning framework is the identification of forest values. This occurs at the strategic or tactical planning level. For any major regional or local forestry development, the major impacts need to be identified, broad guidelines determined and consultation undertaken with the relevant national and local interest groups. Major decisions will be needed as to whether or not the development should proceed, and in what manner.

Identifying operational impacts

Numerous operations will occur at the forest level throughout the forest cycle. It is necessary to identify those operations with potential environmental, economic or social impacts, with reference to forest owners and managers. The CODE OF BEST FOREST PRACTICE highlights key factors and potential adverse impacts associated with each forest operation. Decisions will be needed at this stage to set out priorities.

Specifying procedures to avoid or minimise adverse impacts

The CODE OF BEST FOREST PRACTICE indicates a range of procedures which will avoid or mitigate adverse impacts. These procedures are outlined with basic necessary information. These techniques should be cost-effective and capable of minimising any adverse impacts which cannot be avoided. On the ground discussions between forest owners/managers and representatives of concerned interests will be necessary at this stage.

Checking compliance with approved procedures

Forest managers will also need to be aware of the approved procedures for conducting operations. In grant-aided forestry, these will form part of the conditions imposed to qualify for support. The law must also be observed. The various environmental guidelines should be followed, and provisions of the CODE OF BEST FOREST PRACTICE fully complied with.

Clear instructions must be given to supervisors and operators for each operation. As those who will be most closely involved with forest work, machine operators and manual workers must be aware of the relevant constraints, requirements and procedures.

Monitoring performance

To complete the planning process, it is important that activity is monitored. This should be undertaken during and after the operation and repeated periodically, ensuring compliance has been achieved, planning followed and feedback facilitated.

As well as self-monitoring, adherence to the CODE OF BEST FOREST PRACTICE implies an external assessment to ensure that standards are maintained. This is carried out through inspections by Ireland's forest authority, the Forest Service of the Department of the Marine and Natural Resources, undertaken as part of an impact appraisal process.

FOREST OPERATIONS DATABASE

SECTIONS 1-18 describe operations spanning the entire forest cycle, from nursery to reforestation and including planning and training. Each operation is described in detail under five broad headings:

- Key factors related to a particular operation are identified and objectives listed.
- Technical information describing the operation in adequate detail (with some quantified data and tables) is given, to guide the operator towards the best procedure and to be understood by other interests.
- Potential adverse inputs are identified.
- Procedures to avoid or remedy impacts are identified.
- Other useful reference material is listed.

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IMPACT APPRAISAL

IMPACTS

Impacts on forest values need to be identified, associated with operations, listed and prioritised.

Environmental impacts

Environmental impacts vary widely and can affect soil, water quality, landscape, ecological and scientific values, cultural and archaeological values, and biodiversity. In Ireland, water impacts are considered highly important. Water impacts are a possibility on most sites, due to Ireland's oceanic climate, the wide distribution of streams, rivers and lakes (especially in areas suitable for forestry), and their suitability for salmonids.

Other impacts on sensitive or rare habitats and on the landscape are also ubiquitous and long lasting but can be brought more easily into the planning process. Positive changes in soil fertility and forest health can be influenced by good silvicultural practice.

Productive and economic impacts

Establishment, management and harvesting operations can impact on forest productivity, and species selection, soil preparation and thinning practice can affect commercial viability. These impacts are highly significant to the forest owner or manager, but are of less immediate interest to the general public. However, they do have an important bearing on the Government's Strategic Plan (as set out in *Growing for the Future*) and Ireland's international obligations regarding sustainable forest management.

Social impacts

Adverse impacts on rural development, amenity and safety of operators and the public can result from poor forest practice. Many forest operations have acute safety implications, particularly the use of chemicals and forest machinery such as chainsaws.

As the forest provides increasing opportunities for recreation, forest operations have to be carefully scheduled accordingly. Impacts on local amenities can mean the difference between a supportive and an antagonistic community.

Poor forest practice can diminish employment opportunities, resulting in a loss of earning potential in rural communities.

LEVELS OF IMPACTS

In order to evaluate the significance of forest operations in relation to potential impacts, the two have to be related and levels of risk understood. Table 1 lists sample impacts in the context of their time frames and severity.

The level of potential impact - low to very high - must take into account the likely consequences of the operation for each value related to the area involved, as well as the importance of the value. The length of time can be considered short-term if the effect lasts from weeks to months, or long-term if it persists over several years.

RANKING

The impact of operations can be positive or negative. The purpose of this CODE OF BEST FOREST PRACTICE is to avoid or mitigate adverse impacts. Therefore, the focus of its auditing system is on risks rather than the need to record good quality operations.

The detail involved in impact assessment varies considerably between forest codes produced internationally. Recording requirements tend to be less detailed as the target group becomes more general. Some assessments use an elaborate points system, while others are based on more descriptive information.

In this CODE OF BEST FOREST PRACTICE, which is aimed at the Irish forest industry in general, a numerical points system is avoided. This is because the process of accumulating points from different impacts in different circumstances may actually distract from the objective of identifying the impact and ensuring remedial action.

The examples given in Table 1 indicate possible levels of severity. However, the nature of the impact can express itself very differently depending on the operation, in what circumstances it occurs, how long the effect lasts, and the public perception of the seriousness of the effect.

Table 1 Sample impacts on forest values, with time frame and potential severity of impact.

Value	Operation	Time frame	Potential severity of impact
Soil	Whole tree harvesting on nutrient-poor sites	Long term	Moderately high
Water Quality	Soil preparation and drainage Fertilisation	Short term Long term	Very high Very high
Landscape	Clearfelling large coupes Lowland broadleaf planting	Long term Long term	High Low
Cultural and archaeological values	Site preparation	Long term	High
Biodiversity	Poor species diversity Hedgerow removal	Long term Long term	Moderately high High
Forest protection and health	Deer fencing Spraying for large pine weevil	Medium term Short term	Moderately high High
Sustained productivity	Machine thinning Species selection	Medium term Long term	Moderately high High
Commercial viability	Rotation length Windthrow	Long term Long term	Moderately high High
Amenity and recreation	Felling and extraction	Short term	High
Safety	Motor manual felling	Short term	Very high
Other community values	Road transport	Medium term	High

Impact Assessment Forms

The following Impact Assessment Forms 1 and 2 (pages 37-39), to be photocopied as required, are designed for both internal and external auditing purposes.

In Impact Assessment Form 1, impacts are identified by highlighting the forest value impacted upon by the particular operation. This will alert the assessor that a problem has arisen. It identifies: the forest unit or property; the location of the impact by compartment, townland or other method, e.g. geographical positioning systems (GPS); the owner or responsible manager (individual or company); each of the 18 operations identified in the CODE OF BEST FOREST PRACTICE; and each of the environmental, economic and social values.

Example for Impact Assessment Form 1: An assessor notes discarded chemical containers with residue within 50 m of an aquatic zone. He/she will tick the VEGETATION MANAGEMENT row and the SOIL and WATER QUALITY columns.

Impact Assessment Form 2 is completed for each operation identified in Form 1. Each environmental, economic and social value is listed. Impacts are broken down into

components relevant to each particular value, with space available if additional impact components are relevant. A four-scale level of severity - very high (VH), high (H), moderate (M) and low (L) - is assigned to each of these impact components. Numerical scoring is avoided so that the emphasis will be on the impact and its remedy. The four-scale method is intended to direct the assessor into making a deliberate decision on severity, thereby avoiding neutral assessment. Action can then be specified.

With completed forms in-hand, filled out during previous visits, the assessor should be in a strong position, when revisiting the site, to judge if the impact has been mitigated, still exists or has become more serious.

Example for Impact Assessment Form 2: The operation is VEGETATION CONTROL. The impacts are classed under WATER QUALITY (RUN-OFF, POLLUTION and FISH AND OTHER AQUATIC LIFE), and the severity level as very high (VH). The specified action will be: to remove canisters and, if necessary, any contaminated soil; to evaluate contractors; and to evaluate operational planning processes.

AUDITING

External

The purpose of the CODE OF BEST FOREST PRACTICE is to contribute, within a national framework agreed by the forest industry and other interested parties, to the continuous improvement of operational standards. It is therefore implicit that an assessment system will be available to Ireland's forest authority - the Forest Service - to ensure compliance. This assessment may be carried out by the Forest Service Inspectorate or persons or agencies nominated by the Department of the Marine and Natural Resources.

The CODE OF BEST FOREST PRACTICE incorporates good forest practices specified as conditions of grant schemes and as set out within the FORESTRY AND WATER QUALITY GUIDELINES, FORESTRY AND ARCHAEOLOGY GUIDELINES, FORESTRY AND THE LANDSCAPE GUIDELINES, FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FOREST BIODIVERSITY GUIDELINES. Such practices are mandatory for grant aid purposes, and failure to comply may result in the refusal or withdrawal of grant payments. Also covered are good forest practices specified by conditions attached to the issuing of Felling Licences and inherent in compliance with other relevant legislation (e.g. Safety, Health and Welfare at Work Act, Water Pollution Act, National Monuments Acts) and European Union Directives.

Over and above these factors, the CODE OF BEST FOREST PRACTICE, together with its compliance and assessment procedures, provides an incentive to the forestry sector to adhere to high standards in forest operations, and offers a clear indication to the public of the range and scale of these operations and their potential impacts.

Internal

Different forest owners, managers (individual or company) and other parties may provide their own codes of practice, set standards and implement self-assessment. However, these should conform in broad principle to the CODE OF BEST FOREST PRACTICE.

Chain of custody

The forest ultimately provides products which move to processing and manufacturing or perhaps, in the case of non-wood products, directly to the consumer. It is therefore necessary to identify critical control points at each stage of forest development. At forest operational level, this requires a management structure clearly defining responsibilities and procedures and backed by appropriate documentation, which can be measured against a standard and which ensures that remedial actions are implemented.

IMPACT APPRAISAL AND GEOGRAPHICAL INFORMATION SYSTEMS

Geographical information systems (GIS), which use spatial and associated attribute information to describe areas, are an important tool in facilitating impact appraisal. The use of GIS has been developing rapidly in landuse and forestry-related activities (1). For example, in Ireland, Coillte's inventories have been GIS-based for over 10 years. The Forest Inventory and Planning System (FIPS) of the Forest Service is designed

to incorporate forest and site categories with environmental information, felling control and grants administration (2).

A substantial range of databases from a variety of sources (e.g. forest sector, Dúchas, Ordnance Survey) can now be incorporated into FIPS. Examples include:

- imagery from satellite and aerial photography;
- forest classification, by location, species and development stage;
- ownership categories, private and public;
- digital elevation (terrain) models, contours;
- ordnance detail, roads, aquatic zones;
- location of archaeological sites and monuments;
- location of Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and proposed Natural Heritage Areas (pNHAs);
- forest soils and geology;
- sensitive catchments;
- grant-aided projects;
- landscape models.

The power of GIS analysis has increased greatly with advances in computer technology and image interpretation (3) such as ortho- and stereophotography, satellite, infrared and laser imagery. This can be further enhanced by the use of digital terrain modelling.

Qualitative and quantitative questions can be raised and answered in relation to forest practices. GIS also allows for the modelling of different management strategies.

CERTIFICATION

The CODE OF BEST FOREST PRACTICE is not a certification scheme and does not favour any particular approach towards certification. However, it does form part of a framework within which certification schemes appropriate to Ireland should operate (4) (5).

REFERENCES

- (1) Hale, M. (ed.) 1997. Geo-Information for Sustainable Land Management. Special Congress Issue Vol. 3 & 4., Enschede, Netherlands.
- (2) Fogarty, G., Coggins, K. and Gallagher, G. 1999. Forest Inventory and Planning System (FIPS). Irish Timber Growers Association Forestry Yearbook 2000. Irish Timber Growers Association, 84 Merrion Square, Dublin 2.
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- (5) Mannion, T. 1999. Forest Management Standards for the Republic of Ireland. Second Draft. Document prepared for the 'Irish Forestry Certification Initiative' Group, Just Forests Office, Bury Quay, Tullamore, Co. Offaly.

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[illegible]

IMPACT ASSESSMENT FORM 2 (PART A)

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FOREST UNIT / PROPERTY: LOCATION OF IMPACT: OWNER / MANAGER: OPERATION (FROM IMPACT ASSESSMENT FORM 1):		ASSESSOR: DATE:				
VALUE	IMPACT COMPONENT	SEVERITY LEVEL* (Tick as appropriate)				ACTION
		VH	H	M	L	
Soil	Fertility Condition Erosion Others (specify):					
Water quality	Run-off Debris Sediment Crossings Pollution Riparian zone Fish and other aquatic life Others:					
Landscape	Afforestation impacts Felling impacts Roads Edges Litter / debris Overall design Others:					
Ecological and scientific values	SAC site SPA site pNHA site Habitats Research areas Others:					
Cultural and archaeological values	Ground disturbance Planting Structural damage Others:					
Biodiversity	Species density Hedgerows Trees Open spaces Others:					

* VH: Very high; H: High; M: Moderate; L: Low.

IMPACT ASSESSMENT FORM 2 (PART B)

VALUE	IMPACT COMPONENT	SEVERITY LEVEL (Tick as appropriate)				ACTION
		VH	H	M	L	
Forest protection and health	Health Stability Vigour Openings Damage Others:					
Sustained productivity	Seed origin Yield class Establishment standard Species suitability Maintenance Forest condition Thinning pattern Impact of machinery Felling coupe Roding standard Others:					
Commercial viability	Thinning strategy Rotation standard Others:					
Rural development and farm forestry	Access Training Viability of scale Others:					
Amenity and recreation	Condition of facilities Roads Operation scheduling Others:					
Safety	Operational safety Worker safety Public safety Signage Others:					
Other community values	Dwelling visibility Access Others:					



1. FOREST REPRODUCTIVE MATERIAL

The use of good quality forest reproductive material derived from a suitable and traceable provenance is the key to the establishment of healthy and productive forests.

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1.1 KEY FACTORS

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1.3 PROCEDURES

1.3.1 Forest reproductive material - basic material, origins and categories

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1.1 KEY FACTORS

- EU regulations
- Certificate of Provenance
- Provenance suitability
- Tracking system
- Collection and marketing procedures

1.2 OBJECTIVES

- To ensure tree seed sources are suitable for the site.
- To maximise the use of indigenous material and material from a geographically similar location.
- To ensure material is of good genetic quality.
- To ensure procedures are properly implemented.
- To ensure tracking is transparent.
- To ensure plant health regulations are being observed.

1.3 PROCEDURES

The quality of forest reproductive material is of high importance in ensuring viable, healthy and productive forests. The removal of trade barriers within the European Union applies to forest reproductive material as it does to other marketable products. However, due to the importance of geographical location and inherited characteristics of this material and their impact on forest quality, it is in the interest of EU Member States that rules imposing the highest possible standards are implemented. A substantial part of this section therefore refers to operations which take place under the auspices of the various EU Council Directives relating to forest reproductive material.

1.3.1 Forest reproductive material - basic material, origins and categories

Under existing and new EU Council Directives, forest reproductive material is described on the basis of a number of important terms.

1.3.1.1 *Forest reproductive material*

Forest reproductive material includes seeds, plants and other propagating material which are important for forestry purposes.

1.3.1.2 *Region of Provenance*

The Region of Provenance is an area or areas of sufficiently uniform ecological conditions, in which genetically similar stands or seed sources are found. Ireland is defined as one Region of Provenance.

1.3.1.3 *Origin*

Seed sources can be classified as follows:

- An *autochthonous* stand or seed source is one which normally has been continuously regenerated by natural regeneration. The stand or seed source may be regenerated artificially from reproductive material collected in the same stand or seed source or autochthonous stands or seed sources within the close proximity.
- An *indigenous* stand or seed source is an autochthonous stand or seed source or is a stand or seed source raised artificially from seed, the origin of which is situated in the same Region of Provenance.

For an autochthonous stand or seed source, the origin is the place in which the trees are growing. For a non-autochthonous stand or seed source, the origin is the place from which the seed or plants were originally introduced. The origin of a stand or seed source may be unknown.

1.3.1.4 Basic material

Basic material includes the following:

- *Seed source*: trees within an area from which seed is collected.
- *Stand*: a delineated population of trees possessing sufficient uniformity in composition.
- *Seed orchard*: a plantation of selected clones or families which is isolated or managed so as to avoid or reduce pollination from outside sources, and managed to produce frequent, abundant and easily harvested crops of seed.
- *Parents of family*: trees used to obtain progeny by controlled or open pollination of one identified parent used as a female, with the pollen of one parent or a number of identified or unidentified parents.
- *Clone*: group of individuals derived originally from a single individual by vegetative propagation, e.g. cuttings, micropropagation, grafts, etc.
- *Clonal mixture*: a mixture of identified clones in defined proportions.

1.3.1.5 Categories of forest reproductive material

- *Source identified*: reproductive material derived from basic material which may be either a seed source or stand located within a single Region of Provenance and which meets set requirements.
- *Selected*: material derived from basic material which shall be a stand located within a single Region of Provenance, which has been phenotypically selected at the population level, and which meets set requirements.
- *Qualified*: material derived from basic material which shall be seed orchards, parents of families, clones or clonal mixtures, the components of which have been phenotypically selected at the individual level, and which meets set requirements.
- *Tested*: material derived from basic material which shall comprise stands, seed orchards, parents of families, clones or clonal mixtures. The superiority of the reproductive material must have been demonstrated by comparative testing or by an estimate of the superiority of the reproductive material calculated from the genetic evaluation of the components of the basic material. The material must also meet certain set requirements.

Table 1.1 gives the relationship between types of basic material and their categories, as outlined in the new Council Directive 1999/105/EC on the marketing of forest reproductive material.

<i>Type of basic material</i>	<i>Categories</i>			
	<i>Source identified</i>	<i>Selected</i>	<i>Qualified</i>	<i>Tested</i>
Seed source	X			
Stand	X	X		X
Seed orchard			X	X
Parents of family			X	X
Clone			X	X
Clonal mixture			X	X

Table 1.1 Types of basic material and their categories, as outlined in EU Council Directive 1999/105/EC which comes into force from 1 January, 2003.

1.3.2 EU regulations on forest reproductive material

Two Council Directives currently control the marketing and quality of reproductive material within the EU:

- Directive 66/404/EEC on the marketing of forest reproductive material;
- Directive 71/161/EEC on external quality standards for forest reproductive material marketed within the Community.

Council Directive 1999/105/EC on the marketing of forest reproductive material comes into force from 1 January, 2003.



The quality of forest reproductive material is crucial in ensuring viable, healthy and productive forests. EU Directives set down quality standards and procedures governing the marketing of forest reproductive material within the Community.

1.3.2.1 Purpose of the Directives

Directive 66/404/EEC regulates the reproductive material for sale of species commonly used for forestry purposes in the EU, and specifies approved basic material (e.g. from seed stands and seed orchards) and the delineation of Regions of Provenance. An amendment to the Directive takes into account selected and tested forest reproductive material with strict rules for tested material. The Directive allows for the exchange of information between Member States through the issuing of catalogues.

Directive 71/161/EEC deals with the external quality standards such as weight (for seeds), size and root collar dimensions of plants derived from listed reproductive material.

The new Directive 1999/105/EC proposes the following:

- To impose high standards for the trading of forest phenotypically or genetically superior reproductive material in the context of sustainable forest management and the need for conservation and biodiversity in European forests; rules to be applied for the use of species and atypical hybrids for forestry purposes.
- To allow for the retention of special measures for reproductive material not for sale; to allow for exemptions in relation to exports and re-exports to third countries.
- Those plants or parts of plants conforming to the Directive standards to be subject to no other restrictions. However, Member States will be entitled to impose additional restrictions on material produced and traded within their territory.
- Lists of Regions of Provenance and National Registers of material to be drawn up for inclusion in a European publication and Master Certificate of Provenance details to accompany all material; reproductive material to be properly identified throughout the process; seeds to be properly sealed and labelled.
- Provisions for control by Member State, allowance for prohibition of unsuitable material and less stringent conditions to apply, if needed.
- Uniform rules and their application.
- Special standards for poplar.
- Protection in relation to genetically modified organisms (GMOs).

1.3.2.2 Scheduled species

Table 1.2 lists the schedule of species under Council Directive 66/404/EEC.

Table 1.2 Scheduled species, as listed under Council Directive 66/404/EEC. In Ireland, under the various afforestation schemes, provenance information is also

Botanical name (with synonym in parentheses)	Common name
<i>Pinus sylvestris</i>	Scots pine
<i>Pinus nigra</i> (<i>P. laricio</i>)	Austrian or Corsican pine
<i>Pinus strobus</i>	Weymouth pine
<i>Picea abies</i> (<i>P. excelsa</i>)	Norway spruce
<i>Picea sitchensis</i>	Sitka spruce
<i>Larix decidua</i>	European larch
<i>Larix kaempferi</i> (<i>L. leptolepis</i>)	Japanese larch
<i>Pseudotsuga menziesii</i> (<i>P. taxifolia</i> , <i>P. douglasii</i>)	Douglas fir
<i>Abies alba</i> (<i>A. pectinata</i>)	Silver fir
<i>Fagus sylvatica</i>	Beech
<i>Quercus rubra</i> (<i>Q. borealis</i>)	Red oak
<i>Quercus robur</i> (<i>Q. pedunculata</i>)	Pedunculate oak
<i>Quercus petraea</i> (<i>Q. sessiliflora</i>)	Sessile oak
<i>Populus</i>	Poplar

required for ash (*Fraxinus excelsior*) and lodgepole pine (*Pinus contorta*), and is advisable for other species. The new Directive 1999/105/EC will add extensively to the above list of species. (Table 1.3)

Table 1.3 Tree species and artificial hybrids, as listed in Annex 1 of Council Directive

<i>Abies alba</i> Mill.	<i>Pinus canariensis</i> C. Smith
<i>Abies cephalonica</i> Loud.	<i>Pinus cembra</i> L.
<i>Abies grandis</i> Lindl.	<i>Pinus contorta</i> Loud.
<i>Abies pinsapo</i> Boiss.	<i>Pinus halepensis</i> Mill.
<i>Acer platanoides</i> L.	<i>Pinus leucodermis</i> Antoine
<i>Acer pseudoplatanus</i> L.	<i>Pinus nigra</i> Arnold
<i>Alnus glutinosa</i> Gaertn.	<i>Pinus pinaster</i> Ait.
<i>Alnus incana</i> Moench.	<i>Pinus pinea</i> L.
<i>Betula pendula</i> Roth.	<i>Pinus radiata</i> D. Don
<i>Betula pubescens</i> Ehrh.	<i>Pinus sylvestris</i> L.
<i>Carpinus betulus</i> L.	<i>Populus</i> spp. and artificial hybrids
<i>Castanea sativa</i> Mill.	<i>Prunus avium</i> L.
<i>Cedrus atlantica</i> Carr.	<i>Pseudotsuga menziesii</i> Franco
<i>Cedrus libani</i> A. Richard	<i>Quercus cerris</i> L.
<i>Fagus sylvatica</i> L.	<i>Quercus ilex</i> L.
<i>Fraxinus angustifolia</i> Vahl.	<i>Quercus petraea</i> Liebl.
<i>Fraxinus excelsior</i> L.	<i>Quercus pubescens</i> Willd.
<i>Larix decidua</i> Mill.	<i>Quercus robur</i> L.
<i>Larix x eurolepis</i> Henry	<i>Quercus rubra</i> L.
<i>Larix kaempferi</i> Carr.	<i>Quercus suber</i> L.
<i>Larix sibirica</i> Ledeb.	<i>Robinia pseudoacacia</i> L.
<i>Picea abies</i> Karst.	<i>Tilia cordata</i> Mill.
<i>Picea sitchensis</i> Carr.	<i>Tilia platyphyllos</i> Scop.
<i>Pinus brutia</i> Ten.	

1999/105/EC.

1.3.2.3 National Catalogue

The EU Directives currently require that a complete list of selected stands is included in a National Catalogue and updated annually. Within the catalogue, the following is set out for each selected stand:

- catalogue number;
- location name;
- variety or number for clones;
- latitude, longitude and altitude;
- Region of Provenance (Ireland is one region).

Under the new Directive 1999/105/EC, each Member State will draw up a National Register of approved basic material with a summary in the form of a national list including the following details:

- botanical name;
- category;
- type of basic material;
- code for Region of Provenance;
- location according to category;
- altitude;
- area;
- origin.

1.3.2.4 Documentation necessary for the trading of forest reproductive material

- Certificates of Provenance or referenced documents (suppliers document) to accompany reproductive material.
- A Master Certificate of Provenance according to category will be required under the new Directive 1999/105/EC.
- Approved labels for seed lots.
- The catalogues or registers of basic material to identify location will be held by the Forest Service.

1.3.2.5 Derogations

If there are shortages of forest reproductive material of scheduled species within the EU, applications can be made annually through the Forest Service to trade reproductive material under less stringent conditions, i.e. material purchased outside EU or within EU from unlisted categories of scheduled species. The derogation period is of limited duration.

1.3.3 OECD Scheme

Seed not scheduled under Directive 66/404/EEC may be traded under the OECD Scheme for the Control of Forest Reproductive Material moving in International Trade. This is a voluntary certification scheme aimed at providing the purchaser with basic material and category information. As well as EU Member States, USA, Canada, Switzerland and some Eastern European countries also participate. Documentation, categories and types of material are similar to those in the EU framework. A participating country can include any forest species.

1.3.4 Seed collection procedures

Application to collect seed from a registered stand in Ireland under the EU or OECD framework must be made to the Forest Service. On approval, official Certificates of Provenance and labelling must accompany seed of scheduled species to the forest nursery/seed extractor. Documentation relating to the Certificate of Provenance and quantity of material should accompany reproductive material as far as the final purchaser, so that the origins of any planting stock can be traced. Sown lots must be identified in the nursery.

1.3.5 Import procedure

Official Certificates of Provenance should accompany reproductive material imported under both the EU and OECD frameworks.

1.3.6 Plant health regulations

The movement of forest reproductive material (plants) is also subject to EU 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. There are particular restrictions for Ireland, due to its relatively pest-free status as an island.

Plants of the following genera should only be purchased from registered nurseries and plants must be accompanied by a valid EU Plant Passport: *Abies*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Prunus* and *Sorbus* (see SECTION 8: FOREST PESTS AND DISEASES). If any unusual pest or disease is observed on plant material, contact the local Forestry Inspector.



Conifer seed is usually collected from trees felled during thinning or clearfell. Seed from long rotation broadleaf species, including oak (above), is gathered through ground collection.

1.3.7 Managing seed stands and seed orchards

Seed stand management is aimed at ensuring the continued improvement in quality and vigour of the parent material. Thinnings are based on the retention of the best individuals in order to improve crop characteristics into the next generation. For commonly planted species, the most cost-effective collection method is from felled trees during thinning (which will however increase variability, as these may not be the best individuals) or at clearfelling, on the basis that this takes place during a seed year. For less common or long rotation species and broadleaves in general, other methods may be necessary, including climbing and ground collection. Tree climbing is a dangerous operation, and full adherence to safety measures is essential.

The Forest Service must be notified in advance of the intention to clearfell seed stands.

1.4 ENVIRONMENTAL ASPECTS

A perceived environmental threat is that introduced material will replace or displace native species. In Ireland, modern forestry has developed from introduced species, due to the limited number of native species in general, and the lack of native conifer

species with commercial potential. As modern Irish forestry emerged from a situation where only one percent of the countryside was wooded, very few native woodlands have been displaced by introduced species in recent times. The increased planting of broadleaves, the conservation of surviving native and semi-natural woodlands, and the development of riparian and amenity areas will encourage the spread of native species. New seed processing facilities will allow increased collection and storage of native material.

The inclusion of the category 'source identified' in the new Council Directive 1999/105/EC, which comes into force from 1 January, 2003, should encourage the maintenance of native stands and individuals as seed sources, thereby reducing the dependence on imports. There is always the possibility of the dilution of the native gene pool through imported stock, but this is as yet unquantified and the impact of past imports is unknown. The new Directive takes into account the declaration stated at the Ministerial Conference on the Protection of Forests in Europe in Lisbon, 1998, that the origins of native species and local provenances which are well adapted to site conditions are to be preferred, and that genetically modified forest reproductive material which is unsafe for health or the environment should not be placed on the market.

Environmental risks in relation to introduced pests and diseases are inherent in the trading of plants and timber between countries. Stringent controls are necessary to reduce these risks.

Poor quality genetic material or undesirable vegetatively reproduced or genetically modified plants pose a risk to wild populations of native or introduced species. Strong genetic controls are also required in the large-scale introduction of imported seeds or plants.

1.5 ADVERSE IMPACTS

- **Breach of relevant EU Council Directives**
- **Wrong seed sources used**
- **Poor quality material**
- **Source untraceable**
- **Incorrect or inadequate information on necessary documentation**
- **Genuine documentation but not corresponding to stock**
- **Failure to avail of indigenous sources**
- **Risk of imported pests and diseases**

1.6 BEST PRACTICE

- **Good quality, well-managed seed sources**
- **Proper seed collection procedures**
- **Appropriate packaging**
- **Check documentation and labelling at each transaction**
- **Confirm source with supplier**
- **Ensure sources are listed**
- **Increase home collection sources**
- **Proper processing and storage facilities**
- **Comply with plant health regulations**

1.7 REFERENCE MATERIAL

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- Anon. Various Safety Guides produced by the Forestry and Arboriculture Safety and Training Council, 231 Corstorphine Road, Edinburgh, EH12 7AT, Scotland.
- Council Directive 1999/105/EC on the marketing of forest reproductive material.
- Council Directive 66/404/EEC on the marketing of forest reproductive material.
- Council Directive 71/161/EEC on external quality standards for forest reproductive material marketed within the Community.
- 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.



2. NURSERY PRACTICE

Good nursery practice is critical for the production of suitable planting stock under safe and environmentally controlled conditions.

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2.15 ADVERSE IMPACTS
2.16 BEST PRACTICE
2.17 REFERENCE MATERIAL

2.1 KEY FACTORS

- **Seed quality**
- **Adequate pre-sowing treatments**
- **Physical requirements**
- **Production systems - bare root, seedling and vegetative**
- **Environmental operational requirements**
- **Pest and disease control**
- **Chemicals**
- **Plant handling**
- **Legislation and safety**

2.2 OBJECTIVES

- **To ensure that the nursery facility is properly located and equipped.**
- **To maximise the production of quality and source-identified growing stock.**
- **To ensure that the nursery is managed safely and without damage to the environment.**

2.3 SEED

Many of the issues relating to seed are described in SECTION 1: FOREST REPRODUCTIVE MATERIAL. In addition to these issues, forest practice requires careful handling of seed in the nursery and assurance that the best approved seed is used.

2.3.1 Home collected seed

Home collected seed should be collected from the best stands or seed orchards (see SECTION 1: FOREST REPRODUCTIVE MATERIAL). In the case of non-scheduled species such as ash, seed may be gathered from good quality trees.

2.3.2 Imported seed

Imports of scheduled species should comply with European Union Council Directive 66/404/EEC on the marketing of forest reproductive material and Council Directive 71/161/EEC on external quality standards for forest reproductive material marketed within the Community, and with the OECD Scheme for the Control of Forest Reproductive Material moving in International Trade, where appropriate. Other imports should be of provenances approved for use in Ireland (see Table 2.1).

2.3.3 Documentation

Seed should be labelled and accompanied by a Certificate of Provenance or approved nursery identification. Documentation should follow the seeds (or plants) right through the nursery cycle - from seed storage through seedbeds and lining out beds to planting stock ready for sale. Material should be clearly identified at all stages.

2.3.4 Seed storage

Two types of seed are recognised: orthodox seed, which is capable of long-term storage at low temperature (most conifers); and recalcitrant seed, which becomes non-viable if moisture is reduced (some broadleaves).

For orthodox seed, containers should be at -3°C with moisture content of 6-8% for conifers and some small seeded broadleaves. Beech is an exception and can be stored at -10°C at low moisture content after special drying procedures.

2.3.5 Testing

Sampling and testing for purity, seed weight and viability are required. These are carried out on request by the Department of Agriculture, Food and Rural Development.

Table 2.1 Principal forest species and seed origins recommended for use in

Species	Recommended seed origins
Sitka spruce Most sites below 300 m elevation, except low lying Midland bogs Cold, frost-prone sites, above 300 m elevation and low lying Midland bogs	South Washington and North Oregon Queen Charlotte Islands (QCI)
Norway spruce	Low elevation north-western Europe, Sudeten and Beskid Regions of the Czech Republic, Tatra Mts. (Slovak), the North East and Lowlands of southern Poland, and Danish seed orchard material Alaskan and North Coastal (including QCI and Vancouver Island origins)
Lodgepole pine In mixture with Sitka spruce Exposed, infertile sites Less exposed, mineral soils	QCI, Vancouver and inter-provenance hybrids Inter-provenance hybrids, Lower Skeena River (Terrace, Kalun Lake and Hazelton) and South Coastal seed orchard material Guadalupe or home grown healthy 'green' trees
Monterey pine	South Coastal Washington and North Coastal Oregon
Douglas fir	Olympic Peninsula, Washington
Western red cedar	Coast Ranges and Cascade Mts. of Washington and Oregon
Western hemlock	Irish and British seed orchards
Scots pine	Corsica
Corsican pine	Southern Poland, Czech Republic (Sudeten), Slovak (Tatra),
European larch	Germany (Schlitz), Austria (Wienerwald) - only material from 300-800 m elevation Irish, British, Dutch, Danish, German and French tested seed orchards
Hybrid larch	orchards
Japanese larch	Hokkaido, Japan, and stands derived from this origin
Oak	Registered Irish, Dutch, British, northern German, Belgian and northern French sources
Ash	Registered Irish, British and Dutch sources
Beech	Forêt de Soignes (Belgium), if available, or registered Irish, northern German, Danish, Dutch and northern French sources
Sycamore	Dutch, northern German, British and French registered sources
Wild cherry	Northern European seed orchards (not seeds collected after fruit processing)
Spanish chestnut	French seed orchards (not nuts for eating)

2.3.6 Viability

Viability tests include:

- cutting recalcitrant seeds;
- tetrazolium (TZ) colour staining, indicating live and dead tissue;
- X-ray testing;
- excised embryo test.

A test certificate indicates the percentage germination or viability in terms of numbers and weight under the storage conditions involved.

2.3.7 Moisture content

Moisture content is indicated by weight loss following drying, and is expressed as a percentage of the weight of the original sample.

2.3.8 Dormancy

Dormancy is overcome by:

- increasing the moisture content and chilling;
- outdoor over-wintering (stratification);
- cold treatment;
- warm/cold treatment;

- mechanical scarification of hard-coated seed;
- chemical treatment;
- moist pre-chilling at 2°C.

2.4 BARE ROOT NURSERIES

While nursery practice is a specific activity, it forms part of the forest establishment and management chain. Bare root production fulfils a critical role in providing material for Ireland's afforestation and reforestation programmes.

2.4.1 Physical requirements

Nursery sites should be at moderately low elevation (approximately 100 m) and require 700-1,000 mm rainfall in the absence of irrigation. The site should not be vulnerable to erosion.

Free draining soils are required, free of large stones and gravel and with small quantities (10-20%) of clay and silt and approximately 20 cm of topsoil. Following levelling and cultivation, sites should be cultivated to 20 cm. A level of organic matter is desirable. pH should be 5.5-6.5. Liming can increase pH level. Reducing pH is more difficult and requires treatment with sulphate of ammonia.

Sites should be free of frost hollows and should have a gradient sufficient to enable run-off without erosion. Sites should also be sheltered from exposure. East facing slopes should also be avoided. Internal shelter should also be provided, using beech or *Cotoneaster* hedging, etc. Sites should be free of weeds and woody species such as furze.

2.4.2 Nutrition

Nutrient deficiencies are expressed by loss of foliage colour, generally yellowing of parts of the leaf. Excesses may be expressed by browning of the foliage. A balanced nutrient supply is critical. In addition to nitrogen, phosphorus and potassium, other essential nutrients are magnesium, calcium and sulphur, and the trace elements iron, boron, zinc, copper, molybdenum and chlorine.

Fertilisers are applied as solids or liquids. They can be applied in slow release form. Rates are high compared with forest establishment, e.g. 50-60 kg nitrogen/ha, 55-65 kg phosphorus/ha for seeds, 85-100 kg phosphorus/ha for transplants. To counteract losses by leaching, top dressings are applied at a rate of 75-150 kg nitrogen/ha/year and 35-75 kg phosphorus/ha/year. A range of fertilisers and single nutrient applications are used, e.g. ammonium nitrate, rock phosphate, super phosphate, sulphate of potash, potassium chloride.

Organic matter is important for water retention, soil stabilisation, cation exchange and buffering against changes in acidity and nutrient uptake in light soils. Organic matter can be introduced by green cropping or by adding mushroom compost.

2.4.3 Access, services, buildings and facilities

All buildings and facilities must be serviced by all-weather roads suitable for commercial vehicles. Nursery sections must be accessible by tractor and trailer. Access to water is required for sanitation, drinking and irrigation. The availability of water and restrictions to be observed must all be identified. Bore holes or reservoirs may be required. Local Authorities must be consulted in relation to waste disposal (particularly the treatment of waste chemicals) and the amount of water used and when and how it is to be accessed.

Buildings and facilities are subject to Local Authority planning requirements and should be carefully laid out to maximise servicing and operational efficiency. Depending on the size and scale of the nursery operation, the following are important considerations:

- offices must conform to planning, building and safety regulations;
- machinery and tool stores should be secure against break-in;
- petrol and machine tool stores should conform to fire and safety regulations;

- pesticide and herbicide stores must conform to relevant legislation and guidelines;
- plant storage facilities should comprise cool, well-ventilated sheds capable of holding a large number of plants in polythene co-extruded bags;
- cold stores to enable lifting and holding-over of dormant plants;
- seed extractory and stores in temperature controlled conditions;
- receipt, grading and packaging area kept cool;
- washing and toilet facilities;
- first aid station and equipment.

2.5 BARE ROOT PLANT PRODUCTION

2.5.1 Seedling production

Spraying, ploughing to 20-30 cm and partial soil sterilisation is carried out in early Autumn. Seedbeds, prepared in winter/early spring, are normally 1.1 m wide with 50 cm alleys. Seed dressing is now considered environmentally unacceptable.

The timing of sowing is critical, and must take into account weather, moisture and temperature. Broadcast sowing is used, either by hand or machine. A covering of light coloured grit or sand is added to keep the seeds moist. Rolling may be required to ensure good contact between the seed and the soil surface. Netting is usually used to protect seeds against birds. The sowing densities of the main forest species used in Ireland are listed in Table 2.2.

Species	Pure seeds (number/kg)	Sowing density (number/m²)	Sowing technique
Sitka spruce	400,000	1,000	Broadcast
Norway spruce	145,000	1,000	Broadcast
Douglas fir	88,000	800	Broadcast
Japanese larch	250,000	700	Broadcast
European larch	170,000	800	Broadcast
Scots pine	165,000	900	Broadcast
Sessile oak	300	150	Drills sown in lines
Pedunculate oak	250	150	Drills sown in lines
Beech	4,500	180	Drills sown in lines
Ash	13,000	260	Drills sown in lines
Sycamore	9,000	250	Drills sown in lines
Cherry	5,000	250	Drills sown in lines

Table 2.2 Sowing density of the primary forest species used in Ireland.

2.5.2 Transplants

Transplant systems enable good root development and facilitate grading for quality. Transplanting is usually carried out only once during the nursery cycle, transferring plants from seedbeds to lining out beds.

The ground must be ploughed if fallow or bearing a green crop. Basal fertiliser treatment should be applied before cultivation. Cultivation should be carried out just before transplanting and should be deep enough to accommodate the full root system of the seedlings.

Seedbeds can be loosened manually or mechanically in preparation for lifting and transplanting. Small seedlings are usually discarded at this stage. During transfer, plants must be protected from drying out.

Transplanting is generally best carried out during the period late February-March, although timing may be slightly earlier in the south and later in the north. Deciduous species are usually the first to undergo lining out, followed by pines and spruces and lastly, Douglas fir. Summer transplanting can be carried out with 2-year seedlings or cold stored plants, with timing dependent on rainfall and moisture.



Seedbeds provide suitable conditions for the germination and initial development of seedlings.



Lining out facilitates root growth and the development of a balanced root:shoot ratio among transplant stock.

Lining out is now usually carried out using a transplanting machine, although manual lining out can be done, using boards. Plants should be firmly placed in an upright position. Lining out is normally carried out at 17.5-22.5 cm between rows and 5.0-7.5 cm between plants. Lining out beds should be kept weed-free.

Undercutting is often applied in order to:

- promote and manipulate root development;
- control height growth;
- decrease the root/shoot ratio;
- reduce distorted roots.

The timing and depth (usually 15-17 cm) of the undercut are important. Sowing density of seeds is lower for undercut production, and seedling quality needs to be high. Nitrogen and sometimes phosphorus, potassium and magnesium deficiencies can occur after undercutting, and fertilising is recommended. Wrenching and side-cutting can also be used to enhance root development. Mycorrhizae are fungi which colonise the tissues of the fine roots of plants. They assist in the uptake of nutrients from the soil in exchange for carbohydrates from the plant. Some nurseries are commercially inoculating stock with these beneficial fungi, but this practice is at an early developmental stage.

2.6 CONTAINERISED SEEDLING PRODUCTION

2.6.1 Systems

Containerised seedling production units originated in Scandinavia and USA. They are mainly based on degradable paper peat or moulded slit plastic. Cells are arranged in pre-formed trays. Cell spacing is important for root growth. An important consideration is to ensure the development of good sturdy stock.

2.6.2 Facilities

Containerised seedling nurseries are similar to horticultural nurseries. Plastic tunnels are generally used, and these come in a range of designs and can be linked together. Floors should be separated from the soil. Efficient ventilation is essential. Frequent irrigation is required during hot weather, and there must be a capacity to deliver water uniformly. Mobile and fixed irrigation systems are available. Nutrient systems should be compatible with irrigation. All systems should be tested regularly.

2.6.3 Seedling treatment

Seedling roots are air pruned and trays should be approximately 15 cm above ground. When stock has reached the desired size, it can be hardened off outside. Outdoor hardening off areas should be clean and sheltered, with irrigation. Tunnels with removable sides are an alternative.

2.6.4 Growing medium

The growing medium used should draw well, be capable of holding water and nutrients, and have a pH value appropriate for the species being grown. It should also be free from pests and be able to retain its structure. Peat is an ideal medium. Lime, micro-nutrients and nitrogen, phosphorus and potassium are all added to the base medium. Controlled release fertilisers are sometimes used. Liquid feeds are most easily managed.

2.7 VEGETATIVE PROPAGATION

Vegetative propagation has recently emerged as a significant commercial plant production technique in Ireland.

2.7.1 Basic material

It is important that parent material is fully documented and that evaluation is done to indicate the quality and superiority of the basic material. All basic material should conform with EU and OECD rules.



The development of containerised stock can be carefully controlled under greenhouse conditions.

2.7.2 Species suitable for vegetative production

2.7.2.1 Poplars

Poplars are not planted extensively but their usage may increase. The most common suitable parents are *Populus trichocarpa*, *P. deltoides* and *P. nigra*. Other species, varieties and clones are continually being evaluated. Poplar used for forestry purposes must originate from stool beds approved under EU regulation.

Rooted and leafy summer cuttings can be used for propagation. Cuttings, normally 20-25 cm long, can be rooted in trays or in individual containers at the end of summer. Alternatively, they can be potted in spring under an appropriate nutrient and moisture regime. Cuttings should be identified as appropriate, and should be protected against water loss.

2.7.2.2 Conifers

Most commonly planted conifers can be vegetatively propagated. The vegetative propagation of Sitka spruce is beginning to be practised in Ireland. The initial selection stages are specialised and complex but systems have been much improved by breeders. Polythene houses are typically used, with temperatures of 5-30°C and relative humidity of 95%, falling to 60% after weaning. Temperature is best controlled by fans. A wide variety of mist irrigation systems are available. No misting should be undertaken overnight.

2.7.2.3 Other broadleaves

Most commonly planted broadleaves can now be propagated vegetatively. However, apart from poplar (described above), the vegetative propagation of broadleaves tends to be confined to the horticultural sector.

2.7.3 Maintaining stock

Suitable genotype mother plants should be maintained in a juvenile state by hedging or by serial propagation, where cuttings are collected from the previous year's cuttings.

2.7.4 Propagation regime

Cuttings can be rooted during the period March-May, in a wide range of substrates and under suitable moisture and nutrient regimes. Cuttings should be well-rooted by August, ready for lifting and removal to a bare root nursery. See Table 2.3.

2.8 NURSERY IRRIGATION

2.8.1 Planning

Consideration must be given to:

- crop requirements during dry weather;
- long-term rainfall, temperature and wind patterns;
- availability of water and equipment;
- soil texture;
- cost.

2.8.2 Crop water requirements

The stages where crop water requirements are most needed are as follows:

- at germination after sowing;
- at transplant time;
- at undercutting;
- during dry periods;
- to assist the uptake and effectiveness of nutrients and herbicides;
- to reduce frost and to cool seedbeds.

Table 2.3 Propagation regime for cuttings.

Year	Operation
1	Stratify, sow, germinate seeds, pot seedlings for stock plants
2	Grow on stock plants, promote branching and manage to 10 cm in height
3	Over-wintering, collect second cycle cuttings, insert, propagate, wean, lift and line out
4	Care for lined out cuttings and maintain to 40-50 cm, over-winter
5	Second cycle cuttings - repeat cycle

2.8.3 Water quality

Soft water is required so analysis should be carried out to ensure its availability.

2.8.4 Regulations

Approvals by the relevant Local Authority will be necessary for:

- point(s) of abstraction;
- purpose of use;
- maximum quantity over a given period;
- means of abstraction;
- assessment of quality.

2.8.5 Soil factors

Soil structure and permeability should be considered as these will determine the necessary equipment, available water and infiltration rate, soil and site drainage, and soil bearing capacity.

2.8.6 Equipment

Pumps, filters and pipework are all needed, with actual requirements based on water availability, nursery size, etc. Maintenance pipes can be under- or overground. Sprayers and sprinklers (oscillating or fixed) are also required in irrigation systems. Travelling sprayers or self-propelled rotary sprays are also used.

2.8.7 Control

Rainfall records, including monthly average balance sheets, should be kept. Over-watering should be avoided from a physiological, environmental and economic viewpoint.

2.9 VEGETATION CONTROL

Weed control is a highly complex area and exact details are best obtained from nursery manuals. The following summarises the important aspects.

2.9.1 Objectives

The aim of vegetation control is to kill or remove weed species before they can reproduce or compete. Both chemical and mechanical control methods can be used. See SECTION 7: VEGETATION MANAGEMENT.

2.9.2 Chemical control

Where herbicides are being used, ensure that:

- full label instructions are followed;
- application is carried out safely;
- equipment is cleaned after each use;
- herbicides are safely stored and disposed of.

Herbicides are applied overall to both crop and weeds, or inter-row, where they are targeted more directly at weeds. They can act on contact or by translocation, or can be soil acting or residual. Efficiency is influenced by weather. A variety of herbicides should be used in rotation to avoid the build-up of resistance among target weed species.

There are numerous recommended herbicides and available nursery practice handbooks should be consulted. The most commonly-used herbicides relate to:

- seedbed pre-sowing;
- seedbed pre-emergence;
- seedbed post-emergence;
- repeat post-emergence;
- transplant lines and second undercut seedbeds.

Spraying equipment comprises:

- tractor and knapsack sprayers;
- pressure control nozzles - specifications and calibration are necessary to ensure correct application.

After use, sprayers should be washed down and cleaned in an approved manner. All operators should be trained at a recognised centre. The Safety, Health and Welfare at Work Act 1989 requires that only competent operators are employed to undertake particular tasks.

2.9.3 Mechanical control

The most commonly used mechanical weed control methods are:

- scarifying;
- hoeing;
- ploughing and cultivation;
- manual.

2.10 PESTS AND DISEASES

As with the use of herbicides, pest control involves a range of substances and is subject to strict control (see SECTION 8: FOREST PESTS AND DISEASES). Reference should be made to control manuals and booklets. Nurseries are subject to the EU 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, commonly referred to as the Plant Health Directive (see SECTION 8: FOREST PESTS AND DISEASES).

2.10.1 Fungi

In the nursery, the most common fungal diseases are damping off (mainly *Pythium* spp.) and grey mould (*Botrytis cinerea*). Other common diseases include needle cast of pine (*Lophodermium seditiosum*), larch needle cast (*Meria laricis*), oak mildew (*Microsphaera alphitoides*) and needle blight of western red cedar (*Didymascella thujina* syn. *Keithia thujina*).

2.10.2 Insects

Various root and stem feeders, moths, chafers, weevils, mites, aphids, nymphs and sawflies can build up, although damage is usually not extensive. Insect outbreaks often require the use of insecticides, but these should be used judiciously within the context of an overall integrated pest management strategy.

2.10.3 Control and safety

Control and safety considerations relating to pesticides are listed below (also see SECTION 2.9.2 and FORESTRY AND WATER QUALITY GUIDELINES):

- Label instructions must be followed.
- The use of pesticides is governed by the Safety, Health and Welfare at Work Act 1989, EU Council Directives and environmental legislation.
- Users must be in receipt of instruction and hold a relevant certificate.
- Risk information must be provided.
- Precautions to protect human and animal health are essential.
- The pollution of the environment, particularly aquatic zones, must be avoided.
- Users must use recommended personal protection and equipment.

2.10.4 Other pests

Birds and mice can inflict severe losses to nursery stock. Protection involves netting or, in the case of rodents, traps.



Regular inspection for quality purposes and for pests and diseases is a vital component of nursery management, and must be undertaken throughout the nursery cycle.



Careful handling and storage at all stages from lifting to planting out is crucial for plant survival and the initial development of the young forest.

2.11 LIFTING AND STORAGE

2.11.1 Causes of damage

Dormancy status, shoot frost hardiness and other seasonal patterns affect plant physiological condition and susceptibility to damage. The main causes of damage are listed below:

- Root loss can occur through tearing and breakages during lifting, culling and grading, with a subsequent impact on plant growth and development.
- Short periods of exposure cause desiccation.
- Damage occurs in root system cells if the storage period is too lengthy.
- Once kept under shade, storage in bags avoids excessive cooling and heating.
- Ensure storage bags are not torn, roughly handled or thrown about.

Douglas fir is the most sensitive conifer in relation to handling. QCI Sitka spruce is the least resistant to desiccation, frost and cold storage. It is estimated that up to 20% mortality in Douglas fir and 15% mortality in Sitka spruce arise through poor handling.

2.11.2 Avoiding damage

- Damage can be avoided through careful handling and the prevention of moisture loss.
- Machine lifting using bars will minimise damage.
- Culling can be done in a store provided there is adequate light and shelter. Grading and packing should be done close to the plant store.
- Plants should not be stored under canopy in co-extruded bags for more than 14 days.
- Plants may be kept in a cold store or cool shed, but cold store facilities are essential for plants held dormant for long periods. Outdoor storage is now less common.
- Plants can be safely stored in co-extruded bags, with air expelled, tightly sealed and handled gently. Plants must be packed quickly after lifting, with needles or leaves dry of loose water and shoots pointing in the same direction. Bags should be stored upright out of the sun, and air allowed to circulate between them. Avoid tearing bags. Storage period can be 3-5 weeks.

2.11.3 Cold storage

Stores are directly refrigerated at 0-2°C and humidified above 0°C. Desired temperature and humidity should be strictly maintained. There should be good air circulation, with regular cleaning and disinfection.

2.12 DIPPING

Plants may be dipped against large pine weevil (*Hylobius abietis*) attack before leaving the nursery. Manual handling must be avoided. Insecticide must be collected, stored and disposed of safely. Electrodynic units using oil-based pesticides applied in a mist have been found to be effective in avoiding waste.

2.13 DISPATCH

If there is any risk of drying, plants should be bagged or placed in lined boxes. Packing should not be tight but close enough to reduce movement. Adequate notice to the consignor helps safe dispatch. Consignments should be fully labelled by species and provenances and should be accompanied by the necessary documentation.

Depending on their size, containerised plants can be dispatched in their original containers or in batches placed into co-extruded bags.

2.14 LEGISLATION

Nurseries are subject to environmental and safety legislation and also to the relevant EU marketing requirements for forest reproductive material (see SECTION 1: FOREST REPRODUCTIVE MATERIAL) and the Plant Health Directive (see SECTION 8: FOREST PESTS AND DISEASES):

- Various statutory legislation relating to hazardous substances and the control of pesticides.

- Safety, Health and Welfare at Work Act.
- Trade Description Act.
- Employment Protection Act.
- EU Council Directives on forest reproductive material, 66/404/EEC and 71/161/EEC.
- EU Plant Health Directive 77/93/EEC.
- OECD Scheme for the Control of Forest Reproductive Material moving in International Trade.

2.15 ADVERSE IMPACTS

- **Improperly sourced, poor quality seed**
- **Basic nursery site requirements not fulfilled**
- **Failure to consult with the Local Authority in relation to water usage**
- **Problems with water quantity and quality**
- **Poor production practice, resulting in poor quality planting stock**
- **Weeds, pests and diseases**
- **Over-reliance on chemical control**
- **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**
- **Incorrectly timed fertilising, fertilising during unsuitable weather, or excessive fertiliser application, with subsequent run-off into aquatic zones**
- **Failure to notify relevant authorities immediately of accidental damage to aquatic zones**
- **Poor handling and storage of planting stock**
- **Difficulties in forward planning and scheduling**
- **Accidents to nursery operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Poor, incomplete records of operations and associated expenditure**

2.16 BEST PRACTICE

- **Suitable seed origins**
- **Proper handling and storage of planting stock**
- **Proper culling and grading of planting stock**
- **Carefully laid-out and secure nursery site**
- **Consultation with Local Authority regarding water use**
- **Attention to the timing of the various production operations**
- **Good nursery hygiene**
- **Adequate weed, pest and disease control**
- **Strict adherence to various EU Council Directives on forest reproductive material and plant health**
- **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**
- **Good planning for dispatch, with adequate labelling and documentation**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**

2.17 REFERENCE MATERIAL

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3. NEW PLANTING SITES

Careful assessment of new planting sites is necessary to ensure that establishment can proceed and that environmental and other constraints can be properly incorporated. Both factors are essential to ensure the establishment of a viable forest.

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3.7 BEST PRACTICE

3.8 REFERENCE MATERIAL

3.1 KEY FACTORS

- Forest development suitability
- Site/species
- Environmental considerations
- Other constraints
- Potential productivity
- Forest design
- Access
- Risk factors

3.2 OBJECTIVES

- To assess suitability.
- To assess forest management goals.
- To evaluate environmental, landscape and other impacts.
- To assess risks.
- To select best species.

3.3 FOREST SUITABILITY

Before proceeding with afforestation, the following decisions are required:

- What are the management objectives?
- Are they appropriate to the site?
- If there are constraints, can the management objectives be achieved?

In most cases, the management objectives will focus on commercial timber production over a normal rotation. However, conservation, water quality or special non-wood products may take priority. In such cases, particular approaches to management will be necessary (see SECTION 16: BIODIVERSITY AND SPECIALISED WOODLANDS). In the case of farm forestry, achieving a balance between the forest enterprise and farming activities will arise as an objective.

The main factors governing site suitability can be summarised as follows:

- *Environmental:* The location of the site relative to conservation areas, fisheries, archaeological sites and sensitive landscapes will influence development decisions and economic viability.
- *Economic:* Can the site support a commercially viable crop? Are there major constraints in developing the site, e.g. fertility, access, topography, location? In the case of farm forestry, will forest development complement other farm enterprises?
- *Other compelling interests:* Are there likely to be other demands which will prevent the crop from reaching maturity, e.g. legal rights and constraints? Does the existence of dwellings and other features pose particular difficulties?

As part of the planning process, tools such as geographical information systems (GIS) and indicative forest strategies (IFS) will be useful. Forest owners should have access to these tools as they become more widely available.

3.3.1 Unsuitable sites

3.3.1.1 Strong environmental constraints

Forestry development will not be feasible in the context of the following environmental factors:

- Where planting in a Special Area of Conservation (SAC), Special Protection Area (SPA) and Natural Heritage Area (NHA) is strongly discouraged by the relevant authority. (These areas will not be approved for grant-aided forestry if the Forest Service accepts the environmental objections raised by the relevant authority. Currently, SACs and SPAs are automatically excluded from grant aid.)
- Where the extent of an SAC, SPA or NHA inhibits practical management.
- Where clusters of archaeological sites predominate.
- Where Local Authorities impose severe restrictions for landscape or water quality purposes.
- Where riparian areas are to be kept intact for fishery purposes.



Agricultural lowlands represent a major opportunity for new planting sites, creating the potential to diversify farming activities and enabling the selection of more site-demanding broadleaf and conifer species.



Salt spray is one of many physical factors which may preclude forestry from a particular site.

- Close to dwellings.

3.3.1.2 Silvicultural and economic constraints

Table 3.1 lists site limitations on the achievement of viable forestry. It is highly unlikely that an economic return can be achieved under these conditions, irrespective of inputs.

Table 3.1 Site limitations on the achievement of viable forestry.

For grant-aided forestry, a site must be capable of supporting yield class 14 Sitka spruce or yield class 4 oak/beech, or their equivalents.

Site description	Definition
High elevation	Over 300 m in the West; over 400 m in the East
Infertile blanket bog	Heather, <i>Eriophorum</i> , <i>Scirpus</i> and <i>Sphagnum</i> spp., often dotted with pools
Sites with substantial rock outcrop	25% or more rock cover, depending on location
Severely exposed	Western seaboard and some sea-facing slopes
Undrainable and	No water movement; no outlet for water from field mound drains
Shell marl	Within 70 cm of the soil surface (sites with a thin permeable marl layer and low watertable may be plantable)

3.3.1.3 Other constraints

- Access difficulties, whereby access to or along a public road is severely constrained by width, bends or ownership problems.
- Severe slopes which will limit the use of machinery or location of roads (see SECTION 11: SILVICULTURE AND THINNING and SECTION 14: FOREST ROADS).
- Size of development in relation to other features, e.g. over- and underground utility lines, dwellings.
- Legal and ownership constraints.

3.3.2 Suitable sites

A large proportion of the country is suitable for productive tree growth, including areas submarginal for agriculture, marginal wet soils and areas currently under agriculture. Table 3.2 summarises plantable sites with an estimate of potential production (yield class) for conifers and broadleaves. Vegetation indicators are useful for assessing site productivity.

Table 3.2 Plantable sites with an estimate of potential production (yield class) for conifers and broadleaves.

3.3.2.1 Species

Site description	Definition	Potential yield class
Fertile peats	<i>Molinia</i> spp. and/or grass rush	14-16 conifers
Manual cutaway bog		14-16 conifers
Hand reclaimed cutover bog		16-20 conifers
Old Red Sandstone podsols	Grass/Heather	14-16 conifers
Reclaimed podsols/podsolics	Originally comprising partly or fully formed iron pan	16-20 conifers
Peaty gleys	Rush and sedge	16-20 conifers
Wet mineral enclosed fields	Grass rush	20-24 conifers
Brown earths and grey brown podsolics		16-20 conifers
Free-draining and mineral agricultural soils	Grass, fallow arable land	6-12 broadleaves

Species should be carefully matched with the planting site, availing of local differences in soil, fertility and shelter to introduce diversity. However, to facilitate efficient management, species should be planted in reasonably sized blocks of, for example, 0.3 ha.



At the planning stage, consideration should be given to the overall composition of the plantation from a commercial perspective. Also consider whether or not pure or mixed species, conifers, broadleaves or both are warranted at a local site level, and the requirements for landscape, margins, riparian and open areas.

3.3.2.2 *Environmental considerations for sites*

The statutory requirements are that all sites over 70 ha in area require a full environmental impact statement (EIS) and reference to the planning authorities. *Growing for the Future* and the Department of the Environment's *Sustainable Development - A Strategy for Ireland* both set out the requirement that forest developments over 25 ha in area are referred to Local Authorities. Requirements set out in 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) also stipulate reference to the relevant statutory authorities. These impose a strict need for planning and consultation on all but the very minor afforestation projects. This consultation will take place at the site selection stage.



The protection of water quality is one of several important environmental factors which must be considered when selecting new planting sites.

Water quality: In order to take into account the requirements of salmonids, fisheries considerations arise even where only minor aquatic zones are evident. Salmonids require oxygenated, uncontaminated non-acid water. Sensitivity to acid inputs depends on the capacity of the receiving waters to buffer or neutralise these inputs. This capacity is best expressed in terms of alkalinity. Whether or not the area is deemed sensitive will depend largely on the acidity of the soil parent material. Sensitive areas have been provisionally located on Ordnance Survey maps, giving an initial indication as to whether or not a proposed site is located in such an area. This can be further verified by reference to listed catchments identified by Regional Fisheries Boards. The inclusion of catchments as layers within forest GIS will greatly improve location information. Most of the sensitive areas are located in the western seaboard counties and in Wicklow/Wexford, North Cork, along the Tipperary/Limerick border (Slieve Felims) and in the Slieve Blooms. Water quality is also a key issue for non-sensitive sites. Nutrient requirements must be quantified in order to evaluate the impact of fertilisers, particularly phosphorus. Proximity to Local Authority and group water schemes must be considered, and consultation undertaken where necessary. The issues relating to water quality, fisheries and forestry are set out in detail in the FORESTRY AND WATER QUALITY GUIDELINES.

Landscape: Afforestation implies a major change to a landscape to which the local community has always been accustomed. Landscape issues therefore require detailed consideration. Sites which require particular attention are those over 25 ha in area, areas of sensitivity within Local Authority development plans, and hilly or mountainous landscapes with strong landforms. Forest margins, skylines and open spaces also require careful attention. See FORESTRY AND THE LANDSCAPE GUIDELINES.

Archaeology: All registered archaeological sites, together with others likely to be of significance but not yet registered, are recorded on the Record of Monuments and Places (RMP). The RMP should be consulted at the planning stage to confirm whether or not archaeological features are present on the site of the proposed forest development. The treatment of these features is addressed in the FORESTRY AND ARCHAEOLOGY GUIDELINES. Where ground evidence suggests the presence of an unrecorded site, notification to appropriate authorities is necessary.

Biodiversity and conservation: Each site should be considered in order to incorporate variety in species consistent with economic viability and site suitability. Important habitats such as hedgerows, areas of scrub, pockets of native broadleaf cover, peaty hollows and rocky outcrops, should be retained to protect and enhance biodiversity. See FOREST BIODIVERSITY GUIDELINES. Afforestation of sites within NHAs and National Parks will be constrained by the requirements of Dúchas The Heritage Service. Some afforestation may be permitted but may be restricted to native or semi-native species. Grant-aided forestry is currently prohibited in SACs and SPAs.

At the planning stage, consideration should be given to the overall composition of the plantation from a commercial perspective.

3.3.2.3 Risk factors

Site planning should take into account wind and fire risk in the context of economic viability, future environmental impact and the need for consultation with other landowners. Recent developments in GIS can facilitate this.

3.3.2.4 Access

Planting sites should at least be accessible by tractor and trailer from public roads. Acute bends, narrow roads/rights-of-way and inaccessible slopes are undesirable.

3.3.2.5 Development impacts

The location of cultivation and drainage systems, roads, bridges and culverts, and how these features will affect the site, must be considered prior to development.

3.4 SITE PLANS

All factors having an impact on the site, including safety aspects, should be incorporated into a coherent site plan which should form the basis of a long-term forest plan. The site plan should illustrate the following:

- environmentally sensitive areas, e.g. aquatic buffer zones, archaeological exclusion zones;
- ground preparation and drainage systems;
- species selection;
- access;
- internal roads;
- rights-of-way;
- over- and underground utility lines.

3.5 CONSULTATION

Consultation is a key feature in planning for afforestation. The necessary level will vary depending on the scale of the development and the issues involved, but will typically include: Regional Fisheries Boards and Local Authorities, in relation to sensitive catchments, aquatic zones, road access and the landscape; and Dúchas The Heritage Service, where conservation areas are involved. Developers should be aware of other issues which may be sensitive locally and should consult with community representatives.

3.6 ADVERSE IMPACTS

- Difficulties with site access
- Site not commercially productive
- Site too environmentally sensitive
- Potential species range not fully realised
- Failure to identify constraints and opportunities relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors
- Legal constraints not identified
- Lack of consultation with relevant authorities, interest groups and the local community
- Lack of planning

3.7 BEST PRACTICE

- Ensure adequate access to the site
- Assess silvicultural suitability and potential productivity of the site
- Select species silviculturally suited to the site, optimising productivity and diversity
- Identify constraints and opportunities relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors
- Identify legal constraints

- **Consult with relevant authorities, interest groups and the local community**
- **Identify future operational constraints, e.g. areas of high soil erosion risk, windthrow hazard classification, difficult terrain**
- **Prepare detailed site plan**

3.8 REFERENCE MATERIAL

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4. SPECIES SELECTION

Matching species with the site is crucial for successful forest establishment and facilitates enhanced diversity.

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- 4.1 KEY FACTORS**
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4.1 KEY FACTORS

- Species selection objectives
- Site suitability
- Species suitability for purpose
- Diversity requirements
- Pure crops or mixtures, species compatibility
- Appropriate management regime
- Non-commercial species

4.2 OBJECTIVES

- To maximise wood production potential and economic return from the site.
- To achieve a high quality yield.
- To ensure product diversity.
- To encourage a specified final crop by nursing or complementary mixtures.
- To promote biodiversity.
- To fulfil environmental requirements in relation to internal ecosystems, e.g. riparian species within the aquatic buffer zone.
- To maximise the forest's potential contribution to the landscape.
- To maintain native or semi-natural woodland cover.

4.3 GENERAL SITE SUITABILITY

This section deals mainly with establishing commercial forests with acceptable diversity. Biodiversity, protected and specialised woodlands are dealt with in SECTION 16: BIODIVERSITY AND SPECIALISED WOODLANDS. Measures to enhance biodiversity within commercial forests are detailed in the FOREST BIODIVERSITY GUIDELINES.

In Ireland, the range of indigenous commercial forest species is limited to broadleaves. These generally demand better mineral soils, with the exception of sessile oak which has a wider range but low production. Ash, cherry and semi-indigenous sycamore and beech will grow on most agricultural or old forest soils but can be quite site specific. Cherry is disease-prone and pure plantations have not proved successful.

Commercial forestry in Ireland has relied heavily on introduced conifers from Europe, Japan and North America. Lodgepole pine will grow on a wide range of sites but is subject to various potential constraints in forming a satisfactory crop. Sitka spruce will produce a commercial crop on a wide range of site types, but nutrient requirements on infertile peats and podsols may result in the need for unsustainable levels of fertiliser application to achieve satisfactory volumes. Norway spruce, Douglas fir and Japanese larch suit fertile conifer sites.

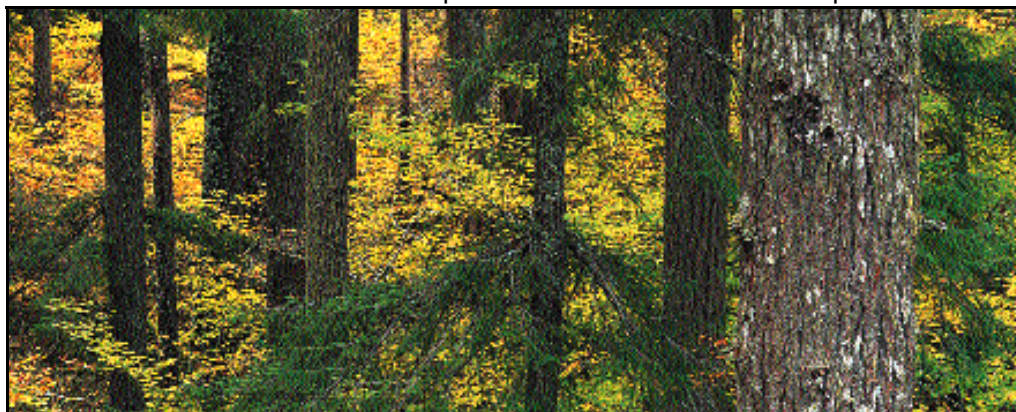
Although slower growing than the spruces or lodgepole pine, semi-indigenous Scots pine will grow well on a range of dry mineral soil types and cutaway or milled Midland peat.

Table 4.1 indicates the range of species which can be grown under suitable site conditions.

Table 4.2 lists sites/soils suitable for particular conifer and broadleaf species.



Selecting the right trees for the right places is a pre-requisite to achieving commercially viable forests in tune with the environment and landscape.



Commercial forestry in Ireland has relied heavily on introduced conifers from Europe, Japan and North America.

Table 4.1 Species with forest potential.

Conifers	Broadleaves
Sitka spruce (<i>Picea sitchensis</i>)	Common ash (<i>Fraxinus excelsior</i>)
Lodgepole pine (<i>Pinus contorta</i>)	Sycamore (<i>Acer pseudoplatanus</i>)
South Coastal	Pedunculate oak (<i>Quercus robur</i>)
North Coastal	Sessile oak (<i>Quercus petraea</i>)
Norway spruce (<i>Picea abies</i>)	Red oak (<i>Quercus rubra</i>)
Serbian spruce (<i>Picea omorika</i>)	Common beech (<i>Fagus sylvatica</i>)
Douglas fir (<i>Pseudotsuga menziesii</i>)	Alder (<i>Alnus</i> spp.)
Lawson cypress (<i>Chamaecyparis lawsoniana</i>)	Cherry (<i>Prunus avium</i>)
Leyland cypress (X <i>Cupressocyparis leylandii</i>)	Lime (<i>Tilia</i> spp.)
Monterey cypress (<i>Cupressus macrocarpa</i>)	Southern beech (<i>Nothofagus procera</i>)
European larch (<i>Larix decidua</i>)	Spanish chestnut (<i>Castanea sativa</i>)
Hybrid larch (<i>Larix x eurolepis</i>)	Norway maple (<i>Acer platanoides</i>)
Japanese larch (<i>Larix kaempferi</i>)	Poplar (<i>Populus</i> spp.)**
Austrian pine (<i>Pinus nigra</i>)	Birch (<i>Betula</i> spp.)**
Corsican pine (<i>Pinus nigra</i> var. <i>maritima</i>)	
Monterey pine (<i>Pinus radiata</i>)	
Scots pine (<i>Pinus sylvestris</i>)	
Western hemlock (<i>Tsuga heterophylla</i>)	
Western red cedar (<i>Thuja plicata</i>)	
Grand fir (<i>Abies grandis</i>)	
Silver fir (<i>Abies alba</i>)	
Noble fir (<i>Abies procera</i>)*	

* Christmas trees and foliage production

** Research into forest potential ongoing

Table 4.2 Sites/Soils suitable for particular conifer and broadleaf species.

Species	Site/Soil
Lodgepole pine	Blanket peats Midland peats Old Red Sandstone podsols Cutaway bog
Sitka spruce/lodgepole pine (North Coastal) mixture	Blanket peats Old Red Sandstone podsols
Sitka spruce/Japanese larch mixture	Old Red Sandstone podsols
Sitka spruce	Fertile peats Peaty gleys Surface water gleys Podsols
Norway spruce	Drier surface water gleys Machine and manual cutaway bog Free-draining mineral soils Frost prone sites
Douglas fir	Free-draining mineral soils
Scots pine	Free-draining mineral soils Cutaway bog
Corsican pine	Mineral soils
Other conifers	Mineral soils Cutaway bog (some species)
Pedunculate oak	Fertile moist mineral soils
Sessile oak	Free-draining mineral soils Cutaway bogs (subject to further research)
Common beech	Unexposed (or tree-sheltered), free-draining, low elevation acid soils
Common ash	Frost-free, fertile, free-draining mineral soils
Sycamore	Free-draining mineral soils
Birch and alder	Riparian zones
Other broadleaves	Fertile, free-draining mineral soils (cherry unsuitable in pure stands)



A quality stand of Scots pine, one of several diverse conifer species suitable for use in Irish forestry.

4.4 CHARACTERISTICS OF COMMONLY PLANTED SPECIES

4.4.1 Conifers

Sitka spruce: The most widely used and highest wood producing conifer over a range of sites in Ireland. It grows best on heavy gley soils at low to moderately high (250-300 m) elevations. Growth is limited on infertile blanket peats and Old Red Sandstone podsols. Sitka spruce is also very susceptible to frost damage and sites on which it is planted can be susceptible to wind damage. The average yield class of Sitka spruce is 16, although yield classes in excess of 28 are possible.

Norway spruce: Between 10-20% less productive than Sitka spruce on similar sites. It is more demanding in relation to site fertility, but is much more resistant to frost damage. With the exception of Midland cutaway bogs, it is not suitable for peat soils.

Douglas fir: Lower production than both Sitka and Norway spruces, but yields a higher quality timber. It is suitable for free-draining or dry mineral and old forest soils, but is generally limited to elevations below 200 m. Douglas fir is susceptible to deer damage and requires careful nursery handling.

Lodgepole pine: Two provenances have been commonly planted in Ireland: south coastal, planted pure on peat and podsol sites or Bord na Móna cutaway sites; and north coastal, planted in mixtures with Sitka spruce on poor sites. South coastal lodgepole pine will produce a crop on most sites with moderate fertilisation, but timber quality is degraded through bad stem form and wind damage. Pine shoot moth (*Rhyacionia buoliana*) damage will also degrade lodgepole pine timber quality. Yield classes of 10-18 can be achieved, depending on the site. North coastal has better form but a 10-20% lower yield. Lodgepole pine is not sensitive to frost.

Scots pine: Regarded as a semi-indigenous species, as it occurred naturally in Ireland in the past. It achieves lower yield than lodgepole pine and is more site specific (mineral soils or cutaway bogs), but does produce high quality wood. Provenance is important for both growth and quality.

Corsican pine: Not widely used. Similar to Scots pine in site requirements and production.

Monterey pine: With pruning, a high volume producer of good quality timber suiting mineral soils, some peats and podsols (mainly eastern and southern coastal regions). It is difficult to establish and suffers high mortality. The species is frost sensitive, and provenance is critical for survival. Requires heavy thinning for best results. The Guadalupe provenance appears to be particularly suited to Irish conditions.

European larch: Low volume producer but timber quality is good. Good sites are required for establishment. The species has a pleasing appearance and is suitable for mixture with broadleaves.

Japanese larch: A higher producer and more site tolerant than European larch, but poor tree form leads to quality degrade. Suitable for planting in mixture with Sitka spruce, as a nurse species and to enhance visual impact.

Hybrid larch: Similar to Japanese larch but more vigorous and better formed. Source of parent material is critical.

Western red cedar: Little planted but has potential on moderately good to good sites. Disease at nursery stage has been a problem. Timber quality is good but the species has a tendency to produce suckers, making management costly. Stem fluting is also a problem, although this can be minimised through careful thinning.

Western hemlock: This is a productive shade tolerant species, and is particularly complementary to Douglas fir. It requires good mineral soil and shelter.



A quality ash stem, demonstrating the potential for native broadleaves in the right site conditions.

4.4.2 Broadleaves

Sessile oak: An indigenous species which grows on a fairly wide range of sites, from acid mineral to peaty podsol soils. Volume production is low and rotations long, but timber can be valuable.

Pedunculate oak: Suits more alkaline loamy soils than sessile oak. Common in the Midlands and on old estates. It is a more productive species than sessile oak and can reach greater individual sizes.

Common beech: Shade tolerant species. Requires shelter and dense stocking for successful establishment and early development. Suitability more likely to be in the rehabilitation of old woodland areas. Timber is less valuable than that of oak.

Common ash: An adaptive native species suitable for new planting. It is successful on agricultural and old woodland sites but susceptible to frost and exposure. Planting can be at spacings equivalent to that for conifers, but intensive management (often including shaping) is required. It requires a shorter rotation than oak or beech and can achieve yield class 8-10 on a 40-year rotation. Exposed sites should be avoided.

Sycamore: Introduced species but considered semi-natural. Suits a wide range of better quality sites. It reaches productivity on a relatively short rotation but can also be grown on longer rotations. Its main threat is grey squirrel, which attacks thicket to semi-mature crops.

Cherry: Although indigenous to Ireland and a producer of good timber, cherry is subject to canker and does not thrive in pure stands. It is best established as a 5-10% component of other broadleaf stands.

Poplar: Normally derived from cuttings. Clone suitability to Irish conditions must be assured. Light demanding and usually established at near final spacing of 4-8 m. Four metre spacing with no thinning may suit conditions here. Poplar is a fast growing species with a rotation of 18-25 years. Timber is used for joinery, structure veneers and pulp. Material grown using short rotation systems is used as bio-fuel. Poplar demands fertile, moist and free-draining soils.



Poplar after five years.

4.5 MIXTURES

4.5.1 Conifer mixtures

A mixture of Sitka spruce and Japanese larch affords a nursing advantage on poor soils and visual diversity for landscape purposes. While height growth of both species is about equal, the yield of larch will be much lower than that of spruce, probably resulting in a small loss in production.

North coastal lodgepole pine is also grown with Sitka spruce as a nurse on poor sites, allowing the spruce to form a pure crop. South coastal lodgepole pine is not a suitable mixture species as it is too vigorous during the initial stages of development.

Douglas fir develops successfully when mixed with European and Japanese larch, western hemlock and western red cedar, but not with Norway spruce. Scots pine can be grown with Norway spruce and European larch but not Japanese larch, Douglas fir, western hemlock or western red cedar (see Table 4.3).

Table 4.3 Conifer species compatible in mixtures (shaded cells indicate compatibility).

4.5.2 Conifer/broadleaf mixtures

Species	DF	NS	SP	JL	EL	WH	WRC
Douglas fir (DF)							
Norway spruce (NS)							
Scots pine (SP)							
Japanese larch (JL)							
European larch (EL)							
Western hemlock (WH)							
Western red cedar (WRC)							

Both Scots pine and European larch can be mixed with oak, beech or ash in 25-50% proportion, in order to capitalise on the nursing effect afforded by these slow growing conifers.

Planting small groups of broadleaves in conifer matrices has been practised in the past but proved largely unsuccessful. Larger blocks of broadleaves (oak, ash and beech) in Scots pine or European larch stands may have better potential.

4.5.3 Broadleaf mixtures

With the exception of sycamore, beech and ash, broadleaf stands can include other species as secondary or minor components. However, difficulties can be posed by different rotation lengths.

4.6 SEED AND PLANT ORIGIN

It is essential that the seed origins selected, if foreign, suit conditions in Ireland (see SECTION 1: FOREST REPRODUCTIVE MATERIAL and SECTION 2: NURSERY PRACTICE).

4.7 CHOICE OF SPECIES FOR ANCILLARY REASONS

4.7.1 Riparian woodland

Many forest developments include aquatic buffer zones created to safeguard water quality and aquatic life from any potential negative impacts of forest operations. In general, trees should not be planted within aquatic buffer zones. However, the development of natural riparian vegetation should be encouraged, and this may involve the planting of single or small groups of suitable native tree species such as birch, willow, alder, oak and ash. Such planting is permitted in the buffer zone and within 5 m of the aquatic zone, if this would, in the view of the Regional Fisheries Board, have a beneficial effect on that particular aquatic zone. Such trees should be planted in selected locations in order to ensure that approximately half the length of the stream is left open and the remainder kept under partial shade. This mixture of sunlight and dappled shade is considered ideal for fish and other forms of aquatic life. See FORESTRY AND WATER QUALITY GUIDELINES.



Species selection for riparian woodland should include trees which occur naturally along river banks, such as birch, willow, alder, ash and oak.

4.7.2 Landscape

Species can have a major bearing on the potential contribution of the forest to the landscape. For example, variety of pattern within the forest can be enhanced by selecting different species, either in pure or mixed stands, which reflect and highlight existing ground surface patterns. The inclusion of Scots pine or larch into the woodland margin can increase visibility into the stand, thereby creating a desirable edge effect. Similarly, the selection of suitable species contributes significantly to the colour and texture of the forest. Site suitability remains the primary consideration in species selection. However, the fulfilment of landscape objectives is normally readily achieved, given the flexibility offered by the range of species and mixtures available, variation within and between sites within the same landscape, and the potential to produce a diverse forest comprising broadleaves, intimate mixtures and small pure stands. See FORESTRY AND THE LANDSCAPE GUIDELINES.



The inclusion of larch adds greatly to the colour and texture of an otherwise homogeneous canopy, illustrating the landscape value of species diversity.

4.7.3 Scrub and other species

As detailed in the FOREST BIODIVERSITY GUIDELINES, the selection of suitable species contributes significantly to biodiversity. In addition, existing areas of woody scrub, native woodland and hedgerows should be identified and retained as important habitats throughout forest development. Suitable native species can be selected for planting within or adjacent to these areas, in order to reinforce or extend existing cover. As well as benefiting biodiversity and conservation, this will promote the forest's landscape and recreational objectives. See FOREST BIODIVERSITY GUIDELINES.

4.8 PLANNING FOR DIVERSE SPECIES

Each species requires different management inputs throughout the rotation, and this factor must be anticipated when selecting species for a site. Initial stocking, vegetation control, shaping, tending and nutrient requirements all have to be tailored according to

species. Consideration should also be given to differences in tolerance levels to frost, exposure and wind, later silvicultural prescriptions and management practices, and actual rotation lengths.

4.9 ADVERSE IMPACTS

- Unsuitable species selected for the site
- Unsuitable mixtures prescribed
- Provenance not or incorrectly specified
- Species management requirements not fully identified
- Planting density not or incorrectly prescribed
- Failure to maximise species diversity
- Failure to identify constraints and opportunities relating to riparian zones, biodiversity, landscape and other environmental factors
- Inadequate planning

4.10 BEST PRACTICE

- Identify site/species suitability
- Assess potential mixtures suitable for the site
- Maximise species diversity
- Identify species management requirements
- Check provenance documentation
- Identify forest objectives
- Identify constraints and opportunities relating to riparian zones, biodiversity, landscape and other environmental factors
- Ensure correct management practice is specified

4.11 REFERENCE MATERIAL

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5. SITE PREPARATION FOR AFFORESTATION

Site preparation operations can take place on the basis that the necessary planning, identification of constraints and consultation have all been carried out.

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5.1 KEY FACTORS

- Access to site
- Scrub and vegetation clearance
- Impacts of burning
- Soil preparation and drainage systems
- Drainage and water impacts
- Nutrient requirements
- Fertilisers and water
- Requirements for aerial fertilisation
- Fencing, gates and stiles
- Firebreaks and reservoirs

5.2 OBJECTIVES

- To achieve conditions suitable for planting and regeneration.
- To minimise environmental disturbance.
- To provide for successful establishment in terms of drainage, fertilisers and protection against grazing animals.

5.3 ACCESS

Machinery must be able to access the forest. Therefore, narrow tracks and sharp bends must be avoided. If the forest adjoins a county road or a suitable right-of-way, ensure an adequate bell-mouth entrance on the forest side. Even where access onto a county road exists, an assessment of usage will be required and it may be necessary to discuss with Local Authorities whether or not planning permission is required.

5.4 ACCESS ROADS

Access roads onto the site are usually only required for large developments. If needed, care should be taken if situated near aquatic zones, controlling sediment run-off and visual impacts. Construction should be carried out during the summer months (see SECTION 14: FOREST ROADS). Strictly adhere to the FOREST HARVESTING AND THE ENVIRONMENT GUIDELINES and FORESTRY AND WATER QUALITY GUIDELINES, both of which contain sections relating to forest roads and ancillary features.

5.4.1 Access and water

The construction of crossings across aquatic zones, whether temporary or permanent, can cause soil and site disturbance, with subsequent soil erosion and the movement of sediment into the aquatic zone. Poorly designed crossings can also hinder fish passage. Careful planning and construction of these crossings are therefore essential. If a crossing is proposed, a decision will be required on whether a ford, culvert or bridge will suffice, based on fisheries and water quality sensitivity. Discussions may be required with the relevant Regional Fisheries Board and Local Authority.

The following apply to the construction of all crossings:

- Limit all work to the period May to September.
- Do not design or build crossings in a way which would hinder fish passage.
- Consult with the Regional Fisheries Board at the design stage of any crossing in a fish-bearing or potentially fish-bearing aquatic zone.
- Minimise the number of crossings over a given aquatic zone.
- Consider the level of traffic expected during the lifetime of the crossing, and select and design the type of crossing accordingly.
- Minimise disruption to the bank, bed, channel and adjacent buffer zone during construction.
- All crossings should be at right angles to the flow.
- Avoid steep approaches to the crossing.
- Ensure that the crossing is located over a stable section of the aquatic zone.
- Carry out any necessary timber treatment off-site.
- Use local stone for bridge kerbs and end treatments for culverts.
- Keep cement and uncured concrete out of the aquatic zone. Keep cast-in-place concrete isolated from any water which might enter the aquatic zone, until the concrete has set.
- Reseed approaches after construction.

5.4.1.1 Open fords

Fords are generally not appropriate, as they can often restrict fish passage and give rise to considerable sedimentation and the contamination of the aquatic zone with fuel and motor oil. Existing fords may be considered acceptable for fish movement. Fords should only be used when the design is approved by the Regional Fisheries Board.

5.4.1.2 Culverts

All culverts should be well-bedded and of sufficient size to carry normal flow and to accommodate 25-year storm events, and to avoid blockages and washouts. Culverts can be open topped or embedded. In fish spawning aquatic zones, embedded culverts are favoured as they provide unrestricted passage for all fish sizes and retain the natural streambed and gravel. Embedded culverts are usually large diameter (greater than 1 m) culverts which aim to maintain the natural channel width, gradient and conditions. Embedded culverts should be buried to a depth of 0.3 m or 20% of their height (whichever is greatest) below the streambed. The original bed material as well as boulder-sized rocks should then be placed in the culvert. All culverts should be maintained, removing debris which can cause clogging and eventual culvert failure.

5.4.1.3 Bridges

Bridges are the most desirable crossing structure as they allow unimpeded fish movement. Bridges also ensure that machine parts (and associated fuel and oils) are kept out of the aquatic zone. Bridges should be planned and designed with reference to the particular site and level of traffic, and with consideration for aesthetic appearance. Do not create shallow or shooting flow at the bridge aprons, to ensure that water velocities do not impede fish movement.

5.5 WOODY VEGETATION CLEARANCE

The site may have a covering of dense woody vegetation such as gorse (furze) or bramble. The nature and extent of this will require a decision as to whether or not it should be removed. If mechanically removed, diggers or bulldozers should be used. Care will be required to ensure against topsoil damage, compaction or removal. Pockets of broadleaf scrub should be maintained for habitat and biodiversity purposes.

5.6 BURNING

The burning of woody vegetation may occasionally be necessary prior to establishment. This is normally carried out during the season prior to planting. Burning may impoverish the site and should be avoided on poor, shallow soils. Burning and the destruction of vegetation is regulated under the Wildlife Act 1976, and must be carried out between mid-April and the end of August.

5.7 GROUND PREPARATION AND DRAINAGE

The objective of forest drainage is to prevent the soil water rising into and saturating the root zone and waterlogging the soil. By maintaining the watertable below the root zone, drainage promotes deep rooting, improves tree anchorage and strengthens the soil. It may also prevent the build-up of soil pore water pressure, which can occur during windy conditions, resulting in hydraulic fracture of the soil and windthrow.

To be successful, forest drainage must remove surplus water rapidly and must be designed against the cause of saturation and waterlogging. Drainage problems can arise through:

- an impermeable layer;
- high watertable;
- hillside seepage;
- springs and artesian seepage;
- type of peatland.

Ground preparation and drainage are both necessary for forest growth. However, they invariably involve some degree of soil disturbance and water control, and



Mounding is suitable for wet sites, providing an elevated and drained planting position which facilitates root development and reduces the severity of weed competition during the initial growing season.

therefore have a direct bearing on water quality in relation to fisheries, drinking water, recreation and other uses.

5.7.1 Operational aspects

A number of options concerning drainage and cultivation are recommended, depending on soil and water factors. Mounding is the most commonly used technique, involving the creation of open drains and the distribution of spoil for planting. In general, drainage is not necessary on sites where the watertable is 45-60 cm below the surface. Sites with watertables 30-50 cm below the surface, rising to 15-25 cm in winter, require drainage. For most of the site preparation operations involving drainage, it will be necessary to construct sediment traps, as appropriate.

5.7.1.1 Mounding

Mounding is the most common type of soil preparation used, as it suits wet mineral soils and is easily assessed for quality. It allows variation in drainage and can help to create stable growing conditions. Mounding is effective on sites which have excessive soil moisture, low soil temperatures or inadequate rooting volume, and on sites subject to frost and heavy vegetation competition. Mounding helps soil aeration but can give rise to loss of soil water in dry conditions. Roots may not penetrate deeply into the original soil surface. Operational considerations are as follows:

- Mounds are normally placed at 2.0 m spacing, unless otherwise required by species.
- Mounds are 45-60 cm wide at their base and 15-20 cm high.
- Mounds should be kept as small as possible, as large mounds may predispose the crop to windthrow at a later stage.
- Soil should be taken from the drain, avoiding subsoil.
- Mound drains are normally spaced 12 m apart, but range from 8-16 m depending on soil, hydrology and moisture conditions.
- Drains should run in the direction of maximum slope and feed into collector drains spaced approximately 80 m apart.
- Collector drains are normally between 40-60 cm deep.
- Mounding is carried out using an excavator fitted with a V-profile bucket.
- Where possible, drains should feed into existing outfalls.

5.7.1.2 Mould board ploughing

Mould board ploughing is infrequently used in site preparation and is usually confined to areas with acute drainage problems and the occasional peat site. The association between mould board ploughing and windthrow has also reduced its use. Operational considerations are as follows:

- Double mould board ploughing furrows are normally spaced 4.0 m apart with ribbon edges 30 cm from furrow edges.
- In general, the maximum ploughing depth is 25 cm, with collector drains 60 cm deep spaced 50-80 m apart. Ploughing in excess of 25 cm should not be undertaken within 50 m of an aquatic zone.
- Where feasible, ploughing alignment should be in a southwest-northeast direction.

5.7.1.3 Tunnel ploughing

Tunnel ploughing has in the past been used on fibrous peat over 60 cm in depth, in which a free drainage tunnel can be created. Planting is carried out on the extruded ribbon. Little afforestation now occurs on these sites.

- Tunnels are at a depth of 60-80 cm in or near the direction of maximum slope.
- Collector drains 80 cm deep are spaced 50-60 m apart, using an excavator after ploughing.

5.7.1.4 Agricultural ploughing

Agricultural ploughing can be carried out on good quality land for broadleaf or conifer establishment. However, all forms of ploughing may predispose the crop to windthrow.

- It involves double furrows at 2.0 m spacing to a depth of 20 cm.
- A vegetation-free band 80 cm wide should be centred on the planting area. Planting is undertaken on the first sod from the drain or between sods.
- Collector drains are spaced approximately 80 m apart, depending on slope.

5.7.1.5 Mole drainage

Mole drainage is the most suitable form of site preparation for heavy, wet mineral soils, particularly those in drumlin areas and on slopes in excess of 4°. It is particularly effective on former agricultural land, but is not recommended for unenclosed land.

A bullet shaped mole, followed by an expander, is drawn through the soil to form a channel 70-75 mm in diameter at a depth of 45-50 cm below the ground surface. The mole channels are intercepted at intervals of 30-40 m by collector drains. Mole drains are installed at a spacing of 2 m, with planting to one side of the mole channel opening. Installation is best carried out during the period April-September, and during periods when the soil is reasonably dry.

5.7.1.6 Ripping

Ripping is typically used on compact hard sandy/silty soil, on stony clayey soils, typically Old Red Sandstone podsoles. The ripper is fitted with a replaceable shoe which bursts the overlying soil, increasing its permeability. Fitted wings further increase this effect.

- Ripping is normally carried out at 2.0 m spacing to a depth of 45 cm.
- Collector drains are spaced 80 m apart (closer and aligned at a 2° slope on erodible sites), and are 55-60 cm deep.
- Setting the ripping depth 75 mm below the average depth of the impermeable layer will usually break up approximately 90% of the layer.

5.7.1.7 Scarifying

Custom built scarifiers are being used more frequently on dry stony sites. However, the method is unlikely to be cost-effective for small areas.

- Scarifying is normally carried out at 2.0 m spacing to a depth of 10-20 cm.
- Collector drains are as required, up to 80 m apart on Old Red Sandstone sites and slopes over 4°.

5.7.1.8 Pit or hoedad planting

Pit or hoedad planting is suitable for mineral or old woodland sites. It may also be appropriate for steep slopes where other types of preparation may lead to sediment run-off. However, the operation is labour intensive and therefore expensive.

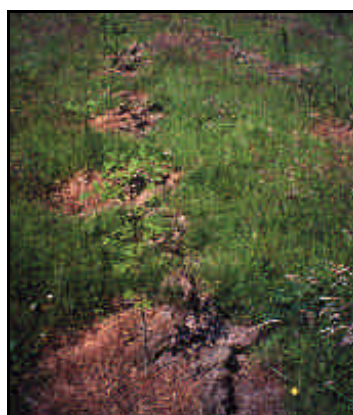
5.7.2 Environmental aspects

Incorrect ground preparation and drainage can result in soil disturbance. This soil may be carried into aquatic zones, particularly if ground preparation is followed by prolonged and heavy rainfall. It is therefore essential that FORESTRY AND WATER QUALITY GUIDELINES are strictly observed and that soil disturbance is avoided close to all aquatic zones. Both the production and release of sediment should be controlled. Measures can be taken: (i) to prevent and limit soil erosion and the generation of sediment; and (ii) to reduce the release of unavoidable sedimentation from the run-off water before it enters an aquatic zone. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are controlled.

FORESTRY AND WATER QUALITY GUIDELINES stipulate the establishment of buffer zones along all aquatic zones, within which ground preparation and other forest operations are curtailed. Buffer zone width is set by slope and soil erodability (see Table 5.1).

Table 5.1 Buffer zone width.

Average slope leading to aquatic zone	Buffer zone width on each side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate (even to 1 in 7 / 0-15%)	10 m	15 m
Steep (1 in 7 to 1 in 3 / 15-30%)	15 m	20 m
	20 m	25 m



Ripping is used on hard compact sites to improve drainage and to facilitate root penetration and development.



Enforce the required aquatic buffer zones at the planning stage of any new forest. Exclude all operations from these zones throughout the rotation, from ground preparation onwards.

- Buffer zones should be actively managed to encourage sustainable vegetative growth and cover for the protection and enhancement of water quality. Open and partially wooded conditions should be planned, so that bank vegetation thrives.
- Do not carry out ground preparation within the buffer zone. Where trees are being planted to restore or create riparian woodland, pit planting must be used, except in wet areas where inverted mounding is allowed.
- Where possible, ground preparation should be carried out when there is less of a risk of heavy rainfall.
- Where possible, do not disturb existing drains.
- Drains and sediment traps should be installed during ground preparation.
- Collector drains should be excavated at an acute angle to the contour (0.3%-3% gradient), to minimise flow velocities.
- Main drains to take the discharge from collector drains must be provided with water drops and rock armour where there are steep gradients, and should avoid being placed at right angles to the contour.
- Ensure that all drainage channels 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. On erodable soils, install sediment traps at the end of the drainage channels to the outside of the buffer zone.
- Sediment traps should be sited outside the buffer zone and have no direct outflow into the aquatic zone. Their capacity can extend over the life of the forest or have limited storage. In the latter case, machine access is required to enable the accumulated sediment to be excavated. Sediment should be carefully disposed of away from all aquatic zones. Sediment traps must be clearly marked and securely fenced for safety. Where possible, sediment traps should be constructed on even ground and not on sloping ground.
- In areas particularly sensitive to erosion, it may be necessary to install double or triple sediment traps.

Care should also be taken to avoid disturbance to archaeological sites and important habitats retained for biodiversity purposes (see FORESTRY AND ARCHAEOLOGY GUIDELINES and FOREST BIODIVERSITY GUIDELINES). For example, the FORESTRY AND ARCHAEOLOGY GUIDELINES stipulate that an undisturbed exclusion zone incorporating an area of at least 15 m back from the edge of the archaeological site is maintained. A larger exclusion zone may be required if the site is deemed to be particularly sensitive.

5.8 INITIAL FERTILISING

Fertilisers are usually applied manually or mechanically after planting. Requirements vary between species and site. It is now becoming more usual to test for fertiliser requirement including foliar analysis. Fertilisers must be kept dry in order to avoid 'caking'.

5.8.1 Phosphorus

Sitka spruce requirements for phosphorus on different sites are given in Table 5.2. Granulated fertiliser should be used. For ease of operation, 25 kg bags should be used.

Table 5.2 Sitka spruce requirements for phosphorus on different sites (based on rock phosphate (14.5% P)).

Site type	Rock phosphate (kg/ha)
Enclosed/Improved fields recently farmed	None
Former agricultural land not recently worked	250
Unenclosed land	350 (on very poor sites, two applications may be necessary, 350 kg/ha at establishment and a second application of 250 kg/ha, as required)

5.8.2 Potassium

Muriate of potash (250 kg/ha) may be needed on Midland fen peat (normally under grass) sites, particularly for Norway spruce.

5.8.3 Other nutrients

10.10.20 NPK application is occasionally required for broadleaf crops. In such cases, vegetation control is essential.

5.8.4 Environmental aspects

If improperly carried out, fertiliser application can lead to fertiliser run-off and entry into aquatic zones, with a major adverse impact of water quality. Strict adherence to the FORESTRY AND WATER QUALITY GUIDELINES is required. Timing is highly important, and all applications should be carried out in the summer months and during dry, calm weather. In sensitive areas, consultation with the relevant Regional Fisheries Board should be undertaken, and consideration should be given to splitting applications. Two applications may be needed on infertile sites. In all cases, applications should not exceed stipulated rates.

- Complete all planting before fertiliser application takes place.
- Fertiliser should not be applied within the buffer zone or within 20 m of an aquatic zone, whichever is greatest.
- Fertilisers should be prepared and securely stored under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone.
- Granular fertiliser formulations should be used, with the exception of muriate of potash which is not available in granular form.
- Phosphate application rates on peat soils should be kept to a minimum in any single application.
- Apply fertiliser manually or by ground-based machine, wherever possible. Fertiliser must be applied by hand in the 20-50 m area adjacent to the aquatic zone.
- Do not, under any circumstances, discharge fertilisers into an aquatic zone. The Local Government (Water Pollution) Acts 1977-1992 forbid the release of pollutants into aquatic zones.
- Do not apply fertiliser during or following prolonged rainfall or if heavy rain is forecast.
- Fertiliser should only be applied during the months of April to August, inclusive.
- Remove all empty fertiliser bags, nursery bags and other rubbish from the site during and after the operation, for environmentally acceptable off-site disposal.

5.8.5 Aerial fertilisation

Where later fertilisation is required to counteract nutrient deficiencies, aerial application using helicopter can be considered where branch growth and onsite vegetation prevent manual application. It should be avoided on sites where the prevention of contamination of aquatic zones cannot be assured. In addition to those outlined above, good environmental practices include the following (see FORESTRY AND WATER QUALITY GUIDELINES):

- A 50 m wide corridor adjacent to aquatic zones must be left unfertilised. The contractor must therefore be made aware of all aquatic zones on or adjoining the site.
- Never undertake aerial fertilisation during high winds.
- Consultation with all relevant agencies should take place before the operation is undertaken.
- Also notify adjoining landowners, the local community and the Garda Síochána well in advance of the operation.
- Proper flight paths should be planned.
- Accurate records must be kept of all drops.
- Fertiliser depots should be agreed with the contractor.

5.9 FENCING

All plantations need to be fenced in order to avoid damage by cattle, sheep, goats, deer, hares and rabbits. Existing stock-proof boundaries, such as walls and hedges, can also be used in many areas. Sheep fencing is normally adequate to keep out stock, but rabbit fencing is becoming increasingly necessary. Deer fencing is a necessity in parts of the country to protect species other than spruce, particularly Douglas fir, and to enhance biodiversity.

High quality fencing material is important in order to maximise the lifetime of the fence and to extend the period of protection afforded as long as possible into the rotation.



Sheep and other grazing animals represent a major threat to young trees. Suitable protective fencing must be installed as part of site preparation before any planting takes place.

Specifications for grant-aided forestry for wire and treated and untreated stakes should be observed. Fencelines should be cleared and rights-of-way margins fenced off. Position fences where there is least visual effect. Stiles should be installed for access into the plantation.

5.10 GATES AND STILES

Gates and stiles are needed for access and assessment. They should be maintained and kept in a safe condition.

5.11 FIREBREAKS AND RESERVOIRS

Firebreaks are necessary, particularly for large unenclosed areas with extensive boundaries and where heather, furze or purple moor grass predominate. Internal firebreaks may also be necessary in large blocks and should follow roads, ridelines and aquatic zones. The usual method of creating firebreaks is to surface scrape with a dozer or grader.

To aid fire control, water reservoirs are required for larger properties in excess of 750 ha. Such reservoirs should have a capacity of at least 20,000 litres, and should be accessible. All reservoirs should be fenced off for safety purposes.

5.12 MARL SITES

Soil tests may be necessary if the planting site is located in an area where marl or highly calcareous subsoil is suspected. Soil profiles should be examined and a 10% solution of hydrochloric acid used to test for alkalinity (i.e. level of calcium carbonate or free limestone present) at various soil depths. There may be a need for further testing by a competent laboratory, possibly followed by a field visit. Fluctuating watertables may heighten the impact of marl on crops.

5.13 ADVERSE IMPACTS

- Access difficulties
- Detrimental impact on public roads
- Failure to minimise the number of crossings over aquatic zones
- Poor design of forest roads, bridges and culverts
- Soil damage due to scrub clearance
- Unnecessary removal of broadleaf scrub
- Fire risk or soil degradation due to scrub burning
- Failure to implement relevant operational measures relating to aquatic zones, archaeological sites, important habitats/biodiversity issues, landscape and other environmental factors, with subsequent damage
- Poor ground preparation and drainage operations, leading to sediment entering aquatic zones
- Inappropriate ground preparation which predisposes the crop to windthrow
- Inadequate or wrongly prescribed fertiliser application
- Incorrectly timed fertilising, fertilising during unsuitable weather, or excessive fertiliser application, with subsequent run-off into aquatic zones
- Inadequate instruction, planning or consultation for aerial fertilisation
- Careless storage or improperly sited storage areas for fertilisers, leading to contamination of aquatic zones
- Inadequate fencing and stock trespass
- Fire damage
- Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements
- Failure to notify relevant authorities immediately of accidental damage to aquatic zones and archaeological sites
- Lack of consultation with relevant authorities, interest groups and the local community
- Poor, incomplete records of operations and associated expenditure

5.14 BEST PRACTICE

- Plan access, consulting with Local Authority in relation to the entrance
- Select appropriate crossings over aquatic zones
- Plan and design forest roads, bridges and culverts

- **Care in mechanical scrub clearance**
- **Adhere to regulations on burning**
- **Care in selecting sites for burning**
- **Minimise the need for burning**
- **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**
- **Protect important habitats**
- **Identify suitable ground preparation and drainage techniques**
- **Care in the selection of ground preparation method and its execution**
- **Care in the layout, slope and angle of drains**
- **Install sediment traps, where necessary**
- **Test for fertiliser requirements**
- **Identify the correct fertiliser and application rate**
- **Apply fertilisers at the correct time and during suitable weather conditions**
- **Observe set-back distances from aquatic zones for both ground and aerial fertilising**
- **Adequate planning, instructions and consultation for aerial fertilising**
- **Store fertilisers at least 50 m from the nearest aquatic zone**
- **Install effective fencing, gates and stiles**
- **Create effective firebreaks**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**
- **Consult with relevant authorities, interest groups and the local community**

5.15 REFERENCE MATERIAL

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6. PLANTING

Good quality trees suited to the site and planted at an adequate stocking density and in the appropriate mixtures, will ensure a viable and diverse crop which is in harmony with the landscape.

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6.1 KEY FACTORS
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Planting marks the commencement of the forest rotation, and a quality operation will offer young trees the best start on the site.

6.1 KEY FACTORS

- Supply of suitable planting stock
- Plant quality and condition
- Storage aspects
- Species planting density
- Species site suitability
- Planting method
- Condition of site
- Environmental requirements
- Safety aspects

6.2 OBJECTIVES

- The establishment of healthy plants suited to the site.
- Adequate stocking to achieve a viable crop of quality timber.
- The selection of species and mixtures to achieve diversity.
- Planting patterns in harmony with the landscape, sensitive areas and local needs.

6.3 DELIVERY OF PLANTING STOCK

Planting stock should be ordered well in advance of the planting season. Plant quality should be assessed on arrival. Consignments should be accompanied by the necessary Certificate of Provenance documentation, with multiple certificates needed where different species and provenances are being used. Under plant health regulations, where appropriate, plants must be accompanied by valid Plant Passports (see SECTION 1: FOREST REPRODUCTIVE MATERIAL and SECTION 8: FOREST PESTS AND DISEASES).

6.4 PLANT QUALITY

6.4.1 Plant handling

- Bare-rooted planting stock should arrive in co-extruded polythene bags. Research is currently underway to evaluate more degradable material.
- Containerised stock should arrive in co-extruded bags or specially-designed trays comprising tubs or paper pots.
- The co-ordination of deliveries from the nursery to the planting site is essential.
- Non-bagged plants and plants removed from bags should be trenched in on the planting site. Plants should never be left with their roots exposed.
- Co-extruded bags containing planting stock should be stored under shade.
- Containerised planting stock should be protected from frost and drying out.
- Planting stock should be handled gently at all times, as rough treatment can damage the plants and affect growth.
- Plants from cold store bags should be planted within seven days.
- On-site distribution should be well organised.
- Nursery bags should be gathered up and removed from the site after use. Bags should not be dumped but disposed of in an environmentally acceptable way.

6.4.2 Plant specification

Quality parameters which young plants of scheduled species (see SECTION 1: FOREST REPRODUCTIVE MATERIAL) must satisfy are outlined in the European Union Council Directive 71/161/EEC on external quality standards for forest reproductive material marketed within the Community. A new Council Directive 1999/105/EC on the marketing of forest reproductive material comes into force from 1 January, 2003.

6.4.2.1 Conifers

Good quality planting stock can be identified by the following features:

- a sturdy root collar;
- good needle cover;
- straightness with single leading shoot;
- well balanced fibrous root system.

The normal size range is 30-60 cm in height. Larger plants suit fertile sites with strong competing vegetation. Smaller plants are suitable for less fertile or more

exposed sites.

6.4.2.2 Broadleaves

Table 6.1 lists the transplant quality limits for broadleaves, as defined by the Forest Service for grant-aided forestry. A considerable amount of additional information on growing broadleaves in Ireland has been assembled through the National Council for Forest Research and Development (COFORD).

Table 6.1 Transplant quality limits for broadleaves.

Species	Maximum age (years)	Minimum collar diameter (mm)	Stem height (cm)
Common ash	3	7	40-75
	4	12	60-90
Oak/Spanish chestnut/ Common beech	3	5	20-40
	4	6	40-55
	4	7	55-70
	5	9	70-85
		11	85+
Sycamore	3	7	40-75
Alder	3	4	30-60
Others	5	4	30-75

6.5 TIME OF PLANTING

Bare-rooted material is normally planted between October and April, although this planting season can be extended by using containerised or cold store planting stock. Correct timing of planting can have a critical impact on successful establishment. Planting during very cold (particularly frosty periods) or dry conditions should be avoided.

As a general rule, broadleaves, Douglas fir and larch are planted before the end of the year, and all other conifers planted from Christmas onwards.

Recent research on cold store planting stock suggests that the optimum planting times for different species are as follows:

- *Sitka spruce*: Tolerant of most planting times except very late in the season. Generally October/November to March.
- *Larch*: Survives well except when planted in April/May. Generally October to February.
- *Douglas fir*: Should be planted from October to early December, as it requires soil warmth.
- *Ash*: November to March.
- *Oak*: December to February/March.
- *Sycamore*: December/January.
- *Beech*: November to the end of February.

6.6 STOCKING

Adequate initial stocking is essential to ensure establishment and crop quality. Current requirements are listed in Table 6.2.

Table 6.2 Stocking requirements.

6.7 PLANTING METHODS

- *Slit planting* suits ribbons, mounds or ripped ground.
- *Dibble planting* as for above.

- *Semi-circular spade* as for above.

Pure crops

Species	Stems/ha
All conifers except south coastal lodgepole pine	2,500
South coastal lodgepole pine	3,300
Sessile and pedunculate oak/Common beech	6,600
Other broadleaves	3,300

Mixtures

Species	Stems/ha
Oak and European larch/Scots pine (75%/25%) (alternative lines of oak and European larch/Scots pine 2 m apart; oak at 0.75 m and European larch/Scots pine at 2 m in respective lines)	4,550
Beech and European larch/Scots pine (84%/16%) (two lines of beech and one line of European larch/Scots pine 2 m apart; beech at 0.75 m and European larch/Scots pine at 2 m in respective lines)	5,280

- *Angle notch* suits ripped ground.
- *Hoedad* is an ergonomic tool suitable for planting ripped ground.
- *Pit-planting by spade* is a traditional method of planting, effective but costly.
- *Machine planting* is at trial stage.

6.8 PLANTING POSITION

Plants are positioned on the top of mounds or ribbons, and beside rips.

6.9 CONDITION OF THE PLANTING SITE

Remove empty nursery and fertiliser bags and other rubbish from the site during and after the operation, for environmentally acceptable off-site disposal.

6.10 PLANTING AND THE ENVIRONMENT

6.10.1 Aquatic zones and archaeological sites

In general, do not plant within aquatic buffer zones. The development of natural riparian vegetation within the buffer zone should be encouraged, and this may involve the planting of single or small groups of suitable native tree species such as birch, willow, alder, oak and ash. Such planting is permitted in the buffer zone and within 5 m of the aquatic zone, if this would, in the view of the Regional Fisheries Board, have a beneficial effect on that particular aquatic zone. See FORESTRY AND WATER QUALITY GUIDELINES.

Do not plant within 15 m of an archaeological site or on the access path to the site. A larger exclusion zone may be required if the site is deemed to be particularly sensitive. See FORESTRY AND ARCHAEOLOGY GUIDELINES.

6.10.2 Landscape

During planting, maximise the forest's potential contribution to the landscape by considering forest landscape planning and design factors such as location, shape, edge and colour (see FORESTRY AND THE LANDSCAPE GUIDELINES). For example:

- visually connect the forest with other landscape features such as field boundaries, streams, gullies and rocky outcrops;
- create fluid shaped forests which respond to changes in landform and emphasise streams, valleys, rocky knolls, ridges and open space;
- avoid sharply defined and dense conifer edges, using groups of 'outliers' to create a gradual transition from forest to open ground;
- where possible, use a mix of species to increase colour variety, with larch and broadleaves being particularly useful for their autumnal and winter colour.



During planting, ensure that the delicate tree roots do not become twisted or bent while being placed in the hole.

6.10.3 Dwellings

- Planting should be set back 60 m from dwellings and associated buildings, unless the owner agrees to a closer set back distance. Set back distance is most critical when a building is surrounded by forest on two sides or more. Where adjoining properties are 0.2 ha or less, planting should be kept back 30 m from the property boundary. See

FORESTRY AND THE LANDSCAPE GUIDELINES.

- Planting should not be within 20 m (for conifers) or 10 m (for broadleaves) of a public road, unless otherwise agreed with the Local Authority.

6.11 ADVERSE IMPACTS

- **Planting stock in poor condition**
- **Poor/incomplete documentation on delivery**
- **Species not suited to the site**
- **Planting stock badly handled**
- **Roots exposed and dried out**
- **Incorrect plant sizes used**
- **Incorrect planting methods**
- **Lack of diversity**
- **Wrong planting density**
- **Planting restrictions regarding aquatic buffer zones and archaeological exclusion zones ignored**
- **Failure to avail of landscape opportunities**
- **Set-back distances from adjoining dwellings ignored**
- **Accidents to operators due to inadequate training/experience, poor equipment or failure to observe workplace safety requirements**
- **Unsanitarily, rubbish-strewn site during and after operation**
- **Poor, incomplete records of operations and associated expenditure**

6.12 BEST PRACTICE

- **Ensure species are suited to the site**
- **Order and reserve planting stock well in advance**
- **Plan for the delivery of the planting stock**
- **Inspect plant quality and documentation on delivery**
- **Select appropriate planting method for ground preparation used**
- **Clear instructions to operators on planting method, stocking levels, species distribution and planting patterns**
- **Ensure a high standard of planting and adherence to site plan**
- **Assess stocking density and adherence to planting restrictions regarding aquatic buffer zones and archaeological exclusion zones**
- **Realise landscape opportunities**
- **Adhere to specified set back distances from adjoining dwellings**
- **Employ suitably trained, qualified and experienced operators**
- **Adhere to workplace safety requirements**
- **Remove empty nursery bags and other rubbish during and after operations**

6.13 REFERENCE MATERIAL

Anon. 2000. Forestry Schemes: Procedures and Standards Manual. Draft. Forest Service, Department of the Marine and Natural Resources, Leeson Lane, Dublin 2.

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

Joyce, P.M. 1998. Growing Broadleaves - Silvicultural Guidelines for Ash, Sycamore, Wild Cherry, Beech and Oak in Ireland. COFORD, National Council for Forest Research and Development, National University of Ireland, Belfield, Dublin 4.

O'Reilly, C., Harper, C. and Keane, M. In press. The Use of Physiological Indicators in Assessing Readiness for Lifting, Cold Storage and Planting of Important Conifer and Broadleaf Species. COFORD, Dublin.



7. VEGETATION MANAGEMENT

Natural vegetation presents a challenge to young developing trees. Competition from weeds and grasses is a serious cause of plant loss and reduced growth.

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7.1 KEY FACTORS

- Safety and legal requirements
- Chemical control
- Commonly used herbicides
- Vegetation types and treatment
- Pre-planting conditions
- Post-planting conditions
- Applications
- Calibration
- Training
- Environmental control

7.2 OBJECTIVES

To manage competing vegetation until the young forest is successfully established, without risk to health, water quality and the environment.

7.3 GENERAL INTRODUCTION

Competition from weeds and grasses represents one of the major difficulties in establishing forests. While this section deals mainly with vegetation management at the establishment stage, it is also relevant to vegetation management prior to reforestation.

Hand-weeding is very labour intensive and, in the case of grass cutting, may actually exacerbate a competition problem. The trampling of vegetation around plants may be carried out if there is a particular need to avoid the use of herbicides. The current standard practice is, however, to eliminate or control weeds using herbicides.

7.4 CHEMICAL CONTROL

The use of herbicides has important safety, health and environmental considerations. It is governed by the Safety, Health and Welfare at Work Act and strictly regulated by user instructions and guidelines. This section relies heavily on the *Guidelines for the Use of Herbicides in Forestry* (see reference list), and these should be consulted alongside manufacturer instructions for details on chemistry of herbicides, rates of application, methods and maintenance of equipment.

Changes in practice are likely to evolve in light of new knowledge on chemicals, new formulations, amendments to existing regulations or the introduction of new regulations.

7.5 SAFETY AND HERBICIDES

7.5.1 Legal aspects

Any person using herbicides must be provided with instructions necessary to enable him/her to comply with the Safety, Health and Welfare at Work Act, European Union Directives and other legislation and regulations. All reasonable precautions must be taken to protect the health of humans, fauna and beneficial flora species, and to guard against damage to the environment, particularly aquatic zones. All operators must receive instructions and training in the safe use of herbicides and on the health risks associated with using hazardous substances.

The “polluter pays” principle applies to the careless use of chemicals.

7.5.2 Safety and protection

Full protective clothing, including suits, aprons, face masks and shields, gloves or armlets, and wellington boots, must be worn. For specifications on the use of chemicals in forestry, see relevant guidelines covering all operations involving herbicide use, e.g. mixing, dipping, spraying and handling sprayed plants. Equipment should be washed or replaced, if damaged.

7.5.3 Storage



On many sites, effective vegetation management using herbicides can mean the difference between a quick and successful establishment and a costly failure.

Chemicals should be kept in supervised and secure stores under strict rules regarding working conditions, safety, first aid and protective clothing. There must be a full reporting procedure for stock movement and accidents. Stocks of flammable or hazardous material should be kept to a minimum. Fire authorities should be notified of the location and contents of the store.

On site, prepare and securely store all chemicals under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone (see FORESTRY AND WATER QUALITY GUIDELINES).

7.5.4 Transportation, spillage and disposal

During transport, containers should be secured against any leakage and firmly held in position. Containers should also be carried in a separate compartment to that of the driver, and clearly marked as hazardous.

Spillage procedures should be specified. Spillage should be dealt with immediately. Material should be absorbed and placed in marked containers. Significant amounts of contaminated soil should be measured and suitably disposed of, e.g. landfilled. The Garda Síochána and the relevant Local Authority and Regional Fisheries Board must be contacted immediately, should accidental contamination of an aquatic zone occur. Ensure that operators have relevant contact details at all times.

Herbicides should be acquired at a rate which avoids stock build-up. Unused herbicides should be sprayed onto waste ground, carefully stored until used, or, in the case of concentrates, returned to the supplier. Empty containers or containing material should not be re-used but disposed of by arrangement with Local Authorities.

The above activities need to be well-supervised and highly co-ordinated (see *Guidelines for the Use of Herbicides in Forestry*).

7.5.5 Records

Operation and operator (health, etc.) records must be kept.

7.5.6 Accidents

First aid procedures following skin and eye contact and poisoning should be understood and observed (see *Guidelines for the Use of Herbicides in Forestry*).

7.5.7 Operational instructions

Specifications relating to each type of herbicide should be understood. These include the following:

- weather conditions, including risk of change;
- notification to neighbours and authorities;
- warning notices;
- correct equipment and risk of faults;
- preparing equipment;
- condition of containers and disposal of material;
- cleaning procedures, return of equipment and repairs;
- cleaning and washing facilities;
- environmental risks;
- safety factors;
- vandalism;
- display of notice if members of the public have access during application.

7.5.8 Training

The Safety, Health and Welfare at Work Act 1989 requires that only competent operators are employed to undertake particular tasks. Training resulting in a Certificate of Competence issued by the UK National Proficiency Test Council meets this requirement. Courses to this standard are carried out at Coillte's Training Centre, Mountrath.

7.6 COMMON HERBICIDES

The common herbicides used in Irish forestry are listed in Table 7.1.

Herbicide	Trade name	Sprayer type	Target vegetation
asulam	Asulox	Knapsack	Bracken
atrazine	Atrazine Atraflow	Knapsack Motor manual Machine sprayer	Grasses Light rush
glyphosate	Roundup Gallup Glyphogan Touchdown	Knapsack Machine sprayer Motor manual	Grasses Rush Bracken Broadleaf weeds Heather Furze Woody weeds Rhododendron (stumps) Bramble
imazapyr	Arsenal	Knapsack Machine sprayer	Bracken Bramble Furze Broadleaf weeds Scrub Woody weeds
propyzamide	Kerb Flo	Knapsack	Grasses
terbuthylazine	Gardoprim	Knapsack Motor manual Machine sprayer	Grasses Rush Broadleaf weeds Heather
triclopyr	Garlon Nettlex Brushwood Killer	Knapsack Machine sprayer	Bramble Furze Scrub Woody weeds

Table 7.1 Common herbicides used in Irish forestry.

Surfactants are added to a spray solution to increase spreading and wetting. Adjuvants are added to enhance the effectiveness of the herbicide, e.g. by breaking down the tough leaf cuticle of target plants such as rhododendron. See *Guidelines for the Use of Herbicides in Forestry* for further details.

7.7 APPLICATION

7.7.1 Application types

Applicators include:

- *Spot gun*: Output is achieved through a cone nozzle. Container capacity is approximately 5 litres. Equipment is useful for filling-in and rough terrain.
- *Vehicle-mounted boom sprayer*: Generally tractor-mounted. Atomisers located along the boom give an operating width of approximately 7 m. Various nozzle types can be fitted. Output is 25-100 litres, depending on machine speed and nozzle type.
- *Knapsack sprayer*: Lever operation and control valve give a constant flow. Various nozzle types can be used.

All applicators should be washed out after use. Nozzles should be removed and washed. When boom sprayers are used, atomisers should be oiled and stripped down periodically. Sprayers should be cleaned out each day after use, with all waste water sprayed over waste ground.

Sprayers can be calibrated using the formula:

$$F = \frac{R \times D \times A}{10,000}$$

where F is boom or nozzle flow rate (litres/minute), R is row or swathe width (m), D is forward speed (m/minute) and A is application volume (litres/treated ha).

7.7.2 Nozzles

Nozzles are classified according to the spray pattern they emit. These include fan, hollow cone and variable cone.

7.7.3 Application methods

Application methods are as follows:

- *Band*: Along a strip of vegetation normally centred between rows.
- *Spot or patch*: Patch of vegetation immediately around plants.
- *Stem or cut stump*: Applied directly.
- *Overall*: Complete treatment of area.
- *Directed*: Applied to minimise treatment of area.
- *Cowled*: Top of trees protected by guard fitted on applicator.

7.7.4 Weather

Some herbicides, such as asulam, glyphosate and triclopyr, require dry weather and a rain-free period of 2-24 hours after application. Others are not affected by rain. In order to minimise run-off, all applications should be avoided prior to, during and after heavy rain.

7.8 TARGET VEGETATION

Vegetation, herbicide, timing and application rates are given in Table 7.2 (overleaf).

7.9 SPECIES RESISTANCE TO HERBICIDES

7.9.1 Conifers

In general, pre-flushed conifers are tolerant to most herbicides. Mounding usually ensures that vegetation management does not become a problem at establishment. All conifers can be treated pre-flush with atrazine. All conifers can be treated with terbutylazine during the dormant season, although a cowl is required for Norway spruce. Terbutylazine can also be applied from March to August to all conifers, except Norway spruce and larch. Asulam can be used during the growing season on all conifers, except western hemlock.

7.9.2 Broadleaves

All broadleaves are generally intolerant to herbicides, and pre-planting treatment is required. Spot treatment with terbutylazine can be used during the dormant season for oak, beech and sycamore. Glyphosate can be used with care as a post-planting treatment, but use of a cowl is essential.

7.10 HERBICIDES, AQUATIC ZONES AND OTHER SENSITIVE AREAS

The protection of aquatic zones is essential (see FORESTRY AND WATER QUALITY GUIDELINES):

- Do not apply herbicides if heavy rainfall is forecast or in high winds.
- Do not apply herbicides within the aquatic buffer zone.
- Refer to *Guidelines for the Use of Herbicides in Forestry*, available from the Forest Service.
- Prepare and securely store all herbicides under shelter on a dry, elevated site at least 50 m from the nearest aquatic zone.
- Cleaning of equipment should not take place within 50 m of an aquatic zone. All wash waters must be disposed of carefully.
- Remove all containers from the site and dispose of carefully.
- The relevant authorities must be informed immediately of any accidental spillage which threatens an aquatic zone.

Operators should also be aware of the location of archaeological exclusion zones, retained habitats and other features, and avoid using herbicides in their vicinity (see FORESTRY AND ARCHAEOLOGY GUIDELINES and FOREST BIODIVERSITY GUIDELINES).



As with all potentially harmful substances, strictly adhere to the FORESTRY AND WATER QUALITY GUIDELINES when preparing, storing and using herbicides within the forest.