woodlands
OF IRELAND
Coillearnacha Dúchasacha

Realising Quality Wood From Ireland's Native Woodlands

Silvicultural Guidelines for Wood Production in the Context of the Native Woodland Scheme

Declan Little and John Cross

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Forest Service

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The Silvicultural Subgroup of Woodlands of Ireland comprises Dr Aileen O'Sullivan, Dr Declan Little, Mr Jerry Hawe, Mr Joe Gowran, Mr John Fennessy, Mr Kevin Collins, Mr Michael Doyle, Professor Emeritus Pádraic Joyce and Dr Sasha Bosbeer.

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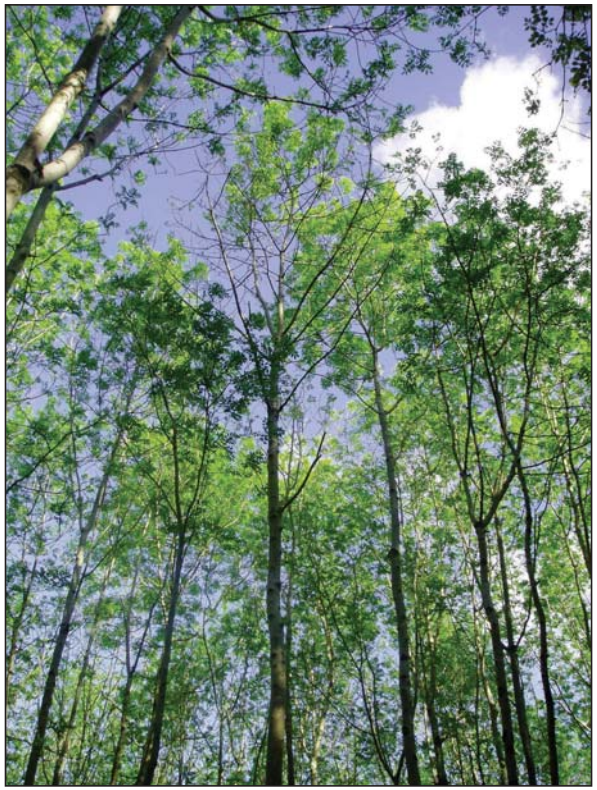
Dedicated to the memory of O.V. Mooney, the gentleman of Irish forestry.

Ní hionann a fhásas a uile shlat
Agus ní hionann nádúr d-uile mhac

(Every tree does not grow in the same way
and every son has not the same nature)

Buíochas le Chití Sheáin Uí Chuinneagáin as ucht an seanfhocal



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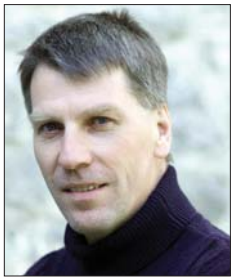

Michael Starrett
Chairman

Woodlands of Ireland has been at the forefront of the revival of native woodland management in recent years. A partnership approach involving foresters, ecologists, relevant State agencies, ENGOs and other stakeholders has resulted in the development of a number of key initiatives, including the People's Millennium Forests Project and the Forest Service Native Woodland Scheme. By drawing on the expertise of numerous individuals and the goodwill of enthusiastic woodland owners, Woodlands of Ireland provides a technical platform that underpins these initiatives and advances the native woodland agenda in Ireland.

Native woodlands are an integral part of our ecological, cultural and economic history. Today, most attention is given to the biodiversity and conservation aspects of the remaining fragments of native woodlands. However, in centuries past, the resource supported a thriving industry that provided a multitude of wood-related products. Although woodlands in the past were often over-exploited and cleared in favour of other land uses, particularly pasture, some woodlands were managed on a sustainable basis using silvicultural systems that required considerable vision, skill and patience to implement. The benefits of sustainable management, particularly in woodlands comprising oak and other long-lived trees, were often not seen in the lifetime of those who instigated the process of establishment and management.

As part of the rejuvenation of native woodlands now underway under the Forest Service Native Woodland Scheme, it is imperative that multiple objectives are met. These include environmental, economic and social considerations. The economic objective is important, in order to provide good quality wood for downstream value-added produce, and also to provide a platform for the revival of woodland management skills and associated crafts. It is also imperative for woodland owners to derive some financial return, so that at least some of this may be re-invested in the continued management of their woodlands. Woodland management should not be solely dependent on grant-aid in the medium and long term; a degree of self-sustainability is required. It is to this end that these guidelines address the production of quality wood while at the same time not losing sight of the overriding nature conservation objective of the Native Woodland Scheme.

The approach adopted in developing these guidelines, involving the expertise and experience of ecologists and foresters coupled with an outside international perspective, should advance our understanding and knowledge of native woodland management. All involved are to be commended for their diligence and attention to detail. In addition, the sponsors of Woodlands of Ireland, i.e. the Heritage Council, the National Parks and Wildlife Service of the Department of the Environment, Heritage and Local Government, and the Forest Service of the Department of Agriculture and Food, fully support this work, as it adds another important dimension to the current efforts to appropriately manage Ireland's native woodland resource.

Michael Starrett
Chairman, Woodlands of Ireland – Coillearnacha Dúchasacha

EXECUTIVE SUMMARY

With the introduction of the Native Woodland Scheme by the Forest Service in November 2001, considerable interest has developed in the appropriate management of semi-natural woodlands. In the past, many woodland owners managed their woodlands for wood production, and this has been a factor in ensuring the survival of these woodlands to the present day. Currently, there are a significant number of woodland owners that are enthusiastic about managing their woodlands with economic sustainability as an important criterion. Although management of most native woodlands ceased decades ago, the Native Woodland Scheme provides an opportunity to reverse the trend of neglect. This would secure at least the short and medium term future of these valuable habitats, many of which are Special Areas of Conservation or Natural Heritage Areas. The development of these guidelines is in response to queries on how to manage these woodlands in a way which protects and enhances their ecological condition while at the same time realising sustainable wood production. The study focused on wood production within the context of the Native Woodland Scheme, and did not address non-wood products such as foliage, hunting, eco-tourism and craftwork, which may further add to the income potential of native woodlands.

The principal outcome of this project is that quality wood can be produced from all of the six native species examined, i.e. pedunculate and sessile oak, birch, alder, ash and hazel, without compromising the ecological integrity of the woodland. Silvicultural approaches adopted can be described generally as being 'close-to-nature', whereby individual or small groups of trees are removed, enabling recruitment from the remaining trees and shrubs. The financial appraisal carried out included a land value in all Net Discounted Revenue (NDR) models for each of the species assessed. Furthermore, assuming that moderate volumes of high quality wood will fetch premium prices, the financial projections indicate that woodlands managed within the context of the Native Woodland Scheme will, in most cases, provide modest returns on par with or even exceeding returns from woodlands managed on a purely commercial basis. This is due at least in part to the continuous Native Woodland Premium of €120/ha/year, which is a unique feature of the Native Woodland Scheme.

The species managed on short rotations, i.e. alder, ash and birch, show considerable potential, with projected returns of c.9% for all three. At the other end of the spectrum, long rotation woodlands with some mature quality wood, such as pedunculate oak woodland on fertile soil, will yield lower revenues due to the necessarily long transformation periods. Transformation in neglected woodlands is required to optimise volumes of quality wood, to enhance biodiversity and to attain uneven aged structure. By adopting transformation over a long timeframe, ecological integrity is maintained, particularly by facilitating slow colonising species, especially in epiphytic communities. Projected returns for pedunculate and sessile oak are both c.5%, with transformation periods of 36 years for pedunculate oak and 70 years for sessile oak.

It is also important to note that woodlands vary from place to place. Therefore, the models and silvicultural prescriptions described are site-specific, and cannot automatically be applied to sites elsewhere. However, general guidelines applicable to native woodlands managed under the Native Woodland Scheme, as well as for the individual species assessed are presented. Although there are a number of uncertainties inherent in the appraisal (such as performance of untested provenances and future wood prices), this project clearly demonstrates that, within the context of the Native Woodland Scheme, there is considerable potential for quality wood production and revenue generation. Realising this potential does require a strong commitment on the part of the forest sector, particularly through continual financial support to land owners, the provision of silvicultural training and native tree research focussed on quality wood production. It also requires a substantial commitment on the part of woodland owners to the application of sensitive silvicultural practices and regular intervention. However, making these commitments will result in a woodland resource that contributes to livelihood while also providing a rich and vibrant habitat for Ireland's native woodland species.

GENERAL INTRODUCTION

In November 2001, the Native Woodland Scheme (NWS) was launched by the Forest Service, then part of the Department of the Marine and Natural Resources. The scheme is aimed at the restoration of existing native woodland, and the creation of new native woodland. Hence, its primary focus is woodland conservation and the maintenance of associated biodiversity. However, there are other objectives associated with the scheme, particularly the protection of freshwater ecosystems and wood production (Collins, 2005). Full details on the scheme and its procedures and conditions are set out in the Forest Service Native Woodland Manual, dated September, 2005 (Anon., 2005).

At the outset it was recognised that there is a considerable challenge in attaining wood production objectives while at the same time ensuring that nature conservation objectives are not unduly compromised. Specific guidelines on how to achieve wood production objectives within the overall context of nature conservation management are urgently required, as many potential scheme applicants are interested in generating revenue from their woodlands. In addition, many woodlands were previously 'working woodlands' and subsequent abandonment and neglect has, to some extent, compromised nature conservation values. This is particularly relevant in woodlands that were managed on a coppice cycle, and in woodlands currently infested with rhododendron (*Rhododendron ponticum**) and cherry laurel (*Prunus laurocerasus*). In this regard, it is important to note that a Felling Licence, as set out the 1946 Forestry Act, applies to all woodlands subject to the NWS, and that conditions attached will preclude clearfelling in favour of systems based on continuous woodland cover. This is one measure within the scheme to ensure that wood production is not achieved at the expense of nature conservation objectives.

The study was undertaken by Woodlands of Ireland, a group established in 1998 to advance the appropriate management and expansion of our native woodland resource. It has a Technical Advisory Group comprising national experts, from which different subgroups are drawn as is required to tackle specific issues. In this way, the Silvicultural Subgroup was established in 2001, to determine if the management of native woodlands for wood production within the context of the NWS is possible.

The purpose of this exercise is to demonstrate from a selection of Case Studies how quality wood can be produced within the framework of the NWS. Sites typical of the native woodland types that include wood producing trees were selected, and where owners wished to integrate a wood production element to the overall conservation management objective of the NWS. It should also be noted that though the focus at each site in this study is on the wood producing species, each site is diverse in terms of flora (trees, shrubs, herbs, lichens, ferns and bryophytes) and fauna (invertebrates, birds, mammals, etc.) and as such, the Case Study sites should be viewed as woodland communities or ecosystems. Management plans for each Case Study were developed using the NWS format and are included on the CD-ROM in this publication.

Before concentrating on wood production, it is essential to put into context the overriding ecological objective inherent in the NWS. Part 1 and Part 2 of these guidelines detail the ecological background and conservation management objectives of native woodlands in Ireland. Part 3 focuses on wood production, and Part 4 sets out conclusions, including financial implications and silvicultural guidelines.

An overview of the Case Study woodlands are presented in Part 3 under the following headings; (1) Description and history (2) Owner's objectives and NWS Ecological Survey/Management Plan (3) Financial implications of alternate management options and (4) Observations from the site visit by the Silvicultural sub-group (where applicable). Under (3) the financial implications of managing the sites under the NWS and alternatively, without any grant aid are presented.

Fig. 1: Bluebell (Hyacinthoides non-scriptus), a common woodland species on calcareous and fertile soils. (Photo courtesy of Declan Little).

** Nomenclature follows Webb et. al., 1996*

As the Case Studies are site specific, it cannot be assumed that the exact same management prescriptions and financial models can be directly applied to similar woodlands elsewhere. However, a number of general management principles and guidelines can be applied more widely and these are outlined in the concluding section (Part 4) for each of the species examined.

In order to bring an outside perspective, subsequent to the plans being drawn up, Professor Juergen Huss, Director of Silviculture, University of Freiburg, Germany, and Dr George Peterken, a private woodland ecological consultant from the UK, were invited to tour four of the sites, i.e. sessile oak *Quercus petraea*), pedunculate oak *Quercus robur*), birch (*Betula pubescens* & *Betula pendula*) and ash (*Fraxinus excelsior*), with the Silvicultural Subgroup on September 9th and 10th, 2002. (The group did not visit the alder (*Alnus glutinosa*) or hazel (*Corylus avellana*) sites during this excursion). Prof. Huss, who has considerable experience in broadleaf silvicultural systems, provided critical analyses of the criteria outlined to produce quality wood in the management plans. Dr Peterken, who has been centrally involved with native woodland policy development, conservation and ecological management in the UK during the past thirty years or so, commented on the impact of proposed management regimes on woodland ecology at each site. The views of each are included in four of the Case Studies outlined in Part 3. (The full text of Dr Peterken's report is in Appendix 2 in the 'General Appendices' on the accompanying CD-ROM).

*PART 1: THE MANAGEMENT OF NATIVE WOODLANDS FOR CONSERVATION - ECOLOGICAL BACKGROUND**

The increasing interest in Ireland's native woodlands, both for conservation and wood production, has stimulated a demand for silvicultural guidelines on their management. This need has developed with the requirements under the EU Habitats Directive to manage woodland Special Areas of Conservation (SACs), the National Biodiversity Plan, and particularly following the introduction of the NWS. The designation of Natural Heritage Areas (NHAs) under the Wildlife Act will stimulate further demand in the future. Given all of these factors, it is important to first put into context the historical and ecological factors that are most relevant to woodland management.

Introduction

Forest once covered much of the landmass of Ireland, but millennia of clearance have reduced the original cover to *c.*1% (Cross, 1987; Rackham, 1995 a & b). Remaining stands comprise mostly of small fragments with only a very few stands exceeding 200ha in size. All these areas, even the most remote, have been greatly influenced by human activity to the extent that past management may be as important as soil or climate in determining species composition and structure.

Much of our understanding of woodland management and history in Ireland is based on work carried out in Britain, notably by Rackham (1995a) and Peterken (1993). While the two countries are not exactly comparable, there is considerable silvicultural, documentary and archaeological evidence which suggests that similar management practices have been employed here (Jones, 1986; Rackham, 1995 a & b). In this section, the ecological background to woodland management is examined. While space does not permit an in-depth examination of all aspects of woodland ecology, the section attempts to provide a background and guidelines for management practices under the NWS. For further details, readers are referred to standard reference works such as Peterken (1993) and Fuller and Peterken (1995).

Definition of native woodlands

Native woodlands are defined as woodlands in which native tree, shrub and herb species dominate. Two principal types may be recognised, based on their age:

- Woodlands that appear on the first edition 1:10,720 (6 inches to 1 mile) Ordnance Survey (O.S.) maps, dating from the 1830s and 1840s. It is concluded from this that many of these sites have a long history of continuous forest cover and some may be modified remnants of the primary, original post-glacial forests. They are described as 'ancient woodland sites', although the trees themselves may not be very old, and they often contain a rich and diverse flora and fauna, including rare species. It is recognised that planting dates back to before the first edition O.S. maps (Forbes, 1933). However, considerable effort is required to locate and examine older maps and documents, and for the present, this date is a convenient cut-off point.
- Woodlands that do not appear on the first edition O.S. maps. These have developed on land formerly cleared and used for agriculture. They are referred to as secondary woodlands and are usually much poorer in species.

This classification is not entirely satisfactory, as it does not take into account clearances for arable land and/or planting within woodlands. It is known that certain ancient woodland sites have been planted in the past and may not therefore contain the original genetic stock. For example, Tomies Wood in the Killarney National Park is documented as having been felled and replanted in the early 19th century, reputedly with oak of Scottish origin (Watts, 1984). However, since this site is known to have been continuously wooded for at least 200 years, it is considered to belong to the 'ancient woodland' category. Notwithstanding this, signs of former cultivation are

*Author: Dr John Cross, National Parks and Wildlife Service (NPWS), Department of the Environment, Heritage and Local Government.

often encountered in stands of ancient woodland, indicating past clearance and subsequent reinvasion of trees. Secondary woods may have arisen as a result of planting or through natural development/regeneration, e.g. on cutaway bog. However, over time they have acquired elements of typical woodland flora and fauna, although these are often relatively poor in species, as colonisation, especially of the rarer species, may be very slow.

Types of native woodlands

There is a considerable variety of woodland types in Ireland reflecting the soils and climate. These are described in Appendix D of the Native Woodland Manual (Anon., 2005). Cross-references to the woodland classification outlined in *A Guide to Habitats in Ireland* (Fossitt, 2000) are indicated **in bold** in the following text:

High Forest

A. Sessile oak-birch-holly woodland. **(WN1 – Oak-birch-holly woodland)**
A1. Species-poor sessile oak woodland on drier sites
A2. Moss- and lichen-rich sessile oak woodland
A3. Sessile oak woodland with hazel and ash
B. Pedunculate oak-ash woodland with hazel **(WN2 – Oak-ash-hazel woodland)**
B1. Pedunculate oak-ash-hazel woodland on relatively deep soils
B2. Pedunculate oak-ash-hazel woodland on shallow, often rocky, soils over limestone
B3. Yew woodland **(WN3 – Yew woodland)**
C. **Mixed alder-oak-ash woodland with willow (WN4 – Wet pedunculate Oak-ash woodland)**
C1. Wet pedunculate oak-ash-alder woodland rich in species on heavy, wet clays
C2. Woodlands of floodplains subject to intermittent flooding
D. Willow woodland alongside river channels **(WN5 – Riparian woodland)**
E. Other wetland woods **(WN6 – Wet willow-alder-ash woodland)**
E1. Willow-alder carr on fen peat
E2. Alder carr with tussock sedge
E3. Ash-alder-remote sedge woodland
F. Birch woodland **(WN7 – Bog woodland)**
G. F1. Dry birch woodland
F2. Wet birch woodland with Sphagnum

Scrub woodland **(WS1 – Scrub and WS2 – Immature Woodland)**

H. Hazel scrub (2 units)
I. Birch scrub (2 units)
J. Willow scrub
K. Ash/hawthorn scrub
L. Juniper scrub
M. Blackthorn scrub
N. Other scrub

Variations within woodlands

Soil type largely determines the species that make up the canopy, although past management practices may have distorted the natural occurrence and abundance of species. Even over a small area, topographical and hydrological variations can lead to subtle variations in soil conditions, which in turn result in considerable diversity of plant species and communities. Sometimes these variations may be clearly visible from the changes in the composition of the tree layer (e.g. oak replaced by alder in wet sites), but often they may be apparent only upon examination of the shrub and/or herb layers. In woodland free of exotic species, especially the more invasive species such as rhododendron or cherry laurel, these differences may be readily apparent. However, where natural patterns are masked by such invasive species or past management, a more critical examination of the flora and soils may be required.

Elements of the woodland ecosystem

- *The canopy.* The priority objective in managing native woodlands for conservation must be to maintain a canopy of native trees over most of the site over most of the time. By maintaining the canopy, the basic woodland micro-environment – shady, moist and sheltered - is retained, thereby providing the correct conditions for associated species. The trees also provide a physical structure for birds and invertebrates as well as support for lianes (climbing plants) and epiphytes (plants growing on trunks, limbs and branches).
  In many cases the canopy is an even-aged monoculture. This is usually the result of past, selective silvicultural management and/or the cessation of intensive management early in the last century. Such conditions are undesirable from a conservation perspective, and steps need to be taken to diversify the age structure and to allow additional native species to colonise and develop. Clearly, obtaining species-diversity in the canopy will take considerably longer than obtaining an uneven age-structure. However, opening up the canopy will create an opportunity for suppressed individuals of other species to grow into the canopy. Extreme care is needed when deciding on the size and position of such openings, as windblow can occur. Similarly, careful light management is required in order to avoid the domination of the open space by particular species (e.g. bramble (*Rubus fruticosus*)) to the detriment of the target trees.
- *The shrub layer.* The shrub layer is often richer in species than the canopy, especially on more fertile soils. It is important as a second layer that provides additional shade to the woodland floor, as well as food and habitat for other organisms. It also serves a valuable function in shading the trunks of trees and reducing the development of epicormic growth, which, if allowed to develop, would reduce the value of potential timber trees. However, the shrub layer may be too dense, leading to suppression of the herbaceous layer and the prevention of the natural regeneration of trees. This situation can arise following removal of grazing animals or the abandonment of coppicing, resulting, for example, in the development of dense stands of holly (*Ilex aquifolium*) or hazel.
- *The dwarf shrub layer.* The dwarf shrub layer consists of low-growing ericaceous species such as bilberry (*Vaccinium myrtillus*) and ling heather (*Calluna vulgaris*). Brambles are not included within this group. This layer is best developed on well-drained, acidic soils where, in the absence of grazing, it may dominate over the herbaceous layer. Where there is strong grazing pressure, the layer may be poorly developed or more or less absent.
- *The herbaceous layer.* The herb or field layer, comprising a variety of flowering plants, ferns and their allies, is often very much richer in species than the tree and shrub layers combined. These plants provide food and habitat for a wide and diverse range of organisms. Many species in this layer are important as soil indicators. A well-developed field layer contributes greatly to the ecological value of a woodland. However, it may be heavily grazed or overgrazed, with many species unable to flower or fruit, or, in extreme cases, grazed out locally. At the other extreme one or two species, such as wood rush (*Luzula sylvatica*) or bramble, may dominate to the virtual exclusion of other species. As with the shrub layer, this is often the result of past management (particularly the cessation of grazing), although some species, such as bracken (*Pteridium aquilinum*), may naturally dominate for a long period.
- *The bryophyte or moss layer.* Although individual species of this layer are small, they may be an important element in the woodland structure and may in fact surpass the total number of species of higher plants, especially in the humid West of Ireland, and in deep valleys and ravines (Kelly, 2000). Bryophytes growing on the ground may benefit from heavy grazing, which removes the competition from the herb layer for light and space. If grazing is too heavy, however, then even this layer may be damaged.
- *Lianes and epiphytes.* Lianes are climbing plants that use trees and shrubs as support. The most common and abundant in Irish woods are ivy (*Hedera helix*) and honeysuckle (*Lonicera periclymenum*). Epiphytes are those plants that grow on the trunks and branches of trees and shrubs. The most abundant species are mosses, liverworts and lichens, but ferns and occasionally higher plants may also take root within the thick mats of bryophytes or in rot holes. The hyperoceanic woods of the

Fig. 2: A typical pedunculate oak-ash woodland with hazel on relatively deep soils, i.e. Type B1. (Photo courtesy of Declan Little).

West are renowned for their epiphytic flora, which also provide habitat for invertebrates. In general, old woodland sites are much richer in lichens than secondary woodlands.

- *Soils*. Woodland soils, especially those that have not been disturbed by cultivation, are an important, if often unrecognised, element of a woodland ecosystem. Primary woodland sites, i.e. those that have been under woodland continuously since the last Ice Age, have soil profiles that have developed largely undisturbed by human activity for 10,000 years, and are invaluable for studying soil development and for comparative studies (Little *et al.*, 1997). This applies not only to the physical and chemical nature of the soil, but also to the soil microorganisms. The soils and associated microorganisms may in fact provide far more information about the age and history of the woodland than the above ground component.
- *Fungi and other microflora.* These elements of the woodland ecosystem are the least researched and understood. In general, however, the older and less disturbed a site is, the richer it is in these organisms.
- *Dead wood and leaf litter.* Dead wood and leaf litter return nutrients to the soil and help to retain soil fertility. The constant removal of these elements, as well as wood, leads to the gradual impoverishment of the soil. Both elements provide habitat for a large number of organisms – bacteria, slime moulds, fungi, invertebrates, birds and mammals. Dead wood includes everything from twig-size material to entire trunks, standing or fallen. In certain circumstances, large fallen logs may act as 'nurse logs' that provide suitable habitat for the regeneration of trees. Many woods that have been heavily managed contain little of the larger material. Conversely, unmanaged woods are often rich in standing and fallen dead and decaying wood of all dimensions. Ideal conditions for fallen timber are cool and moist, as these encourage decay. Leaf litter generally decays rapidly on base-rich soils. On acidic soils, the material decays slowly, and tends to accumulate to form mor humus.
- *Ancient trees.* Ancient trees, including coppiced stools and pollards, not only provide habitat for a wide range of organisms, but also have an important historical function. They serve as links with the past, providing, for example, information related to the location, size and shape of the trees (Rackham, 2003). They should be treated very sensitively and should not be felled or underplanted.
- *Fauna.* Although Ireland has a depauperate woodland fauna, due to its glacial history and loss of woodland cover, ancient and secondary woodlands contain species that find it difficult to colonise new places. They also contain some rare species that have very particular habitat requirements, especially in mature and senescent woodland. Insects are particularly diverse and include several specialist groups. Half of all Irish insect species are dependent on deciduous woodland. Of the macrofauna, there are a number of woodland specialists including birds (e.g. long-eared owl (*Asio otus*), treecreeper (*Certhia familiaris*), buzzard (*Buteo buteo*), jay (*Garrulus glandarius*) and hawfinch (*Coccothraustes coccothraustes*)) and mammals (e.g. long-eared bat (*Plecotus auritus*), red squirrel (*Sciurus vulgaris*) and pine marten (*Martes martes*)).

Conservation of species

The maintenance of the woodland ecosystem will ensure the continuity of the woodland environment. However, the survival of all of the associated woodland species may require specific conditions, many of which can only be obtained by careful management. Leaving woodland unmanaged to develop naturally will ensure the survival of the ecosystem and certain microhabitats, e.g. dead wood. This should be considered as an option in some larger woodlands, (though often the presence of exotic invasive species (rhododendron, laurel, etc.) and/or large populations of grazing animals (deer, feral goats, etc.) will require intervention). However, given the management history of our woodland, this approach will almost certainly result in more or less uniform, even-aged stands with little variety until the canopy begins to break up naturally. Under such conditions, those species with very specific requirements, e.g. light demanders, may be unable to survive, leading to their ultimate loss.

In many sites, it will therefore be necessary to introduce specific management techniques to ensure the survival, or encourage the spread, of particular species, e.g. coppicing for light demanding species, creation of dead wood for saprophytes and invertebrates (Cavalli & Mason, 2003). Maximum species diversity for a site will be obtained by maintaining a mosaic of habitats. However, this should not be interpreted as grounds for creating new habitats inappropriate for the sites or introducing additional species just for the sake of increasing biodiversity: some sites are inherently poor, reflecting the soil type and natural variety of Irish woodlands, e.g. sessile oak woodlands on dry, acidic soils.

The number of species occurring within individual woodlands depends on a variety of factors. These include:

- *Soil type*. In general the more fertile the soil and the greater the variation in soil types within the wood, the greater the number of species present.
- *Past management,* e.g. old coppice, pollards, old trees, neglected sites.
- *Presence of dead wood.* Where this is absent or only present in small quantities, active management will be required to create suitable material (Cavalli & Mason, 2003).
- *Structure*. The more diverse the structure of a wood, i.e. branches/stems from vertical to horizontal positions, rock outcrop, glades, streams, etc. the greater the variety of habitats and therefore the greater the number of species which can be supported. However, a very fragmented structure, which leaves only small areas of high forest, can lead to the loss of suitable habitat for some species.
- *Age of the woodland.* Species richness and the likelihood of rare species, increases with increasing woodland age. Old woodland sites are almost invariably richer in species than secondary woodland, because there has been a very long period for colonisation. Some species are very slow to colonise new woodland, even if it is adjacent to an old woodland.

In assessing the richness of a woodland, it is important to remember that, while the macroflora is the most obvious element, the microflora and the fauna, particularly the microfauna, represent a far greater number of species. Irish native woodlands have almost certainly lost a large number of species, due to the progressive decline and fragmentation of the area of original woodland down through the centuries. Indeed, species loss is probably still continuing, as our native woodlands continue to come under pressure. Where rare species persist, it is important that management aims to retain the habitat required for that species. Given that, in many cases, we do not know the habitat requirements precisely, the "precautionary principle" should be applied.

Economic value of native woodlands

As previously mentioned, our woodlands have been used for productive purposes for generations. In fact, only in recent decades have many of them lost their economic importance and fallen into decline. The objective of producing wood should not therefore be considered as incompatible with conservation, and indeed, it may be an essential component of management to ensure the survival of certain species. The critical factor is to decide on the priorities. Landowners who regard their woodland as a source of income will look after them and value them more highly than those who regard them as having little or no value. In the latter case, intensive livestock production may tip the balance towards conversion to pasture or over-wintering of livestock, resulting in woodland degradation through overgrazing. Even on extensive farms subject to the Rural Environmental Protection Scheme (REPS) there is currently no requirement to proactively manage native woodlands. In practice, Ireland's native woodlands can produce a range of products, as outlined below.

- Large diameter timber for, e.g. construction purposes, furniture.
- Small diameter wood for, e.g. turning, rustic furniture and other craft work.
- Firewood and charcoal.
- Fruits, nuts and fungi.

- Genetic material, e.g. seeds, cuttings.
- Protection, amenity and recreation functions.
- Carbon sequestration
- Utilisation by complementary enterprises, e.g. ecotourism, farm holidays, equestrian centres, etc.

In addition, the landscape value and visual appearance of woodlands in the general countryside – and hence their value to the tourist industry - should not be overlooked.

The impact of past management on woodlands

Today's woodlands are the product of centuries of management, which have shaped their condition and appearance. However, there is a tendency amongst the general public as well as foresters, ecologists and conservationists, to consider today's woodlands as examples of the original woodlands. This is clearly not the case, as past management and disturbances such as clearfelling, invasive exotics and grazing pressure, have altered the original woodland structure and composition considerably. It is important not to ignore these factors, as their impact has a bearing on current and future management objectives and techniques. Some of the more common misconceptions are discussed below.

1. ***Oak is the natural dominant native species.*** Oak is undoubtedly a major component of our native woodlands. However, its overwhelming dominance in many areas, especially on acidic soils, is almost certainly a product of centuries of selective management. Oak is a valuable tree, due to its durable, attractive and strong timber. It was also used in the past for its bark (for tanning), for charcoal (used in the smelting of metal ores) and as a source of acorns (for feeding to pigs). On acidic soils, sessile oak grows with birch and rowan (*Sorbus aucuparia*) and, to a lesser extent, ash. These species, although present, often occur only in very small amounts in today's woodlands, and would almost certainly be more abundant in the absence of human interference. On fertile soils, particularly in the Midlands, pedunculate oak is the principal oak species. Evidence suggests that in the past oak occurred in mixture with elm (*Ulmus glabra*) on fertile soils, while ash was relatively scarce. Unlike sessile oak, pedunculate oak is today rather infrequent outside large estates. This is almost certainly a result of selective felling, which has led to ash becoming the dominant species. As oak does not regenerate well under shade, once ash and the understorey shrub hazel are well established, it is difficult for oak to re-establish itself, either as coppice regrowth or from seed.

2. ***Utilisation of woodlands for wood and other products has led to their destruction.*** Rackham (1995a) has argued persuasively that the need for wood has in fact preserved our woodlands. Many woodlands have only survived where there has been a demand for wood in the past. It is no coincidence that the original 6" O.S. maps often show tanneries located close to woodlands. The presence of charcoal hearths and saw pits, and the evidence of past coppicing, also testify to the economic importance of the woodlands. The principal cause of woodland destruction has in fact been grazing and clearance for agriculture. Indeed, this is still the case today, as the income from agriculture is often more attractive than retaining the woodland for potential income from wood production. However, this may change as a result of the introduction of the EU Single Farm Payment (SFP) Scheme which allows for woodland management under the NWS on up to 50% of eligible land without affecting SFP payments.

3. ***Felling trees is damaging to the woodland ecosystem.*** Trees may be uprooted or broken by storms, or die from disease or old age. The result is a light gap within which new trees will develop. By felling a single tree or group of trees, management is emulating nature, albeit in a controlled manner. The realisation that many of our native trees regenerate from cut stumps led to the practice of

coppicing, whereby small stands, or coupes, were cut periodically to provide a constant source of small diameter wood. The subsequent regrowth is called 'underwood'. In the case of 'coppice with standards' a variation of this practice, individual trees were left to grow to a large size and diameter before felling, to provide structural timber for boat building, construction, etc. The opening up of gaps, or coupes, is also a recognized method of encouraging natural regeneration and is widely practised on the Continent. The development of clearings within a woodland, whether by natural or human means, results in the prolific growth of the herb and shrub layers for a short period before the canopy closes. It also creates a mosaic of light climates that encourages a diversity of both plant and animal life.

Therefore, while felling operations may appear very disruptive initially, the appropriate felling of trees actually plays a positive role in conserving a large number of species and stimulating regeneration. However, felling too many trees, whereby none are allowed to reach maturity or over-maturity is, of course, bad practice in terms of nature conservation, as those organisms which depend on dead or dying wood to complete their lifecycle will not be able to survive. It is important to note that windthrown trees often remain rooted and survive to produce new shoots. Hence, they should not be automatically cut and removed.

Fig. 3: Native woodlands are host to a variety of woodland-specific flora and fauna species, such as the rare woodland orchid Cephelantera longifolia. (Photo courtesy of Sasha Bosbeer).

*PART 2: THE MANAGEMENT OF NATIVE WOODLANDS FOR CONSERVATION - BASIC NATURE CONSERVATION PRINCIPLES AND OBJECTIVES**

Accepting that our native woodlands have a dual purpose, i.e. conservation and income generation, particularly from wood production, it is clearly apparent that a set of guidelines are required in order to ensure that both are catered for in a balanced way. Peterken (1993) lists a series of general principles for the integration of nature conservation with other management objectives in British woods. In this context, nature conservation can be defined as 'management to maintain or, where applicable, enhance woodland biodiversity appropriate to prevailing site conditions'. Most of Peterken's principles are also applicable within the Irish context. These are listed below, with slight amendments. It should also be noted that the following may be relevant to individual woodlands, and/or at a more strategic landscape scale containing a mosaic of scattered woodlands:

1. *Determine the conservation value of the wood.* Where this is not already known, a survey will be required. Normally an examination of the flora and structure will provide considerable information. However, an assessment of the site for bats, birds and invertebrates might also be required. The proximity of the wood to other sites should also be considered.

2. *Afford special treatment to special sites and areas.* Ancient woodlands and woodland SACs will require particularly sensitive management in order to protect their inherent value.

3. *Minimise clearance to reduce the loss of habitat, communities and species.*

4. *Minimise rates of change within woods.* Sudden changes in the canopy over extensive areas may be detrimental to some species. Large-scale clear felling will result in major changes in environmental conditions and will encourage adventive and other fast-colonising species, e.g. bramble, which may dominate and exclude slower colonisers. Continuous cover silvicultural systems are preferable.

5. *Encourage maturity by maintaining long rotations or by retaining a scatter of old trees.* Mature trees carry a much richer epiphytic flora and are valuable for hole dwelling organisms and especially invertebrates.

6. E*ncourage native tree species and remove exotic species* (see below 'Management of exotic species').

7. *Encourage diversity of structure of tree and shrub species and habitat* (glades, rides, hedgebanks, streams, pools, etc.). Structural diversity provides a greater number of niches for a greater range of species, compared to structural uniformity.
   The use of small-scale groups maximises edge habitat, and this encourages species that do not like heavy shade. However, this is not appropriate in all circumstances, and continuous cover broken up by rides and occasional coupes may be more suitable, especially in large woodlands. If there are too many open spaces the woodland becomes too fragmented. Woodlands managed primarily for wood production should be managed to combine stability with diversity by using:
   • long rotations;
   • small-scale groups or coupes;
   • creating and maintaining a normal age structure; and
   • retaining existing diversity.

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   Furthermore, there may be a need to retain an understorey to reduce the growth of side and epicormic shoots, e.g. holly and hazel under oak.

8. *Encourage restocking by natural regeneration or coppice regrowth.* Where this is not possible, planting is an acceptable alternative. Within SACs, native trees and shrubs of local provenance should be used as far as possible. Where this is not possible, seed should be collected from the nearest suitable source. In some areas where species have been selectively removed and are now absent or rare, it may be legitimate to re-introduce them.

9. *Where necessary, take special measures to maintain populations of rare and local species*, e.g. by retaining a selection-based silvicultural system.

10. *Record and retain management actions.* Records are essential in order to understand changes and developments within individual woodlands. Even the best memory is faulty, and unless there is a written record, activities will be forgotten.

11. *Manage a proportion of the woodland on a non-intervention basis in order to restore natural woodland as far as possible.* This may only be realistic in larger woodlands where there is scope to introduce a variety of management practices.

12. *Where a non-intervention reserve area is not possible, introduce alternative silvicultural systems that retain or enhance the conservation value of the site,* i.e. continuous cover.

13. Where possible and appropriate, *maintain or restore traditional management practices.* This needs to be done cautiously. Old coppice stools, for example, do not regenerate well and may have to be replaced. Consideration also needs to be given to the market; a product without demand is uneconomical (although it may still be produced as a 'by-product' of a practice implemented for conservation purposes).

14. *Retain or develop large blocks of connected woodland and maintain a scattering of small woodlands between blocks.*

As a general rule, where forest management for conservation purposes is the primary consideration, the general maxim should be "to make haste slowly".

Management of exotic species

Many semi-natural woodlands in Ireland contain exotic species some of which are invasive and compromise the woodland ecosystem, particularly by displacing native flora. Exotic species can be classified into three categories: (i) non- or slightly invasive species; (ii) highly invasive species; and (iii) recently planted conifer plantations.

i. *Non- or slightly invasive species.* These include species such as lime, sweet chestnut and certain conifers such as larch and Norway spruce, which were often planted during the 18th and 19th centuries. In general, these species regenerate only sporadically or not at all, and cannot be considered a threat to the native woodland. Some may actually be of conservation value, for example, if they contain rot holes or act as nesting sites for certain birds. These trees can be left if present sporadically throughout the woodland. However, where they are under-planted densely in semi-natural woods, thereby inhibiting the regeneration of native flora, partial removal, at least is desirable.

ii. *Highly invasive species.* These include trees such as beech (*Fagus sylvatica*), sycamore (*Acer pseudoplatanus*) and certain conifers, e.g. western hemlock (*Tsuga heterophylla*), and shrubs such as cherry laurel and rhododendron. Both

beech and sycamore cast heavy shade that suppresses the herb layer and prevents the regeneration of native trees and shrubs. They can be very invasive in some localities, beech more especially on more fertile soils (and locally on moderately acidic soils), and sycamore can be particularly aggressive on moist, fertile sites. Both species should be controlled and in general, the mother trees should be removed. An exception should be made for very large, old trees that may have a value for invertebrates, birds, fungi, etc., or which have a particular landscape or cultural value. These should be left until they die naturally, although any regeneration should be controlled. Laurel is a problem principally on fertile sites. Although it forms dense thickets, it generally regenerates vegetatively and can be relatively easily controlled by cutting and by treating the stumps or regrowth with herbicides. Amongst the numerous species of rhododendron present in Ireland, *Rhododendron ponticum* is an aggressively invasive species, principally on acidic soils (Cross, 1975, 1982). Details of the methodology for controlling the species are given by Barron (in press), but the basic principles are as follows.

- Prevent establishment in areas where it is currently absent.
- Contain its spread in areas where it is already present.
- Cut existing stands, apply a stump treatment of herbicide, and treat regrowth with herbicide.
- Remove seedlings on a regular basis.
- Prevent re-establishment by encouraging the rapid development of a dense ground cover, and by keeping grazing and soil disturbance to a minimum.

iii. *Recently planted conifer plantations* include those stands of conifers planted within the last 60 years, often in sites of former native or old woodland sites, some of which may be ancient, i.e. illustrated on the first edition 6" O. S. maps. The objective here is to remove the conifers and to replace them with native trees, and to encourage the development of native shrub and herb layers.

There is a temptation is to remove underplanted conifers as quickly as possible and in many instances this may be unavoidable (e.g. where gradual removal is not appropriate due to the risk of windblow of retained areas). However, experience from Britain shows that this policy is undesirable, as it results in the sudden loss of a woodland environment. The consequences may be that certain native species that have survived or recolonised the plantation will be unable to survive the sudden change in microclimate, especially increased light and lower humidity levels, and will die out. Native trees which have grown up with the conifers may also be negatively affected and often die back and/or become wind thrown. The resultant high light climate may also lead to the development of a dense and aggressive ground cover, e.g. bramble, bracken, etc., which will inhibit the regeneration of native trees and shrubs, and prevent recolonisation by slower colonisers. It is therefore preferable, where possible, to remove conifers gradually by opening up 'haloes' around old broadleaf trees, co-incident with thinning and/or removal of coupes. However, the risk of windthrow must be taken into account, by staggering the harvesting of the conifer crop over an extended period of time.

Fig. 4: Recovering ground flora in a type B1. 'Oak-ash-hazel woodland on relatively deep soils'. Emerging species four years after the removal of cherry laurel are primarily Veronica officinalis and Lysimachia nemorum. (Photo courtesy of Sasha Bosbeer).

Seed sources and provenances

1. Background

The immigration of species into Ireland following the last Ice Age is a very recent phenomenon in geological terms, i.e. less than *c.*10,000 years. Consequently, the biological diversity is relatively poor, both in terms of specific- and intra-specific variation. Our native trees and shrubs display a variety of seed dispersal mechanisms, from the very light, wind-dispersed seeds of willows (*Salix sps.*) to the large, heavy, bird and mammal-dispersed seeds of oak. Bird-dispersed species, such as rowan and holly, can be transported some way from the parent plants, albeit generally in small quantities. Oak can also be spread some distance in this way. However, it is probably only the wind dispersed willows, and perhaps locally the birches, which spread any great distance or in sufficient numbers to form new interbreeding populations over a relatively short time scale. With hazel and oak, there is the additional factor of infrequent mast years. In addition, oak also has a relatively long lead-in period to sexual maturity and the subsequent onset of flowering and fruiting, i.e. more than 40 years for copious fruiting (Jones, 1959). Further, - currently and in the past - the opportunity for successful establishment and therefore genetic mixing has been limited by agricultural practices (i.e. woodland clearance, fragmentation and isolation).

2. Woodland management and genetic integrity

For the purposes of applied management practice in semi-natural woodlands, the landmass of Ireland is currently treated as one seed zone, especially within the context of the NWS, where native material of Irish origin is prescribed (see the Native Woodland Manual (Anon., 2005) for full details on origin and provenance requirements under the scheme). There is a logic to this, given the size of the island, the limited geographical variation, the recent arrival of the biota, the relatively limited biodiversity and the widespread planting of species of unknown origin and provenance. It also reduces the practical difficulties arising from irregular masts and often limited and/or localised seed supplies of some species.

On the other hand, recent genetic studies of oak suggest that very fragmented, isolated woodlands contain inbreeding populations (Kelleher, 2002), while provenance trials show considerable variation in the form and rate of growth of all provenances assessed (Thompson & Lally, 2000). It might therefore be expected that isolated populations also possess variations in other traits, e.g. disease resistance. Similar variations may also exist within populations of other species. Management should therefore aim to maintain such populations as intact as possible. However, in the creation of new native woodlands on green field sites (i.e. Element 2 of the NWS), within the requirements of the scheme, it is desirable to use a mix of provenances at establishment, as long as they are sourced in Ireland, as set out in the Native Woodland Manual (Anon., 2005).

The periodicity and often localised nature of seed production of some species, particularly oak, is a major problem for the NWS, where new stock is required for supplementing natural regeneration in existing woodlands and for the creation of new native woodlands. This is particularly so for SACs, protected under the EU Habitats Directive, and NHAs, protected under the Wildlife Act, where it is desirable to conserve the local genetic stock.

3. Seed stands

Currently, the Forest Service (under the auspices of COFORD) is expanding the database of semi-natural woodland stands from which seed may be collected for use in the NWS. This database includes publicly- and privately-owned woodlands. NPWS of the Department of the Environment, Heritage and Local Government, is assisting this process by proposing sites for possible inclusion in the database. Relevant regulations, including the implementation of the EU Forest Reproductive Material Directive, are enforced by the Forest Service as part of the procedures and conditions of the NWS. These require traceability from seed collection to nurseries to the

planting site, using a system of seed collector and supplier registration, and the issuing of a Supplier's Document/Provenance Declaration Form, which must be produced by the applicant as a condition of grant payment. Full details are contained in the Native Woodland Manual (Anon., 2005).

4. Application of seed guidelines in woodland management
The following guidelines should be adhered to in the management of semi-natural woodlands where planting is anticipated;

- Where planting is to occur within designated SACs/NHAs, seed should be collected from local populations as far as is feasible. The collection of reproductive material from an SAC is a notifiable action under the EU Habitats Directive, and collectors should first contact the local NPWS Wildlife Ranger before commencing collection. Collectors must also be registered with the Forest Service (see the Native Woodland Manual (Anon., 2005) for details).
- Where the above is not possible, material from the nearest comparable area should be used, i.e. from trees growing on similar soil at a similar altitude. This will ensure that the genetic integrity of a site is not unduly diluted. While it is difficult to put a hard and fast boundary to 'the nearest comparable area', a radius of *c.*30 km would be reasonable. Within the context of the NWS, the source must be acceptable to both NPWS and the Forest Service.
- On green-field sites adjacent to designated areas, locally sourced material only should be used, with the proviso regarding availability of supplies as above.
- On greenfield sites which are geographically distant from designated sites, mixing of stock could be achieved by planting populations of different Irish provenances. This would help to prevent the perpetuation of inbreeding depression. Nonetheless, attention should be paid to climatic and edaphic factors, and it is still preferable that, for example, material from Donegal is not planted in Wexford, where climatic and edaphic conditions are very different.
- Adherence to the above guidelines is of particular importance for oak, and hazel.
- Seed from native species with a restricted biogeographical distribution, such as Strawberry tree (*Arbutus unedo*) and whitebeam (*Sorbus aria*) subspecies, should always be used only in their woodland of origin, to prevent inappropriate distribution countrywide. Such species may be acceptable on a case-by-case basis under the NWS, due to this factor regarding restricted range. It is also preferable that yew, which is rather sparsely distributed throughout the country, should not be moved far from their seed stands of origin.
- Where the NWS is being applied to NPWS woodlands (especially SACs and NHAs), these stands should be registered with the Forest Service if seed collections are anticipated.

Fig. 5: Deer fencing has become an integral component of native woodland management as a result of the increasing populations of sika and fallow deer in recent years. Overgrazing of woodland flora may compromise the future viability of many remaining Irish woodlands and compromise future quality wood production. (Photo courtesy of Declan Little).

*PART 3: INTEGRATING WOOD PRODUCTION AND NATURE CONSERVATION UNDER THE NATIVE WOODLAND SCHEME**

Several very useful guidelines for the production of timber from hardwood species (including most of our native species) are available for Ireland (e.g. Horgan *et. al.*, 2003; Joyce *et al.*, 1998). However, these were not developed within the context of the NWS and do not account for the ecological constrains inherent in the scheme. The silvicultural guidelines set out in Part 3 were devised within the context of the NWS, and the rationale presented in Parts 1 and 2.

Early in 2002, Woodlands of Ireland established a Silvicultural Subgroup to address this challenge and specifically, to ascertain if the inputs required to generate good quality wood in sufficient quantities was achievable and worthwhile within the context of the 'constraints' imposed by the scheme's overriding ecological objectives. It was decided to approach the issue by drawing up a management plan for each of the main 'wood-producing' native species eligible under the scheme. Management plans with accompanying operational schedules were subsequently formulated for the following species: sessile oak, pedunculate oak, ash, birch, alder and hazel. These plans were developed following the Ecological Survey/Management Plan (ES/MP) framework document set out in the Forest Service Native Woodland Manual (Anon., 2002), which all applicants under the scheme must follow. In practice, this document is completed by a NWS Participating Ecologist and a NWS Participating Forester. (Note: the framework document has been recently revised and is contained in the latest version of the Native Woodland Manual (Anon., 2005)). Site locations and owners have been omitted to respect confidentiality.

Methodology
The sites chosen in this study are typical of the sites that are encountered in the NWS, especially in relation to the ecological and wood production attributes. Wood quality is most often poor, however many owners have expressed an interest in addressing the situation through active management. In addition to the requirements of the NWS the study was carried out under forest legislation and guidelines which govern forestry activity in Ireland, e.g. the 1946 Forestry Act, the Forest Service Code of Best Forest Practice and Environmental Guidelines.

During this study, each site was surveyed by a suitably qualified forester and woodland ecologist. The ES/MP was subsequently drawn up, following the framework document and taking into account the owner's objectives after detailed consultation. As required, the plan included an ecological survey, which describes the site and its ecological attributes, outlines the principal management requirements and details the operations required to attain the short-, medium- and long-term objectives set for the woodland. Detailed costs and revenues associated with each species over the rotation or transformation period are included. An overview of the NWS ES/MP framework document used in this exercise is included in Appendix 1 in the 'General Appendices' on the accompanying CD-ROM. The classification system utilised in all of the plans and in the following text was devised by Cross (2002) as set out in the Native Woodland Manual (Anon., 2002 & 2005). Cross-reference to the native woodland classification system devised by the Heritage Council is also provided in each plan (Fossitt, 2000). The plans for the six species are available on the accompanying CD-ROM.

Financial appraisals
Numerous financial models may be applied to ascertain the costs and revenues associated with any investment. For the purposes of this exercise, the management plan was supplemented by monetary analyses projected over the financial rotation of each species using Net Discounted Revenue (NDR) models (Anon., 1971). This approach is commonly applied in the assessment of commercial forestry investments.

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The guiding principles in the financial appraisals were as follows:

- A discount rate of 5% is typically used in NDR models for forestry to reflect a minimum hurdle rate for investment in anticipation of subsequent commercial returns. In this appraisal 5% was also considered to be the minimum rate for investment. However, where the 5% discount rate did not co-incide with the internal rate of return (IRR), the discount rate closest to the IRR was calculated for each species.
- The data in these models are an approximate estimation of cost and revenue streams, and projections should not be considered as being absolutely accurate. NDR is applied on a species-specific basis. Since woodlands vary from place to place, these models are site-specific and cannot automatically be applied elsewhere.
- NDR models were applied to the rotation of the species under scrutiny. In some cases, i.e. pedunculate and sessile oak, the model was applied over a 'transformation' period as opposed to a full rotation. The transformation period refers to the time taken to convert an even-aged, uniform stand to an uneven-aged woodland diverse in both species and structure.
- In the case of ash, birch, alder, pedunculate and sessile oak, the NWS model was compared to a purely commercial financial approach where revenue from wood production is maximised. This was done to assess the effects of the ecological constraints inherent in the NWS on revenue streams derived from wood production.
- A land and residual land value was applied at the beginning and end of the rotation/transformation period, respectively. In the case of designated woodland (i.e. SACs and NHAs), the value was set at €2,500/ha, as the constraints imposed by designation reduces the sale potential. A value of €5,000/ha was applied to greenfield sites (Element 2) and to undesignated hazel woodland sites, which are not covered by the 1946 Forestry Act.
- In the operational schedule tables for each species (i.e. in the Appendices in each management plan) on the accompanying CD-ROM, which includes the NDR analyses, revenues are highlighted in red and costs in black.

Results

The following is a synopsis of each species assessment. Particular emphasis is placed on the wood production objective and hence economic criteria. However, it should be remembered that the ecological integrity of these woodlands is of primary importance (as in keeping with the overall focus of the NWS), and is also addressed in the ES/MP.

(a) Case Study 1 - Sessile oak

Description and history

The site chosen is typical of sessile oak woodlands countrywide. Ecologically it falls into the woodland classification category type A. 'Oak-birch-holly woodland', using the NWS classification system (Cross, 2002 in Anon., 2002) (which corresponds to WN1 in Fossitt (2000)). This woodland type is encountered frequently in upland areas, particularly in Co. Wicklow and in western coastal counties, and is ecologically important in a national and European context. Soils are generally of moderate to low fertility status, i.e. brown podzollic soils and podzols.

These woodlands have generally received very little management or intervention throughout the 20th century, apart from the periodic removal of the best quality wood. Remaining stands are often of coppice origin, even-aged and of poor timber quality.

The woodland assessed for this study is 16.3ha and was previously coppiced (Fig. 6). The dominant tree species is sessile oak, most of which are of coppice origin and even-aged. Downy birch is also locally common. In places, the shrub layer is completely

dominated by holly (*Ilex aquifolium*). The wood was almost certainly managed as coppice with standards for a considerable period during the past 400 years. It was subsequently abandoned probably during the late 18th/early 19th century. The wood was apparently almost completely cleared around 1930 A.D. A ring count of the stumps from recently felled oaks indicates that the current canopy cover is approximately 72 years old.

Owner's objectives and NWS Ecological Survey/Management Plan

The owner's objective is to produce some wood whilst retaining the ecological values as much as possible, particularly given that the site is a proposed NHA. During the development of the ES/MP, it was deemed appropriate by the forester and ecologist to pursue wood production objectives. The ecological survey points out that low impact silvicultural activities, such as thinning oak stems and the felling of small coupes, should not unduly compromise the integrity of the woodland and may encourage regeneration of oak and other native broadleaves. The principal ecological priorities were: (i) to control sycamore (which is spreading at the expense of native flora); (ii) to maintain the existing native woodland type; and (iii) to increase the amount of standing and fallen deadwood.

In the ES/MP, the wood is divided into five sections, three of which are managed solely for conservation. The remaining two sections, which comprise *c.*10ha, could be managed for wood production in conjunction with conservation (e.g. deer fencing the entire wood and the removal of invasive exotics) by focussing on three silvicultural treatments: (i) the removal of small coupes; (ii) singling out groups for coppice; and (iii) thinning to release the trees to be harvested subsequently. These operations would diversify the current even-aged structure. It is recommended that 80m³/ha be removed immediately as a thinning, and 40m³/ha at 5-year intervals until the stand is 130 years old. In places, the understorey of holly will be retained to prevent epicormic shoots. During this procedure, the best quality oak (350-400 stems/ha) would be retained in the long term to maximise financial returns in the future. Depending on location, the oak is currently yield class 4 to 6, with a mean diameter at breast height (DBH) of *c.*25 cm. Volume ranges between 300 and 380m³/ha, and the oak has good commercial potential in at least one third of the total woodland area.

In terms of wood quality, the site chosen is broadly representative of sessile oakwoods countrywide. Approximately 20% of the logs will provide low quality sawlog suitable for flooring and outdoor furniture, approximately 10% will make beams and gateposts, and approximately 20% will be suitable as fencing material. The remaining *c.*50% will be utilised as fuelwood.

Financial implications of alternate management options

A financial analysis of two alternative options, which took into account the work programme prescribed, and the grant aid and premiums payable under the NWS, was produced.

Option 1: To apply for grant aid under the NWS for the whole site, i.e. 16.3ha

Using a NDR rate of 5%, and excluding revenue from wood production (i.e. the only source of revenue taken into account is the NWS Native Woodland Premium), this option produced a revenue stream of €29/ha/yr. Where management included wood production and incorporated a land value at the outset, an Internal Rate of Return (IRR) of 5.5% was projected. One advantage of Option 1 is the constant stream of revenue from the Native Woodland Premium. Another major advantage is that management toward ensuring the retention and maintenance of the woodland's ecological integrity would be ensured. This included deer fencing and the control of sycamore. It also allowed for the retention of 'reserve' areas where no wood production would be pursued and where conservation objectives would dominate entirely.

Fig. 6: A view of the sessile oakwood described in Case Study 1. Note the dominance of holly in the shrub layer. (Photo courtesy of Michael Doyle).

The primary disadvantage is that, unlike Option 2 below, most of the potential revenue cannot be derived in the short to medium term. In addition, wood revenue from the most productive areas will be lower, due to ecological considerations, i.e. small coupe size and retention of standards. However, revenue from wood production is supplemented by the Native Woodland Premium, which offsets the losses due to reduced wood revenue.

Option 2: The management of the entire woodland purely for wood production and without any grant aid.

The entire woodland does not have the potential to be treated as a commercial entity as one third of the area adjacent the summit of the wood has very poor, unproductive and shallow soils (podzols). In addition, the woodland is a proposed NHA and this would almost certainly require the owner to adopt conservation management objectives, at least in a portion of the wood. There is *c.*10ha where commercial management can be expected to produce quality wood.

This option produced a revenue stream of €28.9/ha/annum using a NDR rate of 5%, with the advantage that a high proportion of revenue is realised in the short to medium term. However, an IRR of 3% was projected when an initial land value was included in the NDR model. Apart from the constraints imposed by good silvicultural practices, there were no restrictions applied to the most productive areas in the woodland.

Under Option 2, the woodland is not subjected to the structure and 'discipline' the NWS-based approach provides in terms of managing woodland in a way which best balances long-term ecology and production/revenue. There is no obligation to control deer damage or the regeneration of non-native species, both of which constitute a serious threat to ecological integrity in the medium to long term. In short, the owner is not obliged to have a long-term commitment to the maintenance of the ecological or wood quality attributes of the woodland. This option is the least favoured from the economic and ecological perspectives and is not compatible where such woodlands are designated as SACs/NHAs.

Observations from the site visit by the Silvicultural Subgroup

The key issues discussed on this site were whether or not wood production would compromise the ecological integrity, and whether or not the silvicultural systems proposed in the ES/MP would yield the desired results in due course. Dr Peterken was of the opinion that silvicultural treatment, especially thinning, would be very desirable. He observed that the woodland is a dense, closed stand of sessile oak which was formerly treated as coppice, with an underwood of dense holly. In some areas, the oak almost represented a monoculture, while in other areas, there is a substantial birch component. On balance, the advantage for conservation appears to lie clearly with an active approach to management. Dr Peterken's view was to proceed with thinning as soon as possible, in order to transform the woodland into a more uneven-aged, diverse ecosystem, while at the same time optimising wood production potential. The benefits of accepting a policy of managing to grow and harvest oak would be as follows:

- The stand would become more diverse, especially if the thinning were irregular. More birch would enter the woodland.
- Larger, more valuable, trees would be produced faster than through non-intervention. Large trees are currently sparse, and only a small number of older (veteran), high-pollarded oaks were observed on banks and ditches.
- The holly underwood would be disrupted, thus allowing epiphytic assemblages to develop on the lower oak trunks.
- Some regeneration would develop, particularly in small coupes (as opposed to areas where single stems are removed, where the resultant gaps may be too small to allow sufficient light to reach the woodland floor). This would help to bridge the period when the existing, even-aged stand is harvested.
- Sycamore can be controlled as part of thinning operations.

- Broader benefits to the owner and society beyond nature conservation.

Prof. Huss agreed with the approach of improving wood quality by selecting and retaining the best quality oak stems, thinning out competing stems, and by identifying groups for coppice. The opening of small coupes should be considered, particularly as a way to address the even-aged structure, although there is a danger of encouraging bramble due to increased light levels. Thinning operations would disrupt the holly underwood, but they would give the better oaks room to grow and form larger timber faster. There is some commercial risk in thinning, which will almost certainly stimulate epicormics and thereby reduce timber values. However, the quality of the present stand will never make veneer or top furniture grade, and the impact of epicormic growth is therefore less of an issue in this case.

In addition to Prof. Huss and Dr Peterken, those present from the Silvicultural Subgroup were in broad agreement with the management approach suggested in the ES/MP. There were sufficient quality oak standards to support a policy of wood production. It was also agreed that sufficient consideration had been given to the ecological attributes by setting aside reserve areas, diversifying the age and species mix, increasing the deadwood component and retaining veterans. Although thinning would impact on the holly understorey, this was not considered as a negative outcome since species diversity of the understorey may be increased by a reduction in holly, which is locally very dominant.

The group noted the modest revenue generated through entry under the NWS (i.e. the Native Woodland Premium), and that, as many similar woodlands are designated as SACs and/or NHAs, the NWS is a strongly recommended and an entirely appropriate route to take. In conclusion, the consensus was that the ES/MP proposed was appropriate, and that even more intervention might be considered to improve species and structural diversity, and to further open up the rather dense holly understorey. Hence, a stronger intervention policy through thinning should be adopted at this site, to enhance wood production and biodiversity.

Fig. 7: An area of the pedunculate oak Case Study woodland depicting the dense shrub layer dominated by hazel and the ground flora with seed heads of bluebell (Photo courtesy of Sasha Bosbeer).

(b) Case Study 2 - Pedunculate oak

Description and history

This site was selected as it represents many similar pedunculate oak woodlands that are likely to be considered for the NWS (Fig. 7). However, unlike most other pedunculate oak-dominated woodlands in Ireland, the site includes a reasonable amount of valuable standing wood, particularly within the furniture quality grade. Using the NWS classification system (Cross, 2002), the site is classified as type B1. 'Oak-ash-hazel on relatively deep soils', with some sessile oak and hybrids present (corresponds to WN2 in Fossitt, 2000). It is thought that this woodland originates from a plantation of mainly pedunculate oak created in the early 19th century. This type normally exhibits a species-rich tree, shrub and field layer, as soils are of moderate to high fertility. However, cherry laurel had become well established until it was cleared in recent times, with the result that the understorey is rather sparse. In areas where laurel had not encroached, hazel is the dominant shrub species.

The site is 15ha in area, approximately half of which is almost certainly of ancient woodland origin, as it is depicted on estate maps dated before the year 1754 A.D. The remainder of the site was former farmland planted with pedunculate oak sometime between 1754 and 1855 A.D. The woodland may have been previously treated as coppice with standards. Very little management had occurred in recent years, although thinning must have taken place in the past. Six years ago, much of the cherry laurel was cleared from the understorey with the aid of a mechanical digger. In addition, the whole site has been recently deer and rabbit fenced.

Owner's objectives and NWS Ecological Survey/Management Plan
The principal ecological concerns are the maintenance of the extant semi-natural woodland type, the presence of cherry laurel (which is extensive and spreading at the expense of native flora), the presence of beech and sycamore, and grazing pressure exerted by fallow deer.
The owner is keen to maintain the ecological attributes of the woodland, whilst at the same time, generating revenue through quality wood production. The ecologist and forester involved in drawing up the ES/MP agree that this challenge can be met using low impact, continuous cover silviculture. This may be achieved by maintaining 'refuge' or 'reserve' areas (*c*.2ha), where there is a well-developed understorey of hazel and a representative field layer. In refuge areas, no wood production is envisaged.

Elsewhere, veteran, stag-headed and pollarded oak trees will be retained (*c*.2ha). These trees, representing approximately 2ha of the site, originate pre-1820 A.D. and are perhaps 250-300 years old. Diversification of age and species through canopy opening is proposed for *c*.11ha of the site. The ES/MP recommends that most of the woodland, i.e. 11ha (except for refuge areas and veteran trees) should be transformed within a 40 year period, i.e. 3ha felled every 8 years. Felling in coupes of 0.1 to 0.25ha in size over 3ha of the woodland is proposed within the 5-year operational term of the NWS.

Hence, transformation operations, including felling, replanting and thinning, would occur over *c*.40 years, whereby approximately *c*.15% of the oak stock would be retained, distributed irregularly throughout the wood. Restocking would be by natural regeneration or by planting with local stock.

Other measures proposed include the construction of an adequate forest road for management and extraction, removal and control of cherry laurel, beech and sycamore, and the erection of deer fencing.

As this site presented the greatest difficulty in relation to agreed management recommendations and the requisite transformation timeframe, the financial appraisal was not conducted until after the visit by the Silvicultural Subgroup. This allowed for any operational changes recommended to be accounted for in the financial analyses. The financial appraisal of a commercial scenario versus the application of the NWS is presented later.

Observations from the site visit by the Silvicultural Subgroup
This site created considerable debate due to, on one hand, the pressure to realise the revenue from wood production before quality declines because of overmaturity, and, on the other, concerns that ecological attributes may be lost if felling/transformation occurs in too short a timeframe for ecological components to adjust and stabilise. In simple terms, if the woodland is transformed and rejuvenated too quickly by removing mature, even-aged coupes over a 40 year timeframe, certain species, particularly lichens, bryophytes, fungi and possibly invertebrates, may not be able to adapt to open canopy conditions. Even allowing for refuge areas, it is not known if they are large enough to support a viable population of these vulnerable flora and fauna. Furthermore, the colonisation of some species, particularly lichens, from mature woodland to newly transformed woodland areas can be very slow, and hence, such species may be lost.

Prof. Huss agreed with the silvicultural approach suggested in the ES/MP, and was confident that sufficient regeneration would be achieved by seeding and supplementary planting of local stock.

Dr Peterken was keenly aware of the potential negative impact of transforming the woodland too quickly. His views are as follows. "From the nature conservation standpoint, there should be, in principle, no difficulty with felling, extraction and rejuvenating the wood as an oak-dominated stand. However, the rate of change proposed is fast (i.e. 25-40 years) after a long period with little activity. Clearly, it would

have been better to have started 30 years earlier, in which case the whole process would have been less disruptive, and the wood would have had a succession of age classes. Starting now, the best course would be to retain, for as long as possible, mature oaks that have some further growth potential, and to retain a proportion indefinitely. The present non-intervention refuge area (and the group of veteran oaks) will provide some buffer against change, but in the long term it might be better to 'trade in' some of the timber sacrifice this represents for a greater retention of oaks within the rest of the wood, especially if the ground flora is seen to be resilient in the face of the current silvicultural operations."

On foot of this advice and due to the concerns of some of the ecologists in the Silvicultural Subgroup, the ES/MP was altered to reduce the total transformation area from 11ha over *c*.40 years to 5ha over 36 years, with coupe fellings every 15 years. In the short term, i.e. during the first 5 years, only 1ha would be transformed in coupes of 0.25ha scattered throughout the woodland. Along with non-intervention reserve areas, this would provide more time for slow colonising species to adapt to woodland transformation.

Financial implications of alternate management options.
As a result of the visit of the Silvicultural Subgroup to this site it was decided to present two alternative financial scenarios.

Option 1: The management of the entire woodland under the NWS: 5ha purely for wood production, and 10ha for conservation management.
This option focuses particularly on the maintenance of biodiversity, and only transforms one third of the woodland over a 36-year period. It envisages transforming another 5ha over a further 35-year period. However, the value of the standing crop will fall, due to overmaturity. It is envisaged that all operational costs, such as deer fencing and the removal of cherry laurel, would be covered by grant aid. An IRR of just under 5% was calculated for this option.

Option 2: Management without any grant aid: 11ha purely for wood production and 4ha for conservation management.
This option has the advantage of realising the maximum revenue from wood within a relatively short timeframe, i.e. 36 years, while maintaining a minimum area for conservation purposes as the site is a proposed NHA. The disadvantages are that the woodland transformation rate is almost certainly too fast to maintain ecological integrity, and all operations would have to be funded by wood revenue as the woodland would not be subject to grant aid. An IRR of just over 9% was calculated for this option, even allowing for the land value being accounted for (also included in Option 1).

Though it is clear that it is financially more attractive to treat this woodland purely as a commercial entity there are many compelling reasons to recommend Option 1. The site is a proposed NHA and is also a seed stand for oak in the National Register of Basic Material. In addition, although this woodland category is not an annexed habitat, it is very limited in extent in Ireland and should be regarded as being of conservation importance (Fossitt, 2000). Although realising greater revenue compared to Option 1, the ecological integrity of this woodland is not likely to be maintained using a purely commercial approach. Furthermore, the study area is unusual in that very few oak stands in Ireland have appreciable quantities of valuable standing wood. Therefore, it is probable that most pedunculate oak woodlands would realise similar revenue in the medium to long term whether they are managed under the NWS or if treated on a purely commercial basis.

(c) Case Study 3 – Ash
Description and history

Of all the native species examined, common ash, from a wood production perspective, is likely to generate the most attention in Ireland. It is much sought after for hurley and furniture production. The site chosen in this study - an ash-dominated stand of 4.2ha - is typical of woodlands on moist, fertile soils that exhibit strong natural regeneration of ash. Using the Native Woodland Classification System set out in the Native Woodland Manual (Cross, 2002), the site falls into the category B1. 'Oak-ash-hazel on relatively deep soil' (corresponding to WN2 in Fossitt (2000)).
These woodlands typically have nutrient-rich, heavy textured (loam to clay loam) soils. These are invariably brown earth to gley brown earth soils with a pH generally greater than 5.5. Although they would normally support a greater diversity of tree and shrub species naturally (particularly pedunculate oak, spindle (Euonymous europaeus) and hazel), ash is often dominant after felling during the early successional phases. Ash dominated thickets and scrub are therefore often encountered in clearfells and on greenfield sites with heavy textured, calcareous soils, e.g. drumlin soils derived from limestone till.

On the Case Study site, the field layer is characteristic of B1 woodland, even though there was a break in the canopy cover between the clearfell of the ash (and oak) canopy *c*.35 years ago, and the rapid emergence of a new ash-dominated canopy in recent times, through natural regeneration. The ground flora may have quickly recolonised from adjacent B1 woodland areas, presumably when grazing pressure was not significant.

The 4.2ha stand is part of a larger woodland estate, most of which is almost certainly of ancient woodland origin. Some of the few remaining pedunculate oak standards in the study area date back to the year 1820 A.D. Most of the oak in this area was felled in 1975 A.D, and ring counts from remaining stumps indicate that many of the oaks were over 350 years old when felled. Since then, ash has had an opportunity to regenerate profusely; in some areas, up to 22,000 stems/ha were recorded during this study.

Owner's objectives and NWS Ecological Survey/Management Plan

The owner is keen to conserve and manage the woodland on a sustainable basis with a view to producing good quality ash. Much of the woodland estate, including the study site, is designated as an SAC and NHA, and represents one of the best examples of this woodland type in Ireland from an ecological perspective. Its biodiversity value is very high, with a rich tree, shrub and field layer, and a species-rich invertebrate fauna. Of primary ecological concern is the maintenance of the existing semi-natural woodland type. The principal threats include grazing pressure (resulting in frequent interruption of regeneration with consequent poor representation of tree/shrub age classes), and the local presence of rhododendron and sycamore.

In developing the ES/MP, the ecologist and forester concluded that the overriding ecological objectives can be merged with wood production in order to achieve long term goals. Hence, the application of primarily thinning and selection over a 3.5ha area will be used to improve the quality of the ash, diversify the species composition (using locally-derived planting stock and natural regeneration) and to improve the age structure. In the remaining 0.6ha of the site, comprising mature oak-dominated canopy, silviculture focussed exclusively on conservation management will be practised, primarily to protect veteran oak trees, remove invasive non-native trees and shrubs, and diversify species and age structure, This will create opportunities over time for flora and fauna to colonise the larger, 'wood production' area from the smaller, conservation 'refuge' area.

From a productive perspective, the stand has developed beyond the optimum time for silvicultural intervention. In effect, thinning should have been carried out by now over most of the site. One section of the site was thinned approximately 10 years ago and

even here, urgent attention through intervention is required to ensure optimum quality, final crop trees. Most of the ash in the study area is etiolated in nature, with thin, drawn stems and small crowns. It is proposed to immediately reduce the stocking rate from 22,000 stems/ha to 1,000 stems/ha (*c*.3 m spacing), to allow adequate crown development (Fig. 8). A subsequent thinning to leave 400 trees/ha would follow after 5 years. Exotics will also be removed, while native species encountered during thinning operations will be retained. Deer culling will also be carried out to significantly reduce further damage to stems, via stripping, and to facilitate natural regeneration in poorly stocked areas.

Fig. 8: A view of the ash stand described in Case Study 3. Note the overstocking and poor form of some of the ash.

Financial implications of alternate management options

In the financial appraisal, two options were examined. It is important to note that the ash is 22 years of age and that this is the start year in the analysis.

Option 1: To apply for grant-aid under the NWS for the whole site and to apply appropriate silviculture to realise wood production on 3.6 ha of the site.

This option has the advantages of addressing the maintenance and enhancement of the existing woodland type while also combating the principal threats of overgrazing and invasive species. It involves the setting aside of *c*.0.6ha for conservation only, leaving *c*.3.6ha for wood production. Coupled with retaining edge trees around felling coupes of *c*.0.33ha, the overall loss of yield/ha is estimated at 35%. This option also uses a staggered rotation silvicultural system to produce 180 final crop trees/ha. Specifically, an uneven aged group shelterwood system is employed, where a 3-phase felling programme is practised at years 50, 60 and 70.

Other advantages of this option include the creation of age and species diversity, the establishment of refuge areas, and eligibility for the NWS Native Woodland Premium of €120/ha/yr. This option supports the creation of coupe based, uneven aged systems of management which satisfy both conservation and production objectives.

The disadvantages are that the management system applied is more complex than that in Option 2, and that, due to the need to enhance structural diversity, a portion of wood is harvested before (at year 50) and after (at year 70) the optimum time from a productive perspective, with a knock-on impact of revenue. Although there may be

a temptation to fell more of the woodland area prematurely in order to realise revenue, this approach should not be advocated generally, but only in combination with staggered felling elsewhere. Nonetheless, it is interesting to note that the IRR is similar to Option 2, at just under 9%. The reasons for this seem appear to be due to (i) the payment of the Native Woodland Premium, and (ii) the limited premature felling set out under Option 1.

Option 2: The management of the entire site (4.2ha) purely for wood production

Using this approach, it is envisaged that ash is produced over a 60-year rotation using a straightforward thinning and clearfell programme. It is envisaged that grant aid would be provided under the Woodland Improvement Scheme (WIS), and that the stand would be subjected to a total of six thinning cycles. The advantages include the lack of any additional ecological constraints in maximising revenue from wood, beyond standard constraints set out in the Forest Service Environmental Guidelines, Felling Licence, etc.

The disadvantages of Option 2 are that: (i) the maintenance and enhancement of the inherent woodland type is not addressed; (ii) clearfell will lead to the creation of conditions conducive to briar colonisation; and (iii) the non-eligibility of the woodland for premium payments, as the Native Woodland Premium is not available under the WIS. The IRR calculated for this option is just over 9%.

Observations from the site visit by the Silvicultural Subgroup

The management system advocated for this site created considerable debate. All agreed that the management approach adopted under Option 1 maintained and probably enhanced the biodiversity of the site. Prof. Huss agreed that the silvicultural approach proposed to realise wood production in combination with conservation was appropriate, but also suggested an alternative to coupes. He suggested that continuous cover should be adopted by selecting single plus trees and final crop trees, which are then released by repeatedly thinning out competing stems. This approach would reduce operational costs (though overheads costs in terms of consultancy costs would be higher), while also staggering the age structure of the stand. It would also reduce operational impacts, especially the incidence of light to the forest floor and the desiccation of the existing moss community that might otherwise result from the opening up of the canopy during the creation of coupes.

Dr Peterken suggested that the precise thinning regime is not a major issue for nature conservation, though heavy thinning would almost certainly result in bramble thicket. Instead, the eventual treatment of the ash at the harvesting stage, and the fate of the existing mature oaks, were deemed to be of paramount importance. Old oaks (and other mature natives such as ash) should be retained and there should be no crown competition from younger trees. Furthermore, successors should be in place to replace veterans as and when they die. He agreed that it was important to retain some mature ash at harvest, and to allow other natives, particularly oak, the space to develop in the subsequent rotation. Trees damaged by grey squirrels (which were a serious pest on this site up until recently) may be treated as pollards. Eventually, it should be possible to treat the area as a 60 year rotation, with an ash-dominated stand within which there is a permanent shelterwood of retained oak, mature ash and veteran trees. Subsequently, there would be no 'non-intervention' or 'refuge areas', but rather mature habitats scattered irregularly throughout the area. He also noted that ash may not regenerate as profusely next time around but an array of native shrubs and bramble may colonise, which may be desirable in terms of biodiversity but would be silviculturally challenging. In light of this, the suggestion of Prof. Huss to select single stems throughout the crop might offset future ash and bramble regeneration problems. If this system is adopted, it would be important to retain all other native tree and shrub species that become established, particularly hawthorn (*Crataegus monogyna*), spindle and hazel.

As with the sessile oak woodland, the group noted the similarity in revenue generated from both options outlined and, as many similar woodlands are designated as SACs and/or NHAs, the NWS is strongly recommended and entirely appropriate. Even on non-designated ash woodland sites, the NWS is an attractive option, particularly where there is sensitivity regarding the felling of mature trees, since permanent shelterwood/continuous cover can be used instead of clearfelling entire stands. However, sites where there is a high risk of windthrow may not be suitable for shelterwood or group felling.

(d) Case Study 4 – Birch

Description and history

In recent years, birch has attracted attention due to demand for furniture and other products, and also due to its fast-growing characteristics. It is, however, difficult to locate Irish provenances that demonstrate good form, and fluting coupled with crooked stem form is very common. Research to select and propagate good Irish provenances of birch with respect to wood quality has been underway for some time (O'Dowd, 1998; Anon., 2003). In the meantime, it is likely that many birch-dominated woodlands – particularly downy birch - will become the focus for the NWS as it is common on Midland cutaway bogs and on old woodland sites that were planted with Douglas fir and Norway spruce.

The Study Site chosen is dominated by downy birch, with abundant silver birch showing reasonable wood production potential. The birch stand is 3ha in area and is situated within an old woodland site (i.e. woodland present since at least 1840 A.D. and almost certainly much earlier) of 30.5ha in area. Oak was felled from the woodland in 1960 A.D. and replaced with a conifer plantation four years later, which subsequently failed and was clearfelled in 1986 A.D. Oak and ash were subsequently planted but were largely suppressed by regenerating birch. There is a significant area of mature oak and beech (old woodland) in the surrounding woodlands, and the birch stand should be viewed as a subset of this woodland as a whole. Unusually, the birch has good form and vigour, with little evidence of fluting (Fig. 9). This may be exceptional in the context of birch woodlands generally where quality is typically poor.

As birch is generally a pioneer species, the most appropriate native woodland category this site belongs to is type A. 'Oak-birch-holly woodland', subtype A3. 'Oak woodland with hazel and ash' (Cross, 2002); this category equates approximately to WN1 or WN2 (Fossitt, 2000). Of the three units examined on this site, two are presently defined as 'Birch scrub'. Soils are of moderate fertility and acidity, loamy in texture and moist, i.e. gley brown earth. The principal threat to the woodland is the presence of exotics, particularly sycamore.

Fig. 9: A view of the birch-dominated woodland described in Case Study 4. (Photo courtesy of Michael Doyle).

Owner's objectives and NWS Ecological Survey/Management Plan
The owner would like to manage this stand in an ecologically sensitive manner, particularly as it forms part of a larger semi-natural woodland, most of which is being managed with conservation as the primary objective. The owner would also like to integrate a wood production objective, where possible. The forester and ecologist were of the opinion that ecological and wood production objectives will be met through silvicultural management, primarily selection of the best quality stems and re-spacing/thinning. In order to increase the species and structural diversity, other native species present, particularly willow, alder, oak, hazel and ash, will be retained into the next rotation. Refuge areas totalling one third of the area (i.e. 1ha), in which no silviculture will be practised, will be set aside. Some mature birch will also be left at the end of the rotation, to ensure continuous cover and the diversification of the age structure.

The silvicultural programme is designed to manage the birch on a 37 year rotation. Five hundred 'plus' trees (i.e. of the highest quality with respect to form and adequate crown development) will be selected, and will be the focus of thinning (every 5 years) and pruning with a view to ensuring that the quality of the final crop will be as high as possible. The main value product sought will be birch sawlog. The stand will be allowed to regenerate, with the likelihood that birch will again dominate. There is currently a scattering of young, mostly healthy, vigorous oaks, which are competing well with the birch. The young oaks will be retained, so that the next generation will emerge into a shelterwood of young oaks and seed-tree birch.

Financial implications of alternate management options
Two financial scenarios were compared, i.e. (i) managing the woodland under the NWS, and (ii) managing the birch without grant-aid on a purely commercial basis.

Option 1: To apply for grant aid and manage the site under the NWS
The financial implications of the proposed management prescriptions contrast strongly. There is not a major difference between Option 1 and Option 2 in terms of the management approach. However, under Option 1, one third of the area will be managed solely for conservation (refuge areas). Also, the retention of 100 stems/ha of birch, and the retention of any other native species that regenerate during the rotation, will also be observed. At 2003 values, total revenue at the end of the rotation derived solely from wood production was calculated at €8,130/ha. This assumes a final crop stocking of 300 stems, with a clean bole of 4.5 m and a DBH of 34 cm. The added revenue generated by drawing down grant aid and premiums under the NWS yielded an IRR of just over 9%. The NWS grant aid and premiums more than offset the losses due to the reduced production area.

Option 2: To manage the site on a purely commercial basis without grant-aid
A similar silvicultural approach is adopted under Option 2, i.e. selection and re-spacing. Revenue generated from wood production is similar to Option 1, due to the presence of unproductive, waterlogged areas. Without any grant aid, an IRR of less than 5% was calculated. Therefore, there is no advantage in applying a purely commercial approach.

Observations from the site visit by the Silvicultural Subgroup
The main issue discussed at this site was whether it was ecologically appropriate to perpetually maintain the woodland as a birch-dominated ecosystem, i.e. pioneer phase, or to encourage the development of a more advanced successionary phase of woodland development, i.e. oak-birch-holly woodland. Even though other native species in the stand will be retained into the next rotation, with the likelihood that their numbers will increase over time, birch will nonetheless be the primary focus in relation to wood production in future rotations. The consensus was that this was entirely appropriate, especially given the context and stand location, i.e. a small birch stand within a large woodland area dominated mainly by mature oak-birch-holly woodland. Dr Peterken stated that the proposed management approach was entirely

acceptable in nature conservation terms, and noted that the main requirements should be the retention of the few veteran oaks and the development of successors. He also recommended that it was equally important to retain the open areas (i.e. rides and glades) as open habitats, as these will greatly diversify the woodland as a whole.

As the birch stand is part of a much larger woodland area, this factor also led both Prof. Huss and Dr Peterken to conclude that there was less of a need to set aside one third of the site as refuge, non-intervention area. There is ample opportunity for native flora and fauna to migrate into the birch, and hence, the wood production element could be pursued to an even greater extent. Some of the refuge area is retained scrub comprising a mixture of hazel, willow and birch on wet soils. Some revenue from wood would be generated with minimal effort by freeing the crowns of the best of the birch, along with the occasional ash present. In Dr Peterken's view, it would be more valuable to treat this scrub as coppice-with-birch standards, thereby introducing a distinct structure into the mosaic, although light thinning would also be acceptable.

Thinning was not seen as a negative operation, given that self-thinning will naturally occur over time. In addition, the continuous cover objective was seen as conducive to biodiversity enhancement, as was the staggering of age classes by retaining mature birch and oak into subsequent rotations.

(e) Case Study 5 – Alder
Description and history

Alder is a tree that has received very little attention from a silvicultural perspective in both Ireland and Britain. It is interesting to note that alder is not even considered on its own merits as a timber producing tree in the Forest Management Tables (Anon., 1971). Nevertheless, alder historically was highly valued for its wood, due to its durable and aesthetic properties. It was for these very reasons that the tree was commonly referred to in the past as 'Irish mahogany'. Today, alder wood is now much sought after, particularly for fitted kitchens and other furniture. Given optimum site conditions (wet to periodically saturated, heavy textured and fertile soils), alder demonstrates exceptional growth rates, especially during the early years. Little is known regarding the appropriate silvicultural management of alder. However, it almost certainly has considerable potential in Irish forestry, not only due to its very fast growth rates, but also due to the fact that the tree is particularly suited to difficult, heavy textured soils which are susceptible to windthrow for most other tree species. It also appears to have low susceptibility to grazing pressure and, compared to other broadleaf species, is not as vulnerable to browsing by grey squirrels.

The site chosen for assessing alder is typical of the site type that will be eligible for the NWS, particularly under Element 2: Native Woodland Establishment (on greenfield sites). Although the alder plantation studied was planted in 1991 A.D. and was 12 years old when assessed, it technically falls under Element 1 of the NWS, i.e. Native Woodland Conservation. However, it is treated as an NWS Element 2 site for the purposes of this exercise. It represents one of the greenfield site types that are likely to be frequently encountered in NWS Element 2 applications, i.e. fertile, wet, heavy textured, clay loam soils, especially in drumlin belts.

Ecologically, the site is a modification of woodland Type E3. 'Ash-alder-remote sedge woodland' (Cross, 2002) (equivalent to WN6 – wet willow-alder-ash woodland (Fossitt, 2000)) on typically wet drumlin mineral soils. This is due to the woodland's status as an almost pure and structurally uniform alder plantation, situated on what was originally a rush-dominated greenfield site. Since this is the first rotation comprising one dominant even-aged native tree species, the biodiversity value is currently moderate to low. However, there is a considerable potential to enhance biodiversity, due to the retention of very old (possibly ancient) hedgerows and ditches. The hedgerows – which were retained to provide shelter - are made up almost

entirely of native tree, shrub and ground flora species, including ash, hazel, holly, hawthorn, blackthorn (*Prunus spinosa*) and willow. Biodiversity enhancement can be achieved by re-connecting the hedgerows and ditches to a more natural representation of E3 woodland that fringes a lake adjacent to the site. In time, this would allow the migration of flora and fauna throughout the site (Fig. 10).

Fig. 10: A view of the young alder plantation located on a drumlin in Co. Roscommon. (Photo courtesy of Michael Doyle).

The only notable threat to this site is the presence of sycamore planted adjacent to the site, which will almost certainly naturally regenerate in time and compete with the alder. It should be removed before it has the capacity to produce seed. Beech was interplanted with the alder but has subsequently failed and will be removed.

Silviculturally, the site was divided into two plots, both of which were well stocked; Plot 1 was planted at a lower stocking rate (c.5,000 stems/ha) than the Plot 2 (c.5,500 stems/ha). Both plots require urgent thinning to maintain quality, which is very good, especially in Plot 1. The yield class was calculated at 16 and 12 for Plots 1 and 2 respectively, demonstrating exceptionally fast growth rates.

Owner's objectives and NWS Ecological Survey/Management Plan
The owner originally established this site for purely commercial reasons, but is now interested to explore how biodiversity enhancement and wood production objectives can be met. Using the NWS format, the forester and ecologist devised a silvicultural treatment that addresses biodiversity enhancement as well as optimising the wood production potential of the alder. This involves selection, thinning and pruning to produce a final crop of 250 alder stems/ha with a DBH greater than 32 cm, 180 of which will be harvested. In order to retain continuous cover and to provide for the subsequent rotation, 600 alder stems will be coppiced during the final two thinnings. To facilitate diversification of the age structure, a further 70 mature alder standards will be retained into the next rotation. All other native species that naturally colonise or that are already present in the current rotation will be retained and given sufficient space to develop, especially willow and ash. Planting will be carried out at the onset of the next rotation. This will comprise 500 ash, 300 willow and 300 aspen/ha. A buffer strip of 5m will be left on either side of the hedgerows, which will also provide shelter for subsequent rotations. As the woodland matures, it is expected that typical woodland ground flora species will colonise the site, thereby benefiting biodiversity in future rotations.

For comparative purposes, a mature alder site was visited in the same region to ascertain how similar greenfield sites treated as described might develop in future. Although the time of year was not conducive to undertaking a complete botanical survey, the mature alder site visited had a considerable assemblage of vascular plants, lichens, mosses and fungi. Spindle was particularly prevalent in the shrub layer, while ash was an important constituent of the canopy. The DBH and wood volumes data gathered in the mature stand confirmed the projected values for the immature plantation in the study site, and are therefore considered realistic in terms of potential revenue from alder stands managed to produce quality wood.

Financial implications of alternate management options
Although the Silvicultural Subgroup did not visit the site, their views on the management and financial implications of the following options were sought. It was concluded that there is no reason why the NWS should not be pursued in an attempt to realise quality wood while maintaining and enhancing biodiversity.

Option 1: To apply for grant-aid and manage the site under the NWS
The financial analysis using an NDR model was projected over a 40-year rotation on 1.3ha. As the biodiversity objectives were not considered to confer significant constraints on the wood production objectives (as both are very compatible in this case), the main difference between applying a purely commercial approach versus management under the NWS was the capital grant and premiums that are available under the NWS. In other words, a purely commercial approach would yield the same revenue from wood production minus the NWS grant and premiums. The results demonstrated that the added revenue generated from the combination of the Afforestation Premium and subsequent Native Woodland Premium, as available under Element 2 of the NWS (i.e. €442/ha/yr for 20 years, and €120/ha/yr thereafter) added to the appreciable returns from wood production that can be derived from appropriately managed native alder on suitable sites. Even allowing for a land value of €5,000/ha at the outset, an IRR return of just under 9% was calculated, and this was ascribed not only to the premiums payable, but also to low initial establishment and subsequent maintenance costs.

In relation to lower establishment costs, mounding is deemed not only unnecessary (due to the rapid growth rates of alder in the early years and its ability to thrive in very wet soils), but almost certainly counterproductive, as it appears – from observation of the Case Study site - to cause root ball destabilisation and subsequent heave on very heavy textured, wet soils. Vegetation control is only necessary in the initial 4 years, and since alder appears to be less palatable to grazing animals, 'filling in' may also be less likely than for other broadleaf species. Assuming that projected wood volumes are achieved, it would therefore seem that a relatively attractive financial return can be achieved with alder within the context of the NWS.

Option 2: To manage the site solely for wood production under the Broadleaf Afforestation Scheme
The silvicultural management of the site under the general Broadleaf Afforestation Scheme would be almost identical as that under the NWS. It is envisaged that similar volumes of wood would be realised in the first rotation, but somewhat more in subsequent rotations, due to the increased species diversification under Option 1. However, it is financially more attractive to apply for the NWS grant than to enter the general Broadleaf Afforestation Scheme, due to the availability of the Native Woodland Premium amounting to €120/ha/yr, which becomes available under Element 2 after the Afforestation Premium payments cease (after 15 or 20 years, depending on applicant status). This Native Woodland Premium is unique to the NWS, and is not available under the general Afforestation Scheme.

(f) Case Study 6 – Hazel

Description and history

In Ireland, hazel was managed for centuries, primarily as coppice underwood. Though management of hazel declined substantially in recent centuries, it is often an important component of close-to-nature silvicultural systems in Europe today, particularly where continuous cover is being practised. In addition, there is currently considerable interest in the management of hazel and the development of downstream products in Ireland, generated mainly by the activities of Muintir na Coille. For these reasons, hazel is included in this study. Furthermore, although not considered to be a 'timber' tree in the conventional sense, hazel is probably the most important species in relation to the coppice sector and is utilised in a wide range of products, including hurdles, wattle panels, rustic furniture, thatching scallops, roof lats, yurt frames, bean poles, currach frames, stakes, binders, charcoal and woodturned products.

The Study Site chosen is typical of hazel-dominated woodlands found elsewhere in Ireland, i.e. on shallow, free-draining, base-rich soils over limestone. Under the Native Woodland Classification System set out in the Native Woodland Manual, it falls into the category type B. 'Pedunculate oak-ash woodland with hazel, subtype B2. 'Pedunculate oak-ash-hazel woodland on shallow, often rocky, soils over limestone' (Cross, 2002). (This class equates to 'Oak-ash-hazel woodland (WN2) (Fossitt, 2000)). It is envisaged that there will be a considerable number of applications in the future under Element 1 of the NWS involving this woodland type, particularly if marginal land is left unutilised as a result of current policy changes towards reducing agricultural production.

The area of the site is *c.*7ha in total, 0.5ha of which is dense hazel woodland (Fig. 11). For the purposes of this exercise, only the dense hazel woodland area is considered for wood production. The woodland, approximately 50 years old, is secondary in nature, having originated through colonisation from adjacent semi-natural woodland. It lies adjacent to a river and incorporates a riparian zone. In the existing woodland, it is evident that trees and shrubs have been cut from time to time and that the quality of the hazel is poor due to a lack of continual management. In addition to hazel, it also contains blackthorn, hawthorn, willow, birch and an occasional spindle, and has an impressive ground flora community.

Owner's objectives and NWS Ecological Survey/Management Plan

The owners are very aware of the ecological/biodiversity and aesthetic value of the woodland. Their primary objective therefore would be to bring about the sustainable management of all woodland areas, to ensure that these are maintained in an ecologically balanced condition in perpetuity. They would wish to see an appropriate level of wood production integrated within the overall conservation management objective, and would also like to establish the woodland as an education resource for woodland ecology and craft use.

Fig. 11: The hazel-dominated Case Study being restored to a working coppice. (Photo courtesy of Joe Gowran).

The objective is to expand the hazelwood by incorporating and upgrading an adjacent *c.*2ha area of predominantly scrub woodland, under Element 1. A further 3.3ha of new native woodland, dominated by hazel, is being created adjacent to the existing woodland, under Element 2, i.e. Native Woodland Establishment. The remainder of the area will be retained as refuge woodland and open space, including a protective woodland buffer adjacent to the riparian corridor.

The main silvicultural objective would be to develop three initial coppice harvesting coupes of 0.15ha each within the existing woodland. Later, these will be increased to seven coupes of 0.5ha each within ten years, once the adjacent greenfield site is established with hazel woodland.

Natural regeneration of oak, ash, birch, hazel, willow, blackthorn, hawthorn, holly and spindle is currently present in the woodland and scrub areas and will be retained. This will create a more species diverse, uneven aged structure, compatible with ecological

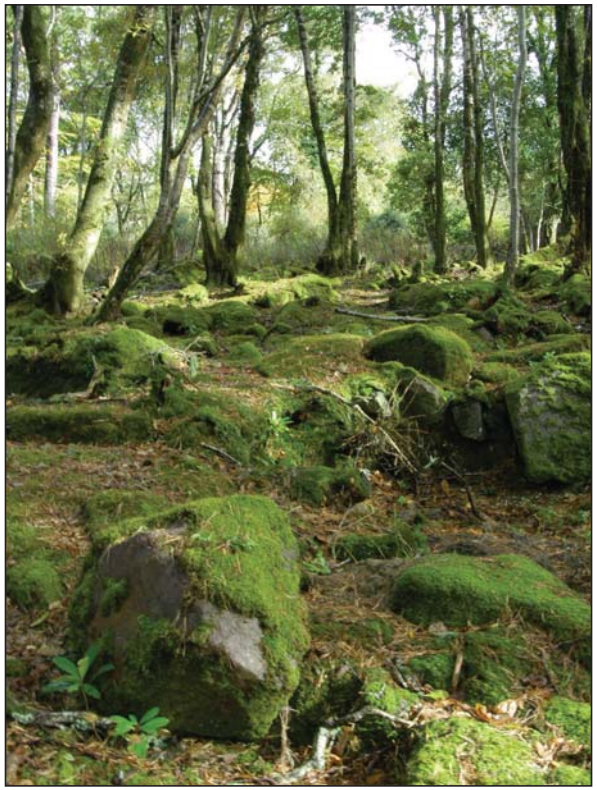
objectives (Peterken, 1993). Developing a systematic coppice regime allows for variation in light intensity on a cyclical basis, which creates a shifting pattern of habitat niches conducive to maintaining and enhancing species diversity. Access to coupes for subsequent harvesting is critical. Harvested coupes and access routes will also act as open/glade habitat.

An equivalent stocking rate of at least 1100 stools/ha is required, to reflect the optimum stocking rate of 1200 to 1500 stools/ha for commercial coppice stands (Anon., 1956). Currently, the existing wood has the equivalent stocking rate of 2,000 stools/ha. A restoration cut is required to realise quality hazel stems, and this entails the cutting back of the existing hazel trees to the stump. Re-growth will subsequently produce 10–20 good quality stems per stool.

Financial implications of alternate management options

As hazel has never been established and/or managed in a commercial forestry context in Ireland during the 20th century, and as it is ineligible for grant aid under other Forest Service schemes, the financial analysis was assessed only in the context of the NWS. Although the site was not visited by the Silvicultural Subgroup, the group saw no reason to modify the ES/MP presented.

The financial appraisal on hazel covered a 52 year period, which included a restoration cut followed by seven harvesting cuts using a coupe system on a 7-year cycle. Though other species such as ash may be retained and harvested later, only hazel was accounted for in terms of revenue. The NWS grant covered all management planning, operational and labour costs (including the restoration cut at €2500/ha) and the NWS Native Woodland Premium of €120/ha/yr was inputted from year 1. A firewood value of €20/m^3 is given for the bulk of the initial harvested material arising from the restoration cut. At 2003 A.D. values, the standing crop of hazel at the end of a seven year cycle as a result of coppice management was valued at €650/ha, which is somewhat lower than what is obtained currently in the UK, i.e. *c.*€800/ha. A land value of €5,000/ha was also included in the NDR analysis. The IRR worked out at just under 4% within the context of the NWS, which is considered less than a modest return for this labour intensive silvicultural system. However, without the NWS grant and associated premium, the projected returns are very poor, with an IIR at under 2%.



*PART 4: GENERAL DISCUSSION AND CONCLUSIONS**

Pretext
Guidelines and recommendations set out in this report are based on the study and reflect the views of the authors, and do not automatically reflect the official policy of the Forest Service and the National Parks & Wildlife Service. All projects under the NWS must adhere to the conditions and standards set out in the Forest Service Native Woodland Manual. Alternative approaches will be considered on a case-by-case basis under the scheme, but must be fully detailed in the Ecological Survey/Management Plan for assessment by the Forest Service.

Managing for conservation and wood production
Since the introduction of the NWS, many woodland owners and practitioners involved in its implementation have asked whether quality wood production can be achieved while also observing the overriding objective of nature conservation. Management under the NWS may encompasses conservation and wood production, where appropriate. These Case Studies clearly demonstrate how these objectives can both be met in tandem, and outline the financial implications of alternative options. In most situations, the general consensus of those involved in this exercise, i.e. foresters and ecologists, is that biodiversity is not compromised by the pursuit, using appropriate means, of wood production. This entails detailed silvicultural prescription designed on a site by site evaluation, taking into account the inherent biodiversity values. In many situations, nature conservation values may even be enhanced by opening up even-aged canopies, rejuvenating previously coppiced woodlands, and diversifying species and structural diversity, all of which may be implemented primarily for productive purposes. The only major concern regarding future ecological integrity arose in situations involving old, even-aged woodlands, where proposed transformation rates may be too rapid to facilitate and maintain nature conservation values. Research based on assessing alternative production management regimes on biodiversity is required to devise appropriate management systems in these woodlands under the NWS.

Conversely, it is clear that the conservation objective constrains and limits the wood production objective in some woodland types, particularly in relation to existing old sessile and pedunculate oak-dominated woodlands entered under Element 1: Native Woodland Conservation, but this is compensated to some extent by the availability of the Native Woodland Premium. In other Element 1 woodlands, particularly those which are dominated by alder and birch, these constraints were not as apparent due to the presence of unproductive waterlogged areas, which may be set aside as refuge conservation zones.

In sites under NWS Element 2: Native Woodland Establishment, wood production and nature conservation objectives are highly complementary as these woodlands may be established using a range of native species, planted in a mosaic containing a single or up to three species at close spacings. Where more than one species is planted in a group, additional species should have similar growth rates and ecological requirements. This will ensure successful establishment and at least provide for potential quality wood production. Sufficient space between groups will add diversity and open space, thereby encouraging nature conservation values (Anon., in press). With careful design and the initial high stocking rates recommended by the Forest Service in the NWS Manual (Anon., 2005), opportunities for thinning (as opposed to self thinning) and shaping in order to produce quality wood are provided.

In newly established woodlands, it is generally not possible to establish the desired optimum floral diversity at the outset. Instead, the focus is on measures that encourage diversity as the woodland emerges, develops and matures. It is frequently recommended that edges and buffers comprise slower growing tree and shrub species

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that can self perpetuate within the woodland as and when conditions allow, i.e. as the canopy matures (Anon., in press). In isolated new native woodlands, ground flora may be introduced during the mature canopy phase. This may be achieved through direct seeding and/or by topsoil/turve translocation, the latter from a similar woodland type in the same region. (If an SAC is involved these operations are subject to a 'notifiable action' under the Habitats Directive and consultation with the local NPWS Ranger is required). Hence many of the requisite conservation measures required to enhance biodiversity values can be achieved by timing them to co-incide with silvicultural operations such as planting, thinning, shaping, coppicing and selective felling.

Financial implications of the NWS

The financial appraisals carried out in this study are designed to compare alternative silvicultural scenarios inside and outside of the NWS. The implications of attempting to produce quality wood within the scheme are assessed. In some situations, i.e. birch, ash, alder and hazel, projections were made over entire rotations. In other woodlands with longer rotations, i.e. pedunculate and sessile oak, defined 'transformation' periods were chosen based on physical attributes and the silvicultural systems being applied, in order to maintain the ecological attributes inherent in these old woodlands.

Clearly, financial predictions in this study must be viewed as indicative guides only, as hardwood prices, costs and inflation values fluctuate over time depending on demand and prevailing economic conditions. Nevertheless, alternative silvicultural scenarios for each species (except hazel which was assessed only in the context of management within the NWS) are compared using identical costs and revenues, thereby allowing comparison and consequent conclusions.

When each of the species assessed is examined within the context of native woodland management and wood production under the NWS, a number of issues of particular interest become clearly apparent.

- Although the performance of Irish provenances of many native species in terms of wood production is unknown, this study suggests that there is no reason why quality hardwood can not be produced under the NWS. This can be achieved by modification of conventional silvicultural systems to include measures that will conserve and/or enhance nature conservation values.
- Existing stands of long rotation species, i.e. sessile and pedunculate oak, are less attractive to manage for wood production than shorter rotation species, particularly ash, birch and alder. However, sites that are designated as NHAs and/or SACs, which are subject to more arduous felling restrictions than would normally apply, can be managed under the NWS at no financial loss and in many cases with a modest financial reward. However, the NWS should not be seen solely as a compensation package for designated sites or for nature conservation purposes alone.
- SAC and NHA oakwoods with standing hardwood of an appreciable value will not realise their full economic potential due to restrictions imposed by nature conservation considerations. However, such sites are uncommon, as the quality of wood in most mature oakwoods nationally is generally considered to be very poor.
- The most attractive financial prospects in relation to hardwood production under the NWS are presented by the shorter rotation species, particularly alder, birch and ash, on greenfield sites that fall under Element 2 of the NWS, i.e. Native Woodland Establishment. This is due to a combination of factors, particularly the earlier realisation of revenue from wood, higher premium payments and the clear potential to produce very high quality hardwood throughout the stand by intervening from the outset through regular thinning and shaping.
- Even though up to one-third of the area is set aside for conservation management (i.e. reserve/refuge areas in SACs and NHAs), these Case Studies indicate that, within the context of the NWS, internal rates of return (IRR) of between *c*.4% and *c*.9% can be obtained in a way that is compatible with nature conservation values. These results take into account an initial land value, which reduces the final potential revenue return. These figures compare favourably with a purely commercial production approach, realising similar or higher returns.
- As 5% is the cut off discount rate commonly used in commercial forestry investment appraisals, and as all species managed under the NWS assessed in this study, except hazel, exceeded this threshold, future efforts to produce quality wood should be promoted. Existing native woodland owners and landowners with an interest in creating new native woodlands should be encouraged to maintain and expand native woodlands with the assistance of the NWS. Those especially interested in generating revenue from wood production should be provided with the encouragement and technical support to do so.
- In particular, drumlin sites (heavy textured, wet, fertile soils) that are currently being afforested mainly with conifer crops have considerable potential for alder and to a lesser extent, ash, under Element 2 of the NWS, particularly in light of the higher Afforestation Premium available for broadleaves and the continuous Native Woodland Premium, which commences after the Afforestation Premium ceases (i.e. year 16 or 21, depending on applicant status).

Fig. 12: Long established oak woodlands require longer periods of silvicultural transformation compared to 'successional' woodlands. This is to facilitate the colonisation of floral species (and possibly fauna, i.e. invertebrates), especially mosses, lichens, ferns and liverworts. Some of these woodland flora live in the woodland canopy, are slow colonisers and require low light levels and high humidity in order to survive. Rapid transformation of old, even-aged oak woodlands may result in desiccation and high incident light levels. Slow colonising species may not be able to adapt to rapid woodland transformation. (Photo courtesy of Sasha Bosbeer).

General silvicultural guidelines

A number of general guidelines apply to all native woodlands managed under the NWS.

1. In the creation of new, or the ecological enhancement of existing, native woodlands, consideration must be given to the ecological requirements of the site. Factors such as climate, soils and altitude will point to the particular native woodland type or types (communities) to be promoted, and will indicate which native trees and shrubs are most appropriate.
2. NHA and SAC designated woodlands may be managed for wood production, subject to approval by the NPWS. The Forest Service refers proposed NWS projects involving SACs and NHAs to NPWS prior to the granting, or otherwise, of approval. It should be generally recognised that the conservation objectives must always receive priority in designated sites.
3. In all other sites, the conservation objective is also paramount and should not be compromised by any wood production proposed. To this end, the issuing of future felling licences for NWS woodlands will be largely limited to the use of continuous cover systems where small groups (between 0.15ha and 0.5ha, depending on species) or single stems are removed at intervals.
4. The retention of biodiversity and other sites features may, in many situations, result in up to one-third of woodland area being effectively managed solely for nature conservation management. Such features include reserve areas, buffers adjacent streams and other water features, glades, veteran trees, rock outcrops, hedgerows, standing and lying deadwood, breeding sites (e.g. heronries, badger setts, etc.), archaeological/cultural features, etc.
5. Woodlands dominated by stands of even-aged trees, with limited species representation in both the canopy and shrub layer, should be transformed gradually over an extended period of time to more diverse, uneven-aged woodland. The incorporation of a wood production objective is not difficult in such circumstances, although a portion of the standing crop will have to be retained well beyond its maximum mean annual increment, in order to meet conservation objectives.
6. Veteran trees and standing deadwood should be retained at all times, unless they constitute a threat to safety, i.e. along public pathways, roads, etc.

Guidelines for individual species

It is difficult to extrapolate the results of the species assessed in this study to similar sites elsewhere, as site-specific factors will greatly influence the outcome even where similar silvicultural treatments are applied. However, a number of general guidelines and critical success factors for each species do apply, and these are outlined below. The adoption of these guidelines should be seen in the context of site-specific circumstances.

1. Sessile oak

Even-aged, mature sessile oak-dominated woodlands, such as that described in the Case Study, may be managed under the NWS with wood production as an objective alongside conservation. In such cases, the transformation of stands to uneven-aged and species diverse woodland can be achieved by adopting either or a combination of group selection and irregular shelterwood, both of which are continuous cover silvicultural systems. It should be noted that single stem selection is unlikely to succeed with slow growing, light demanding species such as oak. Areas of highest biodiversity, accounting for at least one-third of the site, should be managed as conservation refuge zones. This will almost certainly result in the retention of good quality mature trees beyond their optimum value (i.e. maximum mean annual increment), which contrasts sharply with a purely commercial approach. The adoption of this silvicultural approach allows for considerable flexibility in maintaining biodiversity while also pursuing the objective of producing modest volumes of high quality hardwood.

In terms of the optimum physical structure, the woodland should have a dominant oak overstorey and a vigorous mixed middle or understorey, comprising holly, birch and/or hazel, to prevent side branching on the oak stems. Coupes should not exceed 0.25ha in area, and protection from prevailing winds should be given by orienting harvesting in an east-west direction, if possible. Due to the irregularity of mast years for oak in Ireland, supplementary planting of oak in felled coupes will almost certainly be required. In SAC and NHA woodlands, planting material must originate from seed collected from within these areas, or, failing this, from a source involving a similar woodland community and acceptable to both the Forest Service and NPWS (see Native Woodland Manual (Anon., 2005) for further details). Direct sowing (dibbling) may also be appropriate and acceptable.

Whatever system or combination of systems is adopted, selection and improvement are required from an early stage. In naturally regenerated and planted coupes, formative shaping should be applied, commencing at an early stage, to lay down good initial stem development. Selective thinning should begin early in the pole stage to produce an even spread of good candidate trees. Regular thinning will be required until the oak is *c.*50 years old, thereafter less frequently. The aim is to produce 4,000 to 6,000 candidate trees (potentially of very good hardwood quality), 800 to 1,500 claimants (potential elites), and 200 to 500 elite trees (remaining trees of the highest wood quality from which the final crop will be harvested) per hectare.

In unmanaged oakwoods, coppice-with-standards may also be a suitable silvicultural system to adopt, particularly where there is evidence that this was practised in the past. The dominant understorey coppice in sessile oakwoods is birch, although alder may be suitable on wet soils and hazel in locally fertile areas. The understorey coppice may be removed on a 15 to 25 year cycle, depending on species.

In the creation of new type A. 'Oak-birch-holly woodland', consideration should be given to using Scots pine as a nurse species. Care should be taken to remove the pine before it overtops the oak. Alternatively, oak may be planted in pure blocks (6,600/ha) alternating with blocks of birch (4,000/ha), with holly and rowan planted along woodland boundaries. All proposed planting patterns must be detailed in the Ecological Survey/Management Plan.

2. Pedunculate oak

The silvicultural approach recommended for sessile oak also largely applies to pedunculate oak. However, as the intention is to promote the native woodland type B. 'Pedunculate oak-ash woodland with hazel', the understorey species will differ, comprising predominantly of ash and hazel. Care should be taken not to allow ash to overtop the oak once canopy closes. Other species that should be encouraged include blackthorn, hawthorn, spindle and guelder rose, particularly at woodland edges and along rides.

In the creation of new pedunculate oak-dominated woodlands of types B and C, pure oak blocks (6,600/ha) may be planted in a mosaic with either pure or mixed blocks of ash or alder (4,000/ha), with trees and shrubs such as hazel, spindle, blackthorn, hawthorn, willow and guelder rose positioned along edges and boundaries.

3. Ash

When managing ash-dominated woodlands under the NWS, consideration should be given to the ecological context, particularly in relation to woodland type. Ash-dominated woodland is usually the result of past management and as such, requires diversification over time from an ecological perspective. Almost pure ash woodlands are seen as a phase of woodland development or succession, and are often succeeded by a pedunculate oak canopy giving rise to either type B 'Pedunculate oak-ash woodland with hazel' or type C 'Mixed alder-oak-ash woodland with willow'. A decision on how long the transformation period should take when converting pure ash to type B or C will depend on woodland size and the proximity and area of type B or C woodland in the surrounding landscape. In small isolated sites, it is almost certainly more appropriate to encourage species and structural diversity than to maintain an ash-dominated woodland. This can be achieved by ensuring that the subsequent rotation is allowed to develop into a shelterwood of retained young oaks and seed-tree ash. To do this, all naturally regenerating oak (if present) should be retained. Supplementary planting of oak will almost certainly be required.

The Case Study site assessed was a relatively small area of ash-dominated woodland surrounded by a much larger area of oak-dominated type B woodland typical of many lowland estate woodlands often characterised by fertile, heavy textured soils. In these woodlands, it is appropriate to maintain two-thirds of the site as ash dominated woodland in perpetuity. The remaining one-third should be managed solely for conservation, with an emphasis on creating more diversity by retaining oak, spindle, alder, willow, blackthorn, hawthorn and any other native trees and shrubs that may occur. If the ash is being managed for wood production, a single stem selection, group selection or an uneven aged group shelterwood system are all appropriate. Where the latter two options are adopted, circular coupes of *c.*0.3ha are appropriate.

In unmanaged pole stage sites, the stocking rate should be reduced immediately to approximately 1,000 stems/ha (3 m spacing) to allow adequate crown development. A subsequent thinning to leave 400 trees/ha should follow after 5 years. Where a group shelterwood system is employed, a 3-phase felling programme can be implemented at years 50, 60 and 70, with an optimum rotation length of 60 years. The rotation length may vary due to site conditions; rotation length may be longer or shorter and the felling programme adjusted accordingly. The staggered rotation represents one premature, one optimum and one delayed felling, and takes into account the ecological requirement to avoid clearfelling and to introduce an uneven aged, group shelterwood system. The programme should identify and secure approximately 180 elite trees/ha at harvest. When harvesting the coupes, approximately 20 trees/hectare should be retained indefinitely in order to diversify age class in the subsequent rotation and provide some shelter, seed and veteran tree habitat. The re-establishment of ash in felled coupes is normally achieved through natural regeneration.

Where ash is planted on isolated sites to create new native woodland, pure blocks of Irish provenance material should be used at a density of 3,300 plants/hectare. Adjacent blocks of pedunculate oak should be established, with hazel, spindle and guelder rose along the edges, in order to mimic type B or C woodland. If ash is being planted on greenfield sites adjacent to mature SAC woodlands, the material used should originate from seed collected from within these areas.

4. Birch

As with ash, birch-dominated woodland should be viewed as an early successional woodland phase, in this case, of woodland type A. 'Oak-birch-holly woodland' (unless the site equates with type F. 'Birch woodland', which is normally associated with bog). Therefore, maintenance of the birch-dominated woodland phase will depend on size and proximity to adjacent type A woodland. As with ash, up to one-third of the area should be managed solely for conservation and include woodland edge, refuge areas, glades, buffer zones, hedgerows, rock outcrop and waterlogged depressions. In order to diversify species, the promotion of sessile oak, holly, rowan, willow and alder should be practised.

The remaining area within which wood production is practised can be maintained through successive 40-year (approx.) rotations as birch-dominated woodland. This can be done by using either or a combination of single stem selection, group selection or an uneven aged group shelterwood system. Alternatively, the subsequent rotation could be allowed to develop into a shelterwood of retained young oaks and seed-tree birch. This may be achieved by retaining all naturally regenerating oak, if present.

Where birch is regenerating vigorously, it will be necessary to tend and thin from an early stage. Commence respacing when the emerging canopy is 7 to 10 years old, depending on productivity and vigour. Reduce the number of stems to 2,500 per hectare on first respacing, concentrating on retaining the best-formed trees. The aim is to obtain a final stand density of 400 trees/ha. These should be of the highest quality in terms of wood production, which will only be attained if thinning is applied regularly, i.e. every 4 to 5 years. In order to stagger age classes into the subsequent rotation, only 300 of these trees will be harvested. Approximately 50 trees should be coppiced 5 years before harvest, and a further 50 trees retained into the next rotation.

Where wood production is an important consideration, it is not recommended to plant birch-dominated woodlands on greenfield sites under Element 2 of the NWS. Irish birch provenances are generally poor in terms of quality wood production, and until further research identifies good provenances, birch should only be planted for nature conservation reasons. The management prescriptions provided above are only relevant where good form and vigour are apparent at an early stage of woodland development.

5. Alder

Common alder naturally occurs and is well represented in woodland types E. 'Other wetland woods', and occasionally in D. 'Willow woodland alongside river channels (gallery or riparian woodland)'. It may also be locally abundant in type C. 'Mixed alder-oak-ash woodland with willow'. It is particularly prevalent in type E woodland on permanently waterlogged soils, and is often used in the creation of riparian buffer woodlands. Where it occurs in almost pure groups within existing woodlands, there will be opportunities to produce quality wood. Equally, alder may also be considered for planting under Element 2 of the NWS. Quality wood may be obtained either through single stem or group selection, or a combination of both, on a rotation of approximately 40 years. Care must be taken not to damage soils and ground flora with machinery, and it is recommended that most of the work is carried out manually and/or with all-terrain vehicles.

In existing naturally regenerated alder-dominated woodlands, initial respacing within the first 5 years should reduce stocking to 3,300 trees/ha, followed by regular thinnings to produce approximately 250 high quality trees/ha at harvest. In order to retain continuous cover, it is recommended that coppicing commences approximately 10 years before the end of the rotation. A total of 300 trees/ha should be coppiced at both the second last and final thinning (applied at year 30 and year 35 respectively). A further 50 to 70 trees/ha should also be retained as mature specimens into the next rotation. At year 40, a further 300 trees/ha will be singled/coppiced, leaving *c.*1,000 trees/ha. These will provide the basis of the following rotation and allow for diversification of the subsequent woodland.

When planting alder-dominated woodlands under Element 2 of the NWS, this study would suggest that the recommended NWS stocking density of 3,300 trees/ha is more than sufficient. Other species that should be considered are ash (900 trees/ha), aspen (300 trees/ha) and willow (300 trees/ha), either pure or mixed.

6. Hazel

Hazel is normally a constituent of a number of woodland communities, particularly type B. 'Pedunculate oak-ash woodland with hazel', on free draining, fertile soils. It frequently occurs as almost pure hazel scrub on shallow limestone-derived soils as in the Burren, Co. Clare, and in similar situations elsewhere in Ireland. As a species that has been coppiced for centuries for a wide range of products, hazel does provide scope for wood production under the NWS. It is important not to overlook the conservation objective when doing so. Ancient hazel stools should not be cut, particularly where they occur in groups, as cutting could lead to the loss of lichen species that require long-lived stools to colonise and perpetuate. In addition, other native trees and shrubs that occur through natural regeneration should be retained.

As the Case Study is typical of what is likely to be encountered, the woodland should be divided into alternate coupes no greater than 0.5ha in size. These should be managed sequentially so that there is sufficient time for flora and fauna to migrate from mature areas to recently cut coupes. In unmanaged hazel scrub, a restoration cut is almost certainly needed to ensure quality poles are achieved in the future. A further cut should be applied 4 years later, in order to remove the first regrowth, which is generally second grade quality. Thereafter, the hazel stools are cut on a 5 to 10 year cycle, depending on site conditions.

Under Element 2 of the NWS, hazel is normally used as a supplementary shrub in the creation of type B woodland in particular. However, it is particularly difficult to obtain large volumes of hazel from the nurseries. Where hazel is being planted in almost pure blocks for coppice, 1,500 to 2,000 stools/ha are required. Adjacent areas should also be planted with species typical of type B woodland, i.e. pedunculate oak, ash, hawthorn, blackthorn, etc.

Conclusions

It is important to point out that these Case Studies may be used as general models to inform landowners, foresters and ecologists involved in projects under the NWS where a wood production objective is being pursued co-incident with conservation. For specific details on silvicultural management, growth and yield for all of the native species assessed in this study (with the exception of hazel), a number of Irish publications are available and should be consulted (e.g. Joyce, 1998; Horgan et al., 2003).

Each Case Study considers the ecological and wood production objectives as fully as possible and integrates both into a coherent long-term plan. However, outside these Case Studies, every site will have its own unique characteristics, and will require its own specific silvicultural prescription. For example, a recent Irish study on the production patterns in six downy birch stands showed considerable variation between the selected stands (Nieuwenhuis & Barrett, 2001). Operational costs will vary from site to site, as will the financial projections. For these reasons, the Ecological Survey/Management Plans set out for each individual species will almost certainly require adjustment when applied in other locations elsewhere in Ireland.

Some of the financial projections included in this study assume specific revenue rates for wood and sawlog harvested from these woodlands, with hardwood value estimates based on current prices. However, it is impossible to predict precisely how much revenue harvested wood will generate. It is also of note that although there appears to be considerable demand for some of the species assessed, i.e. high quality birch and alder, markets generally have not been developed in Ireland to absorb hardwood supplies if and when they become available.

Income generated from the different premiums available under the NWS (i.e. the general Afforestation Premium and the Native Woodland Premium) are calculated at current rates and do not take into account any future increases. Returns to the owner will be higher should these premiums be increased and/or become index-linked in the future. Conversely, revenue will be adversely affected if premiums are not index-linked and/or if the scheme receives less funding in future programmes.

It is also of interest that while the value of designated land (e.g. SACs, NHAs, etc.) is lower than agricultural land, modest returns are still possible under the NWS. At the very least, it should be possible for woodland owners of designated sites to cover the managements costs, which would ensure that such woodlands are appropriately managed in the context of nature conservation.

It is also important to put in context the general situation regarding quality wood production of native tree species in Ireland. On a general point, there are serious threats to the production of most broadleaves from expanding deer and grey squirrel populations. Population control and management measures are required to ensure that quality hardwood can be produced in future.

The potential loss of productivity due to other biological factors has not been quantified in Ireland. For example, bacterial canker can be locally common in ash stands and can have a degrading impact on wood quality. There is also the threat from exotic pests and diseases. For example, a future possible threat to oak and other hardwoods is 'sudden oak death', caused by the fungus *Phytophthora ramorum*.

It is universally accepted that the use of good genetic material is a central factor when growing high quality trees (Savill, 2003). However, other than oak, there is little or no seed available from certified sources with respect to wood quality. Most stock derived from native sources is untested in terms of form and vigour, and future quality from newly planted woodlands and/or woodlands restored with such material is unknown. Some testing is ongoing in relation to oak and birch, but considerably more research is required to address this deficit (Anon., 2004; Thompson & Lally, 2000; O'Dowd, 1998). It is encouraging to note that a number of native species are also the focus of genetic improvement under the British and Irish Hardwood Improvement Programme (BIHIP). However, all woodlands created or restored under the NWS in the short and medium term are effectively future trials in terms of hardwood quality. A complete set of results for each species will not be available until the end of their respective rotations.

There also appears to be limited experience in the management of broadleaves in Ireland, particularly in the implementation of close-to-nature silvicultural systems. This area is currently receiving attention under the auspices of ProSylva, and this is a welcome development. In addition, the NWS has provided considerable momentum to the application of close-to-nature and continuous cover forestry in Ireland, by creating a platform for its implementation on-the-ground. However, if quality hardwood is to be realised in future, silvicultural training will be required for management planners (ecologists and foresters) and contractors. In addition, the experience gained by foresters and ecologists working together in applying such management systems will certainly advance nature conservation management in forestry generally. In time, some of the misconceptions as a result of the impact of past management on woodlands, as outlined in Part 1, will be overcome as a result of experience gained from applied silviculture.

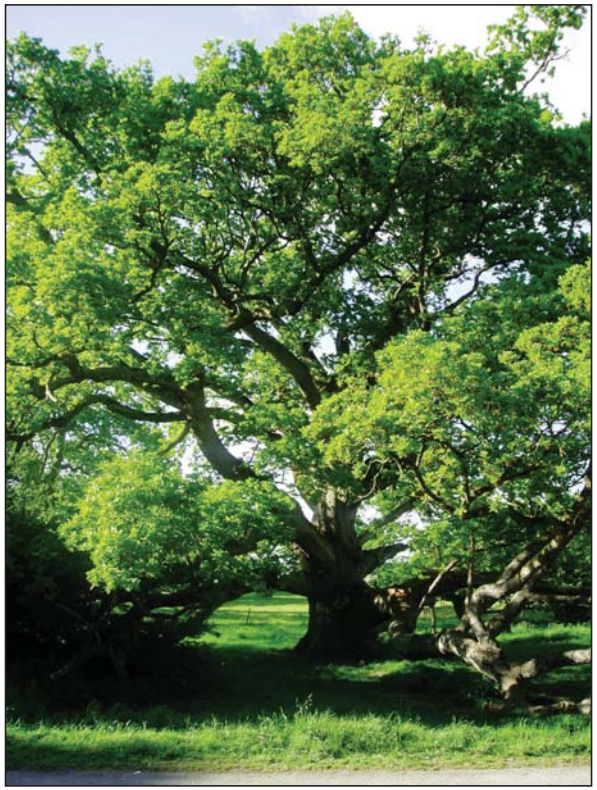
Working closely with Woodlands of Ireland, the National Parks and Wildlife Service and other relevant parties, the Forest Service has adopted an adaptive approach to the development of the NWS, incorporating changes and improvements designed to facilitate its uptake and implementation. For example, the recently revised Native Woodland Manual (Anon., 2005) sets out improvements to the scheme, particularly in relation to a streamlined application process and a shorter, more concise Ecological Survey/Management Plan framework document*.

** Note: this study was based on the procedures, standards and ES/MP framework set out in the last version of the Native Woodland Manual (Anon., 2002), and the recent update to the scheme does not compromise the outputs of this study.*

It is clear that further evolution of the scheme will occur resulting in it being updated. For example, major practical and ecological difficulties can arise from the need to implement detailed and relatively labour-intensive management prescriptions within the limited 5-year time period imposed by the structure of the scheme. In practice, the application of systems that include the continual removal of invasive exotics, regular thinning regimes, continual low-intensity harvesting, etc., will necessitate multi-annual work programmes and a requirement for flexibility in the administration of the NWS over a longer timeframe. For example, the introduction of an 8- or 10-year timeframe under the NWS, followed by thinning grants, would overcome many of the predicted problems that will be encountered under the current format, and would encourage quality wood production, where applicable. It is expected that some of the changes required to address these issues will be made by the Forest Service as the scheme evolves.

Finally, although the NWS is in its infancy and adjustments will be required continually, there is little doubt that the scheme has the potential to contribute significantly to both the conservation and expansion of Ireland's native woodland resource, as well as providing a modest income to landowners who are committed to intensive woodland management incorporating both biodiversity/conservation and wood production. Attention to detail, consideration of multiple objectives, and the ability to be flexible in approaching management are pre-requisites to success.

Fig. 13: An immature beefsteak fungus, (Fistulina hepatica). Mature specimens are a darker red colour. They occur particularly on senescent and dead standing trees. (Photo courtesy of Kevin Collins).





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