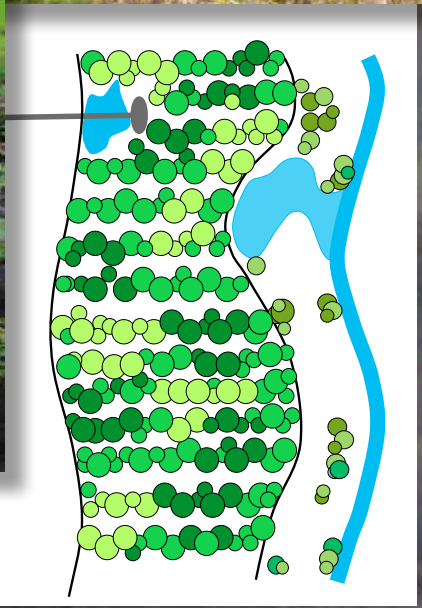
Woodland for Water:

Creating new native woodlands to protect and enhance Ireland's waters



An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine

The Department of Agriculture, Food & the Marine (DAFM) is responsible for ensuring the development of forestry within Ireland in a manner and to a scale that maximise its contribution to national socio-economic well-being on a sustainable basis compatible with the protection of the environment. Its strategic objectives are to:

- foster the efficient and sustainable development of forestry
- increase quality planting
- promote the planting of diverse tree species
- improve the level of farmer participation in forestry
- promote research and training in the sector
- encourage increased employment in the sector

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DAFM acknowledges the assistance of Woodlands of Ireland in compiling an overview of relevant research underpinning the 'Woodland for Water' measure, as set out in Section 4.
April 2018

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Section 1

Woodland for Water: Introduction

Overview

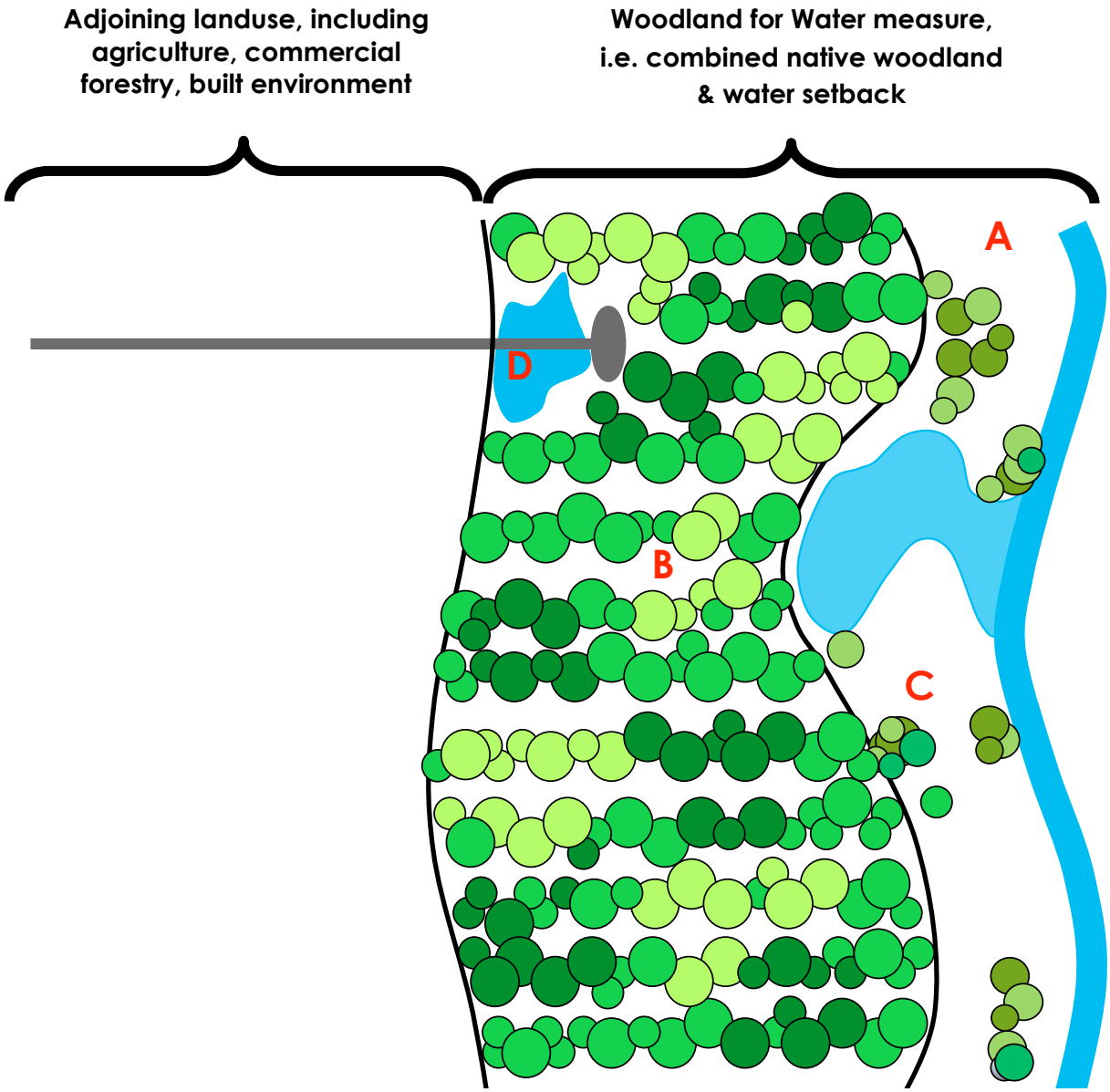
This document explores how new native woodland and undisturbed water setbacks can be used in combination to deliver meaningful ecosystem services that protect and enhance water quality and aquatic ecosystems. This 'Woodland for Water' measure can be realised using the existing Native Woodland Establishment Scheme (NWS Establishment), available from the Department of Agriculture, Food & the Marine (DAFM).

This measure can be used alongside streams, rivers and lakes to form permanent semi-natural landscape features that will protect and enhance water quality and aquatic habitats into the future. Where basic site requirements are met, the DAFM perceives widespread potential for this measure, from upper to lower catchments and in relation to various land uses.

The Woodland for Water measure operates alongside other water protection measures applied by the DAFM throughout its regulatory and promotional role, as part of its responsibilities under the second cycle of the Water Framework Directive (WFD). For further details on other measures, see *Forests & Water: Achieving Objectives under Ireland's River Basin Management Plan 2018-2021* (DAFM, 2018).

The Woodland for Water measure comprises areas of new native woodland funded under the NWS Establishment, which provides grants and 15-year premiums to farmers and other landowners to afforest with native woodland. The water setback – which itself forms an integral part of the NWS Establishment project – follows specifications set out in the *Environmental Requirements for Afforestation* (DAFM, 2016), and forms a strip of undisturbed ground vegetation positioned alongside the bank of the watercourse. Both elements can be widened at key locations onsite, where adjoining land uses, site hydrology and slope increase the vulnerability of receiving waters.

Figure 1 *Overview of the Woodland for Water measure.*



Key:

A Permanent undisturbed water setback, 10-25 metres in width (or wider, if required), uncrossed by new drains & largely unplanted. Can be widened at key locations onsite, where site hydrology & slope increase the vulnerability of receiving waters.

B New native woodland created under NWS Establishment, 20 metres or greater in width & uncrossed by new drains. Can be widened at key locations onsite, where adjoining landuse, site hydrology & slope increase the vulnerability of receiving waters.

C Setback planting comprising single trees or small groups of suitable native riparian species of trees & shrubs strategically planted & maintained for bank stabilisation, dappled shading & as a food source for aquatic life.

D Possible blocking of existing drains (with silt traps, slow-flow dams) to break existing pathways from source to the receiving watercourse, & to create pocket wetlands & settlement areas.

Figure 1 (opposite) provides a visual overview of the Woodland for Water measure.

Water-related benefits

A wide range of a range of significant water-related ecosystem services can be realised under the Woodland for Water measure. These include:

- reduction in sediment mobilisation and runoff into watercourses
- interception of nutrient runoff into watercourses
- bank stabilisation
- food input into the aquatic ecosystem
- shading / cooling
- regulation of floodwater
- riparian restoration

These are in addition to other ecosystem services such as native woodland biodiversity, habitat linkage within the wider landscape, carbon sequestration, amenity and environmental interpretation, etc., which are not explored in this document.

Realising Woodland for Water

The DAFM is keen to work with landowners and with relevant bodies involved in the protection of water, to realise the Woodland for Water measure. These include Woodlands of Ireland, Inland Fisheries Ireland, National Parks & Wildlife Service (NPWS), the Environmental Protection Agency (EPA), Irish Water, and Teagasc, and with the various structures set up to support the implementation of the River Basin Management Plan for Ireland 2018-2021, published in April 2018 (Department of Housing, Planning & Local Government, 2018). In particular, the Local Authority Waters & Community Officers, the Regional Scientific Officers and the Teagsac Agricultural Sustainability Officers will be in a key position to identify important opportunities where the Woodland for Water measure might have a significant impact.

The Woodland for Water measure can also be targeted strategically at particular sites, based on the use of GIS. This approach is echoed by Perrin *et al.* (2008), who make the following recommendation in relation to the National Survey of Native Woodlands 2003-2008: *"The GIS component of the project could assist in regional woodland creation schemes by providing spatial information on the existing occurrence of woodland and woodland types in the landscape. This could assist environmental managers who wish to link up existing sites or create new woodland in largely unwooded landscapes."*

Further targeting may also be possible through the Woodland Fund, an initiative arising from the mid-term review of the Forestry Programme. Through a system of payments for ecosystem services, the mechanism could attract additional funds for farmers and other landowners to create new native woodland in key locations for (*inter alia*) water protection purposes. Although focused on carbon capture, the ongoing Microsoft / Natural Capital Partners / Green Belt project provides a working example of this approach. For further information, also see the European COST Action on forests and payments for water-related ecosystem services (www.forestry.gov.uk/fr/pesforw).

Document overview

Section 2 and Section 3 of this document detail relevant specifications regarding both components of the Woodland for Water measure, i.e. NWS Establishment and the water setback. Section 4 then presents an overview of relevant research and initiatives in Ireland, the UK and elsewhere, which demonstrates the water-related ecosystem services provided by this approach, as listed above. This overview has been compiled with input from Woodlands of Ireland within the context of the partnership between that organisation and DAFM in the ongoing development and implementation of the Native Woodland Scheme package (see woodlandsofireland.com).

The overall Native Woodland Scheme package comprises NWS Establishment and the Native Woodland Conservation Scheme (NWS Conservation), focused on restoring existing native woodlands and converting existing non-native forest into native woodland on key sites. The Woodland for Water measure relates to NWS Establishment only, although NWS Conservation has significant application in the protection of water and and aquatic habitats and species, as set out in *Forests & Water* (DAFM, 2018).

Section 2

Native Woodland Establishment Scheme

Purpose of the Scheme

NWS Establishment(*) provides grant and premiums to farmers and other landowners to support the creation of new native woodland within the Irish countryside. The purpose is to promote the expansion of our native woodland resource and its associated biodiversity, and to realise other ecosystem services that new native woodlands can deliver. These include the protection and enhancement of water quality and aquatic habitats, and promoting linkage between semi-natural habitats at a wider landscape level, using natural features such as streams, rivers and lakes.

(* As represented by Grant & Premium Categories (GPCs) 9 and 10 of the general Afforestation Scheme. For full details, see *Native Woodland Establishment GPC9 & GPC10: Silvicultural Standards* (DAFM, 2015) and Forest Service Circulars 3/2018 and 5/2018.)

Many woodlands created under NWS Establishment are suitable for the future harvesting of quality timber and other wood products on a sustainable basis. This potential is encouraged, so as to provide an economic reason for the ongoing management of these woodlands, similar to what is being achieved in Wales under the Coed Cymru project (see www.coedcymru.org.uk). At a site level, however, this objective is only acceptable where compatible with the scheme's primary ecological purpose and with site factors such as soil type, slope and ecological sensitivities. Furthermore, wood production can only be pursued using 'close-to-nature' continuous cover forestry (CCF) systems such as selection, shelterwood and coppicing. CCF is a silvicultural approach based on the selective harvesting of single or small groups of trees and restocking with natural regeneration, to promote uneven-aged stands and a continuous tree cover more typical of natural forests. It mimics natural woodland processes

A NWS Establishment site, Dunmanway, Co. Cork, subsequently planted.

and excludes large-scale clearfelling – see ProSilva Ireland (www.prosilvaireland.wordpress.com/) for further information.

Woodlands created under NWS Establishment provide opportunities for traditional types of woodland management (e.g. coppice) that form part of our countryside heritage. Other important ecosystem services include carbon sequestration, landscape enhancement, woodland recreation and the promotion of health and well-being amongst users, cultural and historical heritage, and the provision of 'outdoor classrooms' for environmental education and awareness-raising. (These amenity and educational roles can be developed further, by combining the NWS Establishment and the NeighbourWood Scheme (DAFM, 2017).)

NWS Establishment attracts the highest grant and premium available under the Afforestation Scheme. NWS Establishment provides a payment of up to €6,220 / ha for approved establishment works, and a 15-year annual premium of €665 / ha / year, increasing to €680 for sites 10 hectares of over.

Ecological focus

NWS Establishment has an overriding ecological focus. For example, site disturbance and inputs must be minimised, species selection must reflect the most appropriate native woodland type for the site (based on site, drainage, elevation, etc.), and all forest reproductive material (seed, transplants, cuttings) used must come from suitable sources within Ireland (within limited practical exceptions). Since its inception in the late 1990s, DAFM has developed and implemented the scheme in close partnership with Woodlands of Ireland, NPWS, the Heritage Council and a wide range of other stakeholders with a direct and indirect interest in native woodland, including Inland Fisheries Ireland and the EPA, the latter in the context of agreed changes to the Acid Sensitivity Protocol for Afforestation (see later).

With this focus, NWS Establishment creates opportunities for farmers and other landowners within environmentally-sensitive areas to create woodlands which have the potential for future wood production and income generation, and which also contribute towards protecting the particular sensitivity involved, be it water, designed habitats or species, landscape, etc. This

Joint DAFM / Woodlands of Ireland training of foresters and ecologists is a key feature of the Native Woodland Scheme.

is achieved through DAFM's approval system (which includes public consultation, referrals to relevant bodies, screening for appropriate assessment and environmental impact assessment, and procedures regarding fisheries, acid sensitivity areas and Freshwater Pearl Mussel).

NWS Establishment operates within the context of technical support and outreach by Woodlands of Ireland. This includes an extensive training programme run in partnership with DAFM, and the publication of the Native Woodland Information Notes, authored by experienced practitioners and covering relevant topics, from riparian woodland to rhododendron control to deer management (see www.woodlandsofireland.com/publications/native-woodland-information-notes).

Foresters operating the NWS Establishment must be on the Register of Foresters and Forest Companies, and must also complete the required Woodlands of Ireland / DAFM training course, which includes a strong element regarding the use of native woodland to protect water and aquatic habitats.

Specifications

Various scheme specifications apply that relate directly to the use of NWS Establishment to deliver the Woodland for Water measure. Key specifications are outlined below. For full details on these and other specifications, see *Native Woodland Establishment GPC9 & GPC10: Silvicultural Standards* (DAFM, 2015) and Circular 5/2018. Also see *Management Guidelines for Ireland's Native Woodlands* (Cross & Collins, 2017) and the Woodlands of Ireland Information Notes, for good practice in this area.

Site requirements

Each site proposed for NWS Establishment must be capable of supporting the vigorous growth and sustainable long-term development of the most appropriate native woodland type identified for that site (or parts thereof). This must be possible without the need for fertiliser input (with limited exceptions – see below).

Generally, sites that flood are excluded from the Afforestation Scheme. However, NWS Establishment (GPCs 9 and 10) plots located on natural floodplains may be acceptable, where:

- the frequency of flooding and the inundation periods involved do not impede woodland establishment and development; and
- such plots form part of a larger application or a wider multi-site project developed with input from other statutory bodies and aimed at the strategic development of native woodland along a sensitive watercourse, for water protection.

This is in recognition of the rarity of riparian and alluvial woodlands (for example, residual alluvial forests are a priority Annex I habitat under the Habitats Directive) and their role in protecting water and the aquatic ecosystem.

Area, size and width

Sites and individual plots proposed for NWS Establishment must be 0.1 ha or greater in area and 20 metres or greater in width, as measured tree-to-tree (i.e. excluding required setbacks for water, archaeology, public roads, etc.). In certain situations (e.g. to cater for landscape

and existing features), 10% of the proposed area can be less than 20 metres in width. These lower limits allow NWS Establishment to be used to create relatively narrow woodland strips along watercourses, without encroaching too greatly on agricultural land.

Conversely, individual native woodland plots can be widened at key locations onsite, where adjoining land uses, site hydrology and slope increase the vulnerability of receiving waters.

Native woodland type

Each project under NWS Establishment must promote the native woodland type that would occur naturally on the site (or parts of the site). This decision is made by the NWS Forester at the planning stage, using the NWS Framework (see Circular 5/2018). This framework uses location, soil and main habitats and vegetation to identify the most ecologically appropriate native woodland type. Five scenarios currently apply:

- Scenario 1: Podzols (Oak-Birch-Holly Woodland)
- Scenario 2: Brown Podzolics (Oak-Birch-Holly with Hazel Woodland)
- Scenario 3: Brown Earths (Oak-Ash-Hazel Woodland)
- Scenario 4: Gleys (Alder-Oak-Ash Woodland)
- Scenario 5: Highly Modified Peat & Peaty Podzols (Pioneer Birch Woodland)

For illustration, Figure 2 is an extract from the framework, describing Scenario 4 sites.

Acceptable species and mixtures

All tree species proposed under NWS Establishment must be: (i) native to the island of Ireland; and (ii) appropriate to the native woodland type identified for promotion onsite (or parts thereof). To achieve this, each of five scenarios is underpinned with a prescribed species mix designed as a 'starter kit' for the woodland type associated with that scenario. For example, Scenario 4: Gleys (Alder-Oak-Ash Woodland) plots must be planted with the following mixture:

> *Pure groups (30-40 trees) of alder (50%), grey willow (10%) & downy birch (10%). Groups interspersed alternately. Pedunculate oak (10%) on drier areas. Hawthorn (5%) scattered throughout. Minor species (15%) to comprise at least two of the following, positioned between the above pure groups: holly, hazel, guelder rose. Note: The above interspersed group planting of major species is carried out to improve stability & robustness, & to prevent the development of an alder monoculture.*

In order to ensure traceability and to protect native genetic biodiversity, rules apply regarding the source of all forest reproductive material (i.e. seed, plants, cuttings) used.

Site inputs

Under NWS Establishment, the identified woodland type should be realised with the minimal amount of site inputs (e.g. fertilisers) and disturbance (e.g. cultivation). The focus is on retaining natural site conditions and facilitating the emergence of the native woodland type that would occur naturally on the site.

Ground preparation is largely limited to inverted mounding, scrap mounding, shallow ripping, pit planting and auger planting. While standard afforestation drainage practices are not

Figure 2 *Extract from the NWS Framework (from Circular 5/2018), showing the application of Scenario 4: Gleys (Alder-Oak-Ash Woodland).*

If…

Location: Drumlins, river valleys, lake shores & water-logged hollows.

Soil: Mineral & peaty gleys (very wet soils, generally fertile). Average pH c.5.9.

Main habitats & vegetation:

Wet, rushy grassland with yellow flag.

Semi-natural woodland dominated by / hedgerows containing: alder, ash, grey willow, hazel, hawthorn, spindle & blackthorn. Field layer indicators include bramble, meadowsweet, creeping buttercup, remote sedge.

⇩

Scenario 4: Gleys / Alder-Oak-Ash Woodland

⇩

Most appropriate Major Native Woodland Type: AF Alder–meadowsweet.

Predominant trees & shrubs: Alder, grey willow & ash.

Predominant ground flora: Meadowsweet, remote sedge, creeping buttercup, yellow flag & water mint.

⇩

Planting mixture: Pure groups (30-40 trees) of alder (50%), grey willow (10%) & downy birch (10%). Groups interspersed alternately. Pedunculate oak (10%) on drier areas. Hawthorn (5%) scattered throughout.

Minor species (15%) to comprise *at least two of the following,* positioned between the above pure groups: holly, hazel, guelder rose.

Note: The above interspersed group planting of major species is carried out to improve stability & robustness, & to prevent the development of an alder monoculture.

⇩

If NWS Establishment: GPC10 applies (with required min. stocking 2,500 / ha)

A typical 'rushy' field with heavy, wet gley soils. These are sometimes semi-improved for pasture & are common in drumlin belts, low-lying, & poorly drained locations.

A very poorly-drained 'dauby' gley soil profile with a clay-rich topsoil approx. 30 cm deep, which overlies a saturated & mottled, blue-grey & red-brown subsoil. The subsoil overlies a very compact parent material derived from glacial till.

A typical AF Alder–meadowsweet alluvial woodland on gley soil. Hazelwood, Co. Sligo.

accepted under NWS Establishment, localised drainage may be allowed in certain situations to aid establishment – full details must be provided with the submitted application. The slow-water damming of existing land drains may be acceptable, to reinstate natural hydrological conditions and to improve how well the water setback protects the adjoining watercourse.

While standard fertiliser application is not accepted under NWS Establishment, a once-off hand application at establishment (using slow release formulations) is allowed on marginal sites, in order to boost initial growth. However, this need is unlikely to arise on most sites where the Woodland for Water measure might be applied.

The control of competing vegetation such as grasses, herbaceous plants, bramble and bracken is vital for the rapid establishment and growth of young trees. Inadequate control will result in poor growth and increased mortality, leading to further inputs later on (e.g. beating up). Non-herbicide control (trampling, mulches, mats, etc.) is only realistic on a small scale, such as highly sensitive parts of individual sites. Otherwise, targeted herbicide application represents the most practical and effective method of vegetation management.

Pre- and post-planting herbicide application must be kept to the minimum required to ensure success, and should be used together with other methods, e.g. planting with larger transplants. Post-planting application should be carried out using a knapsack sprayer, with the aim of maintaining a 1-metre wide control area around the base of each tree until it has become fully established and free of competing vegetation.

Herbicide application is not permitted within the water setback or within 20 metres of an aquatic zone, whichever is greatest. Limited exemptions may apply, where agreed by the relevant statutory body (e.g. stem injection to eliminate stream-side rhododendron, in order to tackle infestation and to reinstate natural vegetation.)

Acid Sensitivity Protocol for Afforestation

NWS Establishment applications within acid sensitive areas are exempt from the water sampling requirement under the Acid Sensitivity Protocol for Afforestation, as set out in Appendix 11 of the *Forestry Standards Manual* (DAFM, 2015). This change to the protocol was proposed by

Scrap mounding on a riparian site, illustrating the low level of site disturbance at planting stage under NWS Establishment.

Emerging pioneer birch woodland on a sheltered upland site, Co. Wicklow.

DAFM with the support of Woodlands of Ireland, Inland Fisheries Ireland and other scheme partners, and subsequently agreed by the EPA and implemented in early 2013 (see Forest Service Circular 4/2013). The amendment only applies to applications that comprise solely of GPC9 and / or GPC10 on enclosed / improved land, and no fertiliser application is permitted.

This amendment is particularly relevant to the Priority 8 Freshwater Pearl Mussel Catchments, the majority of which are identified as acid sensitive areas under this protocol.

Incorporating NWS Est. Plots into standard afforestation projects

NWS Establishment GPC9 and GPC10 can be used on their own to create a stand-alone native woodland, or as part of a wider afforestation project alongside other Grant & Premium Categories, e.g. GPC3 (Sitka spruce plus 15% broadleaves). This allows for the integration of native woodland into standard forest design, specifically to realise associated ecosystem services regarding (for example) water, landscape and wider habitat linkage. This integration is promoted by the Environmental Requirements for Afforestation, in that the wider water setback required on peat sites or within the catchment area of a high ecological status objective waterbody can be reduced through the use of an adjoining GPC9 or GPC10 plot.

Section 3
Water Setback

Overview

(Please note, the following relates to those mandatory measures set out in the *Environmental Requirements for Afforestation* (DAFM, 2016), as they relate to NWS Establishment plots. Additional measures apply in relation to other types of afforestation.)

As described in the *Environmental Requirements for Afforestation* (DAFM, 2016), the water setback is designed to create, at the very outset, an intact and permanent buffer of natural vegetation alongside the aquatic zone(*), in order to protect water quality and aquatic ecosystems from possible overland flow of sediment and nutrient runoff and other potential impacts. In effect, the water setback breaks the 'pathway' between the source of possible pollution and the receiving watercourse. In the context of native woodland planting, the water setback compliments the protective role of emerging native woodland, established with minimal site disturbance and managed according to close-to-nature silviculture, principally for biodiversity.

(* An aquatic zone is defined as "*Any natural river, stream of lake (but not an artificial drain) illustrated on an Ordnance Survey 6 inch map.*" Other water features are also protected under the Environmental Requirements for Afforestation, i.e. relevant watercourses, hotspots and drinking water abstraction points. See Circular 12/2017 for details.)

The water setback must be left largely undisturbed during afforestation and throughout subsequent woodland development, to allow it to develop into a well-vegetated area of the overall woodland site, supporting a mosaic of natural ground vegetation and (potentially) pockets of native scrub.

A typical water setback installed as part of a broadleaf afforestation project.

A water setback cannot be used for any purpose which might undermine its protective function or which could damage the aquatic zone. Planting is limited to environmental setback planting (see below), and operations such as cultivation and drainage are excluded (such operations are also restricted within adjoining NWS Establishment plots). Machine traffic must also be excluded, apart from limited passage with prior DAFM agreement (e.g. for once-off fencing of a property boundary).

As with other setbacks for retained habitats, archaeology, public roads, etc., water setbacks also have a wider biodiversity role within the woodland, by creating structural diversity and important woodland edge and open habitats for native flora and fauna.

The water setback can be included in the 15% allowance for Areas for Biodiversity Enhancement, without any reduction in grant and premium payments under NWS Establishment – see Circular 16/2017 for details.

The Environmental Requirements for Afforestation specify the minimum width of the water setback. This width takes account of the slope leading down to the aquatic zone. Based on the use of NWS Establishment, the defined water setbacks are as follows (see Table 1). (Note, for GPCs other than GPC9 and GPC10, wider setbacks are required for sites on peat soil or within the catchment area of a high ecological status (HES) objective water bodies. However, the use of NWS Establishment counters these increased setbacks.)

The value of the water setbacks, in terms of water protection, biodiversity, landscape, etc., can be further enhanced by the following:

- The water setback can be widened at key locations onsite, where site hydrology and slope increase the vulnerability of receiving waters.
- Based on the immediate landform / topography, the width of the setback can be varied to avoid artificial lines and to create a naturally undulating forest edge.

Appropriate tree planting within the water setback will deliver direct in-stream benefits such as bank stabilisation, cooling / shading, and food drop into the aquatic ecosystem, and will create further habitat diversity within the setback.

The following applies:

- Water setback planting can involve single or small irregular groups (5-10 trees) of native riparian species (birch, willow, and occasional alder and pedunculate oak) at strategic points within the water setback.
- This planting should not exceed 20% of the area of the water setback.

Table 1 Required water setback width for aquatic zones (as measured from the bank of the watercourse), *as applied to NWS Establishment plots*.

Slope leading down to the aquatic zone (applied as appropriate, where slope varies over the site)	**Setback width**
Moderate (even to 1-in-7 / 0-15%)	10 metres
Steep (1-in-7 to 1-in-3 / 15-30%)	15 metres
Very steep (1-in-3 / >30%)	20 metres

- Trees should be pit-planted and protected from grazing, as necessary. This may involve individual tree shelters or small fenced-off exclosures. Deer-prone areas will require particular attention in this regard.
- Where applied as groups, adopt a robust planting design using trees with compatible growth rates.
- Typically, trees are to be pit-planted. No cultivation is permitted within the water setback, but soil can be imported from outside the setback, and deposited to create individual planting positions, if required.
- Fertiliser application and vegetation management can be applied to establish setback planting, based on the following restrictions:
    - Fertiliser application is limited to the manual application of an appropriate slow-release formulation into the planting pit.
    - Regarding vegetation management, herbicide use is prohibited. Use non-herbicide methods instead, such as trampling, mulches and mats.

As set out in the Environmental Requirements for Afforestation, the Registered Forester must ensure that all operators are aware of the importance of the water setback, its location and extent, and what is and is not permitted within it. The marking out of the setback prior to site operations commencing is encouraged, to avoid incursions. Furthermore, "*An environmental setback must not be used for any forest operation or for any other purpose which could compromise its protective function or which could damage the environmental feature or sensitivity being protected.*" Under the *Forestry Scheme Penalty Schedules* (DAFM, 2015), failure to adhere to the required water setback can incur significant penalties.

Suitable native trees planted singly or in groups within the water setback must be protected against grazing. Tree guards can be used to protect against grazing animals, including deer.

Ongoing maintenance

The required treatment of water setbacks up to the end of the 15 year NWS Establishment premium is as follows:

- The intended protective function of the setbacks must be maintained throughout this stage of the woodland's development. This entails leaving these areas undisturbed, excluding machine traffic, and allowing natural ground vegetation to develop. Management may be required in

some cases, e.g. to control excessive woody growth.

- Any planting carried out in the water setback must be monitored, and trees maintained as needed (e.g. vegetation management, replacement of mortalities, adjustment and eventual removal of tree shelters) until they are fully established and free of grazing pressure.
- The type of natural vegetation likely to emerge in the water setback will vary according to soil, drainage, elevation, aspect, grazing pressure, etc. On most sites, a mosaic of natural ground vegetation and pockets of naturally regenerating woody growth will typically emerge throughout this period.
- However, ongoing monitoring and appropriate control is needed to prevent the colonisation of water setbacks by invasive exotics. In particular, Japanese knotweed, Himalayan balsam and rhododendron, are of significant concern regarding water quality. Where best practice involves herbicide use, consult with Inland Fisheries Ireland and other relevant bodies in advance. Controlling such species is difficult and expensive, and often requires a wider catchment approach for progress to be sustained.
- Existing access by anglers should be maintained, with appropriate stiles added to facilitate the crossing of fencelines.
- Periodic mowing and strimming of vegetation and subsequent removal of cuttings from the site, may be useful in reducing the build-up of nutrients in the water setback arising from its buffering role. Controlled grazing, with prior DAFM agreement, may also fulfil this role.

Section 4
Relevant Research & Initiatives

Introduction

A range of significant water-related ecosystem services can be realised by applying the Woodland for Water measure, combining new native woodland and an undisturbed setback, particularly under the following headings:

- reduction in sediment mobilisation and runoff into watercourses
- interception of nutrient runoff into watercourses
- bank stabilisation
- food input into the aquatic ecosystem
- shading / cooling
- regulation of floodwater
- riparian restoration

This section presents an overview of relevant research in Ireland, the UK and elsewhere, demonstrating these ecosystem services. Various research titles are listed under each of the above headings, together with a concise overview of the main findings of that research. Please note, this is intended as a brief overview of relevant research and full references are provided for follow-up reading.

This overview has been compiled with input from Woodlands of Ireland within the context of the partnership between that organisation and DAFM in the ongoing development and implementation of the Native Woodland Scheme package.

Reduction in sediment mobilisation and runoff into watercourses

The role of riparian vegetation in protecting and improving chemical water quality in streams

Dosskey, M.G., Vidon, P., Gurwick, N.P., Allan, C.J., Duval, T.P. & Lowrance, R. 2010. *Journal of the American Water Resources Association* 46(2):261-277.

A review of the research literature concludes: that riparian vegetation influences stream water chemistry through diverse processes including direct chemical uptake and indirect influences such as the supply of organic matter to soils and channels, modification of water movement, and stabilization of soil. Our analysis suggests that the level and time frame of a response to restoration depend strongly on the degree and time frame of vegetation loss. Legacy effects of past vegetation can continue to influence water quality for many years or decades and control the potential level and timing of water quality improvement after vegetation is restored. Through the collective action of many processes, vegetation exerts substantial influence over the well-documented effect that riparian zones have on stream water quality. However, the degree to which stream water quality can be managed through the management of riparian vegetation remains to be clarified.

Land use management effects on flood flows and sediments – guidance on prediction

McIntyre, N. & Thorne, C. (Eds.). 2013. CIRIA Report C719. CIRIA, London.

At the plot scale, experiments at the Pontbren catchment showed that tree planting can in some circumstances reduce runoff by orders of magnitude.

Interception of nutrient runoff into watercourses

The role of herbaceous woodland perennial diversity for improving nutrient uptake capacity of riparian areas

McMullen, C.M. & Thompson, J. 2006. Leopold Center Completed Grant Reports. Paper 258. Volume 15 (2006) Leopold Center Progress Report.

The principal conclusion is that perennial herbaceous species, because of the biomass they accumulate during the growing season, have the potential to improve the capacity of riparian buffers to seasonally store nutrients and prevent them from entering surface waters. Because the degraded forests in the study were lacking a group of species that have peak growth in early spring, their capacity to retain nutrients was seriously impaired in the spring, a time of high potential nutrient loss.

Design and placement of a multi-species riparian buffer strip system

Schultz, R.C., Collettil, J.P., Isenhart, T.M., Simpkins, W.W., Mize, C.W. & Thompson, M.L. 1995. *Agroforestry Systems* 29(3):201-226.

This suggests better soil stabilization, absorption of infiltrated water, and soil-root-microbe-NPS [non-point source] *pollutant interaction characteristics within the multi-species riparian buffer strip system (MSRBS) than the cropped fields. Nitrate-nitrogen concentrations in the MSRBS never exceed 2 mg l^{-1} whereas the levels in the adjacent agricultural fields exceed 12 mg l^{-1}. The water quality data collected suggest that the MSRBS is effective in reducing NPS pollutants in the vadose* [region of aeration above the water table] *and saturated zone below the system. Overall the MSRBS system seems to be functioning as expected. This MSRBS system offers farmers a way to intercept eroding soil, trap and transform NPS pollution, stabilize streambanks, provide wildlife habitat, produce biomass for on-farm use, produce high-quality hardwood in the future, and enhance the aesthetics of the agroecosystem.*

Theme 2: Nitrate leaching

Hansen, K., Gundersen, P., Rosenqvist, L., Vesterdal, L. & van der Salm, C. 2004. *In:* Guidelines for planning afforestation on previously managed arable land. Edited by Hansen, K. & Vesterdal, L. Forest & Landscape, Hørsholm, 105 pp.

The nitrogen cycle in agricultural soils is an open cycle. Fertilisers (NPK) are supplied regularly in large amounts and approximately the same amount of nitrogen leaves the ecosystem by leaching or in harvested products. Leaching to seepage water and stream water is large since the soils often are 'saturated' with nitrogen and the vegetation cover is sparse during the wet season. On the contrary, old forests are characterized by a tight nitrogen cycle where losses of nitrogen are low. Water from old forests is, therefore, generally of good quality with a low concentration of dissolved nitrogen compared to other land uses. Afforestation of former farmland is seen as a strategy to improve water quality, especially with regard to nitrate leaching. In this context, the challenge is to keep nitrate leaching from the new forests at a

low level, despite the large nitrogen pool, which is a legacy of the former land use.

From existing knowledge about the nitrogen cycle in forests and afforested former arable land we have the following recommendations for afforestation where low nitrate leaching is wanted: Afforestation should preferably be performed over larger united areas building larger fragments of forest in connection to already existing forest in order to decrease deposition caused by edge effects. The new forests should preferably consist of deciduous tree species (e.g. ash and oak) since they have a lower deposition of nitrogen and a higher water recharge which mostly leads to lower nitrate concentrations in leaching water.

Riparian forests as nutrient filters in agricultural watersheds

Lowrance, R., Todd, R., Fail, J., Hendrickson, O., Leonard, R. & Asmussen, L. 1984. *BioScience* 34:374-377.

Riparian (streamside) vegetation may help control transport of sediments and chemicals to stream channels. Studies of a coastal plain agricultural watershed showed that riparian forest ecosystems are excellent nutrient sinks and buffer the nutrient discharge from surrounding agroecosystems. Nutrient uptake and removal by soil and vegetation in the riparian forest ecosystem prevented outputs from agricultural uplands from reaching the stream channel. The riparian ecosystem can apparently serve as both a short- and long-term nutrient filter and sink if trees are harvested periodically to ensure a net uptake of nutrients.

Case study 16: Pontbren catchment land use change study – North Powys

Nisbet, T., Page, T. & Woodland Trust Wales. 2016. Commissioned by the Environment Agency's Evidence Directorate, as part of the joint Flood and Coastal Erosion Risk Management Research and Development Programme, UK.

The study found that tree and hedgerow planting to reduce run-off can help to mitigate diffuse pollutants such as sediment, phosphorus and pesticides, and can help to change sediment yields. Riparian planting was also shown to stabilise riverbanks and to offer refuge for wildlife.

Bank stabilisation

Quantifying the mechanical and hydrologic effects of riparian vegetation on streambank stability

Simon, A. & Collison, A.J.C. 2002. *Earth Surface Processes & Landforms* 27:527-546.

Tree roots were found to increase soil strength by 2-8 kPa depending on species, while grass roots contributed 6-18 kPa. Slope stability analysis based on data collected during bank failures in spring 2000 (following a very dry antecedent period) shows that the mechanical effects of the tree cover increased Fs [factor of safety] *by 32 per cent, while the hydrologic effects increased Fs by 71 per cent.*

The effects of riparian vegetation on bank stability

Easson, G. & Yarbrough, L.D. 2002. *Environmental & Engineering Geoscience*. 8(4):247-260.

[In relation to sweet gum (*Liquidambar styraciflua*),] *Increased tensile strength due to root*

reinforcement was found to be between 0.0 and 245 kPa, depending on depth. For a given depth of 40 cm, the increased tension due to root reinforcement averaged 148 kPa, depending on lateral distance from tree. The modelling results showed a contrast between root-reinforced and unreinforced soil. When no root reinforcement existed, the slope failed marginally. When simulated root reinforcement of 20 kPa was applied, the slope was shown to be completely stable.

The effects of vegetation on stream bank erosion

Wynn, T.M., Mostaghimi, S., Elizabeth, H.E. & Alpin, F. 2004. *In:* 2004 ASAE Annual Meeting. Published by the American Society of Agricultural and Biological Engineers, St. Joseph, Michigan.

Riparian vegetation had multiple significant effects on soil erodibility. In addition to reinforcing the stream banks, the streamside vegetation affected soil moisture and altered the local microclimate, which in turn affected freeze-thaw cycling.

Where along a river's length will vegetation most effectively stabilise stream banks?

Abernethy, B. & Rutherfurd, I.D. 1998. *Geomorphology* 23(1):55-75.

This paper illustrates a structured decision-making approach for assessing the role of vegetation in stream bank erosion at different points throughout a catchment. Bank erosion in upper reaches is dominated by subaerial preparation, in mid-basin reaches by fluvial entrainment, and in the lower reaches by mass failure. We find that in upper reaches, windthrown trees are responsible for most bank sediment transfer to the flow. Where direct fluvial entrainment of bank material is the dominant erosion process, flow resistance due to vegetation becomes crucial. In reaches where bank slumping is the dominant erosion process, increased bank shear strength due to root reinforcement is the major role of vegetation in stabilising banks. Considering the above variables we are able to define a critical zone in which revegetation will be most effective in reducing bank erosion. On the Latrobe River, this zone occurs in that

A potential site for the Woodland for Water measure, to protect against bank erosion.

portion of the river where it first leaves the mountain front and meanders across a broad floodplain.

Effects of wet meadow riparian vegetation on streambank erosion. 2. Measurements of vegetated bank strength and consequences for failure mechanics

Micheli, E.R. & Kirchner, J.W. 2002. *Earth Surface Processes and Landforms* 27(7):687-697.

Wet meadow floodplain vegetation creates a composite cut bank configuration (a cohesive layer overlying cohesionless materials) that erodes via *cantilever failure. Field measurements and a geotechnical model of cantilever stability show that by increasing bank strength, wet meadow vegetation increases the thickness, width, and cohesiveness of a bank cantilever, which, in turn, increases the amount of time required to undermine, detach, and remove bank failure blocks. At Monache Meadow, it takes approximately four years to produce and remove a 1 m wide wet meadow bank block. Wet meadow vegetation limits bank migration rates by increasing bank strength, altering bank failure modes, and reducing bank failure frequency.*

Stabilising characteristics of New Zealand indigenous riparian colonising plants

Marden, M., Rowan, D. & Phillips, C. 2007. *In:* Eco- and Ground Bio-Engineering: The Use of Vegetation to Improve Slope Stability. Volume 103 of the series 'Developments in Plant and Soil Sciences', pp 143-153. Springer.

The effectiveness of riparian restoration programmes using indigenous species, though potentially high for low-order stream, will be limited by their relatively shallow-rooted habit for bank stabilisation on larger rivers without the prior installation of structural protection works.

The effect of riparian tree roots on the mass-stability of riverbanks

Abernethy, B. & Rutherfurd, I.D. 2000. *Earth Surface Processes & Landforms* 25:921-937.

*Modelling bank stability against mass failure with and without the reinforcing effects of River Red Gum (*Eucalyptus camaldulensis*) or Swamp Paperbark (*Melaleuca ericifolia*) indicates that root reinforcement of the bank substrate provides high levels of bank protection. The model indicates that the addition of root reinforcement to an otherwise unstable bank section can raise the factor of safety (Fs) from Fs = 1.0 up to about Fs = 1.6. The addition of roots to riverbanks improves stability even under worst-case hydrological conditions and is apparent over a range of bank geometries, varying with tree position. Trees growing close to potential failure plane locations, either low on the bank or on the floodplain, realise the greatest bank reinforcement.*

Food input into the aquatic system

Role of streamside vegetation as a food source for *Galaxias olidus* Gnnther (Pisces: *Galaxiidae*)

Cadwallader, P.L., Eden, A.K. & Hook, R.A. 1980. *Australian Journal of Marine & Freshwater Research* 31(2):257-262.

Terrestrial organisms were taken more frequently by larger fish than by smaller fish and formed a substantial part of the diet of those fish taken from sites surrounded by overhanging

vegetation. Terrestrial organisms were much less common in the diet of fish taken from sites with little overhanging vegetation.

Linking ecosystems, food webs, and fish production: Subsidies in salmonid watershed

Wipfli, M.S. & Baxter, C.V. 2010. *Fisheries* 35:373-387.

Traditional freshwater food web illustrations have typically conveyed the notion that most fish food is produced within the local aquatic habitat itself, but the concepts and model [presented] *in this article show that most fish food comes from external or very distant sources – including subsidies from marine systems borne from adult returns of anadromous fishes, from fishless headwater tributaries that transport prey to downstream fish, and from adjacent streamside vegetation and associated habitats.*

Resurrecting the in-stream side of riparian forests

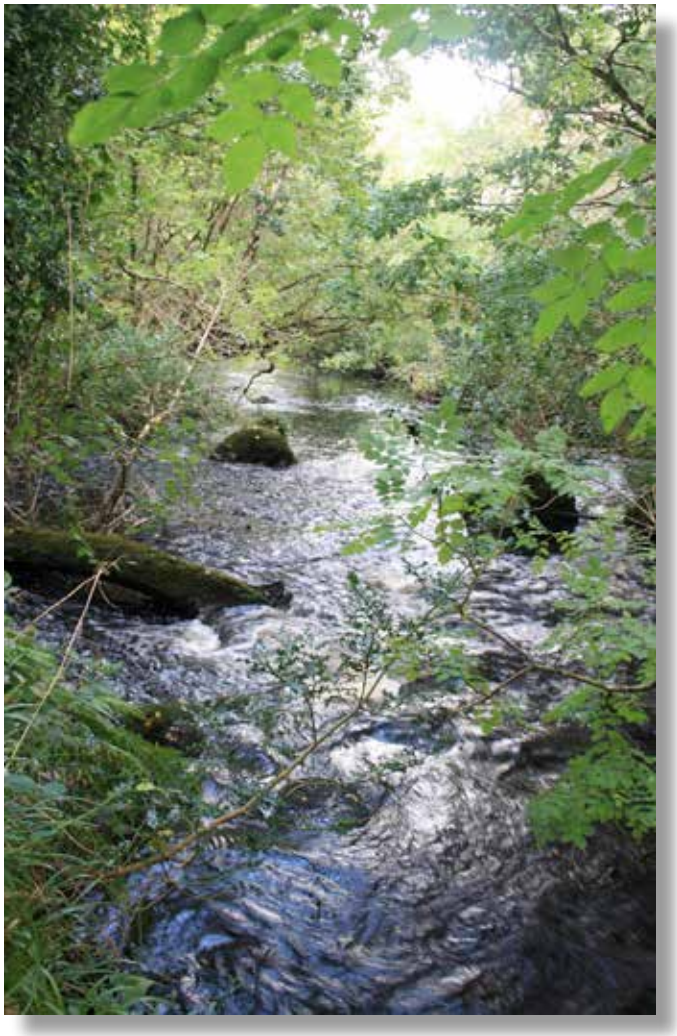
Sweeney, B.W. & Blaine, J.G. 2009. *Journal of Contemporary Water Research & Education* 136(1):17-27.

Forested riparian habitats exhibited greater percent maximum frequency of woody vegetation and reduced water temperatures than unplanted riparian habitats and grass filter strips. Forested riparian habitats also exhibited greater canopy cover, woody vegetation taxa richness, and coarse particulate organic matter input than grass filter strips and greater riparian widths and woody vegetation abundance than unplanted riparian habitats.

Effects of bioengineered streambank stabilization on bank habitat and macroinvertebrates in urban streams

Sudduth, E.B. & Meyer, J.L. 2006. *Environmental Management* 38(2):218-226.

Percent organic bank habitat at each site proved to be strongly positively correlated with many factors, including taxon richness, total biomass, and shredder biomass. These results suggest that bioengineered bank stabilization (i.e. planting trees) can have positive effects on bank habitat and macro-invertebrate communities in urban streams, but it cannot completely mitigate the impacts of urbanization.



As bank-side vegetation develops, native trees, shrubs and other plants contribute directly to the aquatic ecosystem. (Photo C.Bullock)

Shading / Cooling

The influence of riparian shade on lowland stream water temperatures in Southern England and their viability for Brown Trout

Broadmeadow, S., Jones. J.G., Langford, T.E.L., Shaw, P.J. & Nisbet, T. 2010. *River Research and Applications* 27(2):226-237.

Riparian shade was found to have a marked influence on stream water temperature, particularly in terms of moderating diel temperature variation and limiting the number of days per year that maximum temperatures exceeded published thermal thresholds for brown trout. Expansion of riparian woodland offers potential to prevent water temperature exceeding incipient lethal limits for brown trout and other fish species. A relatively low level of shade (20-40%) was found to be effective in keeping summer temperatures below the incipient lethal limit for brown trout, but ca. 80% shade generally prevented water temperatures exceeding the range reported for optimum growth of brown trout.

The vegetation communities of unmanaged aquatic buffer zones within conifer plantations in Ireland

Mc Conigley, C., Lally, H., O'Callaghan, M., O'Dea, P., Little, D. & Kelly-Quinn, K. 2015. *Forest Ecology and Management* 353:59-66.

It is noted that tree species are not a feature of the riparian zone on peat soils and thus tree planting is not recommended as a management option unless used to control water temperatures. There is scope for tree planting on mineral soils, as control sites contained woodland habitats which were absent from the ABZs of clearfell and replanted sites.

Regulation of floodwater

Impacts of upland land management on flood risk: Multi-scale modelling methodology and results from the Pontbren experiment

Wheater, H., Reynolds, B., McIntyre, N., Marshall, M., Jackson, B., Frogbrook, Z., Solloway, I., Francis, O. & Chell, J. 2008. Flood Risk Management Research Consortium (FRMRC) Research Report UR16. www.floodrisk.org.uk

Comparisons of soil hydraulic properties show significant increases in hydraulic conductivity and saturated moisture content of soil under trees compared to adjacent improved pasture. Catchment-scale simulations show the effects of improved and unimproved grassland, and the potential effects of land management interventions, including farm ponds, and tree shelter belts and buffer strips. Results indicate that careful placement of such interventions can significantly reduce the magnitude of peak runoff at the field and small catchment scale. Simulations carried out within a framework of uncertainty analysis suggest that, for frequent events, the median effect of introducing optimally placed tree shelter belts to the current land use is to reduce peak flow by 29%; introducing full woodland cover would reduce flows by 50%. Considering an extreme event (the Carlisle January 2005 rainfall), the corresponding median effects are a 5% and 36% reduction.

Evaluating the effects of riparian woodland and large woody debris dams on peak flows in Pickering Beck, North Yorkshire

Odoni, N.A., Nisbet, T.R., Broadmeadow, S.B., Lane, S.N., Huckson, L.V., Pacey, J. & Marrington, S. 2010. *In:* Proceedings of the Flood and Coastal Management 2010 Conference, The International Centre, Telford, 29 June – 1 July 2010. 10 pp.

A number of key conclusions for wider flood risk management practice emerge. First, a large number of smaller interventions can lead to significant reductions in peak flow, albeit not enough on their own to protect properties from flooding during an event estimated to have just under a 100 year return period. However, such interventions could make an important contribution to a whole-catchment approach to managing flood risk, where the integration of a range of different measures could make a significant difference.

An assessment of the impact of floodplain woodland on flood flows

Thomas, H. & Nisbet, T.R. 2007. *Water & Environment Journal* 21:114-126.

This paper examines the potential role of floodplain woodland in flood alleviation. Both models predicted a reduction in water velocity within the woodland, increasing water level by up to 270 mm and creating a backwater effect that extended nearly 400 m upstream. Flood storage increased by 15 and 71%, while flood peak travel time was increased by 30 and 140 min for the two scenarios simulated. The results suggest that there is considerable scope for using strategically placed floodplain woodland to alleviate downstream flooding. In particular, it offers a means of tackling the increased flood risk associated with climate change.

Land use management effects on flood flows and sediments – guidance on prediction

McIntyre, N. & Thorne, C. (Eds.) 2013. CIRIA Report C719. CIRIA, London.

At the small catchment scale, which may be considered as catchment areas less than 10 km^2, land use effects may also be significant. For example, model results show that low footprint, strategic tree planting in a 6 km^2 sub-catchment at Pontbren would be expected to reduce peak flow by nearly 50% for a short return period rainstorm, decreasing to 5% for a very extreme, long return period rainfall event.

A riparian afforestation project in Perthshire, Scotland, initiated by World Wildlife Fund Scotland for downstream flood mitigation and other water-related ecosystem services.

Case study 16: Pontbren catchment land use change study – North Powys

Nisbet, T., Page, T. & Woodland Trust Wales. 2016. Commissioned by the Environment Agency's Evidence Directorate, as part of the joint Flood and Coastal Erosion Risk Management Research and Development Programme, UK.

At Pontbren, tree planting resulted in significant flood attenuation at the small scale (area 6 km^2). However, this has not been matched in terms of performance in the larger scale (261 km^2) Hodder catchment.

The research at Pontbren confirms other investigations showing that, at the small scale, the placement of individual trees and shelter belts will generally have a positive effect on flooding by increasing interception losses, increasing water storage within the soil and increasing the rate of water movement to the subsurface. More work is needed on how flow peaks from upland catchments combine as they move down river.

Riparian restoration

Water quality in the Scottish uplands: A hydrological perspective on catchment hydrochemistry

Soulsby, C., Gibbins, C., Wade, A.J., Smart, R. & Helliwell, R. 2002. *Science of the Total Environment* 294(1-3):73-94.

The study showed that little acidification of either soil water or groundwater were likely to result from native forest growth. Thus it was concluded that minimal impact of stream water acidity would occur as a result of native woodland re-establishment due to: (a) differences in forest characteristics, such as a less dense canopy compared to commercial forests, slower growth rates and reduced nutrient uptake, lower evapotranspiration and lack of ground preparation (cultivation and drainage); and (b) the relatively small proportion of the catchment being suitable for native woodlands (extensive areas of the catchment have peat soils or are montane and above the anticipated timberline).

Woodland for Water: Woodland Measures for Meeting Water Framework Directive Objectives – Summary of final report from Forest Research to the Environment Agency and Forestry Commission (England)

Environmental Agency. 2011. Environmental Agency, Bristol, UK. www.environment-agency.gov.uk

Opportunities still exist for promoting native riparian woodland as a means of aiding the biological recovery of acidified waters. The clearing back of dense conifer shading and opening out of stream sides to encourage the restoration of native riparian woodland have been shown to greatly enhance aquatic and riparian habitats; this could aid upstream fish migration and the biological recovery of these streams.

The application of the Native Woodland Establishment Scheme in Acid Sensitive Areas: A proposed refinement of the existing acid sensitivity protocol for afforestation

DAFM. 2013. Proposal presented to the Environmental Protection Agency by the Forest Service (Department of Agriculture, Food & the Marine), with the support of Inland Fisheries Ireland, National Parks & Wildlife Service, the Heritage Council and Woodlands of Ireland. Forest Service, Department of Agriculture, Food & the Marine, Agriculture House, Kildare St.,

The Woodland for Water model has a potential role in aiding aquatic ecosystem recovery within acid sensitive areas. Glencree, Co. Wicklow.

Dublin 2.

This paper proposed a refinement of the existing acid sensitivity protocol for afforestation, enabling DAFM to consider for approval applications under NWS Establishment for sites within designated acid sensitive areas, without the requirement for water sampling. The proposal was based on:

- the results of instream Small Streams Risk Score (SSRS) sampling within relevant study areas in Counties Galway, Kerry, Wicklow and Donegal, undertaken by Inland Fisheries Ireland and (for separate reasons) the EPA, which indicated no demonstrable negative impact on water quality arising from existing native woodland;
- the site-specific and highly sensitive establishment and management approach underpinning NWS Establishment;
- the benign impact of native trees on soil development and nutrient recycling; and
- the wide range of ecosystem services (including other water protection mechanisms) that could be delivered within acid sensitive areas, through native woodland creation.

As described in Section 2, this proposed refinement was subsequently accepted by the EPA and introduced in early 2013 (see Circular 4/2013).

General overview of benefits

A key publication by Nisbet *et al.* (2011), entitled *Woodland for Water: Woodland Measures for Meeting Water Framework Objectives*, reviews research in this area. That report considers the key issues relating to woodland and the WFD in England and Wales. The review provides strong evidence to support new proposals to expand woodland in appropriate locations for soil and water benefits. Main drivers for woodland expansion include: sustainable flood management; water bodies remaining at risk of failing good water status despite improvements in agricultural land practices; and the need to mitigate the effects of climate change.

The planting of riparian and floodplain woodlands provide the greatest potential benefits.

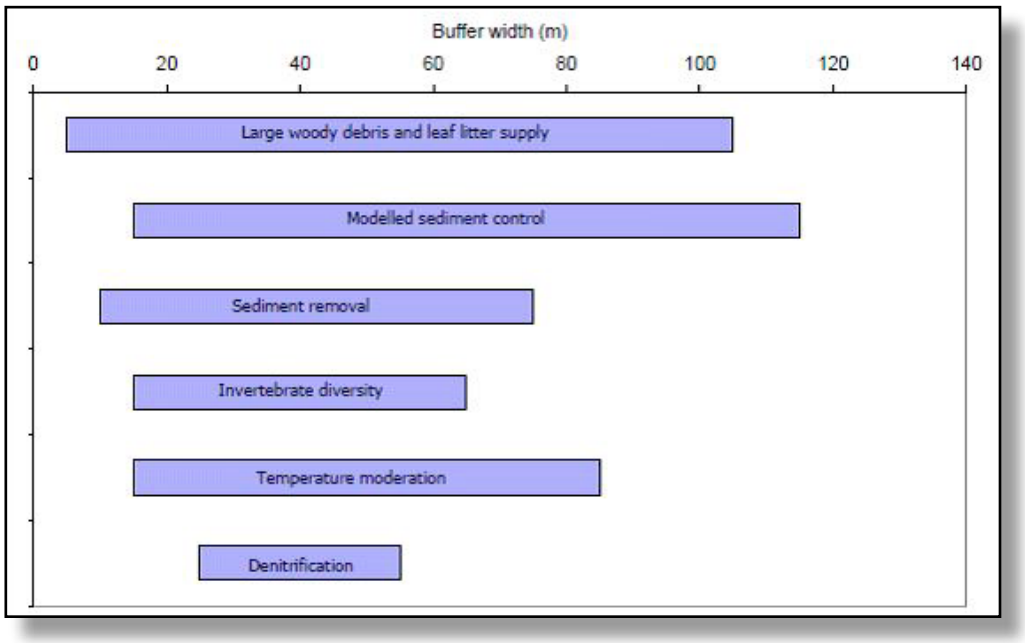


Figure 3 *(From Nisbet et al., 2011)* "Riparian woodland buffers provide a number of water functions, including sediment removal. Plot shows a range of buffer widths reported in the literature as being required for the adequate performance of specific buffer functions."

Such woodlands can help to reduce diffuse pollution, protect river morphology, moderate stream temperature and aid flood risk management, as well as meet Biodiversity Action Plan targets for the restoration and expansion of wet woodland.

Nisbet *et al.* (2011) also present a chart showing a range of riparian woodland buffer widths reported in the literature as being required for the adequate performance of specific buffer functions – see Figure 3.

An unpublished report by DAFM (2007) of a study tour of native riparian woodland projects in Scotland by DAFM, Inland Fisheries Ireland and Woodlands of Ireland, concluded with the following:

> *This document (agreed by the representatives involved) reports on a study tour of native riparian woodland projects undertaken by the Fisheries Research Service, the World Wildlife Fund Scotland and the Tweed Foundation. The visiting party observed a number of initiatives promoting the use of sensitively designed and managed native riparian woodland as a mechanism to enhance water quality and the aquatic habitat, to reduce sediment loading and to protect against downstream flooding. Work ranged from planting on open sites to the replacement of existing conifer forest with native riparian woodland. A common feature of discussion throughout was the uncertainty regarding future climate change, and the general acceptance that having well-developed native riparian woodland in place was a significant step in buffering the riparian system and fish life against whatever negative impacts might occur.*

Recent and ongoing initiatives

Several recent and ongoing initiatives will bring further focus on the use of new native woodland to protect water and aquatic ecosystems. These include: the KerryLIFE Freshwater Pearl Mussel project; a European COST Action on forests and payments for water-related ecosystem services; the DAFM's Competitive Call for Research; and Woodlands of Ireland's Strategy for Native Woodlands in Ireland 2016-2020.

KerryLIFE

The use of new native woodlands to protect water quality and the aquatic habitat for the highly-sensitive Freshwater Pearl Mussel (FPM) is being trialled by the KerryLIFE project, an EU co-funded project focusing on sustainable land use management for the conservation of the species (LIFE13 NAT/IE/000144). The project, focused on the Caragh and Kerry Blackwater FPM catchments in the southwest of Ireland, is trialling and demonstrating sustainable management techniques for farming and forestry in FPM catchments. For further details, see *Forests & Water* (DAFM, 2018) and www.kerrylife.ie/, the project's website.

Concrete measures under KerryLIFE include the stabilisation of riparian sediment sources using broadleaf planting, through the establishment of new long-term native woodland to create a protective physical buffer between aquatic zones and farming activities. Such woodlands are being created under NWS Establishment, and the experiences gained will inform landuse management within other FPM catchments nationwide.

European COST Action on forests and payments for water-related ecosystem services

Another initiative in this area is the European COST Action – Payments for Ecosystem Services (Forests for Water) (PESFOR-W COST Action (CA15206)). The aim of this COST Action, which involves researchers, practitioners and policy makers from throughout Europe, is to improve Europe's capacity to use Payments for Ecosystem Services (PES) to achieve WFD targets and other policy objectives, through incentives for planting woodlands to reduce agricultural diffuse pollution to watercourses. The action will run until 2020. Its specific objectives are to:

- characterise and evaluate governance models;
- evaluate environmental effectiveness of targeted woodland planting;
- explore cost-effectiveness of woodland planting for reducing diffuse pollution;
- create a European PES repository of case studies; and
- develop user guidance on suitability of pollutant, ecosystem service and catchment

The KerryLIFE project, based in the Caragh and Kerry Blackwater catchments, is a multi-agency initiative demonstrating sustainable landuse for the conservation of Freshwater Pearl Mussel. The creation of new native woodland is one approach being trialled under the project.

scale models to quantify the effectiveness of tree planting to reduce diffuse pollution.

Ireland is represented on PESFOR-W COST Action by representatives from Teagasc, NUI - Dublin and Woodlands of Ireland. See www.forestry.gov.uk/fr/pesforw for details.

The current Microsoft / Natural Capital Partners / Green Belt initiative and the Woodland Fund arising from the mid-term review of the Forestry Programme, are precursors to the application of this approach in Ireland. For further details, see *Forests & Water* (DAFM, 2018).

DAFM Research

As set out in *Forests & Water* (DAFM, 2018), the current (2017) Competitive Call for Research Proposals included the following specifications for water-related research under C.6.3 Ecosystem Services – Forests and Water, in order to examine the opportunities for forestry to contribute proactively to meeting Ireland's obligations under the 2nd cycle of the WFD:

The proposal should include the following aspects:

1. Explore the range of ecosystem services which forestry, as a land use, can deliver in relation to water quality and related habitats and species (e.g. buffering against impacts for adjacent land use, sediment and nutrient interception, bank stability, the restoration of natural hydrology; water temperature regulation, mitigation against surface water acidification, the provision of appropriate in-stream inputs, flood mitigation, etc.); and

2. Set out mechanisms to deliver these ecosystem services [for example, through the restructuring of existing forests, the creation of new forests and woodlands (including native riparian woodland), and the strategic deployment of measures, based on WFD]; and

3. Increase awareness of these eco-system services and measures amongst Bodies coordinating and inputting into meeting Ireland's obligations under the WFD, to ensure closer integration of the targeted deployment of relevant forestry measures into water policies land use.

For details, see www.agriculture.gov.ie/research/competitivenationalprogrammes/programmeofcompetitiveforestryresearchfordevelopmentcoford/

A Strategy for Native Woodlands in Ireland 2016-2020

In July 2016, Woodlands of Ireland published *A Strategy for Native Woodlands in Ireland 2016-2020*, developed with input from key government bodies and native woodland stakeholders. The protection and enhancement of water quality and protected aquatic-based species and habitats, and expansion of riparian native woodland were identified as key areas, with "*considerable potential* [under NWS Establishment] *to create new native woodlands, especially riparian woodland along aquatic corridors, to capitalise on the numerous water-related ecosystem services.*" The Strategy called for a particular focus to be placed on realising new native woodland on the following site types:

- sites within and adjoining aquatic-based Special Areas of Conservation (SACs) designated for Freshwater Pearl Mussel;
- sites within and adjoining aquatic-based SACs designated for salmonids;

Minister Andrew Doyle TD, Minister of State with responsibilities for forestry, at the launch of A Strategy for Native Woodlands in Ireland 2016-2020 *in July 2016, Glencree, Co. Wicklow.*

- sites within the riparian zone, specifically for the creation of new riparian woodland; and
- sites adjoining watercourses within high status waterbodies, as designated under the WFD.

The Strategy recommends the achievement of 1,000 hectares of new native woodland focused on water quality over its lifetime, recognising that this target will require coordination between multiple landowners and also between various bodies, including DAFM, NPWS, Coillte, Inland Fisheries Ireland and the EPA, with Woodlands of Ireland playing a central role.

Section 5

Conclusion: Realising Woodland for Water

In summary, a number of key factors now support the realisation of the Woodland for Water measure:

- the body of research and ongoing initiatives focused on the beneficial role native woodlands and associated setbacks play in protecting and enhancing water quality (in addition to native woodland biodiversity, wider habitat linkage, carbon sequestration, wood and non-wood products, landscape enhancement, outdoor recreation and other ecosystem services);
- the strategic vision for this use of native woodlands, set out in Woodlands of Ireland's *A Strategy for Native Woodlands in Ireland 2016-2020*;
- the availability of funding under the DAFM's Native Woodland Establishment Scheme, and the assessment process undertaken by that Department to ensure the suitability of applications regarding existing habitats and other sensitivities;
- the emergence of possible sources of additional payments to farmers and other landowners to develop native woodland in key areas, as demonstrated by the Microsoft / Natural Capital Partners / Green Belt initiative and the proposed DAFM Woodland Fund arising from the mid-term review of the Forestry Programme 2014-2020.
- the one-to-one contact with individual farmers and other landowners in relation to water issues, now possible through the various structures established under the 2nd

The application of the Woodland for Water measure will result in permanent semi-natural woodland ecosystems at key locations, protecting and enhancing water on an ongoing basis.

cycle of the WFD, in particular, the Local Authority Waters & Communities Officers, the Regional Operations Committees and their associate scientific personnel, and Teagasc's Agricultural Sustainability Officers.

The River Basin Management Plan for Ireland 2018-2021, published in April 2018, and the programme of measures for forestry to achieve that Plan's objectives, as set out in *Forests & Water* (DAFM, 2018), draw these components together to provide the basis for identifying key locations where new native woodland will contribute most to protecting and enhancing water, and for reaching out to and engaging with farmers and other landowners to undertake planting. Through this coordinated partnership, significant areas of Woodlands for Water can be realised, for the long-term benefit of Ireland's precious waters.

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