THEME 5

The Future of Ireland's Native Woodlands

EXPANDING NATIVE WOODLANDS: A STRATEGIC APPROACH USING RIVERS AND LAKES AS PART OF A FOREST HABITAT NETWORK

Dr. Philip McGinnity
Marine Institute
Furnace, Newport
Co. Mayo
Tel: 098-42300
Email: phil.mcginnity@marine.ie

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Abstract

There are 78,000 km of rivers and streams in Ireland and an estimated 5,000 lakes. Every fragment of native woodland in the country is adjoined by at least one stream or lake. The river network, therefore, provides an opportunity of connecting fragmented and vulnerable native woodland habitats as part of a forest habitat network. Here, I consider some of the advantages for establishing native riparian woodlands for river ecosystem health. I suggest that the river network provides an obvious framework for reconnecting and reinvigorating the existing native woodland resource.

Introduction

The Native Woodland Scheme (Anon, 2001) has put new energy and urgency into the protection and expansion of Ireland's woodland heritage. However, starting from a very small base of approximately 80,000 ha (Anon, 2001), means that in order for the scheme to make a sufficient impact in achieving its objectives, its implementation will need to be strategic and targeted. A 'shotgun' scatter approach to new woodland development would only add to the already large numbers of isolated small woods, and as has been suggested by Perterken (2002) for woodland restoration programmes in the UK, would homogenise the landscape with minimal ecological benefit and potential loss of locally distinct landscapes. Population biology and the emerging scientific discipline of landscape ecology present new opportunities to: firstly, understand the dynamics of habitat and species expansions, contractions and extinctions; secondly, to consider general principles underpinning the ecology of land mosaics or large spatially heterogeneous areas; finally, to adopt these principles as a means of strategically increasing the effectiveness of efforts to restore and expand the native woodland resource in Ireland.

The objective of this position paper is to introduce some of these new ideas in the context of developing Irish native woodlands, particularly with regard to the use of riparian corridors as a constituent part of forest habitat networks; to consider the potential benefit of riparian corridors to ameliorate effect of global warming induced temperature increases on freshwater fisheries; to stimulate interested parties to evaluate, discuss and carry out additional work that would be complimentary to a landscape ecology approach.

Landscape ecology

Ireland's native woodland is a fragmented habitat of about 11,750 discrete natural woodland patches (Forestry Inventory and Planning System or FIPS GIS database), covering at most, 1.5% of the total land surface. Approximately 9,000 of these woods are in the Republic of Ireland (FIPS) and a further 2,750 existing in Northern Ireland (McElarney *et al*., 2005). The woodlands are small; 40% are less than 5 ha (Martin *et al*., 2005).

There are very few patches of any significant size with only 3% of these woodlands greater than 50 hectares in size.

An examination of the spatial distribution of woodlands across the island would suggest that there is a considerable degree of clustering (Figure 1). Typically, these woodlands are aggregated into approximately 10 km^2 blocks and are separated from each other by distances of between 5 and 20 km. Within these aggregations, small woodland patches, which effectively operate, in a biological sense, as isolated island habitats, are separated by distances of between 100 meters and 1 km, and confined by barriers such as ditches and fences and by grazing, they are captured in a background habitat mosaic of farmland, commercial forest, urban development and other land uses, with little semi natural or transitional habitat (Figure 2).

Landscape ecology theory (Forman, 1995), island bio-geography theory (MacAurthur, 1967) and metapopulation theory (Hanski & Gilpin, 1997), would suggest that small, isolated and fragmented habitats and populations are more vulnerable to decline and an increased rate of extinction in comparison to habitats and organisms living in large interconnected habitats (Figure 3 and Figure 4). There is significant literature describing the health of populations living in fragmented woodland habitats (see references in Peterken, 2002). As the size of the island increases so does the number of species that they support. For example, on average a tenfold increase in size of a woodland habitat leads to a doubling of species numbers (MacArthur & Wilson, 1967). There is little information on the impacts of size and isolation on the trees within the habitat, or the habitat itself in its totality, but the concepts outlined above equally apply to the movement, growth and development of the woodland habitat and the tree species within, in terms of species richness, quality and longevity.

Native woodlands fit well into the metapopulation paradigm. A metapopulation is a population consisting of spatially separate sub populations (discrete woodland patches) that are connected by dispersal of individuals (seeds). For subpopulations on separate patches (trees and other flora in a woodland), the local extinction rate decreases with greater habitat quality or patch size, and the rate of re-colonisation increases with corridors, stepping stones, a suitable matrix habitat or short inter-patch distance. There will be slow colonising species and fast colonising species. Metapopulation dynamics are of special importance because sub populations may drop to zero (local extinctions) especially in small isolated patches. If each sub population dropped to zero, this would mean extinction of the whole population. However, because individuals sometimes move between sub-populations, two results occur. First the local extinction rate (the number of species disappearing from a patch per unit time) is lowered. Second when local extinction does take place, re-colonisation of individuals may re-establish a new population at the site.

What is required to restore woodland habitat?

The destruction or fragmentation of Ireland's native woodland habitat over the millennia would have followed a sequence or sequences similar to those described by Forman (1995). Land is transformed from a more or less suitable habitat in a small number of what Forman describes as basic mosaic-sequences. Five sequences are widespread. **1. Edge:** a new land type spreads uni-directionally in more or less parallel stripes from an edge. **2. Corridor:** a new corridor bisects the initial land type at the outset, and expands outward on opposite sides. **3. Nucleus:** spread from a single nucleus within the landscape proceeds radially, and leaves a shrinking ring of the initial land type. **4. Nuclei:** growth from a few nuclei produces new land type areas expanding radially toward one another. **5. Dispersed:** widely dispersing new patches rapidly, eliminates large patches of the initial land type and prevents the emergence of large patches of the new land type until near the end of the process. Essentially what is required, then, to restore and reinvigorate the native woodland resource is a process or processes capable of reversing these mosaic sequence events.

This might be achieved by regenerating a forest habitat network (Peterken, 2002). A network can be visualised as an array of nodes or individual woods, connected by links, such as streams, rivers, hedgerows or road networks, but set in a constraining matrix of farmland and urban development. A forest habitat network comprises forested nodes and links in a matrix of other habitats.

Peterken (2002) recommends that establishing a forest habitat network involves 'adding new woodland to the landscape where it will enlarge small woods and link scattered woods of all sizes; keeping existing woods and managing them to retain habitat diversity throughout the woodland area; and associating other habitats with the woodland'. He goes on to consider how such a network should be designed. One principle that should be incorporated is design efficiency. 'The design must aim to maximise connections between woodland with the minimum amount of additional woodland. This is not just an issue of cost effectiveness, but is also a recognition that agriculture, living space, communications and other land uses will inevitably restrict the land available for a forest network'. The use of riparian zones in this regard offers a way of expanding the forest network while minimising the impact on the usefulness of agricultural land.

Earlier research by Peterken (2000) indicated that woodland should cover at least 30 per cent of the land within 'Core Forest Areas', as this is the minimum proportion at which the landscape starts to function as if it were a single, large wood for most woodland species (including the trees themselves and associated fauna). A core forest area would be a landscape in which woodlands are well distributed, well connected, and cover at least 30 per cent of the land. The aim should be to reinforce clusters of existing woods until at least 30 per cent woodland coverage is achieved.

In this regard riparian woodland development would seem to have an obvious and useful role in increasing the critical size and connectivity of the existing natural woodland reserve. There are 78,000 km of rivers and streams in Ireland and an estimated 5,000 lakes. Every fragment of native woodland in the country is adjoined by at least one stream or lake. The river network, therefore, provides the best opportunity to reconnect fragmented and vulnerable native woodland ecosystems.

The development of riparian woodland corridors has significant potential to contribute to the native woodland resource. For instance, the development of 10% of the existing stream and river channel network (7,800 km), establishing woodland of 40 metres (recommended in the Native Woodland Scheme) on both banks, would create 62,400 ha of new woodland habitat, which would almost double the estimated existing woodland habitat area of 80,000 ha.

Game (1980) has argued that long, thin woods are better at catching species moving through the landscape, but that compact woods are better at retaining species once they have been caught. So while riparian corridors would be good at capturing organisms they would still need to be sufficiently wide to optimise the benefit. As a rough rule of thumb, it is known that changes in microclimate extend to up to three times the canopy height in from forest edges (McCollin 1998), suggesting a minimum size for effective woodland corridors. Interestingly, Peterken (2002) found that woodland shape had no significant impact on the number of plant species, although specifically referring to ground flora. It is doubtful if this holds for developing tree communities and mixtures in woodland habitats.

Fisheries and commercial forest development

Overall, commercial forest activity has had a significant detrimental impact on ecological functioning of Irish rivers due to: hydrological change (Mueller, 1999); deterioration in morphological structure; nutrient enrichment; changes to sediment transport regimes; acidification (Allott *et al.* 1990). Consequently, based on these experiences, fisheries interests, have by and large, viewed forestry development rather negatively. In response to the findings of these and other studies, Forestry and Fisheries Guidelines (Anon, undated) and Forestry and Water Quality Guidelines (Anon, 2000) were agreed, with the net effect of excluding commercial woodland development from riparian areas and a reluctance, applying the precautionary principle, to facilitate woodland development near rivers and streams.

Yet, excluding trees from riparian areas maybe counter-productive, as sensitively established native riparian woodlands (as opposed to commercial conifer plantations), have the potential to provide a number of tangible benefits for stream ecosystem functioning such as increases in habitat complexity and stability in addition to temperature regulation. Temperature regulation is critical in protecting aquatic resources where climate change is already resulting in significantly higher freshwater temperatures and episodic and extreme delivery of water (rainfall) to river systems.

Temperature increases as a consequence of climate change

Fish are poikilothermic and cannot regulate their body temperature. Thermal conditions will therefore influence their metabolism, growth, and development and temperature extremes may cause mortality. The determinants of the well being of the *Salmonidae* (salmon, trout and charr), the most sensitive of the fish living in Irish freshwaters, are influenced by environmental factors such as water temperature, rainfall, stream flow and the coherence between freshwater and seawater temperatures. These environmental factors are in turn controlled to a large extent directly by meteorological phenomena such as air temperature, storms, wind and the stratification of large water bodies such as lakes. Irish freshwaters are warming through a combination of natural climatic variations described by such processes as the North Atlantic Oscillation and the gulf stream index (GSI) (Jennings *et al*. 2000) and by a process of anthropogenic forcing (global warming) so much so that they are now considerably warmer than they were fifty years ago (unpublished data, P.McGinnity *pers.comm*.). Similar temperature increases have been observed by Langan *et al*. (2001) in upland streams in the Scottish Highlands. Long-term climate model forecasts suggest that mean air temperature will continue to increase by an estimated 3 to 5°C in the next 50 years (Hulme & Jenkins, 1998). It is likely that water temperatures will rise accordingly. Predictions of higher summer water temperatures resulting from current climate change scenarios will result in increased thermal stress and potentially lethal effects in fish (Langan, *et al*., 2001).

In those Irish rivers where long-term biological data exist (1960 to present), changes in smolt quality and performance have been observed and measured, concurrent with changes in the freshwater environment. These studies indicate that salmon and sea trout smolts are entering the sea earlier in Spring than they have done since monitoring of these rivers began, but are also migrating at a smaller size and at a younger age and perhaps in consequence are surviving less well at sea (P.McGinnity, *pers. comm*.).

Evidence from North America suggests that increases in direct solar radiation due to reduction (or absence) of riparian vegetation is mainly responsible for high stream temperatures (Brown & Krygiers, 1970). Other, research has shown that complete riparian canopies transmit about 10 percent of incident short-wave solar radiation (light) and thereby have a cooling or at least moderating effect on steam temperatures. Malcolm *et al*., (2004) in investigating the influence of riparian woodland on the spatial and temporal variability of stream water temperatures in an upland salmon stream found that riparian woodland had a substantial impact on the thermal regime, reducing diel variability (over a 24 hour period) and temperature extremes. They concluded that this temperature effect was likely to have a significant effect on freshwater ecology in general and on salmonid fish in particular.

Management of riparian areas

It appears that the moderation of high summer water temperatures conferred by riparian woodland is likely to be beneficial to salmonids. Consequently, to protect streams against direct solar heating, riparian buffer strips are now usually considered best management practice by the forest industry in North America. In the UK the most recent edition (4th) of the Forest and Water Guidelines, arbitrarily recommends that 50% of each river reach be shaded by riparian trees where salmonid fish predominate. In Scotland, forestry (e.g. Scottish Native Woodlands) and fisheries groups (e.g. Tweed Foundation and Galloway Fisheries Trust) are promoting the (re)introduction of semi natural woodlands to improve the quality of river habitat for fish.

These recommendations assume a diverse, complex and climatic riparian flora. However, in the early stages of development, tunnelling can occur in young riparian woodlands, where large numbers of a single species of tree are recruited synchronously on to a riparian area subsequent to a natural disturbance event or as the result of a deliberate management action and develop into a dense monoculture. The management activity could be the fencing of a riverbank to exclude grazing, the drainage and maintenance of arterial channels or targeted planting that is envisaged in the Native Woodland Scheme. O'Grady (1993), investigating the effects of varying levels of deciduous bank side vegetation on salmonid stocks in Irish rivers found that in summertime, marginal vegetation could limit the extent of incident light reaching the river bed resulting in a marked decline in both juvenile salmon and juvenile and adult trout numbers relative to stocks in adjacent areas with a less dense canopy. O'Grady also collected data showing that the length of a tunnelled channel, upstream of tunnelled sites influenced the standing crop of juvenile salmon with numbers of these fish falling with increasing tunnel length.

On the basis of O'Grady's findings, and in order to protect aquatic ecosystem functioning, some level of ongoing intervention maybe necessary, particularly in the early stages of riparian woodland development.

Summary

The ultimate aim of the Native Woodland Scheme should be to reinforce clusters of existing woodland until 30 per cent woodland coverage is achieved within the clusters Peterken, 2002). An examination of the distribution of woodlands across Ireland would indicate that surviving natural woodland and scrub exists in such clusters or aggregations. The river and lake network presents a logical and natural habitat network framework that could allow prioritisation of appropriate development within these clusters. The precautionary principle would suggest that a considerable amount of research and testing is needed. Nevertheless, it appears, that if managed properly, this forest-stream network provides a 'win-win scenario' with potential benefits for the ecological functioning and protection of both woodlands and freshwaters. Large natural vegetation patches are probably the only structures in a landscape that protect aquifers and interconnected stream networks, sustain viable populations of most interior species, provide core habitats and escape cover for most large, home range vertebrates and permit near natural disturbance regimes (Forman, 1995). Sensitively established woodlands could regulate temperatures, help restore ecological functioning envisaged by the EU Water Framework Directive, improve water quality and habitat quality, while at the same time providing a template for the regeneration of native woodland. Finally, Forman's comments in his 1995 paper seem apt as a concept to form a basis for landscape planning in the future. 'Land containing humans is best arranged ecologically by aggregating land uses, yet maintaining small patches and corridors throughout developed areas, as well as outliers of human activity spatially arranged along major boundaries'.

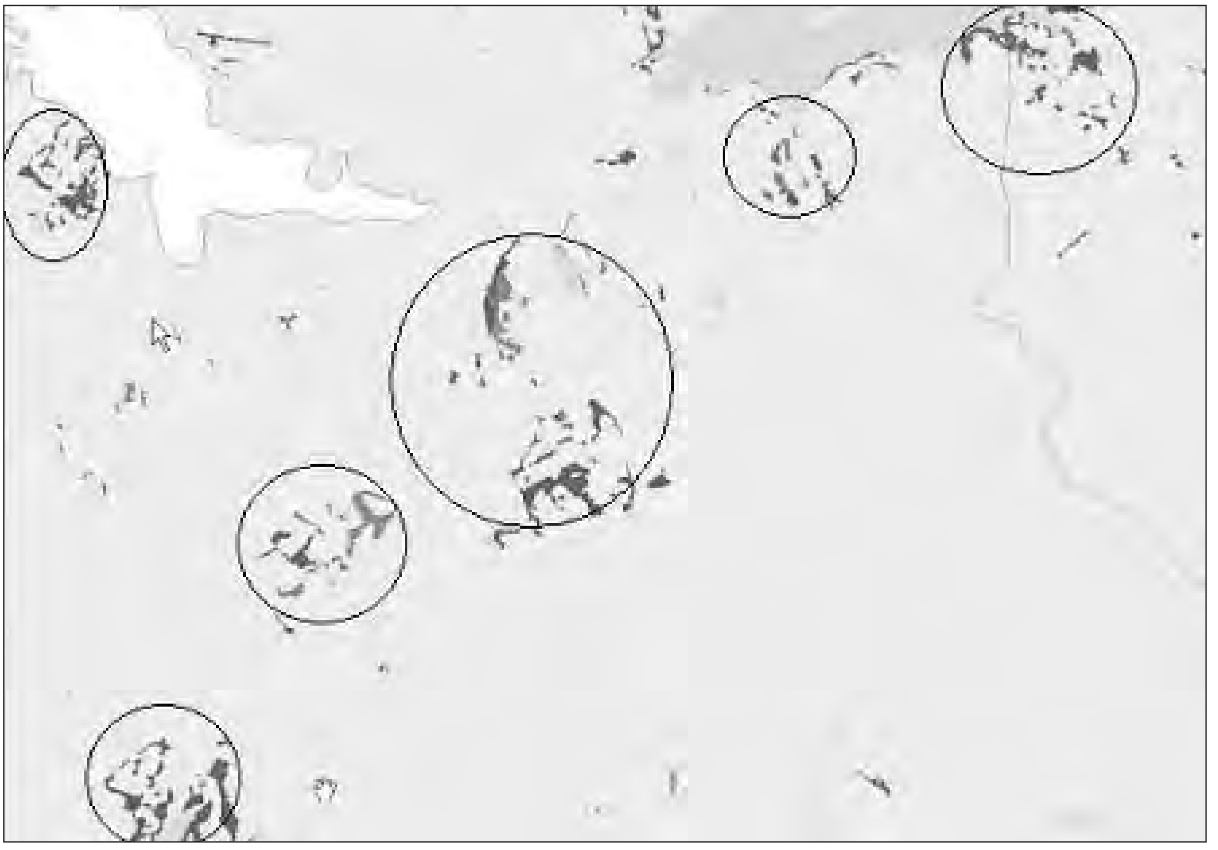

Figure 1. *A map (FIPS) of the distribution of clusters of native woodland in an area south and west of Lough Gill in County Sligo. These clusters cover areas of approximately 10km^2 in size and are separated from each other by distances of between 5 and 25 km.*

Figure 2. *A close up map (FIPS) of a woodland cluster showing discrete woodlands linked by network of rivers and streams.*

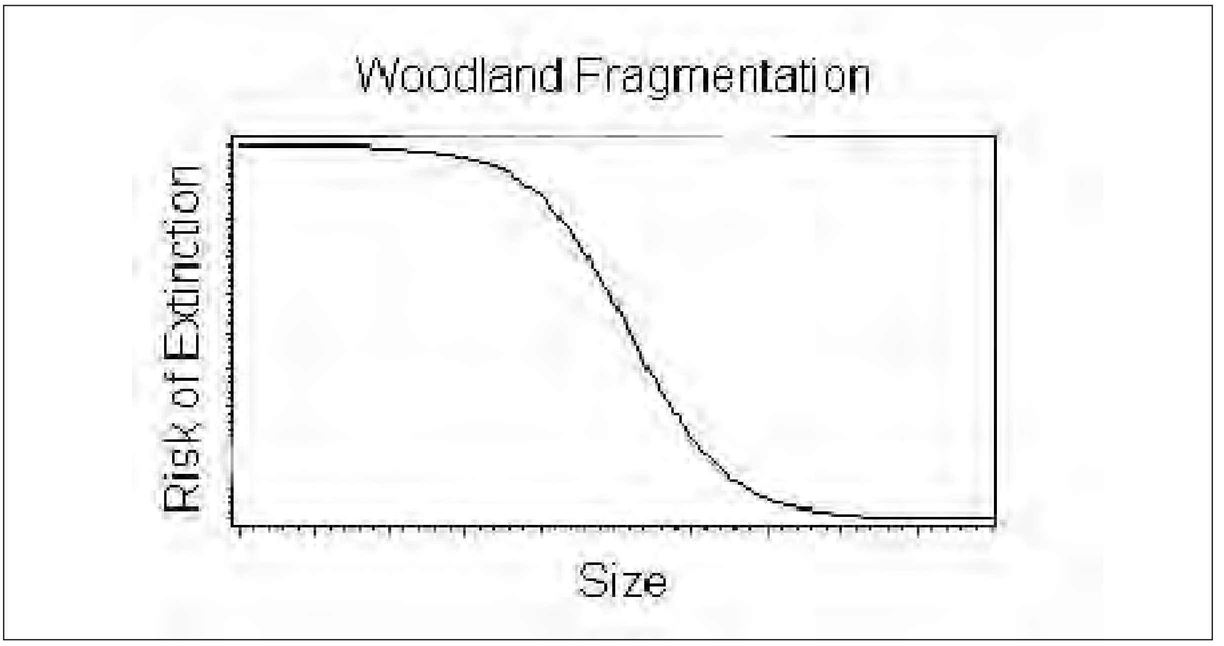

Figure 3. *Theoretical model illustrating the relationship between the size of individual woodland fragments and their risk of extinction.*

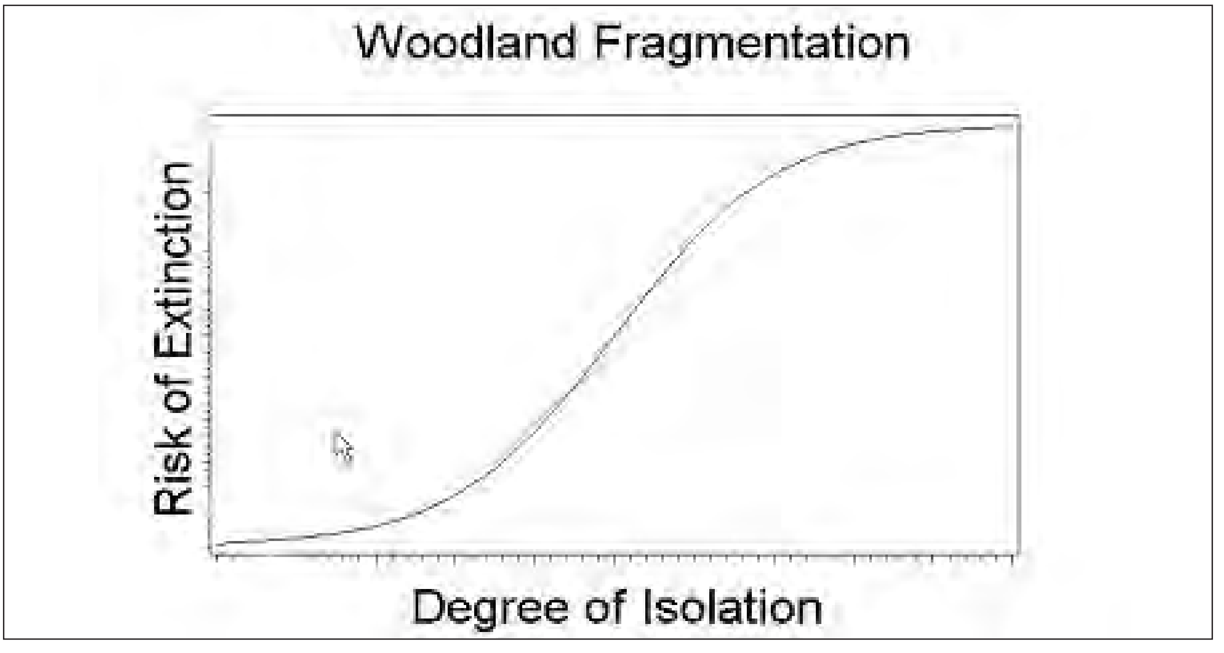

Figure 4. *Theoretical model illustrating the relationship between the degree of isolation (distance) between individual woodland fragments and their risk of extinction.*

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BORDERS FOREST TRUST: NATIVE WOODLAND RESTORATION IN THE SOUTH OF SCOTLAND

Hugh Chalmers, Site Manager and Wildwood Project Officer
Borders Forest Trust
Monteviot Nurseries, Ancrum, Jedburgh
Scotland TD8 6TU
Tel: + 44 1835 830759
E-mail: hugh@bordersforesttrust.org

Abstract

Borders Forest Trust (BFT), set up in 1996, is a small environmental non-government organisation, working in the south of Scotland. This paper describes the work carried out by BFT, and how this model could be emulated elsewhere in the world. BFT currently has around 700 subscribing members, manages 1500 hectares of land, including over 20 community woodlands.

Projects which the Trust has undertaken including Woodschool, Carrifran Wildwood, Riparian Woodland Network, Ancient Woodland Restoration, School Grounds initiative and Community Woodlands, now have a turnover of around £400,000 sterling, with 16 full-time jobs and over £1.5m sterling brought into the local economy.

Introduction

The Trust was formed when three separate, budding environmental initiatives, based in the Borders Region, came together. The main reason for this collaboration was to assemble a bid for funding to the Millennium Forest For Scotland Trust (MFST). The MFST was part of the Millennium Commission, a lottery funded initiative to celebrate the Millennium. The first initiative undertaken focused on 'Community Woodlands' and the first community woodland was established in the Borders at Wooplaw Woods in 1987. Secondly, the 'No Butts' project involved Borders hardwood trees being converted to bespoke furniture by local makers, and thirdly, the 'Wildwood Project', identified an upland valley where the original wildwood would be restored.

The Trust required a vision, in order to focus members and to persuade others to join, as well as convincing other bodies to come on board.

'Our vision for the south of Scotland is a place where a rich network of native woodlands and wild places flourish, cared for by local communities. We work to conserve, restore and manage native woodlands and other natural habitats for the benefit of people and wildlife. We support community woodland, habitat restoration, education and arts projects, and develop woodland based economic activity. Our vision can only be realised with the participation and support of people in the south of Scotland.'

An overview of the Scottish Borders

The Scottish Borders, where most BFT activity currently takes place, covers around 5,000 square kilometres, of which most is drained by the River Tweed catchment. Rainfall varies from 50cm to 200cm per annum over a distance of only 100km,and the ground rises to 840m on Broad Law. Geologically, the west consists of sedimentary rocks, with strips of Old Red Sandstone, and intrusive hills of volcanic dolerite. Badenoch (1994) describes the development and decline of native woodlands in the Borders since the retreat of the ice cap around 13,000 years ago, based on pollen stratigraphy. The evidence illustrates that a pioneer forest of willow, aspen, birch, juniper and pine formed on immature soils and in the following six thousand years, with periods of a milder and wetter climate, the temperate broadleaved high forest vegetation was formed. Since then, the climate has become more oceanic and cool, with peat formation on the higher, poorly drained areas.

With human invasion during the Neolithic period, the natural forest declined rapidly due to the twin effects of domestic grazing and extirpation of predators. Sheep and goats were the mainstay of the Scottish economy, and with the rise of the Abbeys in the Borders in the 12th Century, i.e. Melrose, Kelso, Jedburgh and Dryburgh, sheep farming and a dynamic trade on wool, became dominant, with little interest in native woodlands. By the 1980s less than 0.06% of Tweeddale - the western, higher part of the Borders- was considered ancient, semi-natural woodland. It is only now, in the 21st Century, that we have been presented with an opportunity to restore native woodlands in the Borders, and to revive a woodland culture.

Borders Forest Trust Projects

BFT aims to restore this woodland culture through education using practical examples of native woodland restoration. Through the Community Woodlands project, people are encouraged and enabled to become responsible for the management of woods located close to them and to plant new multi-purpose woodlands. The riparian woodland projects protect and expand existing woodlands close to the River Tweed and its tributaries. The Ettrick Floodplain Restoration project has restored two square kilometres of floodplain to the dynamic woodland mosaic of a natural floodplain. The Carrifran Valley in Moffatdale, a spectacular ice-moulded glen, covering 660 hectares, is now owned by BFT, and will eventually become a unique natural forest. The Woodschool demonstrates how a neglected resource can be utilised locally, bringing jobs and income to the local economy. All these projects are part of the 'woodland culture' that is currently being revived in the south of Scotland.

BFTs woodland restoration efforts imitate the conditions that prevailed in the original wildwood. There are a number of elements missing from most of our remnant woodland sites (which are largely in remote, steep gulleys, locally known as cleuchs, where sheep, deer and goats cannot browse). These conditions include a lack of seed source, heavy domestic grazing pressure aside the gulleys, and an undisturbed grassy sward. To reduce domestic grazing pressure, fences have been constructed (over 70km to date). The wider strategy aims to create significant ecological linkages along rivers and over watersheds and is a strategy shared by Forestry Commission Scotland (FCS). Where native tree seed sources are absent or impoverished - most of our remnant woods consist only of willow, rowan and birch - saplings are grown from locally collected seed, and planted onsite. Soil disturbance - previously carried out by wild swine in the original wildwood - has been mimicked by hand screefing and direct seed sowing, and the role of the wolf in controlling roe deer, hare and rabbit numbers has been undertaken by marksmen with rifles. In other places, plastic tree guards are used to protect trees from browsing.

Access to land for woodland renewal often presents a challenge, particularly where the current land use is heavily subsidised by the European Union Common Agricultural Policy. However, forthcoming changes may make it possible for farmers to work more closely with BFT. At present, farmers are compensated for loss of grazing income if they exclude livestock from land or woodlands, and this, along with the new Scottish Forestry Grants Scheme, is the main mechanism used by BFT to gain management control over farm land, with the aim of restoring native woodlands.

The purchase of the entire Carrifran Valley in 2000, for a sum of £340,000 was an exception. The purchase of this valley resulted from a massive public appeal over a two-year period and over 600 'Founders' came forward with the money to take full control of the land. Following public consultation and a comprehensive environmental statement compiled by volunteers, the work to restore the wildwood was approved and to date over 300,000 native trees have been planted. This achievement gave BFT massive confidence and persuaded various funding bodies, including the Heritage Lottery Fund, that BFT was a credible and responsible body worthy of funding.

Conclusion

BFT now has limited core funding for its wide range of activities from Scottish Natural Heritage (who have always been supportive), Heritage Lottery Fund, and from other Trusts. These go some way to covering the shortfall in funding of land-based grants from FCS. Funding is always a worrisome issue, and BFT is indebted to a core of regular volunteers who sit on steering groups and committees, who plant trees at weekends and who share the desire to work locally to improve the environment.

The activities of BFT demonstrate what dedicated individuals, local communities and volunteers, can achieve using limited resources. Extensive information on BFT projects is available at www.carrifran.org.uk and www.bordersforesttrust.org

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MANAGING THE THREAT OF INVASIVE PLANT SPECIES TO IRELAND'S NATIVE WOODLANDS

Dr. Therese Higgins, Consultant Ecologist
Coolcorcoran Lower
Killarney, Co. Kerry
Tel: 086 1716712
E-mail: gemhig@yahoo.co.uk

KEYWORDS: Threat, biodiversity, species management, rhododendron

Introduction

In recent years invasive species have been recognised as a major threat to biodiversity and to the long-term future of some semi-natural habitats (Anon., 2002). Invasion by *Rhododendron ponticum* L. has been identified as one of the most serious issues affecting native woodland conservation in Ireland (Neff, 1974; Quirke, 2000). Where management plans based on critical ecological and site specific factors have been applied, rhododendron control has been successful (Barron, 2000). By taking a similar approach, strategies may be developed for the control of other invasive species. In a native Irish woodland context there are several such species that spring to mind, e.g. laurel (*Prunus laurocerasus*), snowberry (*Symphoricarpos albus*), red osier dogwood (*Cornus sericea*), beech (*Fagus sylvatica*), sycamore (*Acer pseudoplatanus*), western hemlock (*Tsuga heterophylla*). Each of these is undoubtedly 'invasive' in some sites and under some conditions. However, further information about the extent of these and their impact on Irish woodland is needed, and the National Native Woodland Survey (see Martin *et al*., this volume) will contribute greatly to this. This paper outlines the aspects of Rhododendron ecology that underlie its successful management and uses data from published sources to propose control strategies for a selection of other invasive species.
Nomenclature for angiosperms follows that of Preston *et al*. (2002).

Managing Rhododendron Ponticum
Aspects of rhododendron ecology relevant to its management

The ecology of rhododendron and the history of its introduction to the British Isles are described by Cross (1975, 1981) and its deleterious impact on native habitats is well documented (Cross, 1982; Kelly, 1981; Hayes *et al.,* 1991, Gritten, 1992; Jones, 1972). Rhododendron is a shade-tolerant member of the Ericacaea and thrives on acid soils and in areas of moist, mild climates (Cross, 1975). It is frequently naturalised close to areas of former planting and has the potential for invasion of heath, bog and woodlands over suitable substrates. Rhododendron exhibits prolific seed production, typically flowering annually from 10-12 years onwards. Each flower head can produce up to 5,000 seeds per annum, with seeds being cast from the seed pod between December and March. The majority of seed is usually dispersed within tens of metres of the parent plant but a proportion of the seed may travel farther by wind, water, and other vectors. While light is required for germination, quite low levels (2-5% daylight) are sufficient (Cross, 1973) and germination is frequently successful below an oak/holly canopy. Seedling establishment is relatively high where suitable seed beds such as bare soil and mossy carpets are abundant. While the seeds are not thought to form a persistent seed bank (Cross, 1973), observation suggests that some proportion may survive for up to two years (C. Barron, *Pers. Comm*.). Young plants of rhododendron have a considerable competitive edge over native trees and shrubs in that they are poisonous and avoided by grazers, and in grazed sites where there is a seed source and suitable seed bed rhododendron tends to replace the native shrub layer. Rhododendron regrows vigorously when cut, and the resulting regrowth can produce flowers within 1-2 years (although more usually in 3-4 years). The thick, waxy cuticles of the foliage render it relatively resilient to foliar herbicides and its multi-stemmed growth habit further complicates treatment as herbicide does not translocate laterally.

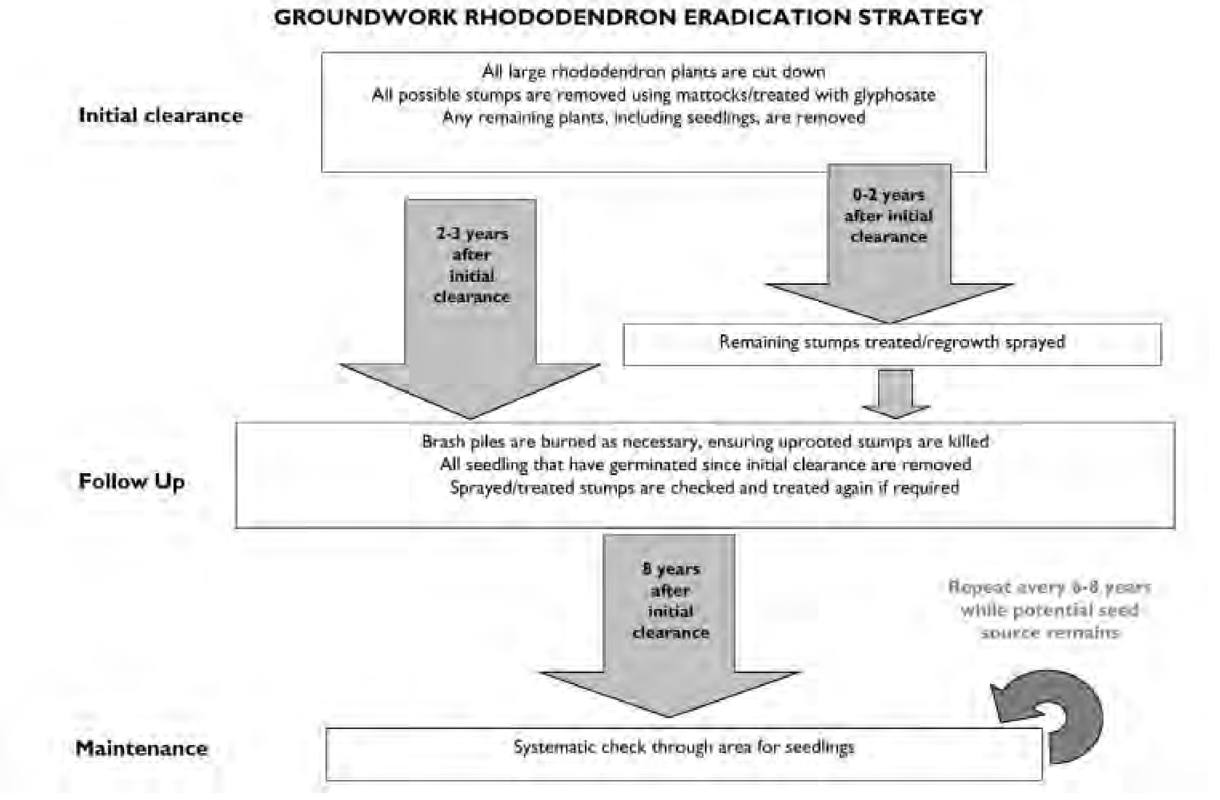

Figure 1. *Work Schedule for Rhododendron Control adopted by GROUNDWORK. Work is timed to ensure that once initial clearance has been carried out, seed production is not allowed within the cleared area.*

Rhododendron control

In vulnerable sites (with acid soils, high rainfall or humidity and abundant seed bed, e.g. heavily grazed sites) rhododendron control must be very vigorous and thorough. If *any* seed source is allowed to remain, then ongoing monitoring and seedling removal will be required *indefinitely*. The primary objective of a management plan should be to prevent seed production in an area once initial clearance has been undertaken. If it is possible, i.e. where the infested area is small or isolated or resources are unlimited, all seed sources should be eliminated first, and subsequent management must then be timed so that no plant is allowed to reach seed bearing age. In many cases, however, this will not be possible and areas will need to be prioritised for clearance. In complicated sites with varying degrees of infestation, it may be most beneficial to tackle areas of light infestation first, thereby achieving control in areas that still retain good native flora. The use of buffer zones and working with the prevailing wind will reduce reinfestation from wind blown seed. Grazing levels in cleared areas should be such that native vegetation can recover quickly, eliminating suitable sites for rhododendron germination and reducing reinfestation. Only rarely, either at the early stages of invasion, or when a very small number of plants are involved, can rhododendron management be carried out in a single work period. Usually several work phases are required. These are outlined below.

1. Initial Clearance - Removal of plants and killing of rootstock

Small to medium sized plants can be pulled or dug out of the ground intact. These must be disposed of in some way that ensures the plant is killed, as uprooted saplings left lying on the damp woodland floor are capable of re-rooting. Effort must be made to remove as much of the rootstock as possible as plants snapped off at ground level will grow back. Large plants should be removed by cutting the branches and dealing with the brash appropriately. While brash piles can increase habitat diversity, it must be borne in mind that access to the area for follow up work is vital for the management of rhododendron to be successful. Stumps may be dealt with by uprooting or by direct stump treatment (with 20% glyphosate within an hour of cutting and with dry conditions for 6-8 hours after application) or spraying of regrowth (20% glyphosate with surfactant, in dry conditions persisting for 24 hours after application, 1 to 3 years after cutting). Either of the first two options is preferable as they are easier to carry out and usually more effective.

2. Follow Up – Quality Control of Initial Clearance Work

In order to ensure success of initial clearance and to remove smaller plants that were missed or have established since initial clearance, systematic checking of the area is required. This should be within 2 years of initial clearance, as stumps that were not killed properly are capable of flowering in that time period.

3. Maintenance – Dealing with reinfestation such that seed production is prevented

Subsequent visits will be required approximately every 8 years to ensure that any newly established plants do not get the opportunity to flower or set seed. If seed input has been minimized, the number of saplings found should decrease with each visit.

The principles outlined above have been used as the basis for the management of rhododendron within parts of the Killarney National Park by GROUNDWORK volunteers since 1981. The work schedule used is illustrated in Fig. 1. More than 370ha have been cleared to date and are maintained clear by the method described above.

General principles for invasive species management

Experience with rhododendron has demonstrated that the management of any invasive species must be well planned before action is taken. In some sites it will be desirable to completely eliminate the problem species, while in others it may be more realistic to contain the spread of such species, or to accept their presence within defined limits. Whatever the specific target set for invasive species management, there are some general principles which, if applied, will assist in the most cost-efficient and effective management being achieved.

1. Prevention is better than cure. With many invasive species, invasion is exponential (Pysek & Prach, 1993) whereby initial colonisation is slow, and then accelerates rapidly after a certain 'critical mass' has been achieved. If the invasion can be controlled before this point, time and money will be saved and the negative impacts of the invasion on the woodland ecosystem can be averted rather than corrected later.

2. Know thy enemy. By understanding the ecology (especially reproductive ecology) of a species it is possible to predict how it will react to management within a site, thus allowing managers to maximise their return on limited financial resources. Lessons learned from some of the 'older' invasions can be used to identify important questions to ask about new invasions, the answers to which are very important in devising an appropriate management plan. Important questions that must be asked about any invasive plant species include:

- Where does the species grow/invade/potentially invade?
- How does the species invade? What is the timescale involved? What is the potential dispersal area?
- What are the site factors that facilitate/hinder its establishment?
- What management allows/promotes increase in spread?
- How can mature plants be killed?
- How does the species respond to cutting (timing, type)?
- Are there requirements for dealing with brash/litter?
- Is reinfestation an issue?

3. Look before you leap. When conservation is the primary objective, it is vital to take a holistic approach to woodland management. Certain operations that may have no direct link to invasive species may, however, have a large impact on the behaviour of such species. For example, increasing grazing pressure will create germination sites for rhododendron, thereby facilitating its spread. Similarly, removal of canopy trees will increase light levels and may allow for the rapid expansion of snowberry.

Selected invasive species and guidelines for their management

Beech (Fagus sylvatica L.)

Introduced from Europe and southern England, beech has been widely planted into woodland and parkland during recent centuries. Beech casts and tolerates deep shade, is relatively unpalatable to grazing herbivores and produces a deep, persistent leaf litter, all of which contribute to it being a very successful competitor with our native long-lived canopy species such as oak (Sydes & Grime, 1982). Beech is associated with lower plant diversity and also with a reduction in natural regeneration of native tree species (Higgins *et al*., 2004). It is widely naturalised in Irish woods, especially oak-birch-holly woods (WN1- Fossitt, 2000), and oak-ash-hazel woods (WN2 – Fossitt, 2000). In the first phase of field survey for the National Native Woodland Survey, beech was found to be present at 72% of sites (n = 215) and was deemed frequent, abundant or dominant in the canopy of 46% of sites (Higgins *et al*. 2004). In some sites, there is a clear trend of beech replacing native trees in the canopy (Quinn, 1994; Dierschke, 1982).

Sycamore (Acer pseudoplatanus L.)

Sycamore was introduced to the British Isles from mainland Europe prior to 1500, and has been widely planted since the 18th century. Sycamore is fast-growing and is a popular broadleaved timber species (Joyce, 1998). Additionally, being very tolerant of exposure and salt, it is often planted as a shelter species. Sycamore requires relatively well aerated, deep soils, and is abundant over limestone, but also found on sands & podzols (Jones, 1944). It is widely naturalised in Irish woods, particularly oak-ash woods and base rich wet woodland. In the first phase of field survey for the National Native Woodland Survey, sycamore was found to be present at 76% of sites (n = 215) and was deemed frequent, abundant or dominant in 26% of sites (Higgins *et al.,* 2004). It is a strong competitor with native tree species, and can form a mono-culture, reducing canopy diversity.

Table 1. *Reproductive biology of three invasive tree species.*

	Seed Production	Seed Dispersal	Seed Longevity in the field	Establishment Requirements
Beech	From 40-50 yrs, mast crops 5-10 yrs	Poor	None	Tolerates shade & field layer, Needs moisture
Sycamore	From 20-30 yrs	Poor (within 85m of source)	None	Tolerates shade & field layer
Sitka Spruce	From 20-25 yrs, mast crops 4-5 yrs	Poor (within 80m of source)	None	Need open conditions – no litter/field layer

Sitka Spruce (Picea sitchensis (Bong.) Carr.

Sitka spruce was widely and abundantly planted in the last century for timber production throughout the country but especially in upland areas. This North American species regenerates freely into adjacent semi-natural woodland and in clear fell areas (von Ow, 1996). It establishes very well on poor soils, particularly peats, and is a particular problem to managers attempting to re-establish native woodland on former spruce plantation sites.

Managing invasive tree species

The removal of invasive tree species is relatively straightforward. Individuals should be felled, taking into account the conservation value of the site. The maximum amount of dead wood should be left to add to habitat diversity (see Cotton, this volume). By ring-barking some trees, standing dead wood will develop. Some very old, veteran trees that have good wildlife value could be left on the site, as long as regeneration from seed is dealt with. Felling is best carried out selectively or in small coupes (~0.5 ha) to create canopy gap rather than clear fell conditions. Felling during the winter months can have fewer negative impacts on wildlife (Murphy, 1997), but care should be taken to avoid disturbing roosting bats and hibernating mammals. Conifer stumps will not show regrowth after cutting, but sycamore and (younger) beech stems may require treatment with chemicals (e.g. 20% glyphosate applied directly to stump within 1 hour of cutting). Regeneration should not be allowed to achieve maturity and become a new seed source. Seedlings are best dealt with after the natural mortality associated with juveniles has levelled off, but while the plants are still small enough to be handled easily and before they mature and set seed. The timescales involved are outlined for some species in Table 1. If seed producing trees are being left near the area managed, e.g. veterans/adjacent stands, managers should be aware of the dispersal area surrounding that source and use either a buffer zone system or regular seedling control to prevent reinfestation.

Red osier dogwood (Cornus sericea L.)

Red osier dogwood is a deciduous shrub, native to eastern North America which, because of its attractive red shoots and white berries has been planted for ornament in parks and demesnes throughout Ireland (Kelly, 1990) and more recently on roadsides. It is found mainly on lowland sites with varying degrees of water logging, and has been described as *'an aggressive invader of natural and semi-natural wetland habitats'* (Kelly *op cit*) along lakeshores and within riparian woodland (Cross & Kelly, 2003). Single plants of the species can grow to 4 metres in height and expand by layering to form extensive thickets, casting summer shade, thus reducing species richness and inhibiting tree regeneration. However, seed production and seedling establishment appear to be uncommon in Ireland and so dispersal of this species from the original area of planting is rare, and may result from rooting of detached fragments that have been transported by water (Kelly *op. cit*). Control by burning has proven to be ineffective in some studies in North America (Middleton, 2002) and it is likely that cutting followed by careful herbicide application (in line with recommendations for use of herbicides near water) will be the most effective method of removing established thickets of this plant.

Snowberry (Symphoricarpos albus L.)

Snowberry is a deciduous shrub, growing to 3 metres in height, and was introduced to Britain from northwest America in 1817 for cover and ornament (Gilbert, 1995). It occurs on well-drained, moist, fertile soils, and forms dense thickets by means of shallow, woody suckers (Gilbert, 1995). Where these thickets are found within woodland they are usually the result of initial planting for game cover and expansion of the thicket is slow under conditions of shade. Thickets cast deep shade that strongly suppresses the field layer below, including tree seedlings. While snowberry flowers and produces white berries annually, there has been no evidence of seed viability found in the British Isles to date: however snowberry spreads easily by seed in Germany (Gilbert, 1995) and the impact of future climate change on the plant's behaviour in Ireland is as yet unknown. Expansion of existing thickets occurs very rapidly on release from shade and this would appear to be the most likely mechanism of invasion in Irish woodland habitats. Snowberry responds to coppicing with vigorous regrowth (Gilbert, 1995) and requires herbicidal control if it is to be effectively removed (Fryer & Makepeace, 1978).

Japanese Knotweed (Fallopia japonica Houtt.)

Although it is a herb rather than a shrub, Japanese knotweed is included here because the impacts of its invasion have been widely publicised and are the subject of much debate. Although it is best documented in Britain, it clearly has the potential for invasion of semi-natural habitats in Ireland. It was introduced to Britain from Japan for ornament in the 19th century. It is a perennial herb which forms large clumps 1 to 3 meters high. Its growth is vigorous and it can grow 3 meters in 12 weeks. Japanese knotweed tolerates a wide range of soil types, but requires high light levels (Palmer, 1990). While the plant undoubtedly causes much structural damage and swamps large tracts of riverbank resulting in habitat loss and erosion, its extent and impact on Irish riparian woodland requires clarification. Control of this plant is difficult. While it does not spread by seed, fragments of the parent plant transported by water or in soil readily results in establishment of new thickets. Because of this, clearance of the plant by manual methods (strimming, flailing, cutting) must be carried out with great care as even very small fragments (down to 0.7g in weight) can give rise to new plants. Any waste that contains Japanese knotweed must be treated with care as there is potential for spread into new sites. Even after removal of shoots, the rhizome system below remains and so full eradication of the plant requires that this be targeted. Research into effective control methods is ongoing. Injection of hollow stems with glyphosate and biological control methods are showing some promise (Shaw & Seiger, 2002).

Conclusions

The management of invasive species is a challenge that will continue to face managers of Irish native woodlands. It is an issue that cannot be tackled in isolation: consideration of the relationship between invasive species and woodland processes, particularly grazing and light regime, is vital for effective management. Attitudes towards invasive species and the resultant policy adopted will vary greatly between sites, depending on local conditions. Some species, e.g. rhododendron, have such a dramatic negative effect on vulnerable sites that they are unlikely to be tolerated in sites designated for conservation. On the other hand, species like beech and sycamore may be tolerated at certain levels in some sites. However, I feel strongly that where the opportunity exists to maintain some sites as wholly 'native' then this should be the objective. We will be in a much better position to make policy decisions such as these once baseline data regarding the extent and condition of our native woodland and the abundance of invasive species are available. It is clear that the ecology of each species must be considered when formulating a control policy. The dissemination of the results of different control attempts among policy makers will increase the success and efficiency of management. While general guidelines should be developed for each invasive species, these must always be applied on a site by site basis and time spent planning management will increase efficiency in the long term.

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MANAGING THE THREAT OF MAMMALS TO IRELAND'S NATIVE WOODLANDS

John Mc Curdy, Deer Recorder, Northern Ireland Deer Society
9 Mount Shalgus Rd, Randalstown
Antrim, BT41 3LE
Email: jmac9@btinternet.com
Tel: 048 9447 2626

KEY WORDS: management, protection, shooting, fencing, tree shelters, chemicals

Abstract

Traditionally shooting was the accepted method of dealing with threats of damage by mammals to agricultural and forest crops. This remains the most cost effective method of management. As an alternative to shooting, adequate fencing and the use of tree shelters offer effective but costly methods of protection. Chemical deterrents are expensive to apply and, may only last a few months.

The most severe damage to woodlands can arise from the activities of deer and goats.

Squirrels, both grey and red, can also cause significant damage. Hares and rabbits may be a problem in the early years of tree establishment.

Introduction

All trees, whether native or exotic, are subject to damage from a wide range of herbivores. These may range in size from, aphids and caterpillars feeding on individual leaves or needles, to rabbits, hares and squirrels taking buds, young shoots, fruits and bark. In addition goats and deer, which feed on tree foliage and bark, may cause severe physical damage to the stem of the tree. With a little experience, it is usually possible to identify which mammal is causing the problem without actually seeing the damage taking place.

The type of damage will vary according to the season of the year.

The threat posed to younger plantations by an over population of the larger mammals can be enormous.

Types of Damage

Browsing

This is the nibbling of buds and shoots of newly planted and young trees. The peak period of this type of damage is from January to May, when other food is scarce and growing shoots are most tender. It can continue however throughout the growing season. Trees that have been continuously browsed will develop multiple leaders and in severe cases end up like topiary specimens.

Fraying

This type of damage is solely attributable to deer. It is caused by male deer rubbing and thrashing their antlers against pliable stems or branches. It usually occurs in August when the deer are removing the dead velvet from their newly grown antlers. Fraying will again become prevalent as the deer begin to mark their territories at the onset of the rut in late September and October.

Bark Gnawing and Stripping

This is the chewing or tearing of areas of bark from the tree and occurs at the buttresses or higher up the stem. It will occur in late winter and early spring as the sap rises. Smooth barked species are most vulnerable. Complete removal of bark from around the stem will result in the death of the tree above the girdling.

Mammals Causing Damage

Both rabbits and hares will browse young foliage and will often stand on their hind legs to reach any higher tender shoots. Periods of deep snow enable them to reach higher to gnaw leading shoots and buds. As rodents are equipped with front teeth on both jaws, buds, leaves and shoots will be nipped off cleanly.

Goats and deer can obviously browse to a much higher level. Where deer have constant access to broadleaf woodland, such as in a deer park, and in woodlands with a high deer density, a distinct browse line, perhaps in excess of two metres from the ground, can be easily seen. As deer have no teeth at the front of the upper jaw, shoots browsed by deer will be partially torn off rather than cleanly severed.

While fraying is attributed mainly to deer, goats can cause the most obvious and severe type of damage to a wide range of tree species by extensive bark stripping. Smooth barked trees are at risk with ash, elm and oak being the most palatable and preferred in that order. Smooth barked spruces and young pines are also at risk Squirrels, both red and grey, will also bark strip and can cause serious damage to young broadleaves at pole stage.

Management

The objectives of management must be prevention and curtailment. There are several methods of preventing, or at least limiting, the damage. The choice will be influenced by such factors as the area of woodland to be protected, the development stage of the forest crop, the value of the trees and the cost of protection.

The traditional method of dealing with mammal damage, particularly large mammals, to agricultural or forest crops was shooting. When carried out by well-trained experienced recreational hunters, it remains the most efficient and cost effective option. Even when carried out by professional hunters it is still a cost effective option. Material costs associated with shooting are low, simply the cost of the ammunition, which in the case of deer and goat control is around 1.50 per bullet. It is essential to ensure that proper weapons are employed and that the hunters conform to the requirements of the Wildlife Act of 1976 (in the Republic of Ireland) and the Wildlife (N I) Order 1985 (in Northern Ireland).

In comparison with this, rabbit proof fencing will cost €5- 6 per metre and rises to €10 – 12 per metre if deer are to be excluded. In addition, fences require regular checking, particularly after storms and during the rut. Such fences need to be maintained to a high standard.

Tree shelters are extremely expensive, working out at between €3,000 - €4,500 per hectare depending on the stocking density of the trees being protected and the height of the shelters required. To protect against rabbits and hares, shelters should be 0.75m high rising to 1.8m high for deer. It can be seen that this option should only be used for areas of woodland of less than 0.5 ha or to protect individual specimen trees.

Chemical repellents are most effective in protecting trees and shrubs from winter browsing by rabbits, hares and deer. However they are time consuming to apply while their effectiveness is reduced by prolonged rainfall. They are really only an option in very small areas and small trees.

With regard to grey squirrels, cage trapping, drey poking and shooting are suitable methods of reducing a population and are most effective in early spring. However the vacuum created will soon be colonised from adjacent areas. Red squirrels are of course fully protected.

Long term solutions to curtail the threat from mammals should include the initial design of the woodland. Leaving plenty of open spaces along stream sides, creating deer lawns and feeding habitats enables the wildlife population to be seen, assessed and managed. Open woodland will encourage the growth of a good herb and shrub layer. Non-commercial species such as bramble, ivy, willow and holly will be readily browsed and absorb much potential damage.

The choice of species will also assist. The most palatable and vulnerable trees have already been mentioned. Birch and alder are much less attractive to deer, posing the question as to whether they possess some in built biochemical component, which affords a level of protection to these pioneer species.

A wildlife population, which exceeds the carrying capacity of its habitat, will pose a threat and cause damage to its environment. If a stocking density of five deer per hundred hectares can be achieved, damage will be reduced to an acceptable level. Culling a ratio of two females to one male will be the first step towards achieving this.

Conclusion

It is not possible to eliminate the threat of damage by mammals to woodlands. Even in a well designed and managed wood there will be some element of damage. The techniques described in this paper offer the opportunity to reduce damage to an acceptable level where both woodlands and wildlife can exist together.

POTENTIAL WOOD PRODUCTION FROM IRELAND'S NATIVE WOODLANDS

Leonard Gallagher - Timber and Forestry Consultant
42 Dunluce Rd.
Clontarf, Dublin 3
Tel: 01 833 4935

KEYWORDS: Commercial potential, native timber production, quality, broadleaf culture

Abstract

This paper lists native timber species with commercial potential. It identifies the type of wood products that may be derived from these species, ranging from small diameter wood to sawlog, and looks at the markets that are available. For the production of commercial timber, quality stems must be produced. The requirements for quality timber production are considered in the context of native woodland management. Market accessibility and prices, as well as related opportunities and constraints are addressed.

Introduction

There is no reason why native woodlands should not produce quality timber. However, the type of woodland created and the management practices adopted will influence the amount of commercial timber that may be produced. Against a background of the creation, regeneration or maintenance of a woodland type indigenous to Ireland, this paper looks at wood products that may be produced.

Species

When we consider timber production in Ireland, we immediately think of Sitka spruce (*Picea sitchensis (Bong.) Carr*), followed by a variety of conifers, mostly exotic, and only then do we consider broadleaves, mainly oak, but also beech and sycamore. So the bulk of timber production in Ireland derives from exotic tree species, and by far the greater volume is softwood.

The Native Woodland Scheme (Anon. 2001) lists seven overstorey and fifteen understorey and minor species. Of these, nine species provide commercial timber. These are outlined in table 1.

Table 1. *Native species that produce commercial timber.*

Overstorey species	**Understorey and minor species**
Alder (*Alnus glutinosa)*	Wild cherry (*Prunus avium)*
Silver birch (*Betula pendula)*	Yew (*Taxus baccata)*
Downy birch (*Betula pubescens)*	
Ash (*Fraxinus excelsior)*	
Sessile oak (*Quercus petraea)*	
Pedunculate oak (*Quercus robur)*	
Scots pine (*Pinus sylvestris)*	

A brief description of the salient features and considerations in growing these trees for timber production follows. The list is in order of commercial importance, listing the broadleaves first.

Oak

Timber

The timber of the two species, pedunculate *(Quercus robur)* and sessile oak *(Q. petraea)* is similar and interchangeable. It is the most readily available hardwood timber in the country, but the quality on offer is very variable, and only a small amount is top quality.

The sapwood is creamy white and the heartwood ranges from yellowish brown to dark brown. Irish oak is often darker in colour than continental European oak. Growth rings and pores are distinct, giving a marked grain structure to the wood. Quarter sawn wood shows attractive silver grain. A medium density wood (720 kg/m^3), it is tough and durable.

Uses

Low grade:	fencing, firewood
Middle grade:	cladding, construction, exterior trim, flooring, rustic furniture, beams
Top grade:	joinery, cabinetry, flooring, panelling, veneers.
Quality butts:	high class and figured veneers.

Market requirements

Light colour; straight cylindrical stem; uniform growth; blemish-free stems.

Management for quality

Early shaping is recommended, but may not always improve form; thinning needs to be conservative to prevent growth of epicormic shoots, otherwise these must be removed annually; aim for large (70cm d.b.h.) clear stems for veneer logs to maximise value with a rotation of 120+ years for pedunculate oak and 150+ years for sessile oak.

Ash

Timber

White to light brown with little or no distinction between sap- and heartwood; growth rings and pores are distinct giving pronounced grain; may have irregular dark brown to blackish heartwood which is structurally sound and can provide an attractive feature known as olive ash. A medium density wood (700-800kg/m^3), it is non-durable.

Uses

Low grade:	firewood
Middle grade:	flooring, tool handles (short clear lengths can be recovered from somewhat knotty timber)
Top grade:	furniture, cabinetry, flooring, plywood, veneers
Quality butts:	hurleys (preferably before the tree is 40 years old)

Market requirements

Unless otherwise sought, light, even colour; straight cylindrical stem; uniform growth with large annual rings (4 - 5mm) for strength.

Management for quality

As ash has good apical dominance, formative shaping may not be required, but where frost damage to the leader occurs it is recommended. Ash is one of the best trees for natural pruning and a stocking rate of 3,300 stems/ha should obviate the need for pruning, but in a native woodland regime pruning may well be required. Ash needs to be grown vigorously and appropriate thinning is essential. Although it is very site specific, ash is capable of producing large volumes of high quality timber over a short rotation on suitable sites. For this reason it is potentially one of our most valuable species and with hurley butts in short supply, prices of 400 per m^3 are attainable.

Wild cherry

Timber

Not frequently found in Irish woods, this attractive tree can supply valuable timber. Wild cherry is a fine-grained timber, with distinct growth rings. Sapwood is a yellowish red colour; the heartwood, when fresh, is only slightly darker but darkens to light golden-reddish brown. It is a highly decorative and valued timber. It is of medium density (600/kg/m^3).

Uses

Low grade:	firewood and woodturning
Middle grade:	furniture and cabinetry
Top grade:	high-class joinery, furniture and cabinetry, panelling and veneers.

Market requirements

Top grade logs must be completely blemish free with good colour. Standing trees are hard to assess due to interior damage. Planking logs should have a mid-diameter greater than 35cm and veneer logs over 45cm. In Ireland a 25cm log is considered big. Defects will cause the log to be downgraded from veneer to sawlog quality.

Management for quality

High value cherry can be produced over a 50 - 80 year period. In Germany prices in excess of 500/m^3 have been realised. As cherry does not shed its branches pruning is essential, up to 6m on final crop trees. Pruning should be carried out between June and August; do not leave pruning to the winter months.

Birch

Timber

The timber of both species, *Betula pendula* and *Betula pubescens*, is similar but *B. pendula* has better log form. An even textured pale whitish yellow wood with no distinction between sap- and heartwood, birch is generally straight grained, and gives a good finish. Medium density of 600kg/m^3. The wood is non-durable.

Uses

Low grade:	firewood, pallet wood
Middle grade:	furniture carcassing, flooring, rustic furniture, kitchen utensils, industrial grade plywood
Top Grade:	furniture, panelling, plywood.

Market requirements

The market for birch in Ireland is not developed. Logs should be straight, defect free as far as possible and sound. Logs greater than 15cm diameter are not readily available.

Managing for quality

Birch is an invasive species and may encroach on other trees. As it is a small tree, reaching maturity at about 60 years, occasional birches in a native woodlot may not be of commercial value. It has good apical dominance, so shaping would rarely be necessary.

Alder

Timber

A light to medium reddish brown wood, somewhat coarse in texture, sapwood being straw coloured. Growth rings are discernible but not very obvious. The density is around 400kg/m^3, which makes it a fairly soft wood. The colour of Irish alder is not as good as American - the latter having a richer, redder hue.

Uses

Furniture and doors, if the stock is large enough.

Market requirements

The market for alder is poor in Ireland, but could be developed.

Management for quality

There is little Irish experience growing quality alder. A tree of wet places, it has been planted, and grows naturally, along river banks and lake sides. It attains full development at about 40 years, thus does not grow to become a large tree. Close spacing will help maintain straightness and reduce branching. Early thinning is essential.

Scots pine

Timber

A light strong softwood, the heartwood is a pale reddish brown colour, while the sapwood remains straw coloured. The density of Scots pine is about 510 kg/m^3. Known as red deal or European redwood, it is the standard by which other utility softwoods are judged.

Uses

Low grade: rough carcassing, pallet wood, fencing, pulpwood
Higher grades: structural timber, joinery

Market requirements

Small branched or knot-free timber fetches a good price for joinery

Management for quality

The tree is self pruning if kept at reasonably close spacing. It is important that branches do not grow too large as this will seriously downgrade the quality.

Yew

Timber

Ranges in colour from a light toffee tan to rich red. The tree, though generally small, can gain considerable girth and is very long lived. Although it is a softwood, it is harder than many hardwoods, with a density of 670kg/m^3.

Uses

Long lengths of yew are rare; most valued for turned craft products and highly prized for veneers, for the manufacture of wall panels, and furniture.

Market requirements

Large sound butt logs are favoured for veneers; smaller material will find local markets for craft work.

Management for quality

Yew is not grown commercially in Ireland, and there are no prescriptions for its management for timber production.

Quality production

Production of timber for the market requires a dedication to maximising quality through the application of good silvicultural practice. As there must be an investment of time, expertise and materials to produce a worthwhile crop of saleable timber, it is important that the process is accomplished in an economic manner. There is a wealth of information available on appropriate management for timber production (e.g. Bulfin1992, Joyce *et al.*, 1998) so this paper will confine itself to some broad prescriptions.

Selection of species suited to the site is of paramount importance. Poor growth performance will make it impossible to afford the required intensity of crop management. Not all sites are capable of adequately supporting a stand of broadleaves, although birch is a pioneer species that will tolerate poor sites. Where the site is marginal for crop production it may be wiser to exclude it, or relegate it to non productive woodland.

Depending on species, formative shaping may be necessary for good stem development. Whereas oak stems are frequently of poor shape, formative shaping may not yield noticeable improvement. Ash, however, does respond well (Bulfin and Radford,1998).

Keeping trees close together in the early stages of development will help to reduce side branching, and will likely improve the overall straightness of stem. Where natural shedding or suppression of side branches does not occur, pruning of selected final crop trees will be necessary. It is important to prune before heartwood develops in the branches, to avoid disfiguring knots and pruning wounds that may allow decay to enter the tree. Timber buyers do not want knotty timber, so every attempt must be made to reduce branching in the lower stem to a minimum.

Thin regularly, and according to prescription, to maintain vigour in the crop. Constant growth rate is important to minimise drying and working defects in the converted timber. Some species, if unduly crowded as the canopy closes, may stagnate and prove difficult to reinvigorate again when thinned. Over thinning in oak must be avoided, as an increase of light to the stem will encourage the development of epicormic branches, thus reducing the timber quality.

An important aspect of management is access to the wood for felling and maintenance. In a native woodland environment the type of access required for mechanised harvesters will hardly be necessary, but for economic extraction of saleable timber there must be reasonable access for a chainsaw crew and hauling unit. If access is problematical, it will be accounted for in the price offered for the timber. The alternative is to organise felling and extraction and offer the timber for sale felled and at roadside. Even in that situation, ease of access will reduce costs. The quality of the felling crew has a serious impact on the value of the timber offered for sale. The amount of hardwood timber sold annually is such a small fraction of total timber sales (softwoods and hardwoods) that there is great difficulty in getting competent felling crews. There is not enough work in any one locality for hardwood felling crews, so they either have to travel extensively or engage in other operations. The net result is that there is a significant lack of skill in felling hardwoods. Unlike the uniform nature of softwood logs, hardwoods are much more varied and require knowledge of the market, saleable lengths and quality logs to ensure that the timber is presented to the buyer in the best possible assortments. Incorrect bucking, or cross-cutting can result in a significant loss of value to the purchaser. Frequently the best option is to present the full tree length for the buyer to assess, who can then indicate how he wants the logs presented. It is well worthwhile to become familiar with log quality so that one can ensure a fair price. Table 2 below shows the range of prices that one may expect to receive for hardwood logs at roadside.

Table 2. *Indicative prices for commercial logs at roadside*

Species	Grade	Price (€/m³)
Oak	A 40cm + diameter	130 - 170
	B	110
	C	50 - 85
	thinnings	35 - 55
Ash	Hurley butts	up to 400
	A	60 - 90
Cherry	Good straight logs	130
Birch	A	65 - 80
	B	30-4

(Heaney & Doyle, 2004)

Market

The market chain is producer to feller, sawmill, manufacturer and end user. Because Ireland's hardwood resource is small, we have imported hardwoods in quantity, for a long time; much of it tropical. Manufacturers have traditionally expected high quality - originally clears or firsts, but currently FAS (firsts and seconds) - and are reluctant to settle for less. Such high quality can only be guaranteed when there is an abundance of supply, which is not the case in Ireland. Seconds and thirds can be quite successfully processed and, it appears, end users do not have the same difficulty accepting such grades. Whereas the softwood market has come to terms with Irish timber and there is a steady demand for it, the same is not true in the hardwood market. Limited supplies, uncertain quality and lack of information on supplies into the future all mitigate against the development of a satisfactory market for the home-grown product. There are some 25 hardwood sawmills in Ireland, of which four to five have kiln drying facilities. The conversion and drying of hardwoods is considerably more complex than softwoods. Whereas structural softwoods can be dried in a matter of days, hardwoods may take up to seven or eight weeks to be successfully dried, depending on species and dimensions. The technology exists to properly process home-grown hardwoods, but work needs to be done to improve its market prospects.

Steps that can be taken to improve the market for hardwoods are as follows:

- The Forecast of Roundwood Production (Gallagher & O'Carroll, 2001), published by COFORD, gives figures for potential hardwood production up to 2015, but the breakdown by species is lacking and the databases from which the forecast was derived need to be updated. The figures presented show that no increase in hardwood production can be expected before 2015 at least. A comprehensive survey of the hardwood resource has been initiated, and needs to be concluded without delay.
- Felling and extraction of timber from small woodlots is expensive. The conservative management of native woodlands means that lower volumes are likely, thereby increasing the unit cost in felling and extraction. Management of the forest should take this into account and ease access to the timber. The proposed felling regime should take account of the need for unhindered movement of machinery. The arrangement of coupes could reflect this.
- As the amount of timber to be harvested from native woodlots is likely to be small, it is imperative that the maximum added value accrues to the trees that will form the commercial crop. Intensive management is not only possible in smaller woodlots, where it would be quite impractical in large plantations, but it must become an accepted practice in hardwood stands, as neglect can ruin a potentially valuable crop. Individual hardwood trees of superior form can be worth a lot of money.
- Shaping and spacing are the most important elements in the production of straight and branch-free logs. Many hardwoods benefit from close initial spacing to draw the stems up. Judicious thinning will then release stems that are tall, straight and branch-free, to encourage increment on valuable trees.

Opportunities

- One of the main opportunities is the demand for quality Irish hardwoods. There are buyers on the continent who are asking for Irish timber, but can rarely get it. Industry growth in the last 10 years has been significant, with improved technology among processors and greater awareness among producers of the value of their timber.
- World markets are changing - continental processors are happy with lower grades and hardwood laminates are becoming acceptable, particularly since the introduction of laminated hevea wood (rubberwood) products from east Asia. This means that there should be a greater prospect to produce marketable goods from smaller trees.
- The enormous inroads that have been made into the once vast resource of tropical timber have had a twofold effect. There is a dwindling supply of this material and a growing demand that residual stocks be conserved. The result is a reducing market for tropical timber, certainly in its unprocessed form, and a growing demand for temperate hardwoods produced from sustainably managed forests. Native woodlands are to the forefront in sustainable management, and any produce from such forests has to be well received.

Constraints

- The major constraint is the small volume of Irish hardwoods currently being produced, and likely to be produced over the next 10 to 20 years. From this arise other constraints listed below.
- There are few competent logging crews to ensure that hardwood trees are felled correctly to maximise their yield.
- There is no developed firewood industry to make viable the harvesting of limbs and defective stems, which would do much to improve the financial reward from harvesting hardwoods.
- The limited resource and the complexity of gathering good statistics on the nature and amount of the hardwood resource does not help in planning the development of the industry.
- The conservative nature of the Irish hardwood processing industry further reduces the volume of material that is acceptable to the market.
- Finally, the nature of native woodland development may limit commercial log supply.

Conclusion

Even though the resource is small, there is a need to develop a broadleaf culture through education and promotion. This should entail promoting the use of smaller logs among processors, and advocating that end users specify native timber wherever possible. Maximising the utilisation of hardwoods should encompass biomass and the development of a fuelwood industry (a growing desire to conserve our peatlands may help such development) and a more complete inventory will help the industry develop in a rational way.

A valid aspect of sustainable forest management is that the endeavor should be economically sustainable. In fact, without economic sustainability the maintenance of native woodland to exclude intrusive non-native species could well be jeopardised. There could be several sources of income to sustain the woodland, and one of those is undoubtedly the supply of quality, native hardwoods, which need not compromise the main objective of conservation. There is every need to develop a hardwood resource in Ireland, and suitable management of native woodlands could be a significant contributor to that resource.

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THE POTENTIAL FOR NON-TIMBER FOREST PRODUCTS IN IRELAND

Dr. Sasha van der Sleesen
Sylvan Consulting Ecologists and Forest Management Group, GMIT
30A Ashleigh Grove, Galway
Email info@sylvaneco.com or sashatrees@hotmail.com
Tel.: 087-6685836

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Abstract

Non-timber forest products (NTFP) are elements from a forest that can be sold and which do not involve harvesting timber. NTFP comprise a wide range of products, from Brazil nuts to carbon sequestration. NTFP are often associated with the diverse forests of the tropics, where forest foods and fodder may still be important parts of rural livelihoods, but old traditions in Ireland include NTFP such as collecting fruits, nuts, herbal remedies, honey, and leaves for fodder. Potential NTFP in Ireland today include foliage and mosses in floral arrangements, photographs of wildlife, and dyes made from higher plants and lichens.

Other ecosystem services, such as contribution to landscape and conservation of biodiversity, are also important potential products but are harder to value because they are only sold indirectly in the marketplace. These services, however, may be essential either for human physical health, such as protection of watersheds from flooding, or psychological health, such as places that inspire artists and places for people to recreate.

It is important not to assume that any elements of an ecosystem can be harvested without consideration of population dynamics and ability to replenish. Bryophyte harvesting currently ongoing in North America, for example, may be unsustainable as branches cleared five years ago have not yet regrown their moss mats. Biodiversity is a key concept in forest policy today, and therefore using any aspect of the diversity, whether trees or other components of the ecosystem, should be undertaken carefully and with harvest levels deemed sustainable with the best of ecological knowledge.

Introduction

Forest owners often like to have the option of generating income by selling products from their forests. Timber has for years been seen as the primary product to be derived from Irish woodlands, but recently other forest products and services have been gaining attention. Non-timber forest products (NTFP) are elements of a forest that can be sold but do not involve cutting timber. NTFP comprise a wide range of products, from nuts to resins to carbon sequestration. They can be used directly by the people harvesting them, sold regionally, or exported. The total value of world trade in NTFP is estimated to be about US$11 billion (www.tropenbos.nl).

Definitions

NTFP are biological resources that are not timber and which can be harvested from forests for subsistence and/or for trade. There are several different terms used to refer to non-wood products, many of which have definitions that are slightly at variance with one another. It is important to be aware of the exact meaning of a term to know the boundaries of the topic under discussion. For example, some definitions of non-timber forest products exclude marketable services, such as carbon sequestration or coppice rods. Table 1 presents common terms and the limits of their definitions:

Table 1. *Common terms used to refer to forest products and services not including timber*

Term	Meaning	Includes	Limitations of term
Non-timber forest products	Products (can be sold in marketplace) harvested from a forest that do not include timber.	Nuts, sap products like maple syrup and birch beer, mushrooms such as truffles, fruit and honey.	Focus on products. Place of wood products like coppice and carbon sequestration not clear.
Non-wood forest products	Similar to NTFP but a greater emphasis that all wood and bark products are excluded.	Similar to NTFP	Focus on products. Wood products such as coppice and bark mulch excluded. Place of carbon sequestration unclear, as wood is the main store of carbon.
Alternative forest products	Products alternative to the main product (generally timber).	NTFP plus wood products such as elm burrs for high value furniture, coppicing, fresh stems as fodder for elephants in zoos.	Implies only one main product and that other products are subsidiary
Minor forest products	Products harvested in smaller numbers or bringing less income than the major products.	Same as above.	Implies one or more main products and that other products are of lesser importance
Ecosystem services	Four subgroups: provisioning (food, water, fuel, fibre, genetic resources, biochemicals), regulating (climate, disease, water), supporting (soil formation, primary productivity), and cultural (spiritual, aesthetic, recreation, educational) services.	All forest products, timber and NTFP, plus services such as carbon sequestration, conserving biodiversity, and landscape.	Broad but this broadens the definition of possible products. Linked to human well-being rather than marketplace. Some services are hard to price although valuable. Not specific to forests.

In this article, the term non-timber forest products will be used, but the broad concept of ecosystem services will also be kept in consideration.

Another way of considering the wide range of products provided by forests is that of De Groot (1992). He describes the functions or role of nature, including forests (see Table 2). Consideration of these functions of nature may help to broaden perceptions of possible forest products and services.

Table 2. *Functions of nature (De Groot, 1992: 15, explanation pp17-138, see also Hart, 1991; Kassioumis, 1981; Madras, 1984: 129-144; Van Maaren, 1984: 6)*

Function	I/D*	Function	I/D*
Production functions			
Oxygen		Water (for drinking, irrigation, industry, etc.)	I
Food and nutritious drinks	D	Genetic resources	D
Medicinal resources	D	Raw materials for clothing and household fabrics	D
Fuel and energy	D	Fodder and fertiliser	D
Raw materials for building, construction and industrial use			D
Information functions			
Aesthetic information	I	Spiritual and religious information	I
Historic information (heritage value)	I	Cultural and artistic inspiration	I
Scientific and educational information, from schools to environmental monitoring			I
Carrier functions: providing space and a suitable substrate for			
Human habitation and (indigenous) settlements	I	Nature protection, which may be combined with other functions such as genetic diversity, water protection, etc.	I
Energy conversion		Recreation and tourism	
Cultivation (crop growing, animal husbandry, aquaculture; types that allow conservation are shifting agriculture of small areas, agro-forestry, and selection cutting)			D/I
Regulation functions			
Protection against harmful cosmic influences		Regulation of local and global energy balance	
Regulation of the chemical composition of the atmosphere		Regulation of the chemical composition of the ocean	
Regulation of the local and global climate (including the hydrological cycle)	I	Regulation of runoff and flood-prevention (watershed protection)	I
Water catchment and groundwater-recharge	I	Prevention of soil erosion and sediment control	I
Formation of topsoil and maintenance of soil fertility	I	Fixation of solar energy and biomass production	D
Storage and recycling of organic matter		Storage and recycling of nutrients	
Storage and recycling of human waste including pollution, sound, dust, etc.	I	Regulation of biological control mechanisms including pest control and pollination	I
Maintenance of migration and nursery habitats	I	Maintenance of biological (and genetic) diversity	I

* D = direct product; can be harvested and sold from the forest (possible NTFP).
I = indirect; important product that can be priced through indirect means but forest owner usually not rewarded with income
(Blank) = support; a crucial and usually unrecognised function with supports and maintains human life.

Table 2 shows the astonishing array of services provided by forests and other ecosystems, many of which are often taken for granted. Until recently, it has been common practise to value only those services that can be sold through the marketplace, i.e. the products. These are classified with a 'D' for direct pricing in the table above. The limitation of this type of valuing is that many contributions of natural ecosystems are sold indirectly, such as a landscape that attracts tourists, or represent benefits which accrue to the general population, such as flood prevention. In these cases, estimating the cost of replacing the function is the only way to assign a financial value. There are currently movements both to expand the valuation of services beyond the traditional marketplace valuation (see Alcamo *et al*., 2003) and to acknowledge the growing interest in the purchase of previously non-market services (see Pukkala, 2002 and http://www.forest-trends.org/whoweare/pdf/bc2000/bc2000_proceedings2.pdf). This means that consideration of what NTFP could be harvested from Irish woodlands may include broader, indirect services, such as maintenance of the diversity of life.

A broad range of ecosystem services should always be kept in mind with regard to NTFP in Ireland. Cultural services, such as education, heritage, and artistic inspiration, are important services of nature. Medieval Irish nature poetry abounds with examples of artistic and spiritual inspiration from ecological processes:

> *The music of the woodlands is like the playing of harps; the melody brings perfect peace; a haze rises from every hill-fortress, a mist from the full-pooled lake.*
> *(Old Irish poem dated at around the 7th century, trans. Carney 1971 quoted in Smyth 1996: 308-9; see also poems in Jackson 1935).*

Another example of the cultural significance of natural processes in the past in Ireland is auguring: an early lawgiver describes how a just king brings benefits to his people, including a good crop of tree fruits, fertile women and crops, full milk in the cows, many fish in the rivers, and peace in the country; an unjust king brings catastrophe such as defeat in war and famine on the people of his nation (Kelly, 1997; MacNiocaill, 1988). In the 12th century, Connaught leader Rory O'Connor was supported in his bid to become high king, at least in part because omens of good fortune were seen in the abundance of nuts and other things created by God in 1168 (Ó Cróinín, 1995).

Although these support and cultural functions may arguably be the most important services provided by ecosystems, owners are more likely to consider direct products that can be sold in the marketplace. One way to consider these is to look at what products were derived from Irish woodlands in the past.

Products – direct harvest in the past

Food, medicine, dyes, and fibres from woodlands were used in the past in Ireland, and this may give some indication of potential NTFP today. For example, wild garlic (*Allium ursinum*) was a common food, and an annual garlic feast in the early spring, consisting of wild garlic with cheese and milk was part of the rent given to the lord (Kelly, 1997: 309). Other food plants were pignut (*Conopodium majus*; the tuber is what is eaten), nettle (*Urtica dioica*), and sorrel (probably *Oxalis acetosella*), although the last two were eaten primarily when other food was not available (Kelly, 1997). Hazelnuts (*Corylus avellana*), which can be kept over the winter, were sold, while acorns (*Quercus* sp.) may have been eaten when other food was hard to get (Kelly, 1997). A wide variety of woodland fruits were collected for food, including cherry (*Prunus avium*), rowan berries (*Sorbus aucuparia*), crab apples (*Malus sylvestris*), elderberry (*Sambucus nigra*), hawthorn berries (*Crataegus monogyna*), sloes (*Prunus spinosa*), rose hips (*Rosa* sp.), blackberry (*Rubus fruticosus* agg.), bilberries (*Vaccinium myrtillus*), and strawberries (*Fragaria vesca*; Kelly, 1997). Apples were highly valued, as they provided a source of vitamins during the winter, and the wild plant was brought into cultivation by the 8th century (Kelly, 1997). Bilberry (*Vaccinium myrtillus*) was found in Dublin excavations of Viking and Anglo-Norman times, while Irish language documents show that it was considered so valuable that it was included in the gifts presented to kings (Kelly, 1997). An 18th century physician noted that many plants were sold on the streets of Dublin for medicine, including bilberries, and also royal fern (*Osmunda regalis*) for obstructions of the liver (Nelson, 1991). Many of these products are still in use today. For example, herbal treatments including hawthorn, birch leaves, and nettle can be found on the shelves of many contemporary Irish herb shops.

Woodland plants were not only used as human food but also to feed domestic animals. Fodder plants included elm (*Ulmus* sp.) and holly (*Ilex aquifolium*), which was used in winter and scorched to remove the prickles (Kelly, 1997; Neeson, 1991; Lamb & Bowe, 1995). Other NTFP included the production of game and domestic stock: pigs (but not cattle) were grazed in medieval Irish woodlands with acorns being a prime pig-feed, and some birds found in or near woodland were hunted, including woodcock, snipe, wild duck, red grouse, and wild goose (Kelly, 1997).

Plants were also used for fibre and dyes. Bracken (*Pteridium aquilinum*) was used for making soap, bedding, and bleaching linen (Neeson, 1991), while elm bark was used to make ropes (Kelly, 1997). Pine resin was used for caulking boats (Kelly,1997; Neeson, 1991). Although social norms dictated the colours people could wear, plants provided the colours: bracken for a yellowish green, lady's bedstraw (*Galium verum*) for grey, and juniper (*Juniperus communis*) for brown (Kelly, 1997).

NTFP in the temperate zone today

Another way to explore possible non-timber products from Irish woodlands is to look at products currently being extracted from other temperate forests. Ciesla (2002) reports many different types of NTFP in use in temperate Europe, mostly for food and drink, including:

- beer, wine, spirit and vinegar made from birch sap (*Betula* sp.),
- jam and cider from the red berries of the whitebeam and rowan genus (*Sorbus* spp.),
- preserves, wines, salad dressings, and desserts from hawthorn berries (*Crataegus mongyna*),
- wine, pie, lemonade and herbal teas made from elderberries (*Sambucus nigra*)
- jelly and liqueurs made from the fruit of the strawberry tree (*Arbutus unedo*) in the Mediterranean region,
- coffee substitute and food from the acorns of the pedunculate oak (*Quercus robur*),
- oil for cooking, coffee substitute, and fodder for pigs from the nuts of the beech tree (*Fagus sylvatica*),
- nuts, nut chocolate, flour for bread, and edible and industrial grade oil from the hazelnut tree (*Corylus avellana*), and
- edible mushrooms including truffles (*Tuber melanosporum*, *T. magnatum* and *T. aestivum*) and morels (*Morchella* spp.).

Considering the range of NTFP produced in the past in Ireland and those which are still being harvested from temperate forests, what can we conclude? The potential NTFP for Ireland today are luxury items, like wild forest mushrooms or ornaments which remind us of either the relaxation from being in nature or the inspiration one can find in natural forms. Possible products include mushrooms and herbs, ferns and holly for decorations, bryophytes and lichens for floral arrangements, and cloth dyes from plants and lichens. Additional products might be identified by considering the broad list of forest functions listed by De Groot (1992), including ornaments, energy and raw materials for fabrics. Large-scale, cost-effective production is not the aim, as the likely customer for NTFP in Ireland is someone who is willing to pay more for ecologically sensitive or local products. They are likely to be concerned about the environment and to seek and be reassured by quality labels such as a certification standard label. This is because these environmentally conscious customers may be aware that harvesting components of a forest ecosystem could affect the balance of processes within that ecosystem.

Harvesting NTFP

One of the misconceptions often held about NTFP is that they are 'greener' or their harvest is inherently less damaging to the ecosystem than harvest of other products, such as timber. Transport is an environmental cost: Irish grocery stores are currently selling bouquets of flowers which contain greenery from the Pacific Northwest of the US ('salal'). The use instead of local material would keep income local and reduce the environmental cost of ships or planes carrying floral material around the world. In addition, NTFP can be overharvested, and their harvest can affect the abundance of other species. The amount of harvest that will not damage the continuation of the population depends on the population dynamics of the target species, the proportion harvested, and whether the other components of the environment continue to be suitable for perpetuation of the population. In the forests of northwestern North America, bryophytes are harvested for the floral trade, and the target species include some which also occur in Ireland such as *Isothecium myosuroides* (Brid.) and *Rhytidiadelphus loreus* (Hedw.; Peck, pers. comm.). One could thus conceivably harvest these species in Ireland. However, the standard method is to remove the entire mat of epiphytic bryophytes, including bryophyte species that are not used by the floral industry, and later sort the material, discarding the unwanted species. A comparison study also found that these bryophyte mats contain nearly 200 species of macro invertebrates (Peck, pers. comm.). These species, some of which may be rare, are being removed from their habitats and then discarded as they are not of use to the florists (Peck, pers. comm.). In addition, a study monitoring recovery of the mats (Peck, pers. comm.) found that the epiphytic bryophyte mats have regrown after five years to cover the branch but not as thickly. The volumes of the five-year-old mats average about $1/5^{th}$ of the pre-harvest volume. These results indicate that expected recovery time, or 'rotation', is fifteen to twenty years (Peck, pers. comm.). In the Irish context, with low woodland cover, these results imply that the quantity of bryophytes that could be sustainably harvested in Ireland is low. In addition, loss of rare species remains a concern in any removal of large amounts of material, especially that containing many species that are small and therefore easily overlooked.

Conclusions

Potential NTFP in Ireland today include mushrooms, foliage and mosses for floral arrangements, wildlife photographs, and dyes made from higher plants and lichens. The very broad range of services that ecosystems provide should be considered when searching for new potential NTFP. The potential customers should also be considered: they are likely to be people who are concerned about environmental issues and have the finances to pay for a luxury products. Implementation of a quality label such as the Forest Stewardship Council (FSC) standards for NTFP would help increase the marketability of Irish NTFP (see, for example, http://www.rainforest-alliance.org/programs/forestry/smartwood/certification/non-timber-forest-products.html).

It is important to recognise that non-timber forest products cannot be harvested in bulk from forests without consideration of population dynamics, effects of accidental removal of non-target species, and the ability of both target and non-target species to replenish themselves. The bryophyte harvesting for the floral industry currently taking place in the large forests of the Pacific Northwest of the US, for example, may be unsustainable and would be untenable in the smaller forest areas of Ireland. Biodiversity is a key concept in forest policy today; therefore, harvesting any component of the forest, whether trees or other components of the ecosystem, should be undertaken carefully and at sustainable levels of harvest. The quantity and frequency of harvesting must be based on the ecology of each species and its place in the ecosystem. Small organisms, such as the bryophytes mentioned above, may have very limited dispersal mechanisms, making the reinvasion of a 'cleared' site difficult. Fungi, however, may be more resilient to harvesting (see Dowding, this volume) and luxury mushrooms for consumption may be the most suitable NTFP available from Irish forests.

Harvesting, whether of timber or non-timber products, is only sustainable if it avoids damage to the continued functioning of the whole ecosystem. Relatively little is known about many of the small organisms in our woodlands, and therefore use of any NTFP must follow the principles of 'adaptive management', collecting data continually and using it to tweak the management (see http://www.iucn.org/themes/cem/ea/docs/ecosystem_approach.doc). Continued unimpaired functioning of the whole ecosystem should be the primary objective in management and harvesting in Irish woodlands today.

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NATIVE WOODLAND DEVELOPMENT: THE UK EXPERIENCE

Gordon Patterson, Forestry Commission Scotland
231Corstorphine Road, Edinburgh EH12 7AT
Scotland, UK
Tel. ++44 131 314 6464
Email: gordon.patterson@forestry.gsi.gov.uk

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Abstract

Interest in native woodlands in the UK has increased exponentially since the 1980s and they have moved from a fringe interest to become part of mainstream forestry, well embedded in policies and practice. Initial effort focused on site protection in designated sites and ancient woodlands and these remain core concerns. But ambition and action have progressively moved to native woodland restoration on ancient sites, improving condition of degraded woods and expanding the area of native woods (through new planting, natural colonisation and conversion of 20th century plantations). Grants available to woodland owners have been key tools alongside management and restoration of the national forest estate. Developing techniques for restoration and establishment of new native woodlands with a native character is still a technical challenge in some situations. But policymakers and practitioners also increasingly have to address larger-scale, joined-up thinking and planning to overcome the limitations of managing fragmented sites, which appear even more vulnerable in the face of climate change.

Creating networks and mosaics of native woodland areas, which are functionally linked to benefit both woodland species and processes, is increasingly the ambition to ensure the best chance of healthy native woodland ecosystems in the future. Although driven initially by nature conservation concerns, the increase in the native woodland resource will mean there will be room in future, for a diversity of types and of approaches to management, ranging from productive native plantations to minimal intervention reserves.

Introduction

This paper attempts to give a rapid overview of the revival of action for native woodlands which has occurred in the UK over the last 20 years. It focuses largely on management policies and programmes and the author recognises that the social and cultural aspects of the native woods revival would merit a paper of their own.

The historic decline of native woodlands

At their peak, in the early post-glacial period, native woodlands may have covered as much as 80 % of the land surface of the UK. The original forest was whittled away over the last 5,000 years or more. The relative contributions of man and changing climate to this loss are a matter of continued interest and debate.

By the early medieval period, the increase in population and agricultural development had caused woodland cover to shrink to around 15%. It continued to decline to a low point of 5% by the end of the Great War in 1918, despite significant planting of native and introduced species from the 17th century onwards.

Outside the most remote areas, the woods which survived were generally those which were useful to somebody, whether as Royal hunting forests such as the New Forest, or as sources of wood, forage and shelter for local communities and their livestock, and later as industrial timber sources for ship building, charcoal and tanning or coverts for game sports. Because of their long continuous history of human use and influence, those ancient woodlands which have survived and retained a more or less native character, are a priceless biological and cultural asset.

Woodland loss and fragmentation, as well as human persecution contributed to the loss of many larger species like beaver, bear, bison, auroch, wolf, elk and wild boar, (all extinct by the 18^{th} century). And in the last 2-3 centuries pine marten, red kite, polecat, red squirrel, capercaillie, roe deer and wild cat also disappeared from large parts of the UK.

Forest expansion-native woodland neglect

The Forestry Commission was formed in 1919 to reverse forest losses and to rebuild a strategic timber reserve, by which time native woodland cover was probably as little as 2.5% of a total of 5% woodland cover.

Since then woodland cover has grown from 5% to 11.6% in the UK (Forestry Commission 2003). But until the late 1980s most of the expansion was achieved with imported species, mostly those with the highest potential growth rate and commercial value. Indeed there was continuing loss of native woodlands by conversion to conifer plantations (over a third of all ancient semi-natural woodlands between the 1930s and mid-1980s), clearance for intensive agriculture and to developments like roads and housing in the lowlands and gradual loss through overgrazing in the uplands. (Kirby *et al* 1989).

One reason for the neglect of native woodlands in this period was the decline of the traditional rural woodland economy as markets changed and labour costs increased. Broadleaved woodlands were seen as unproductive and expensive to work. As post-war affluence and mobility encouraged greater interest in recreation, landscapes and nature conservation, forestry found itself challenged to broaden its objectives from timber and afforestation alone in order to conserve and revitalise the remnants of native woodlands. Recently the burgeoning community movement has sought more influence and benefits for local communities and there has been a stronger focus on increasing added-value from native woodlands for rural economies.

The renaissance of native woodlands

In the early 1980s, the then GB nature agency, the Nature Conservancy Council, compiled inventories of ancient woodlands in England, Scotland and Wales, (Kirby *et al* 1989). These were inspired by Dr George Peterken whose research in eastern England had shown the importance of a continuous history of woodland for conserving the more sedentary and specialist species of woodland plants and animals. (Peterken & Game, 1984).

The inventories used historic records to identify areas of 'ancient' woodland sites, which were present by the 17^{th} or 18^{th} century and have been wooded continuously to the present day. Ancient woodlands include an unknown mixture of primary woodlands (present without clearance from post-glacial times) and secondary woods which had arisen or been planted after a period of clearance in historic times. Ancient woods were also classified as currently either semi-natural or planted stands, with cases of doubt usually being classed as semi-natural. The 'ancient and semi-natural' woodlands typically have higher value for biodiversity conservation than more recent or planted woods.

This work highlighted the rate of loss of ancient and semi-natural woods, which had occurred in the previous four decades and led to a seismic policy change.

The 1985 GB Broadleaved Woodlands Policy (Forestry Commission, 1985) required ancient woodlands to be safeguarded and recognised the importance of bringing broadleaved woodlands back into active management if they were to be maintained for the future. And it called for expansion of broadleaved woodlands by planting new areas of both pure broadleaves and mixtures. A grant scheme was introduced to give incentives with higher rates than for conifers, recognising higher establishment costs and lower profitability.

Over the same period, the plight of the native pinewoods of Highland Scotland was being recognised, helped by pioneering restoration efforts in places like Glen Affric and Black Wood of Rannoch in response to a survey by Steven and Carlisle (1959), and also an international conference held in 1975 (Bunce & Jeffers, 1977). The truly native pinewoods had once extended over perhaps a million hectares but by the 1980s they were now confined to as little as 12,000 hectares.

A pinewoods grant scheme was introduced in 1977 and was enhanced in the late 1980s, to pay for regeneration and planting with local origin pine stock in both existing and new native pinewoods. Promotion of new native pinewood has been particularly successful with over 50,000 hectares of new pine and birchwood established so far.

The switch in 1988 from tax relief for afforestation to grants with enhanced rates for broadleaved species and native pine was a turning point in UK forestry, when large-scale conifer afforestation declined and the balance of new planting shifted towards native species.

Native woodland types in the UK

The 'woodland antiquity' and 'semi-naturalness' categories developed in the ancient woodland inventories have proved valuable as an indicator of biodiversity and cultural values, and have been incorporated into nature conservation and forestry policies and planning guidance.

Ancient semi-natural woodlands are the most important of all for biodiversity as they harbour a greater concentration of specialist and sedentary species. This distinction between ancient semi-natural woods and more recent native woods has proved to be more marked in lowland arable landscapes than in upland semi-natural landscapes, where many woodland species can move through or persist to some degree in open areas.

Planted native woods can eventually develop a structure and composition like those of semi-natural woods, making it hard to distinguish them in the field. A broad classification of 'native woodland' including all woodlands composed mainly of native species, with a subdivision to recognise antiquity and semi-naturalness where these are known, is becoming more popular. It has been used for the UK Habitat Action Plan types for example (Department of the Environment, 1994; UK Biodiversity Group 1995-1998, 2004).

Ecological classifications of native woodlands

The National Vegetation Classification (NVC) system (Rodwell *et al* 1991, Whitbread and Kirby 1992) has become the main system in the UK since the late 1980s. It is widely used in surveys and has proved valuable in developing predictive guidance on woodland type and tree species composition for new or restored native woodland sites (Rodwell & Patterson 1994, Ray 2001, MLURI model). The NVC recognised 19 native woodland and 6 native scrub types.

Based on work by Dr Peterken, the Forestry Commission developed a management classification of 8 broad types of semi-natural woods based on stand and NVC types, and published policy and best-practice guidance for each, in a series which remains the core guidance on managing native woodlands (Forestry Commission 1994). These types were also used as a basis for defining priority woodland types for the development of Habitat Action Plans (Hall & Kirby, 1998).

Policy

Following devolution to Scotland and Wales, policy is decided at country level and England, Scotland, and Wales all have Forestry Strategies, which include as key themes conserving, improving and extending semi-natural and native woodlands and restoring ancient woodlands. Northern Ireland is also preparing a forestry strategy. Native and ancient woodland policies are under revision in both England and Scotland. However, at present, the UK Forestry Standard (Forestry Commission 2004) and the Forestry Practice Guides for the Management of Semi-natural Woodlands remain the best summary of principles and best practice throughout the UK. The ***Management Principles*** set out in these guides are to:

- Maintain semi-natural woodland types;
- Maintain or restore diversity of structure;
- Improve the diversity of species where appropriate;
- Maintain diversity of habitat;
- Maintain a mature habitat;
- Minimise rates of change; and
- Use low-key restocking techniques.

Further guidance has recently been published on restoring native woodlands on ancient woodland sites, which have been converted to non-native plantations during the 20th century. (Thompson *et al*, 2003). Full restoration is advised on high priority sites whilst partial restoration options can be more suitable for lower priority sites. And the pace of restoration should often be gradual: if a woodland canopy can be retained and exotic species gradually removed it helps to retain any ancient woodland wildlife that remains.

Management Systems

Every woodland is different and should be considered on its own merits and in relation to the owner's objectives. Management planning is vital and should include several key elements: description, evaluation, objectives of management, long term strategy and short term proposals, and finally monitoring, with feedback to revised objectives. These may seem obvious steps, but are not always applied. In response to new initiatives or short term funding streams, there can be a temptation to underplay evaluation and long-term objective setting, in addition to the monitoring of outcomes; and instead to focus on short term actions which may not always have a clear rationale.

In protected areas, the opposite tendency may be detected: an emphasis on survey and monitoring and a nervousness about intervention in case something is lost or the wrong action is taken.

A thorough approach to management planning is becoming more widespread however, and survey and evaluation is now expected for grant schemes and for management of native woodland in state forests.

The main management options for UK native woodlands are, in no particular order:

- ***Low intervention with little or no silvicultural management***
  Suited to strict nature reserves and many of the more remote and less intensively managed native woods, or elsewhere where objectives are primarily to promote a relatively natural development and secure the long-term survival of the wood with all its key elements. There is rarely a prospect of complete non-intervention in the UK, even in the larger native woodland areas. Control of browsing animals in the absence of their natural predators is needed almost everywhere. And in the smaller managed woods, continued silvicultural management is usually required if they are to retain a diverse structure and composition.

- ***High forest systems,*** with a range of silvicultural systems, ranging from individual tree and group selection to small-scale felling coupes.
  Many native and ancient woodlands have been managed as high forest in the past or reverted to a high forest structure after a phase of coppicing. Most of the former coppice is best suited to high forest systems in future, except perhaps where a long period of coppicing has ended within the last few decades. The timber quality of many stands is poor. This is partly because of silvicultural neglect, but in the uplands, harsh conditions, over-grazing and burning on moors are also important factors.

- ***Coppice and coppice with standards***
  Organised coppice systems were common in the lowlands for many centuries but in the uplands, coppice systems were probably widespread only for relatively short periods in the last 3 centuries, where industrial markets such as bobbin-making, charcoal for smelting and tan-bark made it profitable. Traditional coppice has been maintained or revived in many places, mainly in lowland England, and there has been a mix of revived craft markets, often precarious, and newer markets like charcoal for barbeques and firewood. Wood energy developments could provide a future boost for coppice systems.

- ***Wood pasturage***
  Some ancient lowland royal hunting forests and parklands associated with country estates still have traditional wood pastures with scattered old trees, often former pollards. These old 'veteran' trees retain a high proportion of the rarer lichens, fungi, and dead wood insects which remain in the UK lowlands, often associated with locally rare remnants of unimproved grasslands. The upland native woodlands have more widespread forms of wood pasture often the result of fluctuating periods of light and heavy grazing. But there is growing evidence of a long history of more managed pasturage and pollard systems in the uplands as well.

Biodiversity Action Plan Targets

Since 1995 the UK Biodiversity Action Plan has been developed in response to the 1992 Convention on Biological Diversity. A set of native woodland priority habitats have been defined as part of the 45 priority habitats in the UK, and they support many of the UK priority species. UK wide targets have been set for native woodland Habitat Action Plans. (UK Biodiversity Group 1995-1998, 2004). For each type of native woodland there are quantitative targets for the period up to 2010-2015 for :

- *Maintaining current total area and extent of native woodland types*
- *Improving condition of existing native woodlands*
- *Restoring areas of non-native woodland on ancient woodland sites back to native woodland (about 10% of each type)*
- *Expansion (of about 10%) by creating new native woods and by converting non-native plantations to native woodland*

This process has been important as a driver and in helping to prioritise action both nationally and locally. Progress is reported in a consistent manner at three-year intervals. While the BAP is sometimes criticised for creating a new 'bio-bureaucracy', it has provided a valuable stimulus to improve systematic monitoring and reporting of what is happening to our important habitats and species.

Monitoring is being addressed in various ways including the inclusion of native woodland area and condition measures in a UK wide sampling system, the National Inventory of Woodlands and Trees (Forestry Commission, 2002), and recording systems built for activity contributing to targets in grant schemes and for Forest Enterprise, who manage the national forest estate in England, Scotland and Wales.

In Scotland a national native woodlands survey project is being developed with the aim of providing a consistent baseline map with condition information for the first time, although there have been many partial surveys over the last 20 years. (Clifford & MacKenzie, 2004).

The role of protected areas

Semi-natural woodlands were amongst the habitats designated as protected areas called Sites of Special Scientific Interest (SSSI) from the 1960s. This designation was intended to protect a representative range of high value or distinctive sites from development but had modest effect at first. It took several decades and more legislation to improve their effectiveness at preventing deliberate damage or loss through development or damaging operations or activities. Since the 1980s the emphasis has changed from protection and compensation for not doing damage, towards providing positive incentives for good stewardship to conserve the woodland and its designated features.

Even so, owners still did not have to take up these incentives, and sites could suffer through the gradual effects of neglect or customary unsuitable management practices.
Recently legislative measures have been taken in England, Wales and Scotland to remedy this. And management of adjacent land can now be controlled where it could affect the designated features of SSSIs. The strengthened SSSI systems thus now provide similar protection to those of Natura 2000 sites under the EU Habitats and Species and Birds Directives.

For SSSIs a system of site condition monitoring has been developed by nature agencies and is now being implemented progressively for all SSSIs. An adaptation of this is now being developed for assessing condition of the wider native woodlands resource. These condition assessments should drive future allocation of resources for management.

Although designated site management is now increasingly being linked to the management of surrounding areas, many sites are likely to be too small to be resilient in the face of unpredictable events and environmental pressures like climate change. The smaller sites often rely on an intensive gardening approach to conserve all the bits of the wildlife jigsaw through time and may still not be able to sustain populations of vulnerable specialists.

A rethink of the role and distribution of protected areas is likely as part of a move to landscape scale planning and management, to build in linkages and resilience.

Forestry grants for native woods in the private sector

Since the 1980s forestry grants have evolved to help deliver policy for native woodlands and a steadily increasing proportion of native woodlands are now included in grant schemes in each of the 4 countries of the UK. These include grants for improving and restoring degraded native woodlands, eg by removing exotic tree species where harvesting is at net cost, clearing rhododendron in upland oakwoods and dismantling fences that are dangerous to woodland grouse. Management grants have also been paid to help towards the costs of ongoing management to provide public benefits, including the maintenance of rides, glades and coppicing. New native woodlands have been created in substantial amounts, notably for native pine and birchwoods in the Scottish Highlands (over 50,000 ha grant aided since1989), and through 'Challenge' funding projects in the National Parks of England and Wales.

The priority habitats and species in the Biodiversity Action Plan have been targeted in grant schemes developed in recent years. For example the Scottish Forestry Grant Scheme (Forestry Commission, 2003) includes 60% or 90% contributions towards standard costs of approved operations; the higher rate applying to native woodlands and designated sites as well as other priority habitats and species. And to encourage functional linkage in the landscape, new native woodlands are funded at the higher rate where they are sited close to existing native woodlands or are within zones targeted for native woodlands as part of Forest Habitat Network Plans.

Forestry grants are now the main mechanism to achieve suitable management of SSSIs, with nature agencies only funding very specific projects, which are beyond the scope of forestry grants. In Natura sites EU LIFE funds are used to supplement forestry grants to pay for specific additional work to be done.

Encouragement for integrated planning across ownership boundaries has developed in recent years and the integrated rural development agenda following CAP reform is encouraging more integrated forms of planning and incentives across land-use sectors so that agricultural and forestry incentives can be better dovetailed in future.
However, it remains the case, that grants will normally only contribute towards the costs of native woodlands and there is a often an understandable reluctance amongst owners to spend their own money for intangible public benefits in the future which will not accrue to them personally. Education and awareness raising can go some way to overcoming this by motivating individual owners to manage native woodlands sympathetically, and this is an important part of extension services from forestry offices and Forest Research.

Native woods on the national forest estate

The Forestry Commission manages the national forest estates of England, Scotland and Wales (approximately a third of all woodlands but a smaller proportion of native woods), as does the Forest Service in Northern Ireland. They have both made substantial efforts over the last 15-20 years to conserve ancient and semi-natural woods and to restore conifer plantations on ancient woodlands back to native woodlands. (Forest Enterprise England, 2002; Forestry Commission Scotland, 2003). The restructuring of conifer plantations at the end of the first rotation has also provided an opportunity to create new native woods and clumps of native species along streamsides, which can act as future seed sources for further expansion.

Many projects on the FC estate have been developed as partnerships with EU LIFE funds, grants to private owners or NGOs and business funding. Several significant EU LIFE projects have focussed heavily on native woodland SACs since the mid -1990s, including Atlantic Oakwoods, Caledonian Pinewoods, Wet Woodlands, the New Forest, and Alluvial woodlands. These have been valuable, not only in terms of work done in important sites but also in raising the profile of native woodlands and providing exemplars and good practice guidance.

Progress in achieving biodiversity targets

This is hard to assess precisely because of the lack of a sound baseline and monitoring and reporting systems, which can assess native woodlands in terms of woodland type and target achieved. A 2001/2 study (MacKenzie & Worrell, 2003), sampled managed areas in both public and private woodlands and suggested that some targets would be achieved if current action was followed through, but most would probably not be achieved without enhanced activity (and some condition targets would probably not be possible in the short time available, eg where a build up of old trees and dead wood could take many decades). All targets will be reviewed over the period 2005/6 and extended to 2020 and beyond. More integration across habitats is being encouraged to take account of landscape ecology and mosaics of wooded and open ground. Climate change can also be factored into targets if possible, although the various scenarios are still highly uncertain in their effects.

Issues for the future

Much has been achieved over the last 20 years, but it is really only a beginning. There is now a strong focus on improving management and achieving national targets, but some challenges remain and new issues are constantly arising.

Policy issues

We need to develop clearer visions in each country of the UK for the long term roles of native species and native woodlands, ranging from wilderness woodlands through those managed mainly for biodiversity and cultural heritage, to native plantations created for wood production, recognising the values that this broad spectrum can provide and locating them in the best places. The increasing native woodland resource and development of spatial planning techniques should allow scope for a diversity of approaches to develop without threatening the key areas for biodiversity. The management of native woods must engage the interest and support of people nationally and in local communities and be seen as part of rural development strategies. A balanced genetic policy needs to be developed, taking account of climate change implications to guide the use of local and distant provenances and genetically improved or selected stock.

Mechanisms

A regional and landscape scale approach to planning is a crucial challenge to enable best integration with other woods and other land uses, and to build in functional connectivity to native woodlands in the face of climate change, land use pressures and invasive species. Integrated mechanisms for planning and public funding for land management are developing in each UK country and native woodlands need to be built in. Good monitoring and surveillance systems linked to systems for reporting against performance targets must be a priority, and sharing the load in developing and managing data systems is important for informing policies and planning.

Technical challenges

Although the basic management practices for native woodlands are now well known, some challenges remain, for example in terms of promotion and training, deer and grazing management across larger scales, encouraging natural regeneration, developing methods of converting and restoring native woodlands and deciding how/where to enhance wood production values and non-timber forest products in a sustainable way. Stimulating adequate production of suitable local provenance planting stock is also important.

Conclusion

The last 20 years have seen a dramatic reversal of fortunes for native woodlands in the UK and they are starting to recover and expand after thousands of years of decline. But the recovery of our native woodlands will be a long- term business and to see their potential realised, we must work to sustain recent efforts and public support, and to ensure that native woodlands are fully integrated into land management policies and mechanisms.

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