The Restoration of Floodplain Woodlands in Lowland Britain

R&D Technical Report W15

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Research Contractor:
Forestry Commission Research Division

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Publishing Organisation:
Environment Agency
Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol BS32 4UD

Tel: 01454 624400 Fax: 01454 624409

ISBN:HO-8/96-C-AVME

Dissemination status
Internal: Released to Regions
External: Released to the Public Domain

Statement of use
This report describes the findings of a literature review of the potential benefits and problems associated with the development of floodplain woodlands. The report contains recommedations for further literature and field based research. The document will be use to those planning such research and those considering the development of floodplain woodlands, particularly flood defence and conservation staff in the Environment Agency.

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Amendments
Any corrections or proposed amendments to this manual should be made through the regional Agency representative on the Water Resources National Abstraction Licensing Group.

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EXECUTIVE SUMMARY

In Britain, floodplain woodland, which was the natural vegetation cover of most floodplains, has been almost completely cleared and the land drained for agriculture and urban development. There has recently been much interest in the possibilities of restoring this very valuable `lost component' of Britain's flora. This study examines the benefits, risks and possible implementation of such a proposal.

Three main types of woodlands on floodplains[1] are considered:-

1. *Broadleaved woodland* which comprises all broadleaved or mixed woodland on a river floodplain that is no longer subject to regular flooding due to engineered flood control, and is not directly associated with existing watercourses.

2. *Riparian woodland* which comprises mainly broadleaved woodland on land immediately adjoining the watercourse and influenced by it. Normally this would comprise a relatively narrow strip of land along any watercourse, which could function as a buffer from the adjacent agricultural land.

3. *Natural floodplain woodland* which comprises broadleaved woodland in close proximity to the intricate hydraulic system characteristic of river floodplains that are subject to a regular or natural flooding regime. This may require the present river management to be changed over a fairly sizeable area resulting in: (a) water flowing through multiple channels, and (b) a transition from open water, through marsh and vernal ponds, to areas with drier soils subject to infrequent flooding. They would usually consist of native broadleaved species, mainly oak, ash, black poplar, willow, suckering elms, alder, birch and lime. The heterogeneity of aquatic, woodland and open areas creates habitats for a wide range of flora and fauna, with the result that they would have high biodiversity. This type of pattern would be repeated on the landscape scale with woodland forming a mosaic with other land-uses on the floodplain.

The establishment of *broadleaved woodland* on river floodplains is considered to be generally desirable for the water environment but was not the main focus of the study.

The primary benefits of restoring *natural floodplain woodland* would be: pollution control; opportunities to diversify options for flood control; nature conservation because of inherent habitat diversity; the production of quality broadleaved timber; possibilities for improved fisheries and enhancing the landscape of many lowland floodplains. On the other hand, the main risks would be: losing control of unpredictable and potentially damaging flooding on previously engineered river systems; the possibility of greater evapotranspiration from woodland leading to water supply problems; threats to existing wetland areas which have high conservation value and problems to navigation. The balance between these benefits and risks depends on the location,

[1] A floodplain has been defined by DoE (1992) as 'all land adjacent to a watercourse over which water flows in the time of flood or would flow but for the presence of flood defences where they exist'.

scale and type of woodland being restored. The creation of *riparian woodland* is considered to be a useful compromise for many sites, providing some of the environmental benefits of *natural floodplain woodland* while maintaining river control where this exists. It is suitable for both small and large scale restoration. The main challenge, however, is the creation of *natural floodplain woodland*; by definition, this would be on a reasonable scale (> 50 ha), but with careful selection of the river system many of the risks may be minimized.

A project to restore *natural floodplain woodland* in Britain provides the Environment Agency and Forestry Authority with a unique opportunity to show vision and leadership in the management of the environment. However, the paucity of information on the interaction between woodlands on floodplains and the water environment in the UK is a constraint to their wider establishment. It is suggested that this is addressed through a concerted programme of research; the study has identified the following as priorities:-

1. A more detailed literature review on the interaction of woodlands on floodplains and the water environment. This would include reference to less well publicized studies, such as by the US Army Corps of Engineers on flood defence issues in the USA.

2. Experimental work comparing different types of *riparian woodland* (eg. high forest, short rotation coppice, non-native species) with grassland in terms of the ability to retain sediments, nutrients and pesticides draining from agricultural land. This would require the disruption of any artificial soil drainage works within the riparian zone.

3. The Environment Agency and Forestry Authority should establish a joint project to examine the feasibility and desirability of restoring a *natural floodplain woodland*, including changed river management, multiple channels and development of appropriate vegetation. The completion of a desk-top study and cost:benefit analysis is a realistic objective in the next 2 years. An integral part of this project would be modelling the effects of *natural floodplain woodland* on water levels and flood flows in candidate catchments. Consideration would also be given to potentially important issues such as access to watercourses for river maintenance, land drainage consents and preserving riparian rights.

4. Experimental work on the transpiration of tree species which are likely to be planted as *riparian* or *natural floodplain woodland.*

5. Development of a preliminary classification system for *natural floodplain woodlands* in Britain and the formulation of draft guidelines for their design and establishment.

6. Investigating appropriate methods for the establishment of *riparian* and *natural floodplain woodlands*. This work would include investigating alternatives to herbicides and ground preparation, planting patterns and the use of natural colonization, and the cultivation and establishment of native black poplar.

7. A series of demonstration *riparian woodlands* should be established within existing community-based tree planting initiatives. The main aim should be to communicate the

potential benefits of *riparian woodlands*, and the concept of *natural floodplain woodlands*, to a wider audience.

Key Words

Woodland, riparian, floodplain, broadleaved, forestry, flood defence, conservation, water quality

1. INTRODUCTION

The floodplain woodlands of Europe were the subject of a special study for the Council of Europe in 1981 (Yon and Tendron 1981). This drew attention to the large scale destruction of these habitats by river rectification and land reclamation, mainly for agriculture and urban development. However, despite these threats Europe still has a sizeable resource of floodplain woodlands, notably on the upper Rhone and Loire in France, around the Rhine and Danube and the Luznice which crosses from Austria to the Czech Republic.

Virtually all natural floodplain woodland in Britain has been cleared and drained because the rich alluvial deposits were sought after for agriculture. Floodplains have traditionally been used for pasture or arable crops and trees have only remained on river banks, swampy ground and field margins. Most native woodlands associated with water in Britain now contain predominantly alders and willows and are of limited stature. However, remnants of natural floodplain woodland survive in just a few locations, notably along small rivers in the New Forest and along the lower Spey in Scotland (Peterken and Hughes 1995). The structure of these woodlands provides some insight into the valuable lost habitats which some authorities have likened to tropical high forest (Walters 1972). If natural floodplain woodlands were restored in Britain they could be tall majestic woodlands containing oak, ash, black poplar, willow, suckering elms, alder, birch and lime.

2. BACKGROUND

The subject of floodplain woodlands was first discussed between the former National Rivers Authority (NRA; now the Environment Agency or EA) and the Forestry Authority (FA) at a meeting in December 1993. This followed the preparation of a discussion paper on this topic, by Dr George Peterken, for the Environmental Sub-Committee of the Forestry Commission's Home Grown Timber Advisory Committee. Interest in the possibilities of restoration of floodplain woodlands has subsequently increased and a case for this has been published (Peterken and Hughes 1995). Enthusiasm for the subject was also demonstrated by delegates of a Floodplain Woodland Workshop organized by the Forestry Authority on 1 August 1995. This was attended by 25 people interested in the development of floodplain woodlands in Britain (a summary note of the meeting is included as Appendix 1). Recently the World Wildlife Fund (WWF) has won Millennium funding to establish a demonstration floodplain woodland in Scotland, as part of their Wild Rivers project. The Milton Keynes Parks Trust is also planning a similar area on a 40 hectare site adjacent to the River Ouse.

3. DEFINITIONS

The subject of floodplain woodlands is rich in terminology and includes alluvial forests (Yon and Tendron 1981), floodplain forests (Peterken and Hughes 1995), riparian woodland (Malanson 1993), river woodlands (Glimmerveen and Ritchie 1993), forested river corridors (Petts 1990) and riparian corridors (Lant 1989). This study is predominantly concerned with

the lowlands and reference is made to broadleaved woodland, riparian woodland and natural floodplain woodland which are defined as:-

Broadleaved woodland

Woodland which comprises all broadleaved or mixed woodland on a river floodplain that is no longer subject to regular flooding due to engineered flood control, and is not directly associated with existing watercourses.

Riparian woodland

Woodland which comprises mainly broadleaved woodland on land immediately adjoining the watercourse and influenced by it. Normally this would comprise a relatively narrow strip of land along any watercourse, which could function as a buffer with the adjacent agricultural land.

Natural floodplain woodland

Woodland which comprises broadleaved woodland in close proximity to the intricate hydraulic system characteristic of river floodplains that are subject to a regular or natural flooding regime. This may require the present river management to be changed over a fairly sizeable area resulting in: (a) water flowing through multiple channels, and (b) a transition from open water, through marsh and vernal ponds, to areas with drier soils subject to infrequent flooding.

Although the creation and management of broadleaved woodlands has important implications for the water environment, for example, in reducing nitrogen inputs to nitrate sensitive areas (NSA's), the range of potential benefits are relatively small compared with riparian woodland or natural floodplain woodland. This scoping study examines the issues involved in the restoration of the latter two types of floodplain woodland in Britain, an important subject which is integral to the activities of the Forestry Authority and the Environment Agency.

4. OBJECTIVES

The objectives of this scoping study were:-

i. To review the potential benefits and risks of the restoration of natural floodplain woodland and riparian woodland.

ii. To identify major gaps in knowledge and recommend priority topics for future research.

5. ISSUES

In any examination of the issues involved in the restoration of natural floodplain or riparian woodland a clear distinction must be made with the debate on forests and water in upland areas. There are two main differences: firstly, the main motivation for early afforestation in the uplands was timber production, compared with the present era of multiple-use forests, which allows a more holistic approach. Secondly, upland afforestation used a range of non-native species planted on poorly drained, peaty soils which necessitated intensive cultivation and drainage. This is in marked contrast to lowland floodplain woodland which would usually consist of native broadleaved species on better quality soils. Consideration of the impact of restoring natural floodplain woodlands may therefore be hindered by comparison with the upland conifer forestry debate. It is more appropriate to consider the many ways these woodlands could benefit society.

5.1 Benefits

5.1.1 Pollution control

The recent success of water regulatory authorities in controlling point source pollutant discharges has resulted in attention shifting to the problem of diffuse water pollution. Siltation, eutrophication and elevated pesticide levels in runoff have been identified as the issues of greatest concern (Muscutt *et al.*,1993; D'Arcy *et al.*, in press). All forms of woodland on floodplains are likely to reduce diffuse pollutant inputs to groundwater and surface water supplies by replacing more intensive agricultural practices. Woodlands have a minimal requirement for herbicides during the short establishment phase, and once established do not require repeated fertilizer or cultivation treatments and maintain an almost continuous vegetation cover to protect against soil erosion (Moffat and Williamson 1991).

In addition to the obvious benefits of replacing other more intensive land uses, the unique position of riparian woodland, as a buffer between agricultural land and the watercourse, offers the further advantage of being able to filter out pollutants draining from the adjacent land. Research in the USA, Canada and New Zealand has shown the pollutant retention function of riparian woodland to be most effective for sediment material (including adsorbed pesticides, nutrients and heavy metals) and soluble forms of nitrogen and phosphorus (Gillian 1994). Studies have demonstrated woodland to be more effective at retaining nutrient pollutants than grassland, although the presence of the latter either as an understorey or adjacent strip has been shown to enhance the removal of sediments (Phillips 1989, Haycock and Pinay 1993, Hubbard and Lowrance 1994). The degree of retention depends on a wide range of factors, the most important being the transit time of water through the strip, which in turn depends on the width of the strip and nature of the vegetation and underlying soil. Other factors which tend to enhance pollutant removal are: the absence of bypass flow via artificial drainage channels, gentle slopes, a dense cover of vegetation, active soil denitrification and small pollutant loadings. While a narrow 5 m strip of riparian woodland can be effective in filtering out sediment material (Dillaha *et al.* 1989), a 10-20 m wide strip is generally recommended for the removal of a major part of nitrate and phosphate pollutants present in surface runoff (Vought *et al.* 1994).

The acknowledged pollutant control function of riparian woodland can be expected to be magnified many times by natural floodplain woodland. Improvements in river water quality are likely to be greatest during periods of flood flows (Wilen and Frayer 1990) when the greater hydraulic roughness and increased floodwater retention times help to promote the natural water purification processes of sedimentation and denitrification. The low permeability, strongly reducing conditions and neutral pHs of wetland soils have also been shown to favour the immobilization of trace and toxic metals (Gambrell 1994). Although some concern has been expressed about the leaching of toxic metals following the restoration of natural floodplain woodland on contaminated agricultural soils, the above processes will act to minimize this threat. A problem would only result if such soils were re-drained at a later date and became strongly acidic on oxidation, resulting in the release of stored metals to drainage waters.

The beneficial role of riparian and natural floodplain woodland in helping to control diffuse water pollution is now recognized in a number of countries (Davies and Christal, in press; Reddy and Gale 1994). Recent research indicates that this important function can extend well beyond freshwater systems and into coastal areas, where it can help to counter the serious threat of eutrophication posed by increasing nitrogen loadings from land drainage (Jansson *et al.* 1994).

5.1.2 Flood control

The NRA reported on recent annual expenditure of over £230 million per annum on flood defence in England and Wales (NRA 1995). This high cost has shifted attention to a consideration of alternative options for flood control, such as reinstating the natural hydrological functions of floodplains (Wynne, in press).

It is widely recognized that the removal of artificial constraints from certain sections of river would allow floodwaters to spread out and so help attenuate flood peaks. However, there is also evidence to suggest that the conversion of arable or grassland cover to woodland on the floodplain would also enhance this flood control function (Bardecki 1984). Woodland cover presents a greater hydraulic roughness to flood flows (Johnston 1993) which, when combined with the higher infiltration rates of woodland soils (McCulloch and Robinson 1993), can be expected to increase the retention of floodwaters and reduce flood flows.

Quantification of the role of woodlands in flood control is limited by a lack of data. Most research in the UK has been concerned with the impact of upland conifer afforestation and is not directly applicable to natural floodplain woodland consisting of broadleaved species. Overseas studies report increased peak flows following forest clearance (Whitehead and Robinson 1993), but once again the applicability of such results to the restoration of natural floodplain woodland under UK conditions is questionable. One point which is clear, however, is that any effect will be dependent on the scale and structure of the woodland cover. Narrow riparian woodland or scattered blocks of broadleaved woodland are likely to have little influence on flooding regime, while at the other end of the scale, the impact of a large natural floodplain woodland could be considerable.

The acknowledged benefit of natural floodplain woodlands in flood protection has already led to a number of active restoration schemes on the Upper Rhine in West Germany (Zinke and Gutzweiler 1990). In the late 1960s and 1970s many villages and towns situated close to the Rhine were flooded. During investigation records showed that in 1955 a flood peak would take 65 hours to travel from Karlsruhe, Germany to Basel, Switzerland whereas by 1977 this had decreased to only 30 hours due to river straightening. As part of the response to this increased risk of flooding a number of measures were proposed including the creation of 500 hectares of polders. It was planned that these would be inundated with the help of sluices when river levels increased and then the water released gradually over the next few weeks. After completion of the first polder in 1987 a number of technical problems arose with its construction. This respite allowed questions to be raised about the use of the land within the polder and whether any biological community could adapt to infrequent heavy flooding. After seeking advice from the Institute of Floodplain Ecology it has been decided to allow recolonization of the polder to a floodplain woodland; this has so far been successful and more developments of this nature are planned.

5.1.3 Low flows

A secondary benefit of the retention of floodwaters by natural floodplain woodland could be the potential enhancement of low flows as the retained water, in the form of surface pools and shallow groundwater, is slowly released to the river system. The expansion of wetland features within floodplain woodland is likely to be particularly important in this respect. Although little attention has been paid to the role of natural floodplain woodland in maintaining river low flows, some research suggests wetlands can form key sources of shallow groundwater for the maintenance of dry season low flows (McGlothlin *et al.* 1988). There could be a possibility of this function being exploited by the EA to assist those sensitive watercourses where the current level of groundwater abstraction results in the cessation of river flows during dry periods.

5.1.4 Nature conservation

While all forms of broadleaved woodland offer significant conservation benefits compared with most agricultural land uses, natural floodplain woodland represents a particularly valuable ecosystem. Natural floodplain woodlands are not described in the National Vegetation Classification of Britain (Rodwell 1991) for the simple reason that they no longer exist on any significant scale. Hence, the major nature conservation benefit of the restoration of natural floodplain woodland would be the restoration of a lost ecosystem. Natural floodplain woodlands have been shown to form a very varied and complex structure in parts of Europe where they still exist (Chytil, in press; Mekotova, in press). The high level of biodiversity originates not so much from individual stands but from the heterogeneity of habitats created by the presence of aquatic and semi-aquatic habitats in close proximity.

The conservation benefits associated with riparian woodland are relatively small compared with natural floodplain woodland. However, riparian woodland has a valuable role to play in forming an important edge habitat between agricultural land and the adjacent aquatic environment. It also plays an important part in forming wildlife corridors linking other woodland habitats.

Both natural floodplain and riparian woodlands could make a great contribution to conserve Britain's native black poplar (White 1993).

5.1.5 Timber production

Both riparian and the drier components of natural floodplain woodlands could form an important resource for timber production. For example, riparian woodland would be suitable for a wide range of production systems such as: short rotation coppice, poplars, other appropriate non-native species and long-term retention of native species.

Natural floodplain woodlands in low lying areas of northern Europe are known to be highly productive if managed correctly (Pirogowicz 1988, Rohle 1982, 1984). As a result of recent changes in EC agriculture policy, forestry is now encouraged, through grant aid, on fertile ex-agricultural land. Most riparian and natural floodplain woodland would be created on former farmland and the high nutritional status and availability of moisture on such sites offers, with good silvicultural management, the prospect of improved growth, compared with normal forest sites, of well formed trees.

It is recognized that the management of natural floodplain woodlands as a timber resource has the potential to cause serious damage to the freshwater environment. Floodplain soils are particularly sensitive to disturbance by machinery and great care would be required during harvesting operations. Studies elsewhere, however, have shown that the impact of forest management on the environment can be effectively minimized by the adoption of good management practices (Berg and Mumper 1989).

5.1.6 Fisheries

A number of benefits are likely to accrue from the restoration of both small scale riparian woodland and larger scale natural floodplain woodlands (Glova and Sagar 1994). These include: improved bankside stability and underwater shelter provided by tree root systems; increased shading by tree canopies preventing lethal water temperatures during hot weather and restricting weed growth; inputs of leaf litter and woodland insects which are an important food source for aquatic life; and the addition of coarse woody debris forming valuable pool and bankside habitats. However, some of these benefits are dependent on the canopy characteristics of the bankside trees, being greatest for light to moderate foliage species interspersed with a good deal of open space. Continuous areas of densely shading trees are to be avoided as they would lead to a significant reduction of in-stream productivity and can lead to bank erosion (Ormerod *et al.* 1986).

A major benefit of the restoration of natural floodplain woodland would be the considerable extension in the overall quality and quantity of aquatic habitats in the form of multiple braided river channels, pools and gravel features.

5.1.7 Landscape and recreation

The design of all new woodland ranging from isolated blocks, through single riparian lines to

natural floodplain woodlands, offers the potential for improving the landscape of many lowland areas, especially in regions of intensive arable production. The combination of water and a mosaic of woodland and open areas would be very attractive in most lowland landscapes.

5.2 Potential Problems

5.2.1 Flood defence

The majority of large river floodplains in Britain have been intensively drained for agricultural use. Road and rail communications often reside in floodplains which have also been subject to considerable urban development in the past. Of the relatively few unmanaged areas that remain many form important meadow and marshland habitats. Consequently, opportunities for restoring large scale, natural floodplain woodlands are likely to be highly constrained by the need to protect existing flood risk and conservation sites. However, suitable sites may exist on a small to medium scale where there may be scope for helping to alleviate local flooding problems.

The unpredictable and potentially very damaging nature of flood flows mean that much care and attention to detail would be required in the planning and management of any restoration scheme. Even engineered schemes based on the limited release of floodwater require great care to ensure that waters are constrained to the desired target area and nearby habitation and communication links are not affected by the backing-up of floodwaters. Obviously, the flood control function of restored natural floodplain woodland will only be useful if suitable locations exist above sites requiring flood protection.

In general, establishment of riparian woodland is unlikely to compromise flood defence, although potentially important issues such as preserving access to watercourses for river maintenance work, the question of land drainage consents in relation to forestry operations and the protection of riparian rights would need to be addressed.

5.2.2 Water supply

Recent water shortages across much of lowland England have led to concern about the impact of increased planting of broadleaved woodland on water supply. Deep rooting trees are generally viewed as having a higher water use than shorter crops and thus widespread planting could have serious consequences for future water resources (Calder 1993). A major study was carried out in 1989 in southern England to investigate this issue (Harding *et al.* 1992). The research concluded that broadleaved woodland is likely to evaporate less water than grassland but possibly more water than arable land.

Unfortunately, the above comparison was severely limited by a lack of water use data for most arable crops. Another difficulty was that the work was only concerned with beech and ash and uncertainties remain about evaporation rates for other species suitable for riparian and natural floodplain woodland. For example, overseas work suggests that willow and poplar can maintain very high evaporation losses when well supplied with water, as would be the case in wetland

situations (Grip *et al.* 1989).

If natural floodplain woodlands have a much greater water use than the vegetation cover being replaced, large scale woodland restoration may not be suitable for catchments experiencing a shortage of supply in dry years. Similarly, the planting of water demanding species would not be advisable in riparian woodland alongside streams which suffer from a cessation of low flows during dry periods. However, if the increased retention of floodwaters by floodplain woodlands led to enhanced low flows, this could help to compensate for the effect of higher evaporation losses on summer river flows.

The need to maintain adequate water supplies to preserve restored natural floodplain forests could also cause problems in some locations if rising demand led to future water shortages. This issue is one which has proved very controversial in other parts of the world (Bren 1993).

5.2.3 Nature conservation

Floodplains have many rich, semi-natural, but unwooded habitats such as meadows and marshes, which would be damaged if they were converted to woodland. With current arrangements for consultation under the Woodland Grant Scheme it is unlikely that an area of particular nature conservation status would be planted. The Royal Society for the Protection of Birds (RSPB) are known to be concerned about the planting of woodlands on floodplains because floodplains *per se* form important open habitats for birds such as ducks, waders and other waterfowl. These concerns are legitimate but the favoured pattern of natural floodplain woodland development would be to establish a mosaic of woodland in amongst other habitats rather than cover the entire floodplain with woodlands. In contrast, the planting of riparian woodland is unlikely to pose any significant conservation problems.

5.2.4 Navigation

Natural floodplain woodlands are characterized by a dynamic system of multiple braided water channels which act to seriously impair navigation by all but the smallest of craft. Restoration would therefore cause serious problems for all those major waterways which form important conduits for river traffic. The only option under such circumstances would be for a managed scheme based on the controlled release of floodwaters from a constrained river channel. Managed schemes would not necessarily be incompatible with restoring most of the natural functions of floodplain woodlands, providing that the timing and scale of water release were appropriate to a given site. However, satisfying the competing requirements of different water users can prove to be a highly controversial issue (Bren 1993).

Some concern has been expressed about obstructions to access caused by the entry of whole trees and other woodland debris into watercourses during flood flows (Peterken and Hughes 1995). Little information is available on this aspect, but it is possible that most large sized material would be retained within the relatively shallow, multi-channel river system of floodplain woodlands.

The creation of riparian woodland is unlikely to seriously interfere with river navigation

because existing channels would be maintained.

5.2.5 Archaeology

Recent experience from planning new woodlands along the River Cole and River Ray in the Great Western Community Forest has caused concern that tree planting would damage archaeology (R. Rowley, pers. comm.). However, any possible conflict with archaeology can be reduced by following the guidelines developed by the Forestry Authority (Anon 1995).

6. DISCUSSION AND CONCLUSIONS

The concept of restoring floodplain woodlands in Britain is inevitably linked to the relationship between forests and water. Unfortunately, the history of this relationship in Britain has, at times, been uneasy. Much of the afforestation which occurred in the first half of the twentieth century had the primary objective of producing a strategic reserve of timber. Non-native conifers, mainly Sitka spruce (*Picea sitchensis*), were planted on wet, exposed upland areas which were marginal for agriculture. Scant attention was paid to the immediate impacts of cultivation, drainage and fertilization operations and little was known about the long-term effects of coniferous tree cover on the quantity or quality of water. The effects of these forestry practices on water are now better understood and modern day foresters are committed to establishing woodlands using the *Forests and Water Guidelines* (Anon 1993).

This is, perhaps, an unhelpful background against which to investigate the possibilities for the restoration of floodplain woodlands. To increase the chances of success it will be important to create new information concerning the impact of lowland forestry on the water environment which will be relevant to the management of floodplain woodlands. This can be achieved through research and an exchange of information. However, it will be equally important to change attitudes. Foresters must accept that the restoration of floodplain woodlands creates a new set of challenges for water regulators whilst, on the other hand, water regulators must accept that foresters are not preoccupied with timber production but are committed to the expansion of multi-purpose forests.

Any discussion of floodplain woodlands raises questions concerning definition and it is hoped that the classification used in this scoping study (Chapter 3) has aided clarification. At present there are mechanisms for the creation of broadleaved woodland and riparian woodland through the Forestry Authority Woodland Grant Scheme and MAFF Farm Woodland Premium Scheme. Riparian woodland could offer many of the potential benefits of natural floodplain woodland: pollution control, timber production, wildlife and fisheries enhancement and opportunities for improving the landscape. On the other hand, many of the potential problems: flood risk, water supply and navigation may be eliminated or minimized. Although riparian woodland only constitutes `planting at the side of rivers' they are a realistic option for the immediate future. There seem to be many benefits if the Environment Agency and Forestry Authority co-operate in carrying out the necessary research to resolve any existing concerns surrounding their wider establishment.

The ultimate challenge, however, is to create a natural floodplain woodland and restore a lost ecosystem to Britain with the potential for considerable environmental benefits. The number of sites where a large scale project could take place are probably small because of existing conservation designations and the distribution of flood risk areas. However, there may be many opportunities for small to medium scale restoration schemes scattered throughout the country. The first step must be to establish a research study to investigate the range of issues outlined in this report and assess the feasibility and cost of various options. This knowledge would then be used to select suitable sites and to guide the design and management of a restoration scheme. The starting point of restoration should be the river flooding regime and then the type and structure of woodland vegetation. Optimal sites may be found in the upper reaches of rivers where remnants of native woodland species sometimes exist in narrow floodplains which have not been subject to overwhelming arable or grazing pressures. A possible alternative is to

create floodplain woodlands inside flood storage areas or washlands which have been created to hold floodwaters which are controlled by sluices, an example of such a scheme on the Rhine was described earlier (Zinke and Gutzweiler 1990).

The concept of restoring floodplain woodlands in Britain is new and presents exciting opportunities for the management of Britain's natural resources. However, it is important to recognize that this may be obvious to advocates, but to policymakers, and others involved in land-use decisions, first impressions may be that the idea is `woolly' and probably infeasible. Clearly there is a need to investigate the economic effects of changing this balance away from existing land-uses towards woodland on the floodplain. The creation of floodplain woodlands would require some form of planting subsidy but would almost certainly result in a net environmental gain. Economic methods such as cost-benefit analysis could be used to investigate these questions and may help to build a convincing case for the restoration of floodplain woodlands.

Throughout the scoping study it has become apparent that there is a paucity of information on the impacts of woodlands on floodplains on the water environment. Both riparian and natural floodplain woodlands offer the opportunity of improving water quality, while the latter also presents options for changing the management of floods; these and other subjects identified in this report need to be studied in greater detail. The study has identified the following areas of work as priorities:-

1. A more detailed literature review on the interaction of woodlands on floodplains and the water environment. This would include reference to less well publicized studies, such as by the US Army Corps of Engineers on flood defence issues in the USA.

2. Experimental work comparing different types of riparian woodland (eg. high forest, short rotation coppice, non-native species) with grassland in terms of the ability to retain sediments, nutrients and pesticides draining from agricultural land. This would require the disruption of any artificial soil drainage works within the riparian zone.

3. The Environment Agency and Forestry Authority should establish a joint project to examine the feasibility and desirability of restoring a natural floodplain woodland, including changed river management, multiple channels and development of appropriate vegetation. The completion of a desk-top study and cost:benefit analysis is a realistic objective in the next 2 years. An integral part of this project would be modelling the effects of natural floodplain woodland on water levels and flood flows in candidate catchments. Consideration would also be given to potentially important issues such as access to watercourses for river maintenance, land drainage consents and preserving riparian rights.

4. Experimental work on the transpiration of tree species which are likely to be planted as riparian or natural floodplain woodland.

5. Development of a preliminary classification system for natural floodplain woodlands in Britain and the formulation of draft guidelines for their design and establishment.

6. Investigating appropriate methods for the establishment of riparian and natural

floodplain woodlands. This work would include investigating alternatives to herbicides and ground preparation, planting patterns and the use of natural colonization, and the cultivation and establishment of native black poplar.

7. A series of demonstration riparian woodlands should be established within existing community based tree planting initiatives. The main aim should be to communicate the potential benefits of riparian woodlands, and the concept of natural floodplain woodlands, to a wider audience.

More detail on these proposals is given in Chapter 7.

7. OPTIONS FOR FURTHER WORK

Throughout the scoping study it has become apparent that there is a paucity of information on the interaction between woodlands on floodplains and the water environment in the UK. Major gaps in knowledge have been identified and the following areas of work are suggested as priorities for future research.

Literature review: water aspects

The scoping study has identified a number of important references relevant to the hydrological and water quality impacts of riparian and natural floodplain woodland. However, the constraints imposed by the scoping study have not allowed a thorough review of a wider range of relevant work. This would include reference to less well publicized studies, such as by the US Army Corps of Engineers on flood defence issues in the USA.

Pollution control

The scoping study has identified that there are few barriers to the wider establishment of riparian woodland but that there is a lack of data quantifying the benefits to water quality under UK conditions. It is recommended that the effects of different types of riparian woodland in retaining sediment, nutrients and pesticides draining from adjacent agricultural land are compared with grassland. The most suitable types of riparian woodland would be: appropriate native species, short rotation coppice using poplar or willow clones; high forest poplars, and a non-native species such as mockernut (*Carya tomentosa*) which is valued for its timber and aesthetic value. The establishment of a selection of these systems in an experimental design alongside a watercourse would allow monitoring of the impacts on the water environment; in addition timber and other environmental benefits, such as to fisheries, could be assessed.

The potential water purification functions of natural floodplain woodlands would become clearer after the above literature review. This could be supplemented by mechanistic studies of pollutant retention within remaining woodland fragments in Britain.

Flood control and the siting of natural floodplain woodland

It is suggested that an exploratory desk-top study examines: (a) locational principles which could be used to identify a number of areas where the restoration of floodplain woodlands would be feasible and desirable; (b) different natural floodplain woodland restoration scenarios

on flood release options, water levels and flood flows, by modelling, using existing knowledge of flood hydraulics and forest soil hydrology; (c) study the macro- and micro-economic effects of changing the land-use balance towards floodplain woodlands. Consideration would also be given to potentially important issues such as access to watercourses for river maintenance, land drainage consents and preserving riparian rights. It is suggested that a joint EA:FA project team is established to carry out the above work which could be completed in 2 years.

Water resources

The recent drought has again highlighted the importance of maintaining adequate water resources for public supply. If riparian and natural floodplain woodlands have a higher water demand than the vegetation being replaced this could have serious consequences for maintaining groundwater resources and low river flows during drought periods. Consequently, it is important that transpiration studies are carried out on the key species likely to be planted in riparian or natural floodplain woodland. This information would be an important input to hydrological models assessing the overall impact of floodplain woodland on water resources.

Literature review: woodland and vegetation of natural floodplain woodlands

A key requirement of the restoration of natural floodplain woodlands in the UK will be a greater understanding of the ecology of these systems, eg. how water regime, site and climate factors interact to produce different types of woodland. This could be achieved by investigation of the literature and visiting continental European examples which are in equivalent vegetation zones. The aim should be to produce a preliminary classification system which is allied to the National Vegetation Classification (Rodwell 1991). This could then be used to formulate guidelines on the design and establishment of riparian and natural floodplain woodland.

Appropriate tree establishment techniques

In order for the establishment of riparian and natural floodplain woodlands to be successful experimental work aimed at answering the following questions is essential: (1) what alternatives to herbicides exist?, (2) what are the most appropriate methods of ground preparation?, (3) to what extent could natural colonization, rather than planting, be relied upon to create new woodlands on floodplains?, (4) to what extent can the initial planting pattern and distribution of species influence the ecological value of the woodland?, (5) which non-native species could be planted as part of riparian, or even, natural floodplain woodland?

Black poplar is, perhaps, the most endangered native timber tree in Britain (White 1993). The species has recently received much publicity aimed at locating and cataloguing to ensure the survival of this valuable native tree. Experiments are required to investigate the most appropriate establishment methods for the species.

Demonstration

A series of demonstration woodlands should be established within existing community based tree planting initiatives. The main aim should be to communicate the concept of floodplain woodlands to a wider audience. It is suggested that these could be sited alongside some of the experimental work described above. Forestry Commission Research Division has wide experience in this type of work and could take the lead in such an initiative.

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Appendix 1

Forestry Commission
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11 August 1995

Floodplain Woodland Workshop

Tuesday 1 August, Snibston Discovery Park, Leicestershire

Background

1. Recent work by George Peterken has created great interest in the prospects for restoring floodplain woodlands in Britain. A number of initiatives involving floodplain woodlands (FW) were known to be taking place in the Great Western Community Forest, Milton Keynes Park Trust, the River Restoration Project as well as work initiated by the Forestry Authority and the National Rivers Authority. The aim of the Workshop was to bring all interested parties together to form a clear idea of how FW restoration could proceed in lowland Britain.

Objectives

2. The objectives of the meeting were:

   a. To develop a protocol for the establishment of FWs.

   b. To consider the potential benefits and risks.

   c. To form an action plan for a research and demonstration project.

   The agenda and list of participants are attached. The main points in each of the sessions were:-

George Peterken

3. Nearly all floodplain woodland in Britain has disappeared due to clearance for agriculture. In Europe, where significant areas exist, FW are rich, diverse habitats.

4. Restoration of FW in Britain appears to offer many benefits: re-creation of a missing forest type, rich and diverse habitats, corridors for movement of flora and fauna, production of quality timber, flood control, enhanced water quality, reduction of agricultural surplus, improvements in fishing, recreation and landscape.

5. There has traditionally been antagonism between forests and water in Britain. Although this has mainly centred on forestry in upland, acid sensitive areas, tree planting on lowland floodplains can also raise difficult issues.

6. Restoration of FW does not mean plantations on floodplains but a range of woodland types within a mosaic of open and wet areas (and possibly other land uses) with 25-30% of the floodplain with woodland cover. A balanced relationship between river and woodland is required.

7. Existing FW initiatives in Britain include Great Western Community Forest, Milton Keynes Parks Trust and the WWF Wild Rivers project in Scotland. The main hurdles encountered to date have come from (a) people concerned with nature conservation, particularly birds, who feel that existing valuable wetlands are threatened, (b) archaeologists, who wish to prevent tree planting on sites rich with history of human activity, (c) landowners concerned with the reduction in the capital value of land being converted to forest (£800 per ha loss reported in the Tay valley), and (d) clear communication of the concept of FW.

8. Existing NRA Catchment Management Plans seem to perceive forestry as a threat, not a productive view for the restoration of FW's.

Tony Brown

9. Gave a detailed account of an existing FW known as the Gearagh on the River Lee in Ireland which has been the subject of recent studies, see Hammond and Brown (1993) and Brown *et. al.* (1995).

10. The existence of multiple channels with differing depths and widths is an essential feature of FW as this creates a range of water velocities which help produce habitat diversity. Islands separating channels are stable (anastomosing) rather than abraided. The overall effect of multiple channels is to hold water back up river.

11. Debris dams within channels help to create cross channels which reduce the velocity of main channels and encourage siltation, but in parallel channels debris dams can increase velocity of the other parallel channels.

12. Windthrow of single, or small groups of trees, helps create faunal diversity and woodland regeneration; and can help to create debris dams usually on the larger channels.

13. Growth of trees is excellent within FW, some reports of large oaks that were 60 years old.

14. The system is stable mainly because of annual flooding and maintenance of the debris dams, the area of island:river has remained constant for a long period of time (from historical records).

15. Complete restoration of FW in Britain will not be achieved by simply planting trees by rivers. The first step should be to identify existing floodplains, say 10-100 km^2, where remnants of multiple channels still exist. The starting point of restoration should be the river and then the vegetation and woodland. Minimal `washlands' around FW's can be calculated and are usually 7-10 times the width of the channel system. Optimal sites may well be found in the upper reaches of rivers where remnants of native woodland species sometimes exist in narrow floodplains which have not been subject to overwhelming arable/grazing pressures.

Paul Raven/Brian Empson

16. The NRA does not oppose the restoration of FW in Britain and wishes to enter into partnerships with other interested organizations to explore the subject. There is movement within NRA towards a more holistic approach to flood defence planning. NRA has statutory duty to protect urban areas and dwellings from flooding and restoration of FW in Britain must not endanger this.

17. The term `not managed' has been used to describe the requirements for the river component of FW restoration. However, working with natural processes and approaching flood defence less intensively than in the past does not mean `not managed'; there must be a greater appreciation of the risk of flooding under changed river management.

18. There needs to be an appreciation that all catchments are unique.

19. Quantification of the benefits, at the macro and micro scale, of the restoration of FW is required.

20. If traditional means of flood defence were withdrawn the river system would need to be surrounded by a washland into which excess water would flood. The effect of trees within this washland would be to reduce the volume of water that could be stored because the presence of trees would increase siltation. Hence FW development needs to be in a very wide area around the chosen river and probably is only practical on the upper or mid reaches of a river where perpetuation of a multi-channel system would significantly lessen the impact of siltation due to the processes identified in the Gearagh study.

General

21. The concern that restoration of FWs poses a threat to existing wetlands questions the philosophy underlying nature conservation. Wetlands have been created and sustained by man; the natural vegetation cover for these areas would be FW. However, there is little doubt that such areas are valuable and in areas where FW restoration is practical a sensitive approach is required.

22. The Forestry Authority is committed to preserving the known archaeological interest

in any area where tree planting may take place. There are good examples of ridge and furrow formations being preserved in woodlands (eg. Monkswood). For buried archaeology the main problem is often that there is little information about where it exists. Maintenance of water levels is thought to be important in preserving buried archaeology and restoration of FW does not threaten water levels.

23. Points 21 and 22 above suggest that FW restoration is probably most suited to existing initiatives where an holistic approach has been taken to determine preferred areas for tree planting.

24. The present land use pattern of floodplains is supported by subsides to flood defence and agriculture. There is a need to study the macro and micro economic effects of changing this balance towards FW. WWF have commissioned this type of study in Scotland and results will be published in late 1995. It was agreed that Government Departments working on the quantification of environmental benefits, particularly the FC and MAFF, should be co-operating in such work so that more objective decisions can be taken in future.

25 A representative from MAFF had not been invited to the Workshop. This oversight should be corrected and a dialogue started at the earliest opportunity (R Swash and N Cumberlidge were suggested as appropriate contacts).

26. The Forestry Commission Research Division and the Environment Agency will be undertaking a scoping study on the restoration of FW in Britain, this will identify the important issues involved, refine the objectives behind FW restoration, begin to identify criteria for selecting potential restoration areas, propose a feasability study and suggest priorities for further research. The study will be completed in late 1995.

27. It was agreed that a sensible action plan for research and demonstration would have 2 parts:-

    a. Existing and planned demonstrations would attempt to communicate the concept of FW to a wider audience. Forestry Commission Research Division has wide experience in this type of work and would welcome an opportunity to form a partnership with another organization to establish a FW demonstration. It was recognized that it is unrealistic for these demonstrations to be much more than `planting at the side of a river', depending on the site.

    b. The FC:NRA scoping study should aim to identify further research needs. The objective of this longer term work would be to enable the restoration of a natural FW, including changed river management, multiple channels and development of appropriate vegetation.

28. A majority of participants felt there was a need for regular communication on the subject. A meeting would be convened in 12 months time to review progress.

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Gary Kerr
Silviculturist

Floodplain Woodland Workshop

List of Participants

Speakers

Dr A Brown	Dept. of Geography, University of Exeter
Dr G Peterken	Consultant Ecologist
Dr P Raven /Mr B Empson	National Rivers Authority (now Environment Agency), Bristol

Organizer

Mr G Kerr	Silviculturist, Forestry Commission Research Division

Participants

Dr R Britton	Conservator Greater Yorkshire, Forestry Authority
Miss A Brown	National Forest Company, Donistorpe
Mr G Bryant	Great Western Community Forest
Mr B Empson	National Rivers Authority (now Environment Agency), Bristol
Mr S Evans	National Forest Company, Donisthorpe
Dr M Everard	National Rivers Authority (now Environment Agency), Bristol
Mr B Hibberd	Assistant Chief Conservator, Forestry Authority, Cambridge
Mr C Jones	Forestry Policy Unit, DoE
Dr K Kirby	English Nature, Peterborough
Mr M Mathers	WWF Scotland, Wild Rivers Project
Mr G Patterson	Wildlife and Conservation Officer, Forestry Commission, Edinburgh
Dr P Raven	National Rivers Authority (now Environment Agency), Bristol
Mr S Potter	Principal Planning Officer (Forestry), Staffordshire C.C.
Mr N Rylance	Silviculturist, Forestry Commission Research Division
Mr R Rowley	Swindon Community Forest
Mr M Sangster	Policy Studies Division, Forestry Commission, Edinburgh
Mr K Sheridan	Archaeologist, Staffordshire C.C.
Mr M Street	Milton Keynes Park Trust
Dr N Weatherley	National Rivers Authority (now Environment Agency), Cardiff
Mr P Webb	Conservator East Midlands, Forestry Authority