The Drainage Channel Biodiversity Manual

Integrating wildlife and flood risk management

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NATURAL ENGLAND

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Integrating wildlife and flood risk management

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Contents

Foreword

We believe that *The Drainage Channel Biodiversity Manual* will provide invaluable assistance for operating authorities engaged in the complex management of our lowland drainage systems. The challenge has always been to manage the balance of benefits for flood risk, agricultural drainage and biodiversity. And as recent severe flooding has illustrated, the prospect of increased flood risk brought about by climate change means that this challenge is likely to grow in scale and complexity.

At the same time, there is a growing need to address the plight of some of our most important wetland plants and animals. As Natural England's *State of the Natural Environment 2008* report has shown, breeding waders such as snipe remain in decline outside of Sites of Special Scientific Interest (SSSI), while numbers of water voles, great crested newts and the European eel also continue to fall.

Internal Drainage Boards are uniquely equipped to make a vital contribution to the conservation of wetland wildlife:

- Collectively, the IDBs are one of the biggest managers of freshwaters and wetlands in the country and thus have a significant role in maintaining and enhancing biodiversity.
- The thousands of kilometres of IDB ditches and drainage channels are biodiversity-rich networks comparable in conservation importance with England's hedgerows.
- Water level management by IDBs supports distinctive wetland habitats and, more widely, characteristic landscapes such as the Norfolk Broads and Somerset Levels.
- Hundreds of wetland plant and animal species that are targeted as priorities under the UK Biodiversity Action Plan can be found in IDB districts – from lichens to wildflowers and from insects to mammals.
- And IDB drainage districts host scores of SSSIs and Local Nature Reserves.

We hope that this manual will assist IDBs to fulfil their role as custodians of wetlands and watercourses and, importantly, help to tackle the challenge of making space for both flood waters and wildlife through the integrated planning and management of drainage catchments.

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September 2008

One

Introduction

This new manual for the biodiversity management of drainage channels, with its aim of integrating the requirements of wildlife and flood risk management, supercedes *Nature Conservation and the Management of Drainage Channels,* jointly published nearly 20 years ago by the Nature Conservancy Council and the Association of Drainage Authorities.

We have sought to keep firmly within the spirit of that earlier, ground-breaking publication by providing an accessible and practical guide to channel management techniques that are sympathetic or beneficial to wildlife.

The manual has been written principally for the staff and members of Internal Drainage Boards operating in England. However, the techniques described should be just as useful for other public authorities undertaking flood risk and water level management activities – the Environment Agency and local authorities. Many of the techniques, particularly those that are relevant to the smaller drainage channels, could also be deployed by private landowners and conservation bodies on their landholdings.

The techniques are also applicable in other parts of the United Kingdom where drainage channel networks occur, with the caveat that different laws and policies may pertain to the management of flood risk and wildlife conservation.

The focus of the guidance is on artificial channels and modified natural watercourses containing slow-flowing water. The waters in these systems are often retained behind sluices and pumped out into main rivers or the sea. We use the term "drainage channel" to collectively address these types of watercourses. Guidance on managing watercourses with a more natural structure and swifter flows can be found elsewhere, particularly in *The New Rivers and Wildlife Handbook* (Ward, D., Holmes, N. and Jose, P. 1995) and the *Manual of River Restoration Techniques* (River Restoration Centre 2002).

Our task in producing this new guide has been greatly helped by the willing input of the staff of Internal Drainage Boards and Natural England.

We would particularly like to thank our principal authors Dr Roger Buisson and Professor Max Wade of RPS Group plc, and our illustrator and designer Coral Walton of Coral Design Management.

Finally, we would like to acknowledge our debt to the earlier authors of *Nature Conservation and the Management of Drainage Channels* – Chris Newbold, John Honnor and Karen Buckley. Their authoritative work has largely stood the test of time and formed the foundations of this new publication.

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Background

A manual for drainage channel biodiversity

In 1989, the Nature Conservancy Council and the Association of Drainage Authorities jointly published guidance titled *Nature Conservation and the Management of Drainage Channels*. It was a time of growing awareness of the potentially important contribution to wildlife conservation represented by drainage channels. The guidance sought to capture the techniques that were being applied in drainage systems by some Internal Drainage Boards (IDBs) for the benefit of wildlife, and to bring them to the attention of a wider audience. The publication proved to be very popular with other flood operating authorities and with landowners and conservation bodies, but eventually went out of print.

Since 1989 there have been advances in our understanding of the characteristics of channels – both in terms of structure and management regime – which are beneficial to wildlife; and new techniques have been developed to deliver appropriate management. There have been several phases of reform of the Common Agricultural Policy and the subsequent revision of agri-environment schemes. In England, the Environmental Stewardship scheme has created a new agri-environment framework that provides a range of options for ditch and wetland maintenance, restoration and creation. The scheme agreements are with landowners and occupiers but IDBs can and do play a significant role in facilitating the habitat restoration and creation options that require management of water levels and drainage systems.

Given these developments, Natural England and the Association of Drainage Authorities decided that it would be timely to publish a new guide to the management of drainage channels for biodiversity.

The aim of this manual remains the encouragement of those practices that conserve and enhance wildlife within drainage channels while delivering a standard of maintenance appropriate to the water level and flood risk management needs of the area. It also aims to promote an awareness of the opportunities for significant wildlife enhancement that can be achieved when capital projects are initiated to renew or upgrade the drainage system, or when landowners are keen to enter agri-environment schemes.

Historical background

Wetland drainage

The drainage of wetland areas and the claiming of land from the sea have occurred in England for two millennia but the scale and rate of wetland drainage accelerated from the 17th Century with technical advances in the ability to control and pump water. It has been estimated that by the 1930s only a quarter of the historic extent of floodplain wetlands remained in England, mainly in the form of periodically flooded grassland and grazing marsh. The vast majority of natural floodplain woodland had also been lost. There was another step-change in the post-war era with further advances in drainage technology and increased availability of financial resources for the combination of in-field drainage and the improvement of the arterial drainage system.

These largely publicly-sponsored drainage improvements in the post-war period resulted in remarkable increases in our ability to produce food and equally remarkable losses in wetland wildlife. Losses of wet grassland in this period included 37 per cent in the Norfolk and Suffolk Broads area, 48 per cent in the North Kent coastal marshes and 64 per cent in the Thames Valley. Other wetland habitats were also lost including fens and reedbeds. Associated with the improvement of the arterial drainage system has been the straightening and deepening of most of England's lowland rivers and their disconnection from the surrounding floodplain.

Special wildlife sites

The remaining significant blocks of wetland habitat occurred in areas where drainage was most difficult and the present-day Sites of Special Scientific Interest (SSSIs) that contain extensive ditch systems within grazing marshes occur in these locations. The most important of these grazing marsh sites are:

- The Somerset Levels and Moors
- The Norfolk and Suffolk Broads
- The Essex coastal marshes
- In Sussex, Pevensey Levels and Amberley Wild Brooks
- In Kent, Romney Marsh, Sandwich Levels and the North Kent Marshes
- In South Yorkshire and the Midlands, Derwent Ings, the Vale of Trent and Hatfield Chase

Within arable farming areas there are some remnants of fenland intersected by ditches such as Woodwalton Fen in Cambridgeshire. Across the East Anglian Fenland run a number of man-made watercourses designed to carry water across the low-lying land and out to sea. To cope with heavy rainfall in the upland catchments these Fenland systems contain washlands such as the Ouse and Nene Washes in Norfolk and Cambridgeshire. These are wetland systems of great importance for wildlife located within a highly-productive agricultural landscape.

Significant changes in wildlife site protection and management requirements have taken place in recent years. This follows the recognition of past losses, the degradation of remaining wetlands through fragmentation and inappropriate water level management (driven by Government policies

Channel management: balancing the benefits for flood risk management, agriculture and biodiversity.

promoting the intensification of land-use) and the wish to link those fragments into larger and more sustainable wetlands. Wildlife site protection has been improved through the strengthening of obligations on public bodies, including flood operating authorities, the introduction of special decision-making processes for sites of international importance, and a raised of awareness of the value of such sites through the services that they supply to the community. Management of wetlands has been improved through the programme of Water Level Management Plans implemented by flood operating authorities and by the financial incentives available to landowners and occupiers from agri-environment schemes. Within the first phase of agri-environment support, the Environmentally Sensitive Areas Scheme targeted a number of significant wetland areas including the Norfolk and Suffolk Broads and the Somerset Levels and Moors. This targeted approach has now been taken forward through the Higher Level Stewardship component of Environmental Stewardship.

Many of the historically drained wetlands have remained as open landscapes and, on first viewing, the intensively managed fields and the absence of trees, copses and hedges suggest an absence of wildlife. It is now recognised that the drainage channels and field ditches provide a network for wildlife in the same way that hedges do in the enclosed lowland landscape of much of England. In arable farmland with few hedgerows, ditch margins may be the only remaining refuges for many terrestrial plants and animals. They provide corridors for movements of terrestrial and aquatic wildlife and they can act as the source for colonisation of the many field margins that are being created through agri-environment schemes.

Wetland visions

We are now moving into an exciting and challenging phase for wetlands. Visionary ideas for joining up fragments of wetlands to form large areas, some of which would be managed extensively by free-ranging herds of grazing animals, are now being put in place. The most advanced of these are in the Cambridgeshire Fens, including the Wicken Fen Vision and the Great Fen Project. Recent purchases have meant that parcels of land have been secured adjacent to the existing wetland areas and these are now being restored as wetland habitats.

The bittern is an important wetland species that has benefited greatly in the last two decades from the restoration and creation of reedbed habitat.

Nationally, the Wetland Vision project, set up by the conservation agencies and non-governmental organisations, has mapped out a 50-year vision for England's freshwater wetlands. It shows where new wetlands could be created and current wetlands restored. The hope is that by turning the Vision into reality it will not only help wetland wildlife but benefit flood risk management by making space for water in the countryside, help people and wildlife adapt to a changing climate, protect local landscapes and archaeological heritage and reap the ecosystem service benefits that wetlands can provide. Further information can be found at www.wetlandvision.org.uk.

Flood risk management

Organisations

The three main types of organisation with statutory powers to undertake flood defence and water level management works in England are:

- Environment Agency
- Internal Drainage Boards
- Local authorities

The Environment Agency covers the whole of England and Wales. There are local authorities with flood risk management responsibilities throughout England, but IDBs only occur where they have been created by statute in areas of special drainage need.

These organisations have been given permissive powers to carry out flood defence works, maintenance and operational activities. The Environment Agency can only exercise permissive powers on Main Rivers. Local authorities exercise their permissive powers on watercourses that have not been designated as Main Rivers and that are not within Internal Drainage Board districts.

This guidance focuses on the water level and flood risk management functions of IDBs and how this can be integrated with the conservation and enhancement of biodiversity. IDBs have other roles that include managing water for the licensed irrigation of crops, managing water levels to create 'wet fences' for livestock, managing water levels on protected nature conservation sites to ensure their conservation interest is maintained and enhanced, sustaining fisheries and, in a few cases, managing a statutory navigation.

Assets at risk

There are significant artificial and natural assets in England that are potentially at risk of flooding from both rivers and the sea. It has been estimated that at the beginning of the 21st century there were some 1.8 million residences and 140,000 commercial properties, equating to perhaps 5 million people, potentially affected in England and Wales. An estimate for England has suggested that £3 billion of damages per year could occur if nothing were done to manage the risk and that average annual damages from flooding are some £1 billion per year. The capital value of assets at risk has been estimated at £250 billion. In England there are over 9 million hectares of agricultural land, of which two million are dependent on the continued operation of the drainage systems, both gravity and pumped, to enable people to live and work in these areas and to produce food by modern agricultural methods.

Flooding – processes and consequences

Flooding brought on by heavy rain in a catchment is a natural occurrence and it is unreasonable to expect that, with the resources available to the public sector, it can be entirely prevented. This is one of the reasons why the approach to flooding is risk-based and not one that attempts to deliver absolute protection for people, their property and public infrastructure. It is also why flood risk management is not just about the design, building and maintenance of defence structures. It can include preventative actions such as reducing the source of flood risk through changes in land management or use and avoiding inappropriate development in flood risk areas. It also includes responding to the prediction of flooding by warning those at risk and seeking to build resilience into properties.

Flooding can occur from a number of sources: from rivers and the sea, directly from rainfall on the ground surface, from rising groundwater, and from overwhelmed sewers and drainage systems.

Woodwalton Fen: a restored fragment of the once vast East Anglian Fens that supports internationally important wetland habitats and species, and also provides vital storage of flood waters.

Flooding can also occur when defences are overtopped or breached, where flood water cannot pass rapidly enough down a channel to where a pump is sited, when pumps fail, and often when channels, culverts and bridges are blocked by debris.

Flooding can develop gradually or rapidly according to how fast water runs off the land surface into watercourses and how steeply the ground rises in the catchment. In a large, relatively flat catchment, flood levels will rise slowly and natural floodplains may remain flooded for several days, acting as the natural regulator of the flow. In small steep catchments and heavily-urbanised catchments, intense rainfall locally can result in the rapid onset of flooding with little warning. Such 'flash' flooding, which may only last a few hours, can cause considerable damage and possible threat to life.

Factors which affect the scale and severity of the consequences of flooding include the:

- Origin and mechanism of flooding.
- Duration of flooding.
- Rate of onset of flooding.
- Rate of rise of flood water.
- Depth and velocity of flood waters.
- Presence or absence of debris in the flood water.
- Degree to which people and or assets are exposed to the flood water.
- Extent and vulnerability of the people and properties affected.

For floodplain wetlands, flooding has to be considered as part of a natural and essential process that maintains their wetland status. The plant and animal communities of these wetlands have evolved

partly in response to that flooding and now depend upon regular cycles of inundation and drying. In most cases, floodplain plant and animal communities have evolved with regular winter flooding and gradual drying during the spring and summer. The winter flooding is essential to provide water to the system and it also provides an element of dynamism and change. The flooding moves seeds and other plant propagules around the system, and through erosion or sediment deposition creates areas of bare mud and shingle for plant and animal colonisation. In some cases the flood flows can be strong enough to uproot and remove shrubs and trees, setting back the process of vegetation succession that would otherwise lead to an open floodplain becoming a floodplain woodland.

Flooding can have adverse effects on nature conservation interests and these arise under specific circumstances, including:

- The season of the flooding – summer floods can wash away nests and for some birds this will be the end to their only breeding attempt that year.
- The duration of flooding – extended flooding in warm weather can lead to de-oxygenation of the water and the risk of fish kills on site or when the flood water is pumped back into a river.
- The nutrient content of the water – nutrients deposited by flooding can raise soil nutrient levels leading to changes in the vegetation, frequently an increased dominance of robust grasses over rarer flowering plants.
- The sediment content of the water – erosion of channel banks and adjacent land introduces sediment within the system, which is then redistributed. This can both create new habitat and damage existing habitat.
- The presence of invasive species – flooding can spread plants and animals from one part of the drainage area to another, e.g. fish fry, seeds and other plant propagules.

A changing climate

It is predicted that the effect of increased greenhouse gas emissions on the UK climate will mean that, overall, it will become hotter and drier in the summer and warmer and wetter in the winter. The predictions for rainfall are that annual average precipitation across the UK may decrease slightly, by up to 15 per cent by the 2080s. The seasonal distribution of precipitation is expected to change significantly, with winters becoming wetter and summers drier. Under the 'High Emissions' scenario for greenhouse gases, precipitation in the 2080s may decrease in summer by 50 per cent in the South-East and increase in winter by up to 30 per cent. It is also predicted that there will be an increase in the occurrence of extreme weather events. High summer temperatures and dry conditions will become more common. Very cold winters will become increasingly rare and extreme winter precipitation will become more frequent.

These changes have the potential to increase the probability of flooding from rivers and drainage channels due to increases in the frequency, duration and intensity of storms. Government has advised the flood operating authorities that an allowance should be made for climate change in the appraisal of existing and future flood defences. This is set out in table 2.1.

	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%	+20%	+20%

Table 2.1 – Recommended allowances for climate change in the appraisal of flood defences

© Dr Chris Gibson

Fen raft spider *Dolomedes plantarius*

For flood risk managers and nature conservationists these climate change predictions have a number of potential consequences for the management of drainage channels. Foremost amongst these is an increase in uncertainty, making it necessary to monitor and review:

- Changes in flows and levels in drainage channels.
- The timing and rate of growth of vegetation.
- The potential for invasion by new species and the loss of familiar species.

Reduced summer rainfall will lead to an increase in periods of low flow and water level management measures may be needed to mitigate the effects of this on wildlife and habitats. Increased intensity of storms and wetter winters will lead to greater flows, presenting both challenges to flood risk management and opportunities for wildlife as works are required to improve the capacity of the system to store and convey flood waters.

Further reading and information

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Defra (2006). *Flood and Coastal Defence Appraisal Guidance - FCDPAG3 Economic Appraisal. Supplementary Note to Operating Authorities – Climate Change Impacts (October 2006).* Defra, London.

Defra (2008). *Future Water – The Government's Water Strategy for England.* Defra, London.

Office of Science and Technology (2004). *Foresight – Future Flooding.* Office of Science and Technology, London.

UK Climate Impacts Programme – regularly updated scenarios for future climate change in the UK available at www.ukcip.org.uk.

The Wetland Vision partnership website www.wetlandvision.org.uk. The partnership includes English Heritage, Environment Agency, Natural England, the Royal Society for the Protection of Birds and the Wildlife Trusts.

Three

The drainage channel system and its management

Multiple functions of drainage channels

Drainage channels are expected to deliver a number of functions for landowners and the wider community. This guidance focuses on the relationship between the water level and flood risk management function of watercourses and the fact that these channels are a habitat that supports a varied and important wildlife resource. Water level management is also critical to maintaining appropriate wetland conditions in the floodplain and at protected nature conservation sites. Other functions carried out by drainage channels include:

- Irrigation
- Wet fencing
- Navigation
- Fisheries
- Recreation

Irrigation

In areas of high-value crop production where producers have licences to irrigate their crops, drainage channels can act as the means to move water around the system in order to facilitate irrigation. This may involve direct abstraction in the summer or it may be winter abstraction to fill a farm storage reservoir. For summer abstraction this requires water levels to be held high and brings with it additional benefits of maintaining a body of water that will support aquatic vegetation and wildlife through periods when the channel might otherwise have dried out.

Wet fencing

In grassland areas the water levels can be held high in the ditches to create 'wet fences' to enable the management of the pasture and also to provide an accessible drinking water supply for livestock. Holding the water level high through the spring and summer ensures that the soil remains moist adjacent to the ditches and, where they exist, water is held in the foot drains that run from the fields into the ditch. This ensures the conditions that breeding waders require to feed successfully – soft soil in which they can probe for food, muddy ditch margins and shallow water with a rich invertebrate life.

Navigation

A number of drainage channels are also statutory navigations and in some instances the operating authority is also the navigation authority. The Environment Agency manages some of the major navigable river systems such as the Great Ouse, Nene and Thames as well as the Ancholme, Stour, Welland, Glen and Medway – all of which also serve a flood risk management function. There are also navigable waters in the East Anglian Fens managed by the Middle Level Commissioners and other IDBs. Maintenance of high and stable water levels for navigation provides habitat for wildlife in the channel and along its margins. In anything other than conditions of infrequent boat passage, the disturbance to the water, particularly the suspension of silt by boat wash and propellers, means that aquatic plant growth is limited to the more widespread species.

Fisheries

The fish life of drainage channels is an important component of the system's wildlife. These fish are recognised as of value in their own right – some species are listed in the UK BAP, such as the European Eel, or in the Habitats Directive, such as the Spined Loach. Angling is a very popular recreational pursuit; it provides income to riparian owners and has created an industry in the manufacture and supply of angling equipment. There are commercial fisheries for European Eel in some drainage channel systems, such as the Somerset Levels.

Managing the channel for fish – with their requirements for well-oxygenated water, diverse aquatic plant growth and rich invertebrate fauna – will mean that excellent habitat is being sustained and that a wide variety of other wildlife will also be supported by the waterbody. Some of the other needs of anglers – open places on the bank to fish from and weed-free water in which to cast their bait – can occasionally conflict with conservation interests. Vegetation cutting to create swims and access points can give rise to concerns over loss of habitat and bird nesting sites. However, given the very light angling pressure on most drainage channels, these areas of conflicting interest tend to be minor and localised. Management of the drainage channel vegetation can also give rise to problems for fisheries with spawning areas removed and the risk that large volumes of cut vegetation in the water can lead to de-oxygenation and fish kills.

Recreation

In addition to recreational boating and fishing, drainage channels can provide an extensive network for bankside walking, horse riding and cycling where the relevant rights of way exist. They also provide areas for wildlife watching and simply enjoying the open air. Access to greenspace has been shown to provide health benefits through gentle exercise and an increased feeling of well-being. All these recreational users seek an attractive landscape that is rich in wildlife.

Planning for multiple functions – balancing priorities

To deliver these many functions simultaneously requires careful planning, dialogue with stakeholders and the resolution of potentially conflicting uses. Not every use can be delivered on a single drainage channel and consideration has to be given to the balance of priorities assigned to each length of channel.

Water level or flood risk management will always be the primary function of the channel system as a whole, but in some cases other statutory requirements will pose challenges for channel management. It is in such cases that thinking holistically across the wider drainage system can bring benefits. Considering the drainage system as a whole can enable different requirements and functions to be balanced. This approach is considered in greater detail in the next chapter, specifically in relation to achieving both flood risk management and nature conservation requirements. It is an approach that can be applied more generally to the multi-functional management of drainage systems.

The system – flood risk management

Intervention to manage flood risk often takes the form of ensuring that the standard to which the drainage channel was designed is maintained by regular and planned maintenance, such as vegetation cutting and de-silting. Where that standard is not being achieved because the population or property assets at risk have changed or the drainage structure has significantly deteriorated, then consideration will have to be given to improvements in the drainage system through upgrading of existing channels and water control structures or new infrastructure.

Actions to improve the flow of water past a risk area include widening, deepening, straightening and measures to increase flow velocities in channels. The purpose is to reduce flood levels by improving conveyance through increases in flow or in cross-sectional area of the channel.

Consideration of change should not include just those options to improve flood conveyance past the area at risk, especially where this will exacerbate the risk of flooding further downstream. An option is to consider measures that would reduce the volume of water or the timing of the flood peak reaching the risk area. This might be achieved by reducing the speed that water reaches the upstream watercourses or providing additional capacity through a detention area or washland upstream. These options also offer great opportunities for wildlife habitat creation and other uses such as angling and informal recreation.

Water level management

The water level within a drainage channel system is a function of:

- The system's design.
- The operation of the system.
- Rainfall.
- Water run-off from the surrounding catchment.
- Adjacent land use.

Water levels may be controlled by gravity outfalls or pumping stations at the bottom of the system, while sluices and other structures may provide localised control of water levels within the system. Gravity outfalls are dependent on river or sea levels for their functioning, factors outside the control of the operating authority.

Pumped systems provide greater control of water levels with just over half of the drainage systems in England controlled in this way. Modern pumping stations operate on demand and the pumps are often controlled by sophisticated telemetry devices that monitor water levels in different parts of the drainage system. The pumping station and the channel work together to control flood risk, the channels providing storage during periods of high rainfall that would otherwise overburden the pumps. Increasing storage in channels can be an economic method of reducing flood risk and adapting to climate change, while also increasing wetland habitat within the system.

Operating authorities commonly vary water levels on a seasonal basis, typically raising them in summer when flood risk is lower. This maintains wetland habitat and wildlife in the drains, wetland habitat across the floodplain and also provides water for agricultural irrigation and recreational uses. Within drainage systems where there are water-dependent nature conservation sites, such as SSSIs, this seasonal variation is programmed through a Water Level Management Plan. Maintaining deeper water in channels may also limit the spread of reeds and other vegetation that impede flows and require regular cutting while, at the same time, enhancing the channel for other wildlife. Advances in rainfall-runoff modelling and improved weather forecasting may provide operating authorities with the confidence to raise water levels more widely without increasing flood risk.

Environmental and heritage enhancement projects, such as grazing marsh restoration projects, may require changes to water levels to achieve their objectives. This may include installing sluices to manage water levels in hydrologically discrete areas, or the creation of washlands. Such projects often involve agri-environment schemes, such as Environmental Stewardship, to provide incentives for land managers, with operating authorities working in partnership with the land managers and environmental organisations to deliver the water level management appropriate to the project's objectives.

Widening channels

By making a channel wider the cross-sectional area of flow is increased and the channel will convey floodwaters at a lower level. The use of two-stage (or more) channels is favoured above a general widening approach as it better accommodates low and high flows. This is usually achieved by constructing a 'berm' which is a widening at a level higher than the channel bed, allowing low flows to continue in their natural-size channel and higher flows to occupy a greater area as levels rise. Berms can offer good environmental habitats on the margins of watercourses that can be semi-wetland in nature depending on the ground conditions locally. This form of widening applied to a river or more natural drainage channel also allows the retention of meanders, pools and riffles in the lower stage of the channel whilst more hydraulically efficient conditions are managed within the higher, wider channel shape. Some management of channels is essential, such as removal of large scrub on the berm which would block flows, but many other forms of vegetation are acceptable.

Deepening channels

The purpose of channel deepening by lowering the bed is to reduce local flood levels. This usually necessitates long-term maintenance. Rivers develop a natural bed gradient over thousands of years as hills erode and valleys develop. Seeking to change this gradient works against natural processes, such as siltation, which will endeavour to return the bed to a stable regime. In addition, local deepening alone will not increase conveyance if downstream influences are controlling the water level – the water will simply flow at a slower rate. For these reasons channel deepening has become a less favoured engineering option in recent years. However, it can be an effective option on steeper watercourses and where other options are constrained by the proximity of development in urban areas. It can resolve local pinch points, such as bridges, provided that the stability of their foundations can be maintained. Channel deepening is unlikely to offer any environmental benefits and is more likely to do damage to habitats.

Channel deepening is also undertaken as a water level management measure to lower normal river or ditch levels to facilitate agricultural practices by increasing the depth of the outfall from piped field drains into field ditches. This practice can lead to a reduction in the biodiversity value of areas such as grazing marshes as water levels are reduced.

Creating flood by-pass channels

Flood channels are usually purpose-built channels designed to convey flood flows across a floodplain in an additional route to the natural channel. They may take flood flows away from a built-up area where widening the channel may not be possible. Built as natural channels with their designed capacity retained by management, they can offer considerable opportunities for wildlife habitat creation.

Constructing flood banks or walls

Flood banks and walls work by effectively deepening a river channel so that a greater conveyance capacity is achieved without flooding of the area behind the flood bank, although upstream levels will also be raised. Flow velocities can be increased by the reduced friction of smooth walls or grass banks. There is a balance to be struck between additional depth and the loss of conveyance through the area to be protected from flooding. The higher flow velocities within the channel compared with floodplain flows and loss of storage usually make this an effective solution.

Setting back flood banks and walls

Changes in land use or the objectives of landowners in areas protected by flood banks and walls can offer the opportunity to move the position of the defence away from the watercourse to increase conveyance. Increasing flood risk in areas where people or dwellings are not at risk in order to reduce

the flood risk to populations elsewhere should be considered as an option. The potentially affected parties should be brought into a detailed discussion of how the reduced risks to some can be delivered by negotiation and agreement with those whose land-use interest would be affected. Early consultation and detailed involvement of local communities is essential when considering such set-back or re-alignment options.

The area over which there has been set-back or re-alignment of flood defences presents great opportunities for wildlife habitat creation. Since the land is likely to be subject to an increase in flood frequency or increased soil water levels, the creation of wetland habitats would be appropriate. The Local or IDB Biodiversity Action Plan should be used to inform the selection of the precise habitat, or mosaic of habitats, that are set as the objective for future land and water management.

The system – biodiversity value

The biodiversity value of a drainage system can be considered as a combination of its communities of plants and animals and the connections and interrelationships between them. The vegetation communities are categorised into a series of habitats and these habitats support specific communities of animals. Within the habitats and animal communities there will be species that are widespread and common, and species that are scarce or rare. The drainage channel system contributes additional value to the conservation of biodiversity beyond the simple area of habitat that it hosts by providing 'connectivity' – linking corridors – for both aquatic and terrestrial species between habitats and across regions.

Planning for the conservation of biodiversity in the UK has recently been through a systematic, science-based review in order to identify future priorities, set objectives and describe the actions required to achieve the objectives. This process is embodied in the UK Biodiversity Action Plan (UK BAP). The prioritisation process has identified both habitats and species for priority action. Within the priority habitats there are 'broad habitats' such as rivers and streams and more specific habitats such as wet woodland and grazing marsh.

Broad Habitat	**UK BAP Priority Habitat**
Rivers and Streams	Rivers (a specific action plan exists for Chalk Rivers)
Standing Open Water and Canals	Oligotrophic and Dystrophic Lakes
	Ponds
	Mesotrophic Lakes
	Eutrophic Standing Waters
	Aquifer-fed Naturally Fluctuating Water Bodies
Arable and Horticultural	Arable Field Margins
Boundary and Linear Features	Hedgerows
Broadleaved, Mixed and Yew Woodland	Wet Woodland
Neutral Grassland	Lowland Meadows
Improved Grassland	Coastal and Floodplain Grazing Marsh
Fen, Marsh and Swamp	Lowland Fens
	Reedbeds
Bogs	Lowland Raised Bog

Table 3.1 – UK BAP habitats associated with IDB watercourses

Table 3.1 lists those UK BAP habitats that are particularly associated with the types of watercourses and banks under the control of IDBs. This is not a complete list of UK BAP habitats, which can be accessed from www.ukbap.org.uk. The habitats listed in Table 3.1 deserve particular consideration for action, where practical, to conserve, enhance, restore or create them. There may be other habitats targeted for action in the Local Biodiversity Action Plan, which usually operates at the county scale, and these should also be considered if the IDB has an opportunity to contribute. Identifying and planning biodiversity objectives for an IDB system of drainage channels should be delivered through the IDB Biodiversity Action Plan (IDB BAP) process. Guidance on developing an IDB BAP is available on the DEFRA website.

Group/Species	**Scientific name**
Plants	
Tassel stonewort	*Tolypella intricata*
Great tassel stonewort	*Tolypella prolifera*
Pillwort	*Pilularia globulifera*
Ribbon-leaved water-plantain	*Alisma gramineum*
Floating water-plantain	*Luronium natans*
Tubular water-dropwort	*Oenanthe fistulosa*
Grass-wrack pondweed	*Potamogeton compressus*
Greater water-parsnip	*Sium latifolium*
Cut-grass	*Leersia oryzoides*
Invertebrates	
White-clawed crayfish	*Austropotamobius pallipes*
Norfolk hawker	*Aeshna isosceles*
Fen raft spider	*Dolomedes plantarius*
a diving beetle	*Laccophilus poecilus*
Depressed river mussel	*Pseudanodonta complanata*
Shining ramshorn snail	*Segmentina nitida*
Little ramshorn whirlpool snail	*Anisus vorticulus*
Narrow-mouthed whorl snail	*Vertigo angustior*
Large-mouthed valve snail	*Valvata macrostoma*
Desmoulin's whorl snail	*Vertigo moulinsiana*
Amphibians	
Great crested newt	*Triturus cristatus*
Common toad	*Bufo bufo*
Fish	
European eel	*Anguilla anguilla*
Spined loach	*Cobitis taenia*
Birds	
Yellow wagtail	*Motacilla flava*
Reed bunting	*Emberiza schoeniclus*
Mammals	
Water vole	*Arvicola terrestris*
Otter	*Lutra lutra*

Table 3.2 – UK BAP species associated with IDB watercourses

Table 3.2 lists those UK BAP species that are particularly associated with the types of watercourses and banks under the control of IDBs. These species deserve particular consideration for action to maintain or enhance their populations, or to conserve, enhance, restore or create the habitats on which they depend. The list is not a complete one; it highlights those UK BAP species with a particularly high association with IDB watercourses. The guidance on producing an IDB BAP provides a longer list of UK BAP species (including the high association species in Table 3.2) that could be associated with IDB spheres of operation. The Government has also produced a list of species that are of principal importance for biodiversity in England under provisions of the Natural Environment and Rural Communities Act 2006. A sub-set of this list identifies UK BAP species that are particularly relevant to statutory bodies regulating and managing the freshwater environment and that list is repeated in this guidance as Appendix 5.

There are other UK BAP species that are found around watercourses but have the vast majority of their population in other habitats, particularly terrestrial ones. These species have not been included in Table 3.2. Examples include skylarks that are found feeding and nesting along drainage channel banks where they adjoin open farmland, and bats that roost in bridges and buildings adjacent to drainage channels. The complete list of species of principal importance for biodiversity in England can be accessed at www.defra.gov.uk and the complete list of UK BAP species can be can be accessed at www.ukbap.org.uk.

There may be other species identified for priority action through a Local BAP and these should also be considered. Again, the process of identifying objectives and planning action for species within a system of drainage channels should be undertaken through the IDB BAP.

Underpinning ecological processes

Drainage channels can support a great diversity of plants and animals, including many rare and scarce species. Understanding why drainage channels have such a potential for biological diversity helps to inform decisions about the management required to sustain this biodiversity. There are a number of underpinning ecological processes and understanding them gives context to the advice in this manual. It also serves to emphasise that drainage channel management for nature conservation is best planned in the context of the drainage system as a whole rather than with a narrow focus on an individual drainage channel.

Range of habitats in a single drainage channel

A drainage channel is made up of a number of habitats. Starting off at the top of the bank, the habitat is determined by the adjacent land use. This may be a field margin, a wood or a built-up area. Then comes the bank. This is essentially a terrestrial habitat but, moving down the bank, conditions become progressively damper. The aspect of the bank can also affect the nature of the habitat, with one bank subject to the drying sun or wind and the other shaded from the sun. At the base of the bank the conditions are wet and the plants change to reflect this, with emergent aquatic plants occupying the wetted margin. Where the water depth permits, the open-water channel will support floating and submerged aquatic plants. The gradients of dry to wet, and from shallow water to deeper water create conditions suitable for a wide range of species.

Different types of drainage channel within a drainage district

A drainage network is typically made up of different types of drainage channels. These include a capillary network of ditches, usually the responsibility of farmers and other landowners, and arterial channels receiving the drainage from the ditches. The arterial channels are usually the responsibility of the IDB or the Environment Agency.

The ditches are smaller than the arterial channels and water depth is less, with some ditches drying out periodically. The profile of a ditch will vary with adjacent land use within a drainage district, for example, ditches in grazing marshes compared with those draining arable fields. Ditches in some areas may have hedgerows along them. The intensity and frequency of maintenance of ditches is less than that for the larger channels and is usually mechanical in nature. The maintenance carried out also varies with flood risk, the objectives of the riparian owner and its location in the drainage system. Those ditches nearer to the IDB drain are more likely to be intensively managed than those at the back end of the system. Local flood risk might affect this with intensive management of some small ditches to remove the risk posed by rapid run-off from hard surfaces.

The drainage channels for which IDBs are directly responsible are typically permanent water bodies increasing in size as the flow of water moves through the system towards a tidal outlet, a pump or a

main river. The channels typically receive regular and relatively intensive maintenance as is necessary in order to maintain their flood risk management function. This can be by physical means, usually mechanical, but occasionally by hand, and by use of chemical herbicides. The maintenance of an open water habitat encourages a range of species, which are different in large measure to those found in the ditches under the control of the adjacent farming landowner or tenant.

In most drainage districts, the water from the IDB drains flows into or is pumped up into main river channels, normally managed by the Environment Agency. These can be canalised, and often substantially larger and deeper than the IDB drains. The lower reaches may be markedly affected by the tide. At certain times of the year, the discharge can be substantial and the flows greater than those encountered in the IDB drains. The plant and animal communities reflect the nature of the habitat, for example, supporting significant fisheries. There are also rivers or streams that convey water draining from upland areas through the drainage district but have little or no connection with its network of drainage channels. These are known as highland carriers and can be quite different from the IDB drains, for example, in their water chemistry and channel-bed sediment.

A special type of channel, which is not necessarily an integral part of the drainage system itself, is the back-ditch, or borrow, soak or soke dyke. This is a channel created when a flood embankment or seawall is built, with material for the flood defence structure being won from the adjacent land. Where the flood defence is a sea or tidal wall, the water in the back-ditch can be weakly brackish and host associated plants, insects and crustaceans.

Changes in a drainage channel from year to year

Management interventions will typically cause a drainage channel's community of plants to change in composition. From its new, post-management state the vegetation will then begin to develop back towards the plant community that was present just before the management was undertaken. The management in question could be weed cutting undertaken on an annual to three-yearly basis or it could be dredging to remove accumulated silt undertaken every seven to 10 years. This continual development of the plant community within the channel is termed 'succession'. The composition of the species at each stage will be slightly different as the changing conditions favour different species.

As a channel passes through this vegetation succession, the plants present at each stage produce 'propagules' – seeds and other structures by which aquatic plants reproduce or survive periods of unsuitable conditions. The propagules accumulate in the sediment of the channel creating a form of seed bank. When conditions prevent the propagules from developing, they remain alive but in a dormant state, sometimes for many years. For example, the submerged water plants known as stoneworts have spores that can exist in the sediment for decades before conditions become suitable for their germination. In the case of the stoneworts, these conditions are created when a drainage channel is dredged. After dredging, stoneworts may re-appear after many years of absence.

The plant species in drainage channels are generally well-adapted to surviving the succession process. At any one time only a proportion of the species present in the channel and its sediment will be visible. The proportion that is effectively 'invisible' is present as buried seeds or other propagules in the sediment. This feature of having plant species present, but lying dormant waiting for suitable conditions, encourages long-term stability in the plant communities of the drainage network.

Re-colonisation as conditions become suitable is augmented by those species that, from time to time, are moved around drainage channels. Plant movement can take a number of forms:

- Species such as duckweeds and frogbit may be carried along channels by water flow.
- Machinery and animals, such as waterfowl or livestock, may carry plants from one channel to another, or introduce them from outside of the drainage network.

In summary, there are two main processes responsible for vegetation changes in drainage channels from year to year: the succession of plant communities, encouraging stability, and the movement of species around and into the system representing a less predictable element.

Effects of land use

Land use has two main effects on the ecology of the drainage channels. These are the direct and typically immediate effects along any given channel, and the indirect effects, which produce long-term impacts across the drainage system as a whole.

The plants and animals found along a length of drainage channel are strongly influenced by the nature of the channel, its size, water depth and management regime. It might be supposed that the communities of plants and animals would therefore be relatively uniform along a length of channel. This is true to a certain extent but where a channel passes through more than one field, it is modified by the land use on either side of the channel. For example, in the case of a channel with three different adjacent land uses:

- A silage field.
- A cattle-grazed field unfenced from the channel.
- A field of oilseed rape.

The channel will thus have plant communities affected in a number of ways:

- Cattle may have access to the channel at drinking points and the grazing and poaching of the soil will encourage species tolerant of such conditions.
- The silage and rape fields are ungrazed and as a result the vegetation in the channel will not be grazed or the soil poached.
- Vegetation on the edge of the oilseed rape field may be affected by the herbicide treatment of the crop.

The direct effects of land use last only as long as that use continues adjacent to the channel. In the above example, if the silage field is used for cattle grazing the following season, the flora will quickly respond to the different conditions.

The indirect effects of land-use change result from a shift from one land use to another, for example from grazing marsh to arable agriculture. Such a change is typically catalyzed by increased levels of drainage, for example, the introduction of pumping to achieve lower water levels and allow crop production in areas where this was previously impossible. Changes could result in a drop in water levels in grazing marsh channels and a need to provide drinking troughs and the fencing-off of the channel margins.

Combination of factors

As can be seen above, at any one time there are a number of factors operating to encourage a diversity of plants and animals in drainage channels. Not only do the different types of drainage channel support inherently different communities, but these communities change with management intervention and over time through succession. They are also modified by the immediately-adjacent land use and, over the longer term, by the overall change in land use within the catchment as a whole.

The combination of factors means that it is very difficult to make decisions about a single drainage channel in isolation from the other channels. The aim should be the development of an overall management strategy so that objective decisions can be taken about the biodiversity management of any individual ditch or channel within the context of the strategic management of the drainage system as a whole. An IDB Biodiversity Action Plan can play a key role in developing this over-arching management strategy.

The system – its biodiversity potential

Appropriate management of the drainage channel system can deliver a range of benefits for biodiversity. Foremost among these is the continued delivery of wildlife-rich habitats through the management of the existing network. This includes helping to maintain Sites of Special Scientific Interest in favourable condition through the programme of water level management plans. Delivery of appropriate water level management by the IDB may be essential for the ecological interests in drainage channels themselves but may also be essential to facilitate appropriate land management, perhaps in conjunction with agri-environment support. Entering land into Higher Level Stewardship can also deliver new wetland through habitat creation, and IDBs have a key role in facilitating the water level management that would be required for successful HLS applications by land managers.

Barn owl: a bird species that commonly uses drainage channel banks as hunting grounds.

The role of the drainage channel system as a network linking many small patches of habitat throughout a catchment to provide a 'corridor' for the movement of wildlife can be enhanced by the IDB supporting land managers who wish to enter their land into Entry Level Stewardship. This can provide funding for further linking of habitats through the sympathetic management of field ditches, and for strips of non-cropped land alongside both these ditches and the drainage channels under IDB management.

The greatest opportunities exist for significant habitat enhancement when a part of the system has been identified for capital works. It is at this point that consideration can be given to options that can reduce flood risk and create wildlife habitat. Such options may include increased flood conveyance or flood water storage capacity, and accompanying creation of washland or floodplain habitat. This opportunity is recognised in the Government's strategy for flood and coastal erosion risk management in England, *Making Space for Water*. This advocates the greater use, where appropriate, of land-use solutions to reduce flood risk, such as the creation of wetlands and washlands and managed realignment of coasts and rivers. The creation of such wetlands can make a major contribution to the achievement of the habitat and species targets in the UK BAP.

Washlands tend to be feasible in very specific circumstances. There may be more frequent opportunities for IDBs to make space for flood flows and wildlife by widening channels or setting back flood embankments to increase conveyance. If designed sensitively, these sorts of schemes can create spaces in which flood waters and wildlife can both be accommodated. Thus, the process of designing and constructing capital works may present opportunities for reducing overall flood risk and contributing to nature conservation.

Further reading and information

The UK Biodiversity Action Plan is available at the UK BAP website www.ukbap.org.uk

Guidance on the production of an IDB BAP is available at the Defra website www.defra.gov.uk/environ/fcd/policy/idbrev/default.htm

Four

Making decisions about intervention

The wider-system approach

It is recommended that, when considering the appropriate management techniques to apply in a specific drainage channel, the IDB makes its decisions in the context of an integrated evaluation of the wider drainage system. The essential elements of this integrated approach are set out below:

1. It is vital to establish a hierarchy of drainage channels based on the flood risk management and biodiversity priorities assigned to each individual channel given its function within the system as a whole.
2. At one extreme, some channels may be of over-riding strategic importance for flood conveyance and therefore their ability to support biodiversity may be very limited.
3. At the other extreme, some channels may have a minimal flood conveyance role and can be managed for maximum biodiversity benefit.
4. In between the two extremes, channels will variously contribute to a balance of flood conveyance and biodiversity requirements. In some locations, the balance will be in favour of flood risk management. In others, the balance will be in favour of biodiversity.
5. The various management techniques set out in this manual can be deployed selectively in accordance with the flood risk management and biodiversity balance deemed to be appropriate for the individual drainage channel.
6. Management techniques to benefit biodiversity can be deployed as part of annual and long-term maintenance programmes, and as part of capital works.

Importantly, the integrated, wider-system approach is founded on three principles:

i. The management of an individual drainage channel should be considered not in isolation, but in the context of the wider system and its functioning.
ii. Notwithstanding the need to maintain appropriate standards of flood risk management, all of an IDB's network of drainage channels has the potential to be valuable for biodiversity to a greater or lesser degree.
iii. The management of the channel system needs to comply with legislation on species protection and on designated nature conservation sites, where these exist.

A well-planned, systematic approach to management of the channel system, as set out in this manual and in the guidance on the production of IDB Biodiversity Action Plans, can help demonstrate that appropriate steps have been taken by the IDB to comply with biodiversity and species protection legislation.

In developing a management programme for the system, thought should be given to targeted enhancements for species that have an identified priority. This priority will have been identified through:

- The IDB BAP.
- The Local BAP if an IDB BAP has not yet been prepared.
- The UK BAP.
- Listing in Schedules to the Wildlife and Countryside Act or the Annexes to the Birds or Habitats Directives.

There are significant opportunities for wildlife to be gained during the design and implementation of capital works. This is because at the design stage it is possible to consider how to build in those features of wildlife benefit that require more space than is usually available in many existing drainage channels because they have an effect of causing a reduction, to one degree or another, in the capacity or conveyance of the existing channel.

Planning for nature conservation

The key to planning for biodiversity within drainage channel systems is to know where the nature conservation interest exists, or may potentially exist. This can be gained through a combination of:

- Specific habitat or species surveys by IDB staff, consultants or local volunteers or wildlife groups.
- Information from Local Biodiversity Action Plan partners.
- Consultation with the statutory conservation and environment agencies.
- Information from groups and individuals with specialist knowledge, such as the network of Local Biological Record Centres.

How to conduct a 'Biodiversity Audit' in this way and use it to develop an IDB Biodiversity Action Plan is comprehensively explained in the guidance produced by ADA, Natural England and Defra on preparing IDB Biodiversity Action Plans. Undertaking an audit of this sort can be very helpful in developing a programme of channel management.

Targeting drainage channels for biodiversity enhancement

The next step after gathering information on the conservation value of the drainage channel system is to evaluate channels according to their flood risk management priority and their biodiversity potential.

Where a drainage channel has been identified as critical for flood risk management then management actions should primarily be targeted to maintain this function in compliance with protected species and site legislation. Even on these channels consideration can be given to sensitive timing and rotations of cutting beyond that required by compliance with protected species legislation. These channels can also be considered for promoting with the landowner or occupier the creation of buffer strips alongside them, funded through agri-environment schemes.

Targeting for biodiversity enhancement should be based on the following prioritised list of sites and features:

- SSSIs with advice being sought from Natural England on the measures required.
- Water Level Management Plan areas where enhancements have been identified in the plan.
- Drainage channels supporting or having the potential to support populations of UK BAP species or areas of habitat.
- Drainage channels supporting or having the potential to support populations of species or areas of habitat targeted in the Local Biodiversity Action Plan or identified as being of local importance in the drainage district.

- Other specific interests. This might include:
  - Drainage channels with good water quality (low nutrient status), which retain water throughout the year without sudden fluctuations in water levels, for enhancement for dragonflies and other invertebrates.
  - Channel banks with good nectar sources, such as Purple Loose-strife and Hemp Agrimony, to be managed for the benefit of butterflies and a wide variety of other insects.

If an IDB BAP has been prepared, the programme in that plan should be regarded as the first point for guidance on prioritisation for enhancements since it should already have considered the factors above.

Making decisions – consultation

Consultation should not be regarded as a burden but an essential and effective way of managing the planning of operations. Early consultation is essential:

- For planning programmes of work.
- For proper assessment of the risks accompanying management programmes.
- For designing any mitigation proposals.
- For delivering the project on time, at minimal cost and without adverse impacts on relationships with interested parties.

Before starting any programme of management actions it is important to identify the interested parties that should be consulted. Early consultation is often helpful in preventing delays that would otherwise result from an adverse reaction to a proposal. There are occasions when the adverse reaction stems from exclusion from the decision-making process rather than serious concern with the final outcome of the action.

Where an action, inside or outside the site boundary, might affect an SSSI then the IDB has a statutory duty to consult with Natural England.

Compliance with legislation and policy

This section outlines the requirements of legislation and policy but does not seek to be a comprehensive description or a definitive interpretation of the law. It focuses on those duties and policies as they apply to IDBs when carrying out flood risk management operations.

Flood risk management responsibilities

Landowners have the primary responsibility for safeguarding their land and property against flooding. Landowners and occupiers are also responsible for managing the drainage of their land in such a way as to prevent, as far as is reasonably practicable, adverse impacts on neighbouring land. There is no general duty on the Government or operating authorities to protect land or property against flooding but the operating authorities have permissive powers to carry out works and maintain flood defences in the public interest.

IDBs and Biodiversity Legal Duties

When carrying out their functions, IDBs are required to have regard to a number of statutory duties relating to conservation and biodiversity. Some of this legislation relates specifically to maintaining or restoring the condition of designated sites such as SSSIs, but there are duties to conserve and enhance biodiversity in the wider landscape:

Land Drainage Act 1994

Section 61 of the Land Drainage Act 1994 places a duty on every IDB, when formulating or considering any proposals relating to its functions, to exercise its powers to further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological or physiographical features of special interest. It is also required to take into account any effect that such proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects.

The Act also places a duty on every IDB to consult Natural England before carrying out any works, operations or activities which appear to the board to be likely to destroy or damage any of the flora, fauna, or geological or physiographical features by reason of which an area of land or water has been notified as an SSSI. This will include actions outside of the SSSI, such as changes to water levels or flooding regimes that would affect the SSSI.

Wildlife and Countryside Act 1981

As public bodies, every IDB has a duty under Section 28G of the Wildlife and Countryside Act 1981 to take reasonable steps, consistent with the proper exercise of its functions, to further the conservation and enhancement of the flora, fauna or geological or physiographical features by reason of which a site has been designated a Site of Special Scientific Interest.

Natural Environment and Rural Communities Act 2006

Section 40(1) of the Natural Environment and Rural Communities Act 2006 places a duty on IDBs to conserve biodiversity. As a public body, every IDB must have regard in exercising its functions, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity.

Section 40(3) states that conserving biodiversity includes restoring or enhancing a population or habitat. In so doing, an IDB should have regard to the list published by the Secretary of State of living organisms and types of habitat that are of principal importance for the purpose of conserving biodiversity. In effect, this list consists of the Biodiversity Action Plan priority species and habitats for England. Those species that warrant particular attention by IDBs are listed as an appendix to this manual.

In its *Guidance for Public Authorities on Implementing the Biodiversity Duty*, the Government states that, in order to demonstrate that it has implemented its duty under the Act to have regard to the conservation of biodiversity, a public authority is likely to be able to show that it has:

- Identified and taken opportunities to integrate biodiversity considerations into all relevant service areas and functions, and ensured that biodiversity is protected and enhanced in line with current statutory obligations.
- Raised awareness of staff and managers with regard to biodiversity issues.
- Demonstrated a commitment and contribution to Biodiversity Action Plans, where appropriate.
- Demonstrated progress against key biodiversity indicators and targets for BAP-listed priority habitats and species and LBAP listed species and habitats, where appropriate.

Birds Directive 1979

IDBs are required to assist Government in fulfilling its obligations under Section 3 of the Birds Directive 1979 to take requisite measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for all species of naturally occurring birds in the wild state.

Habitats Regulations 1994

Regulation 3(4) of the Habitats Regulations 1994 require that an IDB, when exercising any of its functions, must have regard to the requirements of the Habitats Directive 1992 so far as they may be

affected by the exercise of those functions. This includes taking appropriate steps to avoid, in Special Areas of Conservation, the deterioration of natural habitats and the habitats of species as well as the disturbance of the species for which the areas have been designated. The Regulations also impose a general duty on competent authorities to ensure that the habitats and species listed under the Directive are maintained in favourable conservation status. It also requires that when a Board is planning work or considering granting consent to a third party, it must consider whether the work is likely to have a significant effect on the special interest of the European site.

Protected species legislation

The key elements of the protected species legislation for those species most likely to be encountered by IDBs carrying out works to watercourses are set out below (see Appendix 9 for further details).

Otter

Otters are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994, which make it illegal to:

- Deliberately capture, injure or kill an otter.
- Deliberately disturb an otter in such a way as to be likely significantly to affect the local distribution or abundance of otters or the ability of any significant group of otters to survive, breed, rear or nurture their young.
- Damage or destroy an otter holt.

Otters have become exempt from many of the provisions of the Wildlife and Countryside Act 1981, but are still protected under Section 9(4)(b) and (c) and (5). This means that it is also illegal to:

- Intentionally or recklessly disturb any otter whilst it is occupying a holt.
- Intentionally or recklessly obstruct access to a holt.

There is provision within the legislation to allow actions, which would otherwise be illegal, to be carried out under a licence from Natural England. Licences for management work can be issued for the purpose of preserving public health or public safety or other imperative reasons of overriding public interest. Licences can only be issued where there is no satisfactory alternative and where the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range. Management work should therefore be planned to avoid any direct impact on otters and therefore avoid the need for a licence.

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Badgers

Badgers and their setts are protected under various legislation, drawn together under the Protection of Badgers Act 1992. This makes it an offence to:

- Wilfully kill, injure, take, possess, or cruelly ill-treat a badger, or to attempt to.
- To interfere with a sett by damaging or destroying it.
- To obstruct access to, or any entrance of, a badger sett.
- To disturb a badger when it is occupying a sett.

There is provision within the legislation to allow action to be taken under a licence from Natural England for the purpose of any operation (whether by virtue of the land Drainage Act 1991 or otherwise) to maintain or improve any existing watercourse, or to construct new works required for the drainage of land. Drainage Boards can apply for licences for specific improvement works and annual licences for maintenance works.

Bats

Bats are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994. Under the Regulations, bats are classed as European protected species and therefore it is illegal to:

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- Deliberately capture, injure or kill a bat.
- Deliberately disturb a bat in such a way as to be likely significantly to affect the local distribution or abundance of bats or the ability of any significant group of bats to survive, breed, rear or nurture their young.
- Damage or destroy a bat roost.

Bats have become exempt from many of the provisions of the Wildlife and Countryside Act 1981, but are still protected under Section 9(4)(b) and (c) and (5). This means that it is also illegal to:

- Intentionally or recklessly disturb any bat whilst it is occupying a bat roost.
- Intentionally or recklessly obstruct access to a bat roost.

A roost is defined as any structure or place which a bat uses for shelter or protection. As bats tend to re-use the same roosts, legal opinion is that a roost is protected even if the bats are not there all the time. If bat roosts are present, it may be possible to arrange the work in such a way as to avoid committing offences, though in some cases it may be necessary to apply for a licence from Natural England where bats are likely to be disturbed or where roosts will be affected.

Great crested newt

Great crested newts are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994. Under the Regulations, they are classed as European protected species and therefore it is illegal to:

- Deliberately capture, injure or kill a great crested newt.
- Deliberately disturb great crested newts in such a way as to be likely significantly to affect the local distribution or abundance of great crested newts or the ability of any significant group of such newts to survive, breed, rear or nurture their young.
- Damage or destroy a great crested newt breeding site or resting place.

Great crested newts have become exempt from many of the provisions of the Wildlife and Countryside Act 1981. However, they are still protected under Section 9(4)(b) and (c) and (5), which means that it is also illegal to:

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- Intentionally or recklessly disturb any great crested newt whilst it is occupying a structure or place which is uses for shelter or protection.
- Intentionally or recklessly obstruct access to any structure or place which any great crested newt uses for shelter or protection.

There is provision within the legislation to allow actions, which would otherwise be illegal, to be carried out under a licence from Natural England. Licences for management work can be issued for the purpose of preserving public health or public safety or other imperative reasons of overriding public interest. Licences can only be issued where there is no satisfactory alternative and where the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range.

Reptiles

Adders, grass snakes, slow worms and common lizards (the species most likely to be encountered by a drainage authority exercising its powers on a watercourse) receive partial protection under Section 9 of the Wildlife and Countryside Act 1981, as amended. This makes it an offence to:

- Intentionally kill or injure any individual.

Where the translocation of a population of one of the species listed above is proposed then Natural England should be consulted as a matter of good practice. A licence is not needed to capture or disturb these species or to damage their habitat. However, the animals themselves are still protected so it is important to ensure that the animals are not injured or killed.

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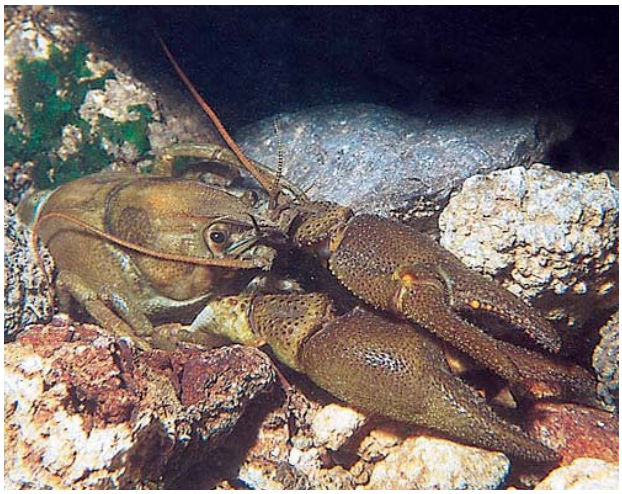
White-clawed crayfish

The white-clawed crayfish is partially protected under Schedule 5 of the Wildlife and Countryside Act 1981, as amended by the Countryside and Right of Way Act 2000. It is an offence to:

- Intentionally take (capture) a white-clawed crayfish.

There is provision within the legislation to allow action to be taken under a licence from Natural England. The conditions under which a licence might be granted are tightly defined. Natural England should be consulted to discuss if these conditions might apply to a particular circumstance faced by an IDB.



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Crayfish spend the daytime sheltering among boulders, tree roots and in crevices (including structures such as gabion baskets, bridges and walls) and 'taking' can very easily occur during maintenance or capital works on watercourses and associated structures. Where it is intended to catch crayfish to remove them temporarily from a watercourse or channel prior to the commencement of works, then a licence will be required from Natural England and bye-law consent for trapping is required from the Environment Agency.

Water vole

The water vole is protected under the Wildlife and Countryside Act 1981 (as amended). An amendment to the legislation came into force in April 2008, extending the protection to the animal itself. The result is that it is an offence to:

- Intentionally kill, injure or take water voles.
- Intentionally or recklessly damage, destroy or obstruct access to any structure or place used for shelter or protection.
- Intentionally or recklessly disturb water voles whilst occupying a structure or place used for that purpose.

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There is no provision under the Act for licensing what would otherwise be offences for the purpose of development, river or drainage maintenance or land management. Such activities must be covered by the defence in the Act that permits otherwise illegal actions if they are the incidental result of a lawful operation and could not reasonably be avoided. Where action is proposed that will potentially cause disturbance to water voles or loss of burrows then it is important that it only proceeds after alternatives have been considered and discounted otherwise an offence will be committed. Where action is likely to impact on water voles then it must be planned to ensure unnecessary damage is avoided and all reasonable steps are taken to minimise the impacts on water voles.

In some circumstances it may be in the best interest to capture water voles and move then to a different location. Trapping will require a licence from Natural England as it cannot be considered as 'incidental'. Licences can be issued for conservation purposes to trap water voles in situations where other possibilities to retain them on site have been fully considered and discounted, and where the actions would produce a conservation benefit to the water voles.

Spawning fish

Spawning fish are protected under the Salmon & Freshwater Fisheries Act (1975). Its provisions are that:

- Any person who in the exercise of a legal right to take materials from the waters, wilfully disturbs any spawn or spawning fish, or any bed, bank or shallow on which any spawn or spawning fish may be, shall be guilty of an offence.
- Any person who causes or knowingly permits to flow, or knowingly permits to be put, into any waters containing fish or into any other tributaries of water containing fish, any liquid or solid matter to such an extent as to cause the waters to be poisonous or injurious to fish or the spawning grounds, spawn or food of fish shall be guilty of an offence.

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A person shall not be guilty of an offence, if he proves to the satisfaction of the court that he has used the best practicable means, within a reasonable cost, to prevent doing injury to fish or to the spawning grounds, spawn or food for fish.

Nesting birds

The Wildlife and Countryside Act 1981, as updated by the Countryside and Rights of Way Act 2000, makes it an offence to:

- Kill, injure or take any wild bird.
- Take, damage or destroy the nest of any wild bird while it is being built or in use.
- Take or destroy the eggs of any wild bird.

Special penalties exist for offences related to species listed on Schedule 1, for which there are additional offences of disturbing these birds at their nests, or their dependent young.

There is provision within the legislation to allow action to be taken under a licence from Natural England. This does not include facilitating routine management work, and therefore it is important that such work, which may affect nests, is planned so as to avoid impacts.

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How the 'lawful operation' defence might apply to watercourse management actions

The legislation relating to those species that are given protection under the Wildlife and Countryside Act 1981 (as amended), but that are not European Protected Species as listed above, allows for the defence against an offence that it was the incidental result of a lawful operation and could not reasonably have been avoided. This applies to nesting birds, the widespread reptiles listed above, white-clawed crayfish and water voles. To apply this defence it would be necessary to convince a court, based on the specific circumstances, that reasonable steps had been taken to avoid the offence. Reasonable action would include discussing with Natural England whether the proposed works are likely to be detrimental and whether the mitigation is appropriate. This might be on a work-specific basis, on a site-specific basis and on a programme of annual 'standard' maintenance operations. This forward planning process could be described in the IDB BAP. Reasonable actions are most likely to include:

- Undertaking specific surveys prior to planning the work.
- Modifying the proposed work as a result of the survey.
- Further survey work immediately before the work.
- Training for the staff undertaking the work on features to look for and actions to take.
- Appropriate mitigation measures and working practices to be applied during the work.
- Actions to be taken triggered by specific observations when undertaking the work.
- Reporting procedures to senior management.

Other legislation

Environmental Impact Assessment

The Town and Country Planning (Environmental Impact Assessment) Regulations 1999 (SI 1999 No 293) apply to relevant projects in England and Wales that require planning permission. However, almost all land drainage improvement works undertaken by drainage bodies are 'permitted development' under the Town and Country Planning (General Permitted Development) Order 1995 and therefore an application for planning permission is not required. Since such works might have significant effects on the environment, the principles of Environmental Impact Assessment need to be applied to them. This is done through the Environmental Impact Assessment (Land Drainage Improvement Works) Regulations 1999 (SI1999 No 1783)) and their subsequent amendment by the Environmental Impact Assessment (Land Drainage Improvement Works) (Amended) Regulations 2005 (SI 2005 No 1399). The Regulations apply only to 'drainage bodies' carrying out specified 'improvement works'. These works are those that aim to deepen, widen, straighten, or otherwise improve or alter any existing watercourses, or raise, widen or otherwise improve or alter any existing drainage works. The 1999 Regulations require consultation with Natural England and any other public authority, statutory body or organisation which the drainage body considers has an interest in the proposed improvement works. Defra has produced guidance on the regulations that is available on its website.

Appropriate Assessment

Proposals brought forward by IDBs, including Water Level Management Plans, may be considered to be a plan or project under the meaning of Article 6(3) of the Habitats Directive. As a result the IDB must consider whether an appropriate assessment is required where all or part of a European site (SPA, SAC and, by Government policy, Ramsar sites) might be affected. The purpose of an appropriate assessment is to identify if the actions proposed would adversely affect the habitats and species for which the European site was designated, or the integrity of the site. Natural England should be consulted about the proposal, the possible need for an appropriate assessment and the outcome of any assessment. Further guidance on Water Level Management Plans and the Habitats Directive is contained in the Defra publication *Guidance on Water Level Management Plans for European Sites*.

Obstructing migratory fish passage

IDBs will need to consider if any structure that they are proposing to install in a watercourse used by migratory salmonids (salmon and sea trout) might create an obstruction to their migratory movements. Section 9 of the Salmon & Freshwater Fisheries Act 1975 makes it an offence to install structures in such waters that create increased obstruction to these species. There are proposals to extend this measure to obstructing the passage of non-salmonids such as European eel, species of shad and species of lamprey.

Waste management legislation

Material removed from a watercourse or cut from its banks may be regarded as waste and require very specific and costly disposal procedures. The Environment Agency has provided advice on this matter. A basic guide is that if the material is dealt with in one machine movement, being taken from the watercourse and placed on the bank, then an exemption can be registered with the Environment Agency for this operation. Material collected at a pumping station and temporarily stored in a skip (for example, weed screenings) does not benefit from this exemption. If cut or screened vegetation has to be removed from a site and classed as waste then taking it to landfill should be regarded as an undesirable and costly option. The best option for the environment would be to have it recycled as green waste for composting or for biogas production

Government policy requirements

In addition to discharging their legal duties to conserve and enhance biodiversity, IDBs are required as flood operating authorities to carry out their functions within a policy framework that sets goals for biodiversity and environmental performance.

Making Space for Water

The Government's aim for flood and coastal erosion risk management, as expressed in its *Making Space for Water* strategy, is to manage the risk from flooding and coastal erosion by employing an integrated portfolio of approaches that reflect both national and local priorities:

- To reduce the threat to people and their property; and
- To deliver the greatest environmental, social and economic benefit consistent with the Government's sustainable development principles.

Flood and coastal defence works therefore need to be environmentally acceptable as well as technically sound and economically viable. The Government is urging flood operating authorities to consider environmental opportunities in all their activities and to achieve greater sustainability by working with natural processes.

Flood Risk Management Outcome Measures Targets

The Government has established a framework of Outcome Measures to allocate flood risk management resources and to guide the activities of flood operating authorities so that they reflect *Making Space for Water* and Government policy more generally. There is an Outcome Measure for nationally important wildlife sites with an accompanying target that requires flood operating authorities to deliver programmes of measures for bringing SSSIs into favourable condition.

There is also an Outcome Measure for UK Biodiversity Action Plan habitats. Its accompanying target specifies the net increase in the area of priority BAP habitats that the Government expects to result from the activities of flood operating authorities, including IDBs. Thus, all flood operating authorities are expected to demonstrate the benefit to UK BAP habitats that they have contributed through their activities.

Pevensey Levels: a characteristic scene of grazing marsh and drainage channels.

Water Level Management Plans

A Water Level Management Plan is a written statement of the water level management objectives for a given area, and considers the means by which the objectives may be achieved. WLMPs are prepared by the Environment Agency, Internal Drainage Boards and certain local authorities that exercise drainage powers.

The WLMP considers the water level requirements for a range of activities, including agriculture, flood defence and conservation and how these can be reconciled and integrated.

A WLMP is normally required where:

- a site of nature conservation interest has listed on the site designation plants and/or animals that are associated with a wetland habitat,

and either

- has water level management structures such as sluices or pumps on the site, or
- is affected by such structures outside the site boundary.

Most wetland SSSIs have a WLMP and the priority for the WLMP is to ensure that water level management makes the required contribution to securing the favourable condition of the SSSI.

The minimal objective for each WLMP is to maintain a water level management regime that is consistent with the ecological requirements of the interest features for which the site has been designated as a SSSI. Natural England sets conservation objectives for each SSSI, taking account of the requirements of the interest features, and these objectives should be embodied in the WLMP.

IDB Biodiversity Action Plans

Through IDB Biodiversity Action Plans, it is hoped that the conservation and enhancement of biodiversity, particularly outside the boundaries of Sites of Special Scientific Interest (SSSI), can be better integrated into IDB planning and work programmes. In addition, BAPs provide IDBs with a formal mechanism to better record and demonstrate the contribution to biodiversity that they already make.

Contributing to biodiversity is an important part of an IDB's role as a modern public authority. IDBs are uniquely placed to conserve and improve freshwater and wetland habitats, and to forge partnerships to ensure sustainable water level management in lowland areas:

- IDBs are, collectively, one of the biggest managers of freshwater and wetland habitats in the country and therefore have a critically important role to play in maintaining and enhancing the nation's biodiversity.
- The thousands of kilometres of IDB ditches and water courses host a major wildlife resource.
- Water level management by IDBs supports distinctive wetland habitats and characteristic landscapes.
- Hundreds of UK BAP wetland plant and animal species can be found in IDB districts – from lichens to wildflowers and from insects to mammals.
- IDB drainage districts contain hundreds of SSSIs and local wildlife sites.

By setting objectives and targets to conserve and enhance wetland species and habitats, IDB BAPs will help to link the ongoing conservation work of IDBs to the national and local BAP targets and actions. ADA, Natural England and Defra have produced guidance, available on the Defra website, to assist in the production of IDB BAPs.

Making decisions – emergency works

All IDBs should have a planned maintenance and improvement programme that has been informed by surveys of features at risk, asset condition and protected species location and have undergone consultation with interested parties. Occasionally, there may be the need for unforeseen and urgent repair work. Where this is needed to be delivered in a very short timescale in order to maintain public safety there may not be the time for such processes. This is most likely to occur when there is a failure of structure, be that one constructed with artificial materials or a slip in an earth bank.

In such cases there are risks that species such as badgers, nesting birds, bats or water voles might be affected or that action is needed within, or affecting, a SSSI. There will be a need to make an assessment of the risk of such species occurring at the site of the emergency and decisions on reasonable steps that can be taken to minimise damage. The consultation requirements over SSSIs recognise that emergencies arise and in such circumstance the obligation is to contact Natural England as soon as is reasonably practical.

In the case of an emergency action where there may be animal burrows (i.e. badger or water vole) in an embankment that itself has failed or is at risk of failure, then the emergency works should be designed to eliminate, or minimise, the risk of animals being buried or trapped underground.

In the case of bat roosts that are in buildings or trees made unsafe by subsidence, flood damage or erosion, the minimum work to make the structure safe should be undertaken until advice is received from Natural England.

Norfolk hawker *Aeshna isosceles*

Further reading and information

ADA and Natural England (2007). *National Guidance for Internal Drainage Boards: Mitigation Measures for Water Voles*. ADA and Natural England.

ADA, Natural England and Defra (2008). *Internal Drainage Board Biodiversity Action Planning: A Guide to Producing IDB Biodiversity Action Plans*. Defra, London.

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MAFF, Welsh Office, ADA, English Nature and National Rivers Authority (1994). *Water Level Management Plans: A Procedural Guide for Operating Authorities*. MAFF Publications PB 1793. MAFF, London.

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Natural England (2007). *Otter: European Protected Species*. Natural England Species Information Note SIN006. Natural England, Peterborough.

Natural England (2007). *Bats: European Protected Species*. Natural England Species Information Note SIN010. Natural England, Peterborough.

Strachan, R. and Moorhouse, T. (2006). *Water Vole Conservation Handbook*. Second Edition. Wildlife Conservation Research Unit, Oxford.

The Natural England website can be accessed for descriptions of the interest features of each SSSI (site citations) at www.naturalengland.org.uk.

Boundaries of SSSIs can also be viewed alongside other environmental data at the multi-agency website www.magic.gov.uk.

Further information on waste management regulations can be found at www.netregs.gov.uk.

Five

Management techniques

Introduction

This chapter sets out the techniques that can be variously applied to drainage channels to deliver, ideally, both effective flood risk management and the enhancement of plant and animal communities.

In the introductory sections, consideration is given to:

- The process of selecting appropriate techniques.
- Techniques to apply for specific interests.
- Restrictions that may apply to the timing of works.
- Techniques suited to application in maintenance or capital programmes.

The following catalogue identifies techniques that are applicable to the channel, its margin and channel banks. Brief consideration is also given to techniques that can be deployed outside the immediate channel system, particularly across the floodplain.

Choosing techniques

As set out in the previous chapter, this manual recommends an integrated, wider-system approach to planning the management of drainage channels. The benefit of this approach is that the flood risk management function and biodiversity potential of any individual channel can be evaluated within the context of the functioning of the channel system as a whole. Once this evaluation has been conducted, then appropriate management techniques for the individual channel can be selected given the balance of flood risk management and biodiversity enhancement deemed appropriate.

The aim should be to achieve the correct balance in all channels, thereby maximising both the flood risk management and the biodiversity potential of the system as a whole. It should be stressed that any management needs to comply with legislation covering protected species and designated wildlife sites.

As explained in the previous chapter, targeted enhancements are sought for species and habitats that have an identified priority attached to them. The biodiversity evaluation of the drainage system is best delivered through a Biodiversity Audit and translated into action through an IDB Biodiversity Action Plan that informs the IDB's maintenance and capital works programmes.

To provide guidance on delivering these enhancements, this chapter describes a range of techniques whose application can provide significant wildlife gains. The techniques have a range of effects on flood conveyance and channel capacity. Some may simultaneously have beneficial effects on flood risk management while others may have no benefit or even reduce flood conveyance or storage capacity. Thus, it is important to have undertaken the evaluation of channel requirements within the context of the system as a whole. The ideal is to deploy the right technique, in the right place, at the right time.

Many of the techniques can be successfully incorporated within annual or long-term maintenance programmes with dramatic gains for biodiversity as a result. There are also significant opportunities for wildlife to be realised during the design and implementation of capital works. At the design stage it is possible to consider how to build in those features of wildlife benefit that require more space than is usually available in existing drainage channels. Intelligent design can introduce additional capacity to handle flows or store water, plus provide space for wildlife. Indeed, climate change predictions suggest that building in additional capacity, with the potential benefits for biodiversity, will be increasingly required.

In choosing the best technique to apply it is essential to examine the effect on flood conveyance in the specific location and circumstances that the technique would be used. This will require judgment informed by experience and one of the available flood risk modelling tools. In many circumstances, the Conveyance Estimation System (www.river-conveyance.net) may provide the information needed. Modelling allows prediction of the effects of management techniques on conveyance and storage and can identify the additional capacity needed to offset any reduction in conveyance caused by additional wildlife habitat created, such as a wider uncut marginal strip of vegetation in the channel.

Core components of a channel management programme

This chapter presents a wide range of techniques that an IDB may find relevant to its activities, some immediately through maintenance programmes and others when considering capital works.

However, there are some core components that should always be considered as part of a channel management programme:

- Timing operations to avoid the bird nesting season.
- Leaving one bank and the water margin of smaller channels uncut through to late summer.
- Leaving both banks and the water margin of larger watercourses uncut through to late summer.
- Leaving one bank and the water margin of some larger watercourses uncut through to a second year and alternating the side that is uncut through to a second year.
- Alternating the bank from which machine clearance of vegetation is carried out.
- Establishing vegetated berms on all but the smallest of channels.
- Maintaining higher water levels in smaller channels to prevent drying out in the summer.

Timing of vegetation cutting

The timing of vegetation cutting and its effects on wildlife need to be considered both during the course of a year and between years. The following sections summarise the programme of cutting that could be considered with further information provided in the individual techniques sections. The programme needs to accommodate a combination of flood risk management, nature conservation constraints and biodiversity enhancement objectives.

In-channel and emergent vegetation cutting

Cutting does not usually commence until significant quantities of vegetation have grown, usually by late spring or early summer, although this is very season and site dependent. This is the time when there is the greatest risk to birds' nests hidden in the vegetation and to fish spawn. The cutting of vegetation early in the season also allows time for it to re-grow and create a further impediment to flood flows. This may be to an extent that a second cut needs to be considered later in the season. For these reasons, early season cuts should be avoided if possible. If a need for a mid-season cut has been predicted based on previous years' experience of flood risk to people or property, it may be better to

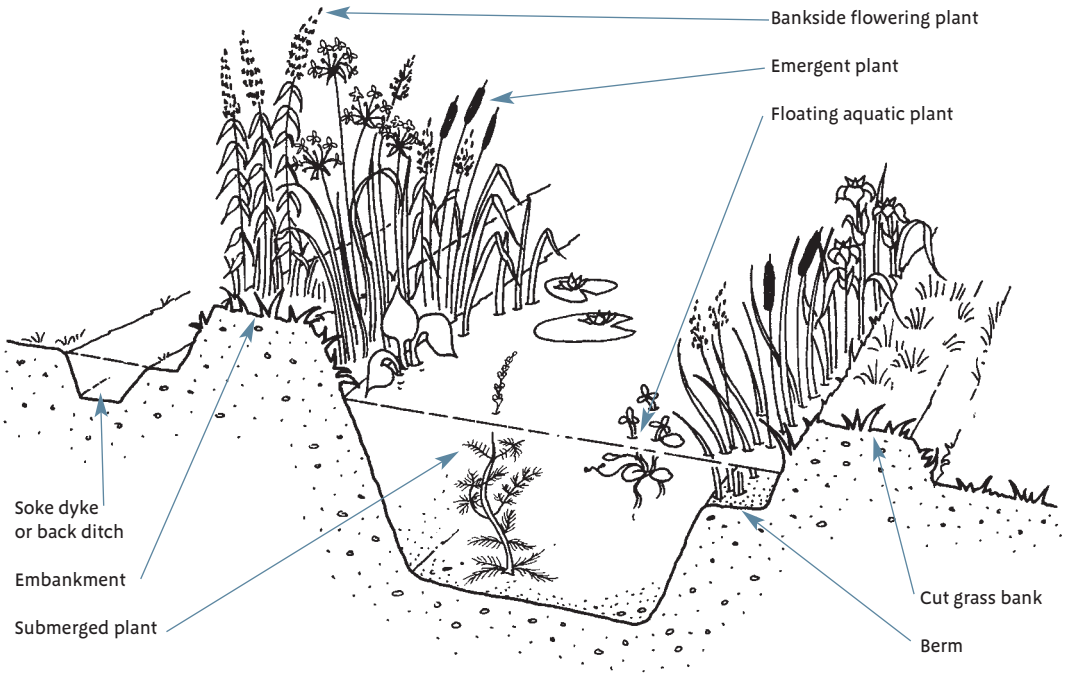


Figure 5.1 – The structural features of a characteristic drainage channel

plan for regular, repeated cuts that commence before the nesting season to deter birds from nesting in the emergent vegetation. A regime of regular cutting would then need to continue throughout the season. This practice should only be undertaken as an exception, and in circumstances where there is an established flood risk to people and property. Alternative solutions should also be considered, including works to increase the capacity of the channel, where this is feasible.

For drainage channels where the risk to people and property from summer flood flows is not considered significant, then cutting only in the autumn, in advance of predictable autumn and winter flood flows, is the best approach for wildlife. Many emergent plants remain standing throughout the autumn and winter and leaving this vegetation in place can be the cause of reduced flood conveyance both directly and by trapping additional material flowing in the channel. Where the conveyance capacity of the channel allows, leaving the strip of emergent vegetation at the water's edge should be considered along with cutting only every second year.

Bankside vegetation cutting

The optimum frequency and timing of cutting bankside vegetation can be varied where particular biodiversity objectives have been set and there is not a risk to people or property. For specific conservation objectives the appropriate cutting programme is:

- **Enhancement of floating and submerged plants in the channel.** Cutting in late winter to early spring (March) will tend to delay the spring regrowth of bank side vegetation and reduce shading of the open water, favouring those plants in the channel.
- **Maintaining plant species diversity along the banks and at the water margin.** Cut annually (in late winter-early spring) or twice a year (in autumn and again in late winter-early spring).
- **Promoting thick tussocky vegetation.** Cutting only once every two years will promote thicker and more tussocky grass growth.
- **Promoting scrub on selected parts of the bank.** Cutting only on long rotation cycles (five to 10 years) will allow scrub to establish.
- **Maintaining reed domination.** Cutting in a two to five-year rotation will promote thick reed growth without allowing scrub to establish or dominate.

As in the case of cutting emergent and marginal vegetation in the spring and summer, there is the risk of destroying birds' nests. Again, management choices should be based on flood risk. On high-risk channels, it may be necessary to adopt an early-and-often approach and on low-risk channels cutting can be carried out after nesting has finished. The practice of regular cutting should only be undertaken as an exception, and in circumstances where there is an established flood risk to people and property. Alternative solutions should also be considered, including works to increase the capacity of the channel, where this is feasible.

Overall the cutting of bankside vegetation in the autumn, winter or early spring is much less damaging to wildlife than that carried out in the summer. Cutting during the summer removes the cover, food and nectar sources of many invertebrates which, in turn, provide food for breeding birds. However, cutting in the winter does remove the over-wintering sites for some hibernating invertebrate adults, larvae, pupae and eggs. To permit over-winter survival of invertebrates, stretches of bankside and emergent vegetation should be left uncut, applying a two-year rotation with alternate banks cut each year.

Figure 5.2 gives examples of the year-round management regimes that may be appropriate for channels with low, medium and high flood risk status.

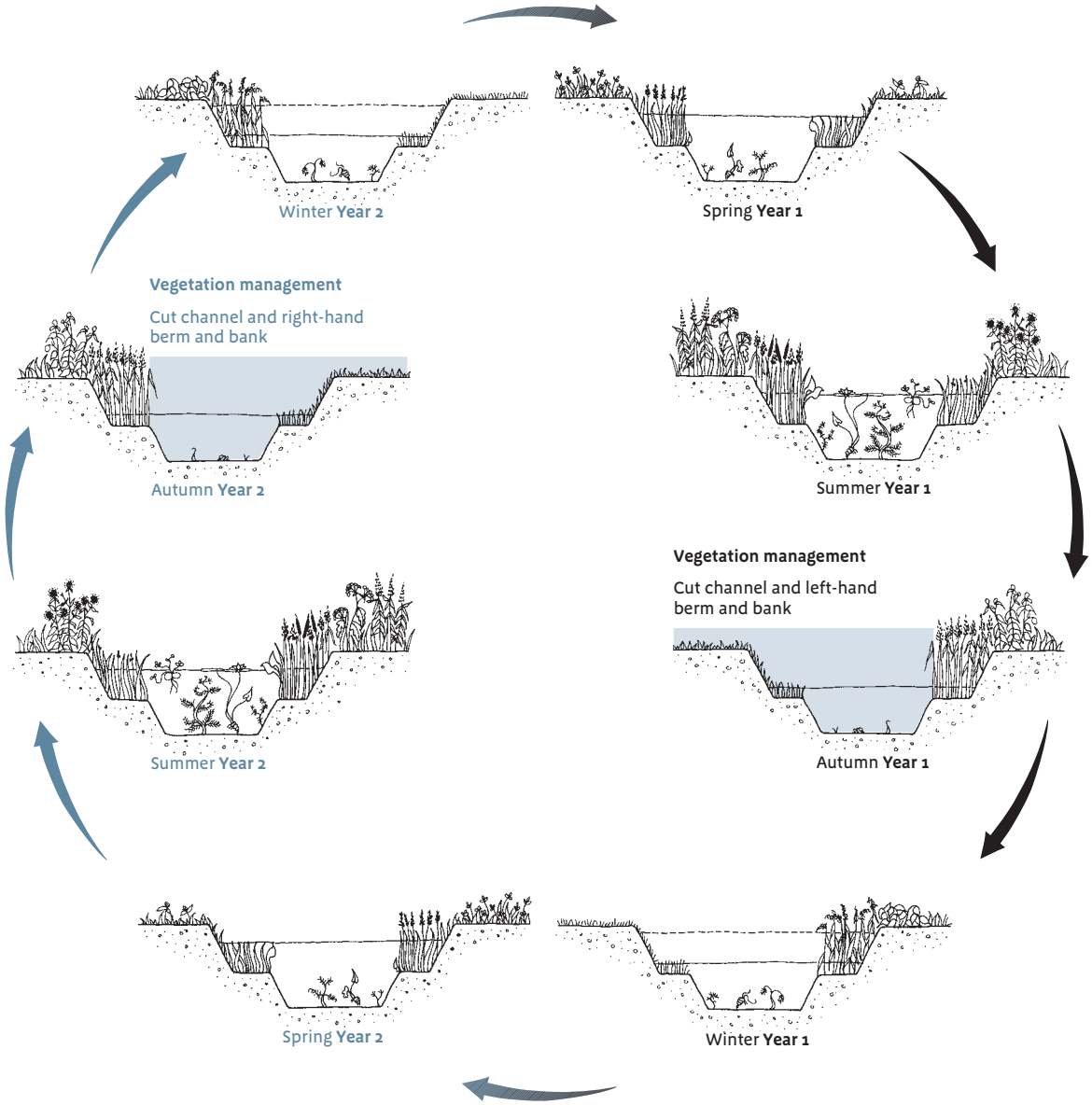


Figure 5.2a – Example of a two-year vegetation management programme on a channel with **low** flood-risk status.

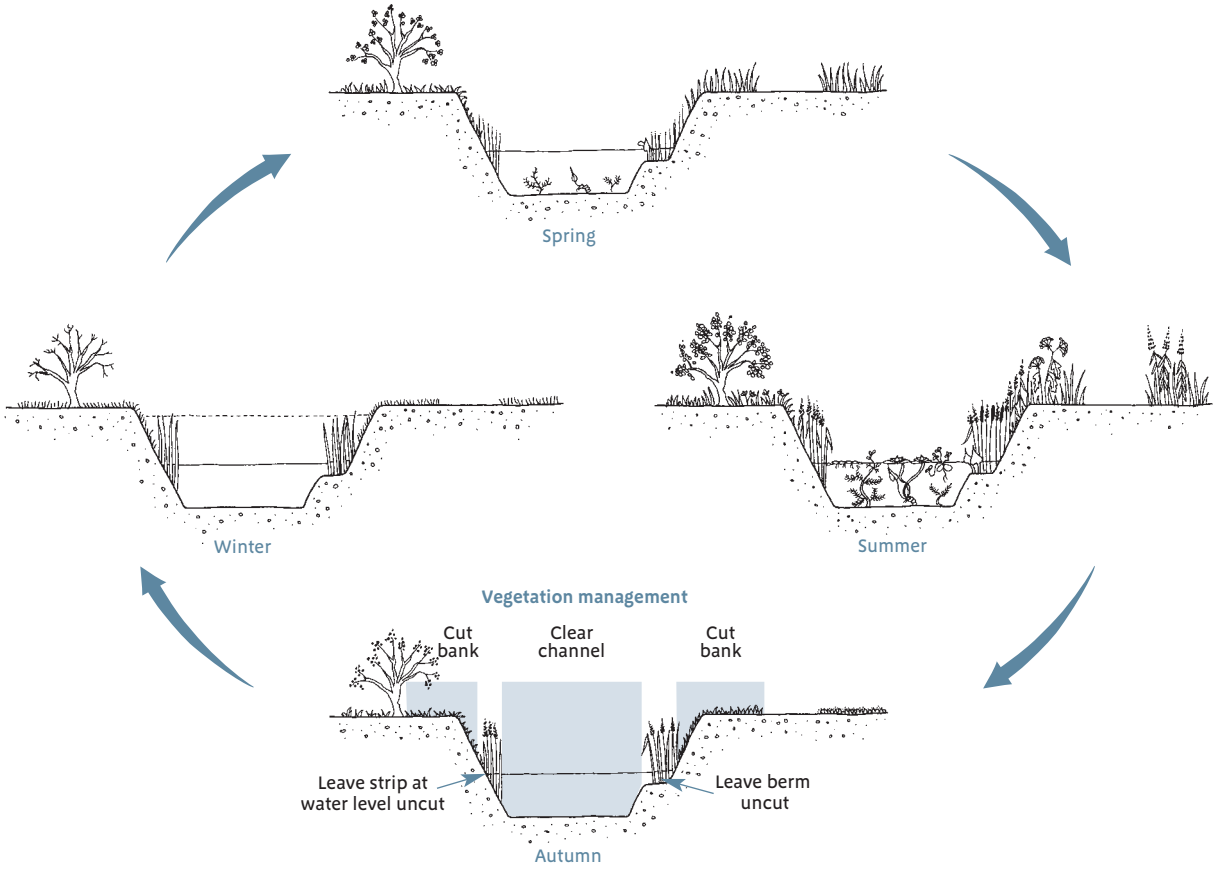


Figure 5.2b – Example of an annual vegetation management programme on a channel with **medium** flood-risk status.

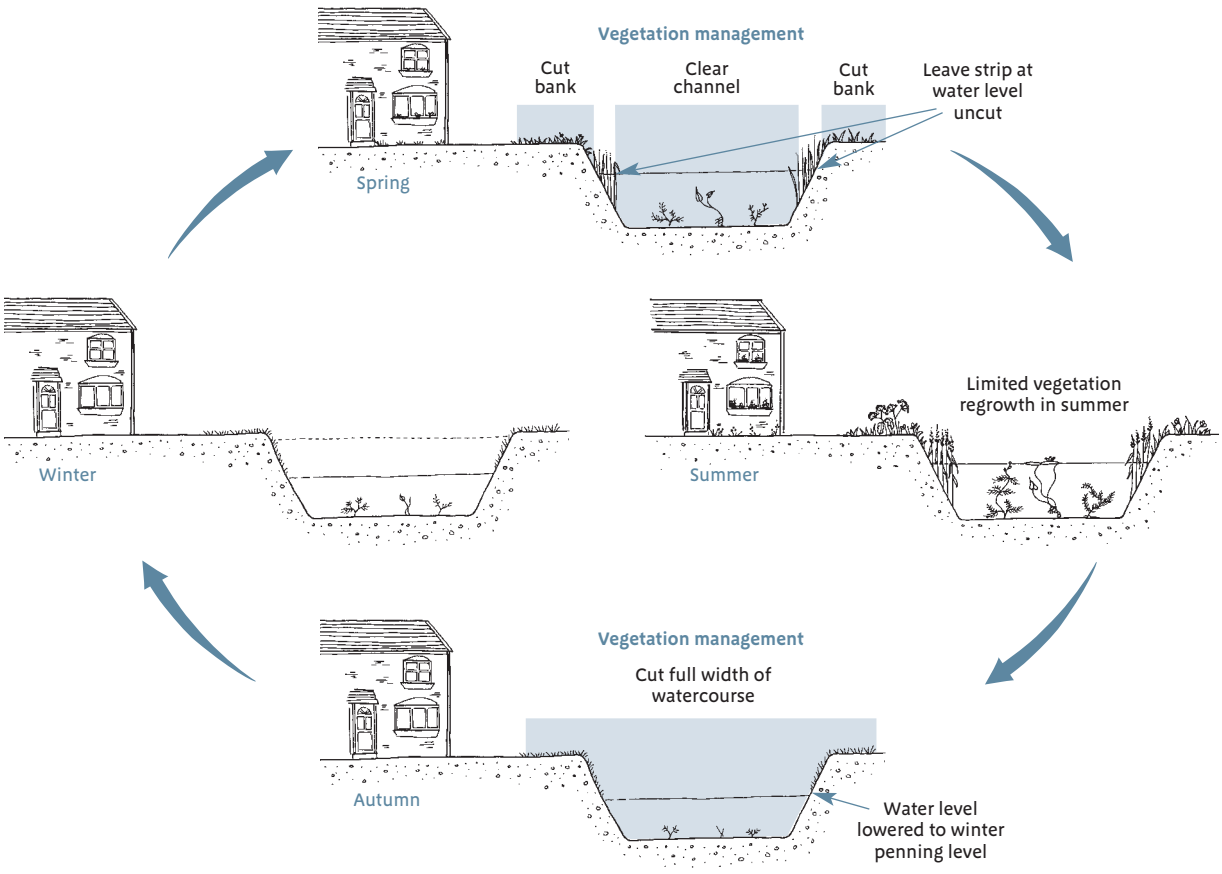


Figure 5.2c – Example of an annual vegetation management programme on a channel with **high** flood risk-status.

Use of machinery

There are three components to the use of machinery that need to be considered:

- The timing of use.
- The skill applied in use.
- The type of machinery.

The timing of use has been considered above. A high degree of skill by the operator in using the machinery is required if many of the individual techniques described later in this chapter are to fulfil their potential for maintaining or improving wildlife habitat and managing flood risks. This includes carrying out techniques that require the selective removal or cutting of vegetation, vegetation establishment, the creation of vegetated berms and the selective removal of silt.

There are many individual designs of machine available and manufacturers are continually refining existing models and developing new ones. This section considers only the general aspects of the different types of machinery and concentrates on the features that influence how they are able to manage drainage channels in a manner sensitive to wildlife.

Machines that work from the bank

There is a wide variety of machines that work from the bank, fitted with either tracks or wheels including tractors, excavators and specialist ditching machinery. The latter includes very narrow tracked machines (bicycle mowers) for working in confined spaces between the channel and the adjacent land (e.g. crops, trees or structures) and the Berkenheger 'spider' that operates within the channel between the banks. Each type of machine has a number of features that will influence their deployment in particular circumstances, including their ability to manage channels sensitively for wildlife:

- Machines working from the bank can be more selective than weed boats, being able to cut or remove relatively small patches of vegetation or silt.
- Working from the bank may mean that bird nests attached to floating vegetation or emergent vegetation are obscured by the closer marginal and bank vegetation.
- Machines with weed-cutting buckets are most effective in narrower channels, where they can reach across the whole width of the channel and where they can be very selective in the width and extent of vegetation that they cut.
- Tractors and excavators can be used for other tasks at other times of year, including habitat management and creation works elsewhere in the catchment.
- Collected vegetation is deposited regularly along the bank as the machine carries out its work and this greatly reduces the need for off-site disposal of cut material.

The machine must have access along the bank and this can be a major limitation in some circumstances such as more natural channels and in urban areas where an easement has not been maintained. Having to work around buildings, trees, fences and side channels, often making long detours, can slow the work rate.

Machines that work in the water

There is a more restricted range of machinery that operates in the water, principally weed-cutting and harvesting boats and amphibious weed-cutting and harvesting machines. These machines have features that will influence their deployment in particular circumstances, including their ability to manage channels sensitively for wildlife:

- Compared to bank-based machines, the selective cutting of plant material is more difficult.
- Working from the water enables bird nests attached to floating and emergent vegetation to be seen readily.

- Weed-cutting and harvesting boats and amphibious machines have very limited seasonal use and cannot readily be applied to other tasks throughout the year in the way that a tractor or excavator can.
- Weed boats have a greater work rate than a machine working from the bank and hence they are the most effective method of cutting in large watercourses.
- They differ in their ability to remove the cut material, some combining cutting and removal and some requiring a second boat to collect the material. The alternative is to allow the cut material to float down the channel to a structure containing a weed screen.
- Additional costs, time and risks can be incurred if the collecting, moving and disposing of the cut vegetation are separate operations. The collected material is gathered to one point and may have to be taken off site for disposal as waste, thereby incurring additional costs.
- Amphibious, tracked weed craft can access the water in a much wider variety of locations and are faster and safer than launching a traditional boat. The machine can also climb from the water to deposit cut vegetation away from the banks. The machine can work in shallower water than a traditional weed boat. As with weed boats they have limited seasonal use and are not readily applied to other tasks.

Fitments to machinery – cutting heads

There are a number of different types of mechanically and hydraulically powered cutting heads available that are either attached directly to the front or rear of a machine or onto a hydraulic arm. Such fitments are possible to wheeled and tracked vehicles, boats and pontoons. Attachment to an arm enables the head to work up or down banks and to reach other locations where a machine cannot manoeuvre with a fixed implement. Below is listed a variety of heads with their basic uses, advantages and disadvantages:

Flail

For cutting hedges, grass and other light vegetation. It is a quick and reliable cutting technique using a robust tool. The disadvantages of flail use are that cut material can smother bankside vegetation leading to invasion by less desirable species and even bare ground and erosion. The cut material can fall into the watercourse. If it sinks it can add to sediment loads, but any floating material is of a short length and less likely to block culverts and weed screens compared to material cut for with a reciprocating cutter bar. Larger hedgerow stems can look very unsightly when cut with a flail.

Some flail heads can be fitted with a rake, conveyor or vacuum unit to remove grass cuttings. To date, a flail fitted with a conveyor has proven effective in IDB use on the banks of watercourses. Rake and vacuum systems may not be as suited for use on rural watercourses.

Drum, clearance or forestry flail

For cutting scrub and other woody vegetation down to ground level. This type of flail can have swinging hammers or teeth that are mounted on a drum. It is able to cut up and mulch woody material much more rapidly than the two-stage cut and chip process. The tool spreads the chipped material over a wide area to a relatively shallow depth.

Circular saw (single or multiple)

For cutting hedges and limbs of trees. This tool produces a very much neater appearance than a flail used on hedges and tree limbs. The larger cut material has to be dealt with in a two-stage process, the cutting being followed by removal for chipping, removal for burning or running a flail over the material on the ground.

Reciprocating-blade cutter bar

For cutting grass, emergent vegetation such as reeds, and submerged vegetation when attached to a weed boat. The cut material has to be dealt with in a two-stage process. If left, the long lengths of

material pose a greater risk of blocking culverts and weed screens. The blade on the bar is susceptible to damage by natural materials in the channel such as stones and by metal and other hard materials dumped in the water or on the bank. The result is a higher maintenance need compared to a flail, and with the risk of greater downtime.

Tree shear (grip cutter)

For the cutting and movement of scrub, trees and limbs of trees. The cut material has to be dealt with in a two-stage process. It can be used very selectively to cut limbs overhanging the water (including pollarding) and to lift and move them to the bank for secondary processing. This can be carried out considerably more safely than the same operation with an operative and chain saw.

Weed-cutting bucket

For cutting and removing in-channel and some emergent vegetation. The bucket is a basket, used to remove the cut material with a fixed blade or a reciprocating knife on its leading edge. It can be very selective dependent on the size of the bucket and, particularly, the skill of the operator. In rural areas the cut material can be placed on the bank in a position where it will not fall back into the water or be carried away by flood flows. This also avoids having to collect the material for disposal as waste. The reciprocating blade can be vulnerable to damage by metal, concrete and stones.

Fitments to machinery – removing cuttings

There are considerable benefits to be gained in certain circumstances by the removal of cuttings from their source. These include:

- Avoiding entry of the cuttings into the channel, either shortly after cutting or during a flood event. The cut material may block culverts, or end up at the pumping station and require raking out and disposal as waste.
- Avoiding a thick mulch of cut vegetation on channel banks that kills the underlying vegetation, leading to invasion by undesirable ruderal species and potentially reducing the stability of the bank.
- Removing nutrients from the system, particularly on grassed banks where the objective is to maintain or create a species-rich grassland.

These benefits are sufficient for cuttings removal to be recommended for widespread application. It is a method of working that has a particular application in encouraging water voles to move from one bank where excavation or engineering work is proposed (the conditions being made less favourable by cutting of the vegetation) to the opposite bank (where the vegetation is left uncut). Where nutrient removal is sought to benefit plants growing on the bank (see Technique BA3), the effort should be targeted where the greatest benefit is to be gained.

The manner in which cutting heads deal with the cut material has been explained in the section above. In addition, it is possible to attach systems of rakes, conveyors or vacuum hoses to cutting heads, such as flails, or to use such tools to collect the material as a second operation. The disadvantage is that this can reduce the flexibility of operation that is gained with a cutting head like a flail.

Techniques for specific interests

This section introduces the overall approach and techniques that can be applied in specific circumstances where protected, non-native or invasive species are encountered within the drainage system and may require management. Further detail is given in the relevant appendices.

Techniques to apply for protected species

The legally protected species considered in this section are those that IDBs are most likely to encounter in their drainage districts. These are:

- Nesting birds
- Badgers
- Bats
- Otters
- Great crested newts
- Reptiles
- White-clawed crayfish
- Water voles

There are many species protected by schedules to the Wildlife and Countryside Act 1981 that are very rare and localised, and most watercourse managers are unlikely to encounter them. Natural England should be able to inform the IDB if one of these rare species occurs within their district and provide information on the specialist management that they might require. Such information should be included in the IDB BAP.

Nesting birds

The preferred approach is to avoid the risk of damage to birds' nests, their eggs and young by:

- Avoiding the intentional creation of suitable nesting habitat in areas that may require intensive management to tackle high flood risk.
- Avoiding the unintentional development of suitable nesting habitat through changes in vegetation management programmes in areas with high flood risk.
- Avoiding the annual growth of nesting habitat in areas with high flood risk, i.e. by deploying a programme of early and repeated cutting in such locations.

Where a programme is proposed of early and repeated cutting in a high flood risk area then every endeavour should be made to off-set the loss of potential nesting habitat by creating additional nesting habitat elsewhere within the drainage system. The practice of regular cutting should only be undertaken as an exception, and in circumstances where there is an established flood risk to people and property. Alternative solutions should also be considered, including works to increase the capacity of the channel, where this is feasible.

In the case of proposed engineering, earthmoving, vegetation removal or similar works that have to be programmed to take place in the bird nesting season, then action is required in advance to avoid the potential for destroying a bird's nest. This action should be to remove any features that would provide bird nesting sites within the area of the proposed works before nesting commences and the site maintained, usually by mowing, in a condition that it will not attract nesting birds. Thus, removal of features should take place from October to February.

Where it has not been possible to undertake the pre-nesting season clearance, consideration can be given to attempting to locate any birds' nests during the breeding season. This will only be practical where the area for the proposed works is limited or, if on a larger area, the extent of features likely to contain nests is limited. The approach to locating nesting birds during the breeding season is set out below. These actions should be undertaken in the period one to three days in advance of the proposed works. (Appendix 8 gives the nesting seasons for 25 bird species.)

1. Observe the length or area concerned from a distance, either from a concealed position or from a vehicle, looking for adult birds returning to particular locations carrying food for young or the incubating adult. Also listen for the calls of young begging for food. In good weather,

30-60 minutes should be devoted to this action over each visible reach, concentrating on those features and vegetation types in which birds would nest. In poor weather a longer period may need to be allowed. Note any features that will allow the nest to be located more precisely on a close approach.

2 Approach the area or site slowly and quietly, watching for birds walking, swimming or flying away from possible nesting sites and listening for birds giving alarm calls. Note any features that will allow the nest to be located more precisely by a detailed search. Where there are species that have nests attached to floating and emergent vegetation an approach from the water (by boat or wading, where safe to do so) may be more effective.

3 Carry out a detailed search of any areas where the observation from a distance and during the approach indicated that a bird might be nesting. In these areas if it is possible to part the vegetation by hand or with a stick and see clearly through the vegetation that there is not a nest present then they can be marked as free of nesting birds on the ground and on a plan which is provided to the machine operators. Where there are species that have nests attached to floating and emergent vegetation a search from the water (by boat or wading where safe to do so) may be more effective. If it is not possible to see clearly into the vegetation (particularly the case with bramble thickets) then the area cannot be declared free of nests and should be marked as such on the ground and on a plan which is provided to the machine operators.

4 Machine operators should be instructed to leave any section of watercourses or site uncut or uncleared with a buffer of 5m for most nests, extending to 10m for the common birds of prey. If a nest of a species listed on Schedule 1 of the Wildlife and Countryside Act is found or suspected then there should be specific consultation with Natural England over the size of this buffer.

5 During the cutting or clearing operation of the marked nest-free areas, machine operators should be instructed to maintain a close watch for birds rising from the vegetation ahead of them as they work and must investigate all sightings.

If there is to be a gap of more than three days between this nest searching exercise and the cutting or clearance operation then there should be a re-survey following the above procedure.

This nest searching procedure is time-consuming, requires a skilled naturalist familiar with the signs of nesting birds and good weather in which birds are more likely to be observed, particularly feeding young. It is strongly advised to carry out the relevant operations and advance clearance outside the bird nesting season in preference to the nest-searching approach.

Badgers

The preferred approach is to avoid the risk of damage to badger setts by:

- Avoiding the intentional creation of sett-building habitat in areas where access is required for management purposes.
- Avoiding the unintentional development of sett-building habitat through changes in vegetation management programmes in areas where access is required for management purposes.

Where a sett already exists the first consideration should always be how to avoid damage to the sett by modifying the location, design, and execution of the work. The use of machinery that will eliminate the risk of disturbance to the sett should be considered. Examples of such modifications include:

- Use of lighter weight-machinery close to the sett or manual labour if suitable.
- Avoidance of percussive piling techniques.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. This can include temporary or permanent closure of the sett. This can be a time-consuming process involving additional surveys to establish the number of animals using the sett and can require specialist input. Natural England should be consulted about the proposed sett closure. The necessary licence should be applied for from Natural England.

Bats

The risk of unknowingly destroying a bat roost, blocking access to a bat roost or killing bats using a roost through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting roosting bats.

2 If the location is likely to support roosting bats, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of the year, identifies that the site is not a bat roost then proceed with the works as proposed.

3b If the survey identifies the site as a bat roost, or roost use cannot be ruled out, then the first consideration should always be avoidance of damage to the roost. This is often possible through careful location and design of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve destruction of the roost and its replacement away from the affected area. The replacement roosting feature will need to be established before the works commence. Establishing the nature and scale of replacement roost creation can be a time-consuming process requiring specialist input. Natural England should be closely consulted at the early stage of the development of the proposed roost replacement. Their comments should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial proposal.

The presumption in any acceptable roost replacement programme is that the population of the bats affected remains at a favourable conservation status in the area. Without the likelihood of this statutory requirement being fulfilled, it is unlikely that a licence would be granted.

Otters

The preferred approach is to avoid the risk of damage to otter holts by:

- Avoiding the intentional creation of a holt or holt-building habitat in areas where regular access is required for management purposes.
- Avoiding the unintentional development of holt-building habitat through changes in vegetation management programmes in where regular access is required for management purposes.

Where a holt already exists the first consideration should always be how to avoid damage to the holt by modifying the location, design or execution of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve destruction of the holt and its replacement away from the affected area. The replacement holt will need to be established before the works commence. Natural England should be closely consulted at the early stage of the development of the proposed holt replacement. Their comments should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial proposal.

The presumption in any acceptable holt replacement programme is that the population of the otters affected remains at a favourable conservation status in the area. Without the likelihood of this statutory requirement being fulfilled, it is unlikely that a licence will be granted.

Great crested newts

The risk of unknowingly killing great crested newts or destroying habitat used by them through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting great crested newts.

2 If the location is likely to support great crested newts, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of year, identifies that the site is not used by great crested newts then proceed with the works as proposed.

3b If the survey identifies that the site is used by great crested newts, or use cannot be ruled out, then the first consideration should always be avoidance of damage to the site. This is often possible through careful location and design of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve trapping and removing or excluding great crested newt from the site, the destruction or damage of the site and its replacement away from the affected area. The replacement habitat will need to be established and the great crested newts moved before the works commence. Determining the size of the population to be moved and establishing the replacement habitat can be a time-consuming process. Natural England should be closely consulted at the early stage of the development of the mitigation proposal. Their comments should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial proposal.

The presumption in any acceptable great crested newt translocation or exclusion programme is that the population of the newts affected remains at a favourable conservation status in the area. Without the likelihood of this statutory requirement being fulfilled, it is unlikely that a licence will be granted.

Reptiles

The risk of unknowingly killing reptiles through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting reptiles.

2 If the location is likely to support reptiles, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of year, identifies that the site is not used by reptiles then proceed with the works as proposed.

3b If the survey identifies the site is used by reptiles, or use cannot be ruled out, then the first consideration should always be avoidance of actions that might lead to the killing of reptiles. This is often possible through habitat management in advance of the works, a translocation of the reptiles or careful location and design of the works.

If a modification to the site or nature of works is not practical or cost-effective then other mitigation methods should be explored. There are two options most widely applied. They both involve the identification of land that can be managed to improve its quality as habitat for reptiles in advance of the proposed works being undertaken. They also both involve moving reptiles when they are active. The options differ in where that land is located and how the reptiles are moved to it.

i) If the improved habitat is immediately adjacent to the proposed works then the reptiles can be persuaded to move to it by the progressive, phased strimming of the vegetation on the site of the works to make it unsuitable for reptiles. At the same time any structures that might

be used for winter hibernation should be taken apart by hand. Once the habitat on the works site is unsuitable and reptiles have been given sufficient time to move, it should be fenced to prevent their return.

ii) If the improved habitat is separated from the proposed works by a natural or man-made barrier then the reptiles will have to be trapped and translocated. The efficacy of trapping is enhanced by appropriate fencing to prevent immigration to the site, by the phased strimming of the vegetation on the site and the manual dismantling of any hibernation structures. Once all the reptiles have been trapped the works can proceed or, if there is to be a period before the works commence, the fencing monitored and maintained.

Neither of these procedures requires a licence but it is recommended that Natural England is consulted about the method statement.

White-clawed crayfish

The risk of unknowingly killing white-clawed crayfish or destroying habitat used by white-clawed crayfish through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting white-clawed crayfish.

2 If the location is likely to support white-clawed crayfish, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate season, identifies that the site is not used by white-clawed crayfish then proceed with the works as proposed.

3b If the survey identifies that the site is used by white-clawed crayfish, or use cannot be ruled out, then the first consideration should always be avoidance of damage to the site. This is often possible through careful location and design of the works.

If a modification to the site or nature of works is shown to be impossible or unreasonably difficult then other mitigation methods should be explored. These usually involve trapping and removing white-clawed crayfish from the site, the destruction or damage of the site and its replacement away from the affected area. The replacement habitat will need to be established and the white-clawed crayfish moved before the works commence. Natural England and the Environment Agency should be closely consulted at the early stage of the development of the mitigation proposal. Their comments should be addressed and the necessary licence and consent applied for from them after any modifications to the initial proposal.

Water voles

The risk of unknowingly destroying water vole burrows and killing water voles in those burrows through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting water voles.

2 If the location is likely to support water vole, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of the year, identifies that water voles are absent then proceeding with the works as proposed.

3b If the survey identifies the presence of water voles, or cannot rule out their presence, then the first consideration should always be avoidance of habitat damage. This is often possible through careful location and design of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve either temporary or permanent translocation of water voles away from the affected area. This is a time-consuming and expensive option requiring specialist input. The Environment Agency and Natural England should be

closely consulted at the early stage of the development of the proposed translocation. The comments of these agencies should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial translocation proposal.

The presumption in any acceptable water vole mitigation scheme is that, by the end of the project, at least an equal quantity and quality of occupied habitat will remain on the site or adjacent, as that which exists when water vole presence was identified. Without the likelihood of this objective being fulfilled it is unlikely that a licence for a translocation will be granted. Ideally, more habitat or higher quality habitat than previously existed can be incorporated into the design of the proposed works.

Techniques to apply for invertebrates

In most waterbodies, the margins are the most important parts for invertebrates. Invertebrates occupying channel margins benefit from gently sloping banks with a broad 'drawdown' zone with patches of bare mud. In grazing marsh ditches, gently sloping banks and areas of bare mud created by the treading actions of livestock are commonplace. Grazing maintains a diverse sward structure and water levels usually have to be maintained to provide drinking water for the livestock. In arable ditches, on the other hand, the banks tend to be steeper, grazing is replaced by cutting or the use of herbicides, and bare mud may only result from fluctuations in water level or through ditch management operations.

In shallow water, the most species-rich invertebrate communities tend to be associated with dense vegetation e.g. tussocky and trailing grasses. In general, there should be a varied structure of vegetation rather than a uniformly even sward. Most common emergent plants support invertebrate communities, some feeding on the plants, others, such as aquatic species, living amongst the stems in shallow water. This vegetation is also used by emerging dragonflies and other invertebrates with aquatic larvae and flying adults. The best populations of dragonflies are likely to be found in relatively shallow water that is not heavily overshaded by trees or other tall vegetation. Management actions should be avoided that result in dominance by very dense stands of common reeds. Emergent and marginal vegetation should not be cut before September to avoid removing plants used by emerging dragonflies and other invertebrates. The provision of shelter, roosting and feeding habitats (tall vegetation, woodland and grassland) beyond the channel corridor will be beneficial to adult dragonflies.

All stages of succession support interesting invertebrate communities and the best communities tend to occur in sites where there are numerous ditches. This is because extensive networks of ditches safeguard the communities from localised extinctions due to extremes of climate or management operations and allow damaged or managed ditches to be recolonised more easily. The greater the range of different ditch sizes and stages of succession, the greater the range of invertebrates a site will support.

Flowering plants on the ditch banks and bank tops are also important for invertebrates as sources of nectar for hover-flies, bees, soldier flies and butterflies. Butterflies tend to be more abundant in ditches where tall-herb fen has developed and less abundant in ditches dominated by common reed (although there are specialist moth species associated with reeds and rushes).

A combination of intensive management of some channels and neglect of others is important in retaining the habitats required by a wide diversity of invertebrates.

Techniques to apply for non-native and invasive plant species

This section summarises the approaches and techniques that may be applied to the management of non-native and invasive plant species that most frequently occur in drainage channels. (Appendix 7 provides greater detail.)

A broad habitat classification has been applied to these species, dividing them into those species that occur within the water of the channel or its wet margin, and those species that occur on the banks of the drainage channel. The species considered are:

Channel or wet margin

Australian swamp stonecrop	*Crassula helmsii*
Canadian pondweed	*Elodea canadensis*
Curly pondweed	*Lagarosiphon major*
Floating pennywort	*Hydrocotyle ranunculoides*
Parrot's-feather	*Myriophyllum aquaticum*
Water fern	*Azolla filiculoides*
Water hyacinth	*Eichhornia crassipes*
Water lettuce	*Pistia stratiotes*
Water primrose	*Ludwigia grandiflora*

Bankside

Giant rhubarb	*Gunnera tinctoria*
Giant hogweed	*Heracleum mantegazzianum*
Himalayan balsam	*Impatiens glandulifera*
Japanese knotweed	*Fallopia japonica*

Basic information about the legal status and distribution of these species is provided in Table 5.1 and further information about their life cycle is given in Appendix 7. The column that refers to legal status presents the position for England in April 2008. The listed status may well change.

Species	Legal status	Distribution
Australian swamp stonecrop	-	Widespread
Canadian pondweed	-	Widespread
Curly pondweed	-	Widespread
Floating pennywort	-	Concentrated in the south-east of England but spreading rapidly
Giant rhubarb	-	Limited distribution which is concentrated in south-west England
Giant hogweed	Wildlife & Countryside Act Schedule 9	Widespread
Himalayan balsam	-	Widespread
Japanese knotweed	Wildlife & Countryside Act Schedule 9	Widespread
Parrot's-feather	-	Widespread
Water fern	-	Widespread
Water hyacinth	-	Limited distribution but likely to become more common as winter temperatures increase
Water lettuce	-	Limited distribution but likely to become more common as winter temperatures increase
Water primrose	-	Limited distribution and being subjected to an eradication programme

Table 5.1 – Invasive plant species of drainage channels

Overview of the approach to managing non-native and invasive plant species

Management of non-native and invasive species can adopt a preventative approach, seeking to control or suppress a species, or it can aim to achieve eradication. The approach should be developed for the specific drainage system and plant species in question and could include:

- Identification of potential sources of non-native and invasive plant species.
- Prevention – stopping a drainage system from becoming infested by an invasive species.
- Eradication – completely removing a particular species from a drainage system.
- Control or suppression – managing or reducing the population of the species in a drainage system but not completely removing it.

While priorities will be specific to each site, it is anticipated that in most cases the following sequence should be followed:

- Identify any immediate health hazards posed by invasive species and mitigate them (e.g. install warning signage and erect barriers to prevent access).
- Identify and, where possible, stop or reduce any activity that may be encouraging the invasion or spread of invasive species in the drainage system.
- Where possible, identify currently active pathways for introduction of invasive species and attempt to block them.
- Plan and implement management priorities.

The approach to management will be governed by the species' method of reproduction. This can be by seed or by vegetative reproduction. Where the latter is the only method of reproduction, there is no long-term seed bank to control.

The available control techniques include:

- Cutting
- Flail mowing
- Excavation
- Prevention of flowering or seeding
- Seed removal
- Herbicides (see Appendix 4)
- Burial
- Grazing
- Shading
- Biological control

The major risk in the case of channel and marginal invasive species is that small fragments of these aquatic plants, which can be produced by management actions, can easily disperse and establish further down the channel. The major risk in the case of bankside invasive species is that intermittent or regular disturbance of the natural vegetation community during flood risk management activities can provide sites for establishment of invasive species. The technique that causes the least disturbance is herbicide application. Appendix 7 contains management techniques applied to specific non-native or invasive plants.

In some cases, invasive species can be accidentally spread as a result of improper use of management techniques. For plants this is usually where viable fragments or seeds of the plant are accidentally spilled or spread by machinery, vehicles or personnel movement. The sharing, transfer and import of materials and equipment between drainage systems can facilitate the spread of invasive species. Particular care should be taken when transferring soils or any live plant materials. Water-borne plants in particular may attach to equipment that has been used in the water and these should be thoroughly cleaned before moving between sites in different catchments.

Techniques available

This section presents the different techniques available for the maintenance and enhancement of the wildlife value of drainage channels. The techniques are presented in a standard format that includes:

- Technique title
- Reference code for the technique
- Illustration of the technique
- Approximate size of the watercourse
- Description of the technique
- Purpose of the technique
- Method of applying the technique
- Nature conservation advantages
- Flood management effects
- Scoring of the technique's benefits by numbered bittern and water droplet symbols

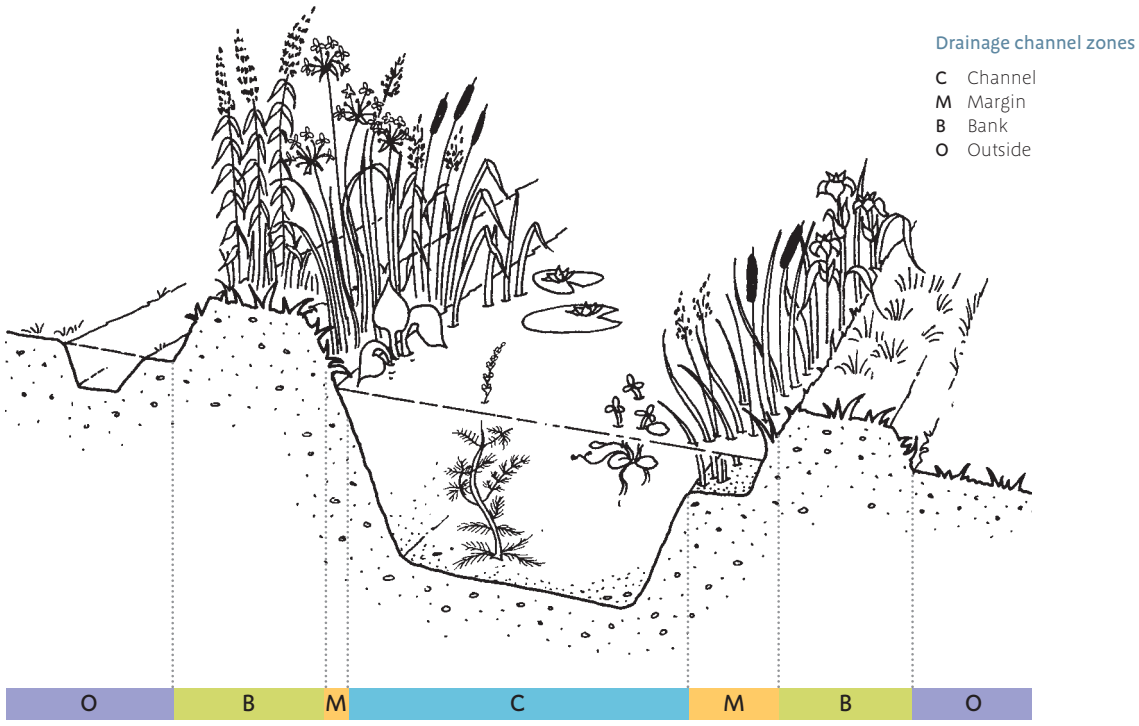
The different techniques have been grouped and ordered in a way that seeks to aid selection of the most appropriate technique. The primary grouping, indicated by colour-coded marginal tabs, is based on the area of the channel where the technique should be deployed:

The channel – the part of the watercourse which is normally permanently water-filled. These techniques are prefixed 'C'.

The margin – the part of the watercourse where the water level is normally held. These techniques are prefixed 'M'.

The bank – the part of the watercourse which is above the normal water level and that will hold flood flows. These techniques are prefixed 'B'.

Outside the operating corridor – land beyond the bank where the IDB would normally operate in co-operation with the landowner or occupier.
These techniques are prefixed 'O'.



The secondary classification of techniques is based on the operational planning of IDBs:

Annual maintenance — Annual or frequent maintenance activity. These techniques have an additional 'A' label.

Long-term maintenance — Long-term maintenance activity over perhaps 5 to 15 years. These techniques have an additional 'L' label.

Capital works — Actions that can be combined with, or are themselves, capital works. These techniques have an additional 'C' label.

Thus, a technique to scallop vegetation and underlying silt to create meanders has the reference code 'CL1', indicating that it is a technique to deploy in the channel as part of a long-term maintenance programme. The numeral uniquely identifies this technique within the set of channel, long-term maintenance techniques.

The techniques are not suitable for application to all watercourses. Appendix 3 identifies those techniques that are best suited to small channels less than two metres in width, medium-to-large channels over two metres wide, or that could be applied to both. It presents this in the context of the operational planning carried out by drainage authorities.

The benefits that each technique provides for flood risk management and biodiversity are summarised by two symbols that occur in the margin of each technique:

 A bittern for biodiversity

 A water droplet for flood risk management

Within the symbol is a number that gives a relative scoring for the benefit of the technique on a scale of zero to three.

A zero indicates that the technique provides no benefit for that factor.

A three indicates that there is significant benefit. In the case of biodiversity, this means the creation of new habitat. In the case of flood risk management, it means the creation of a significant flood conveyance or storage capacity resulting from capital works.

When scoring flood risk management benefit in instances where the flood conveyance ability of the channel may be affected by the technique, it has been assumed that the existing channel has sufficient capacity to cope with its designed standard of flood flows. If flood conveyance capacity is already inadequate then the technique will not be able to provide the benefit that is indicated.

Table 5.2 places each technique in its respective drainage channel zone and operational category, and provides its flood risk management and biodiversity scores. Technique BC4, which considers materials used in the stabilisation of banks, has separate categories for each type of material and these are listed in a separate table included in the description of the technique.

Channel

Annual maintenance				**Page**
C-A-1	Selective removal of aquatic plants to permit recolonisation 1	1	2	53
C-A-2	Selective removal of aquatic plants to permit recolonisation 2	1	1	54
C-A-3	Selective removal of aquatic plants to permit recolonisation 3	2	1	55
C-A-4	Selective removal of aquatic plants to permit recolonisation 4	2	1	56
C-A-5	Leaving headwaters untouched	3	1	57
C-A-6	Biological control of water fern (*Azolla*) using a weevil	2	2	58
C-A-7	Herbicide application to maintain an open channel	2	2	59
C-A-8	Herbicide application to maintain an open channel over selected reaches	1	2	60
Long-term maintenance				
C-L-1	Scalloping vegetation and underlying silt to create meanders	2	1	61
C-L-2	Re-establishment/re-distribution of aquatic plants	2	2	62
C-L-3	Creation of pools	2	1	63
C-L-4	Over-deepening the centre of the channel	2	2	64
Capital works				
C-C-1	Selective removal of waterplants to permit recolonisation	2	1	65
C-C-2	Re-establishment/re-distribution of aquatic plants	2	2	66
C-C-3	Creation of pools	2	1	67
C-C-4	Reed-bed to reduce diffuse pollution	3	1	68
C-C-5	Silt traps to reduce diffuse sediment pollution	2	2	69
C-C-6	Stabilising of bed at culvert mouths	1	1	70
C-C-7	Sluices	2	2	71
C-C-8	Washlands	3	3	72
C-C-9	On-line and off-line flood storage ponds	3	3	73

Margin

Annual maintenance				**Page**
M-A-1	Selective removal of emergent plants to give a sinuous effect	1	1	74
M-A-2	Selective removal of emergent plants	2	1	75
M-A-3	An emergent fringe on a single side	1	2	76
M-A-4	An emergent fringe on both sides	2	1	77
M-A-5	Herbicide application to maintain an open margin	2	2	78
M-A-6	Herbicide application to maintain an open margin over selected reaches	2	2	79
Long-term maintenance				
M-L-1	Re-establishment/re-distribution of emergent plants.	2	2	80
Capital works				
M-C-1	Re-establishment/re-distribution of emergent plants	2	2	81
M-C-2	Submerged berm	2	1	82
M-C-3	Submerged berm and linear reedbed	2	1	83

= Biodiversity = Flood risk management

Table 5.2 – The techniques in context

Bank

Annual maintenance				Page
B-A-1	Cutting technique – targeting specific wildlife interest	2	2	84
B-A-2	Cutting technique – differential cutting parallel to the water line	2	2	85
B-A-3	Cutting and removal of bankside grass and similar non-woody vegetation	2	2	86
B-A-4	Cutting technique – cutting by hand	2	2	87
B-A-5	Cutting technique – hay cut	2	2	88
B-A-6	Cutting technique – flail mowing	1	2	89
B-A-7	Grazing	2	2	90
B-A-8	Bank cover – scrub	2	1	91
B-A-9	Pollarding willows	2	2	92
B-A-10	Trimming of overhanging branches	2	2	93
B-A-11	Working between trees	2	2	94
B-A-12	Coppicing	2	2	95
B-A-13	Singling coppice	2	2	96
B-A-14	Laying hedges	2	2	97
B-A-15	Manipulation of shading	2	2	98
B-A-16	Management of drove roads	2	0	99
B-A-17	Herbicide application to manage plants along the bank	1	2	100
B-A-18	Herbicide application to manage plants at selected sites along the bank	2	2	101
Capital works				
B-C-1	Natural regeneration of banks	2	0	102
B-C-2	Re-seeding banks	2	0	103
B-C-3	Retention of vertical banks	2	0	104
B-C-4	Stabilising banks using natural or prefabricated materials	*see table on p*		106
B-C-5	Hedgerow planting	2	0	107
B-C-6	Introduction of bushes and trees	2	0	108
B-C-7	Planting of trees or shrubs at drain junctions	2	0	109
B-C-8	Planting and managing trees as biological control for vegetation control	2	1	110

Outside the corridor

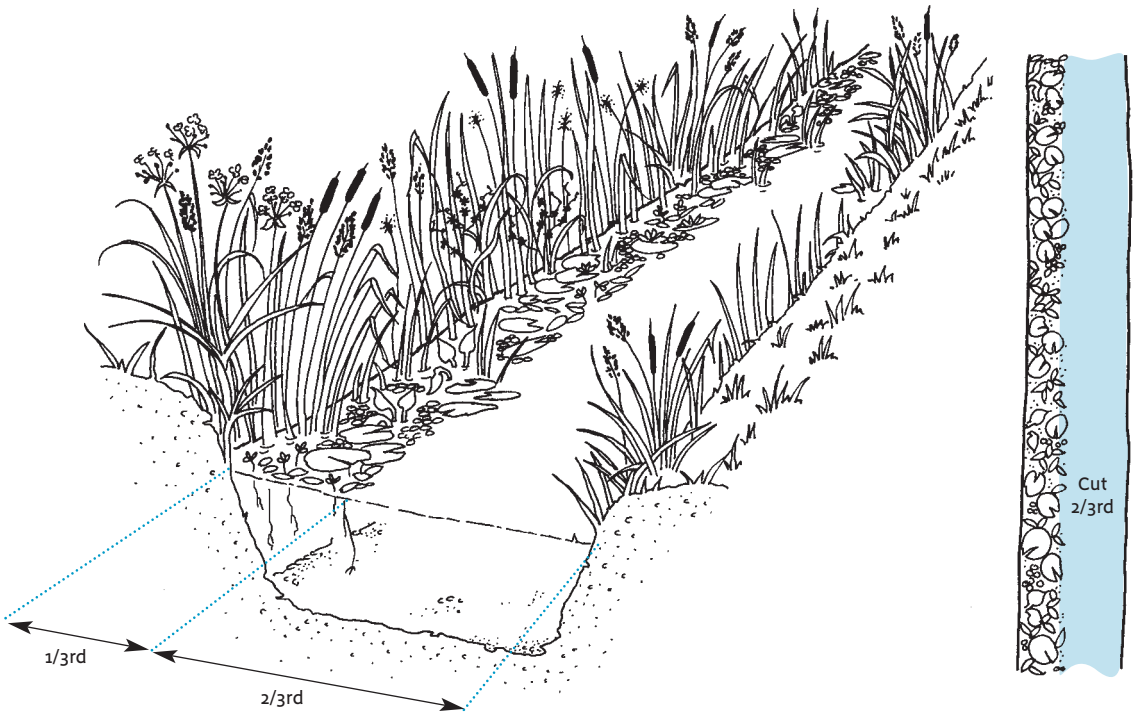
Annual maintenance				Page
O-A-1	Buffer strips on the bank tops	2	0	111
Capital works				
O-C-1	Borrow pits	3	0	112
O-C-2	Creation of willow carr	3	0	113

= Biodiversity = Flood risk management

Table 5.2 – The techniques in context *continued*

Selective removal of aquatic plants to permit re-colonisation 1

Technique
CA1



Size of watercourse > 2 metres.

Description A continuous strip of aquatic plants is left uncut along one side of the watercourse, extending to no more than a third of the way across the channel.

Purpose To foster wildlife.

Method Cut two thirds of the width of the channel, leaving one third of the width untouched.

1 **Conservation advantages** Provides continuity of the plant community in the channel, allowing the establishment of an associated invertebrate and vertebrate animal community including, for example, dragonflies and fish. It also permits the development of a varied plant structure that encourages a wider range of wildlife.

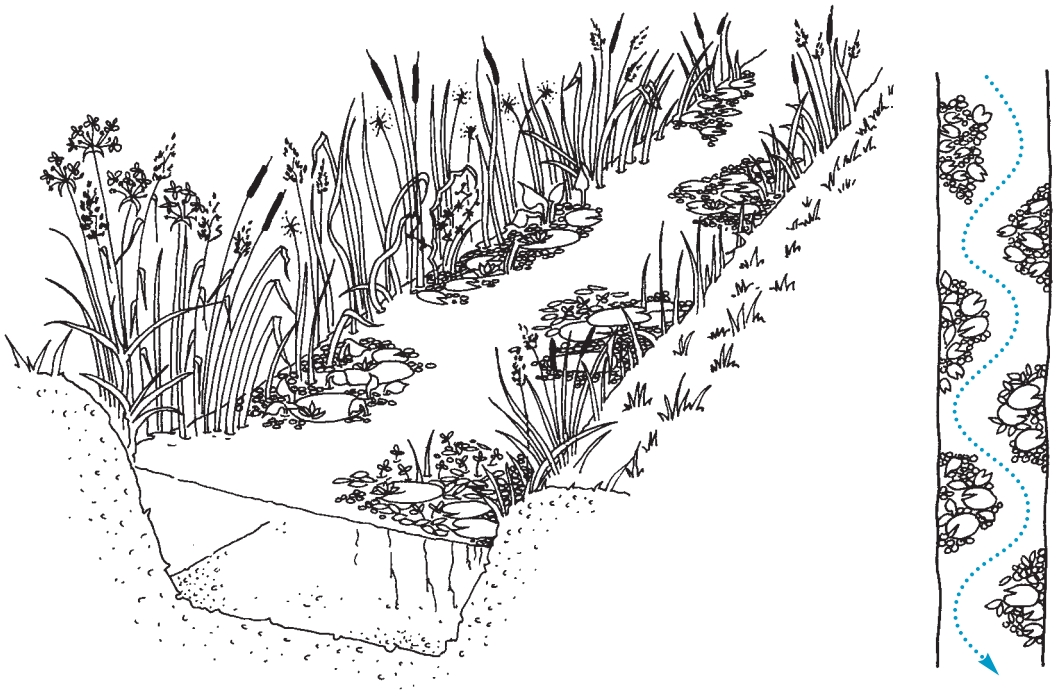
2 **Flood management effects** Maintains a predominantly open channel and limits the impediment to water conveyance.

Channel

Annual
maintenance

Technique
CA2

Selective removal of aquatic plants to permit re-colonisation 2



Size of watercourse > 2 metres.

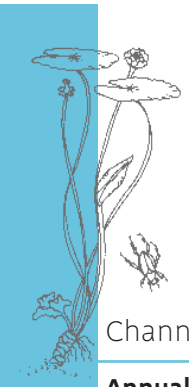
Description Aquatic plants are left in patches on alternate sides to give a clear sinuous route along the channel.

Purpose To foster wildlife.

Method Cut a continuous but sinuous route leaving plants in patches on alternate sides. Take care not to facilitate bank erosion or undercutting that might result from removing all protective vegetation on the outside of the bends.

1 **Conservation advantages** Provides continuity of the plant community in the channel, allowing the establishment of an associated invertebrate and vertebrate animal community including, for example, dragonflies and fish. It gives a more varied plant structure than Technique CA1 and this encourages a wider range of wildlife.

1 **Flood management effects** Maintains a predominantly open channel and limits the impediment to water conveyance. The meanders that have been created will reduce the flow to some extent.

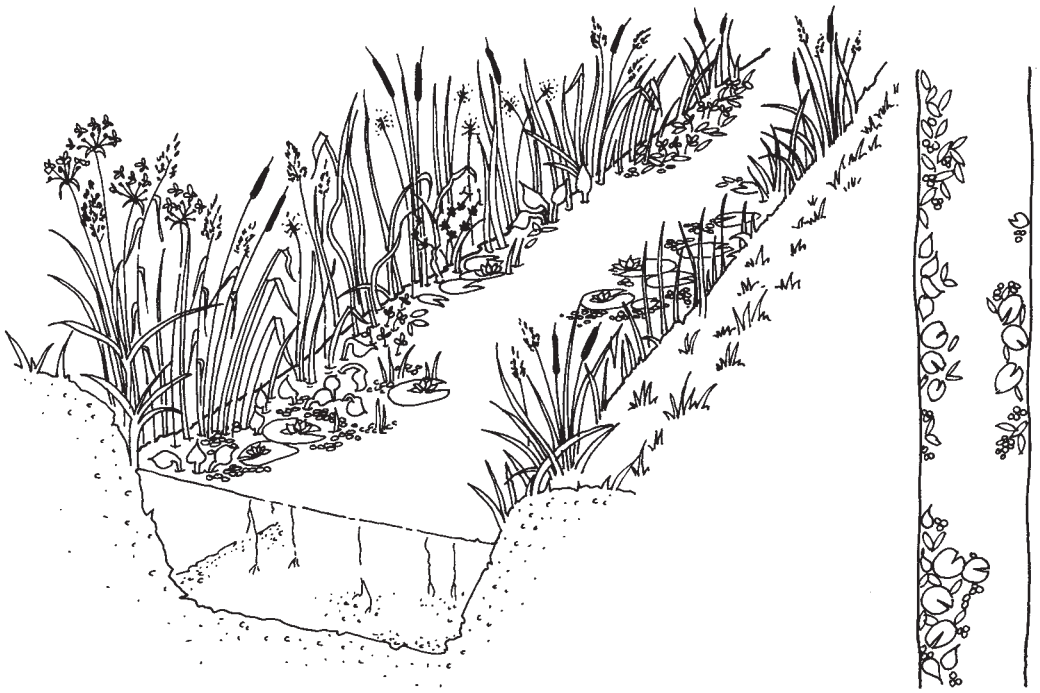


Channel

Annual
maintenance

Selective removal of aquatic plants to permit re-colonisation 3

Technique
CA3



Size of watercourse All.

Description Particular patches of aquatic plants are left according to their conservation value (e.g. BAP species) or aesthetic appeal (e.g. in highly visible locations).

Purpose To foster wildlife.

Method Survey the channel in advance to identify the location of high-value plants that will be left. Inform the machine operator what plants to leave (if the operator can identify species) or provide a map of locations to be left uncut. Cut most of the aquatic plants but select and leave uncut the targeted plants. This will require pre-planning to select the target plants (a process that can be informed by the IDB BAP) and specific training for operators or contractors to identify these plants.

2 **Conservation advantages** The deliberate retention of targeted species will increase the conservation value of the drainage system when BAP or rare species are chosen. It will also provide vegetation continuity in the channel and add structure to the channel, increasing the wildlife interest.

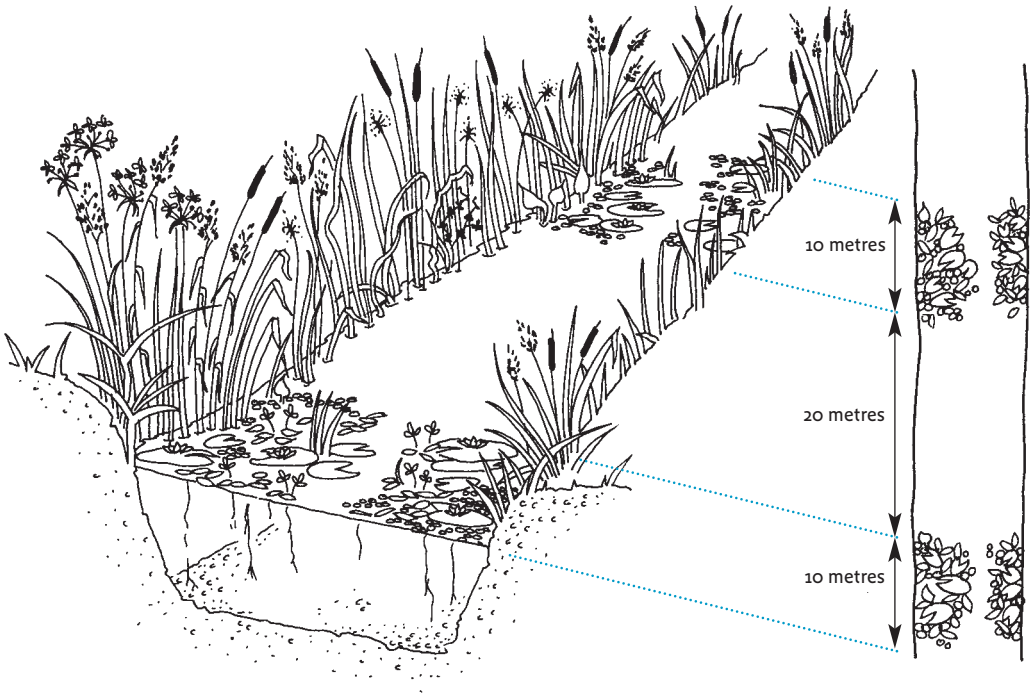
1 **Flood management effects** Maintains a predominantly open channel and limits the impediment to water conveyance. The degree of impediment will depend on the extent to which patches of uncut vegetation are left.

Channel

Annual
maintenance

Technique
CA4

Selective removal of aquatic plants to permit re-colonisation 4



Size of watercourse All.

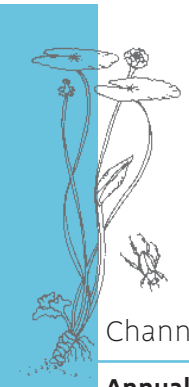
Description Patches of aquatic plants are left at regular intervals.

Purpose: To foster wildlife.

Method Cut aquatic plants from the full width of the channel in a section, alternating with sections where aquatic plants are left uncut. Cut and uncut sections alternate in blocks of 20 m and 10 m respectively. It is a method that is easier to implement than Techniques CA2 and CA3.

2 **Conservation advantages** Provides continuity of the plant community in the channel, allowing the establishment of an associated invertebrate and vertebrate animal community including, for example, dragonflies and fish.

1 **Flood management effects** The retained blocks of aquatic plants may reduce conveyance, depending on the vigour of growth and the plant species, making this technique unsuitable for all watercourses.



Channel

Annual
maintenance

Leaving headwaters untouched

© Rob Cathcart

Size of watercourse All.

Description The headwaters of watercourses and the beginning of drains where flooding is not an overriding consideration are subject to a greatly reduced frequency of desilting and cutting to create channels in which the vegetation community matures.

Purpose To add diversity to the drainage system by leaving some channels to mature, creating a vegetation community and habitat for the wildlife that may be rare within the overall drainage system.

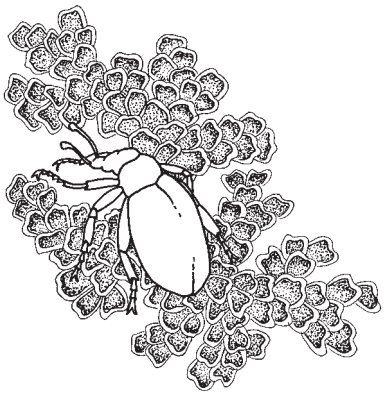
Method Identify sites with the agreement of relevant landowners. The channel is left to develop a linear marshland (potentially a sedge or reedbed), perhaps with some areas over-deepened during previous desilting operations to form ponds. Management will be necessary in the long term if the channel is not to dry out, such as selectively cutting invading willow or removing vegetation and desilting to set back the succession to open water again.

3 **Conservation benefits** Encourages the development of relatively undisturbed linear marshland sites with mature plant communities that are rare in many drainage systems and provide habitat for some scarce invertebrates and plants. Nesting birds will also benefit from the thick vegetation.

1 **Flood management effects** Drains have to be carefully selected to ensure that the maturing vegetation does not give rise to flooding of the adjacent land. It is recognised that there will be few occasions when an IDB has adopted and maintained a headwater that does not have through-flows. A reduction in management costs may be achieved. This would be the case if the desilting works required in the long term to retain the channel as a wetland system (rather than drying to scrub) is not disproportionately expensive due, for instance, to additional costs in disposing of the accumulated material.

Technique
CA6

Biological control of water fern (*Azolla*) using a weevil



Size of watercourse All.

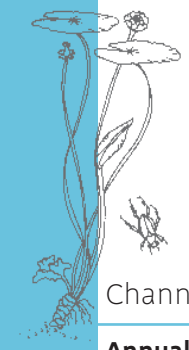
Description Control of the floating water fern *Azolla filiculoides* using a weevil *Stenopelmus rufinasus*.

Purpose To reduce the growth and extent of the water fern, a non-native species, in order to prevent the deleterious effects that it can cause to nature conservation interests, including covering the surface and blocking out light (damaging aquatic plant populations) and reducing oxygen availability (leading to the death of fish and invertebrates).

Method Follow the instructions on the product 'Azollacontrol', which introduces the weevil *Stenopelmus rufinasus*. It is a North American weevil that is an effective natural controller of the Water Fern. The weevil can only feed and reproduce on water fern species and it has proved itself to be a successful biological control agent in the UK.

The weevil is released early in the season before the water fern has grown out of hand. Usually, one release of the weevils is sufficient to exert control but with a large infestation or a requirement for more rapid control, more releases may be necessary. It can be used as a precautionary measure as soon as the water fern appears. If an infestation of water fern is encountered too late for the use of the weevil, mechanical clearance can be used to remove the bulk of the water fern after which biological control can be implemented.

The weevil is known in the wild in the UK, presumably having also been imported with the water fern at some point in the past. It is thought that these wild populations do not keep water fern infestations in check because the rate at which the weevils colonise a water fern population and multiply is slower than the rate of water fern multiplication.



Channel

Annual
maintenance

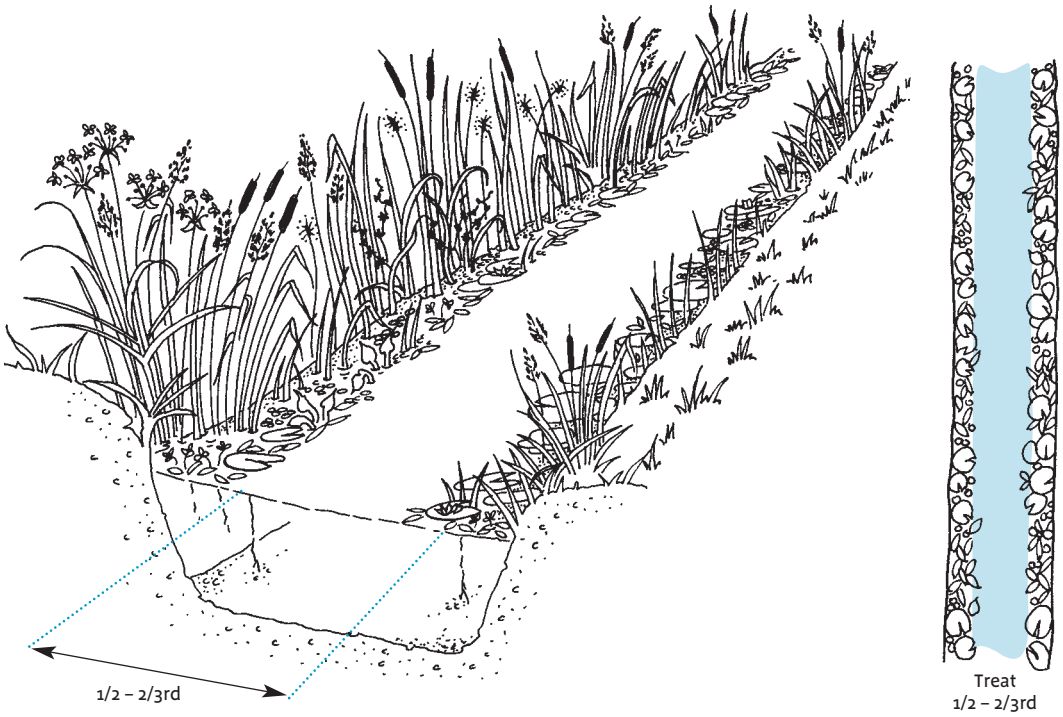
2 **Conservation advantages** A selective method of water fern control, since it only removes the water fern, which benefits other aquatic plants and submerged aquatic animal life e.g. pondweeds, aquatic beetles and newts.

2 **Flood management effects** Removal of the water fern will reduce the restriction of water conveyance within drainage channels. It is possible that ending the water fern's suppression of other aquatic plants may allow other species that can affect flood risk to dominate.

The use of the weevil has a number of advantages over herbicide use. It can be applied by one operator and there is no need for certificated users or for personal protective equipment. However, it is a relatively expensive application.

Herbicide application to maintain an open channel

Technique
CA7



Size of watercourse All.

Description Clearing filamentous algae, submerged and floating plants early in the year.

Purpose To cause minimal disruption to the channel while ensuring efficient conveyance during the summer months. Excessive growth can be removed for part of the year with regrowth occurring within a few weeks.

Method Apply herbicide to control filamentous algae, submerged and floating plants. Different herbicides affect the same species of plants differently. Consult the herbicide label and seek advice from a BASIS-qualified adviser.

2 **Conservation advantages** Causes minimal disruption to the ecology of the channel. For example, fish spawning sites can be conserved early in the season and the herbicide used to create open water later in the season. Herbicide application from a boat avoids the need for access along the bank. This may remove the requirement for bank cutting as a safety measure to enable the machine driver to see the crest of the bank. Minimises the disturbance of sediment that occurs with mechanical cutting.

The frequent use of herbicide treatments on a drainage channel can cause a shift in the plant species composition, favouring plants such as filamentous algae. These have a negative effect on the biodiversity of the channel and can cause intractable vegetation control problems for channel maintenance.

2 **Flood management effects** Ensures that the channels critical for conveying high summer flows are in appropriate hydrological condition in advance of such events.

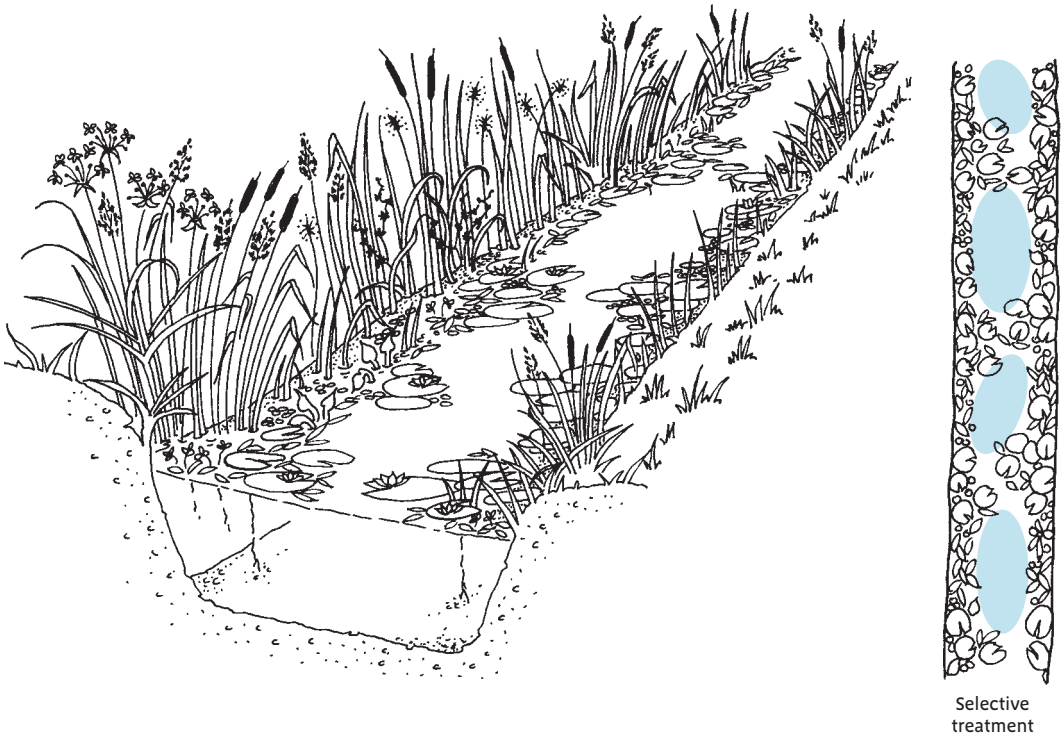
There are strict procedures to follow when using herbicides in or near water. See the appendix on herbicides

Channel

Annual
maintenance

Technique
CA8

Herbicide application to maintain an open channel over selected reaches



Size of watercourse All.

Description Selective or partial clearing of filamentous algae, submerged and floating plants.

Purpose There are two purposes:

- To avoid specific areas of vegetation, e.g. protected or rare plant and animal species, and fish spawning areas.
- To clear or partially control patches of plants to ensure retention of drainage function while minimising disruption to the channel.

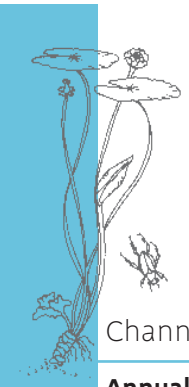
Method Apply herbicide to selectively control filamentous algae, submerged and floating plants. Different herbicides affect the same species of plants differently. Consult the herbicide label and seek advice from a BASIS-qualified adviser.

1 **Conservation advantages** Uses the herbicide to maintain the drainage function while avoiding sensitive areas of plants or generally minimising disruption to the ecology of the channel.

Treatment of all of the filamentous algae, submerged and floating plants with those herbicide products that cause rapid die-off could cause deoxygenation as the plant material decomposes in the water.

2 **Flood management effects** Achieves open water along parts of the channel, removing particularly dense stands of floating and/or submerged plants in order to maintain hydraulic function.

There are strict procedures to follow when using herbicides in or near water. See the appendix on herbicides.

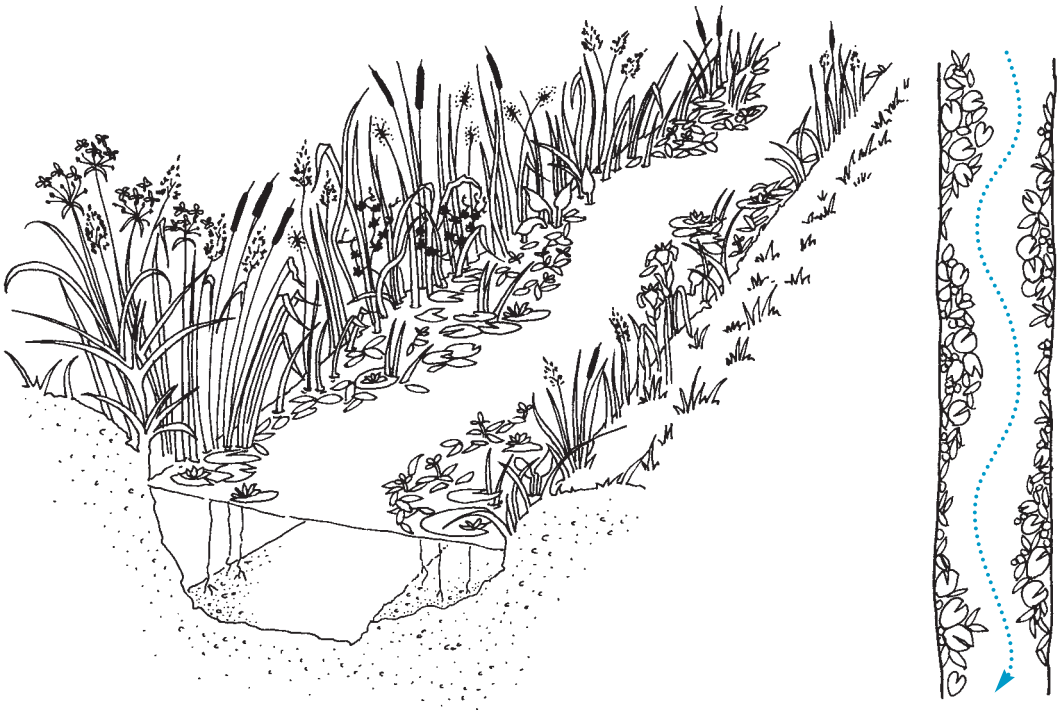


Channel

Annual
maintenance

Scalloping vegetation and underlying silt to create meanders

Technique
CL1



Size of watercourse > 2 metres.

Description Patches of wetland plants are left on alternate sides during desilting.

Purpose To foster wildlife.

Method Remove silt and plants on alternate sides to create a sinuous channel for the water flow. Such meanders often develop naturally within enlarged channels and these can be accentuated during the desilting operation.

2 **Conservation advantages** Provides continuity of the plant community, allowing the establishment of an associated invertebrate and vertebrate animal community including, for example, dragonflies and fish. Creates a diversity of structure in the channel which benefits both plants and invertebrates.

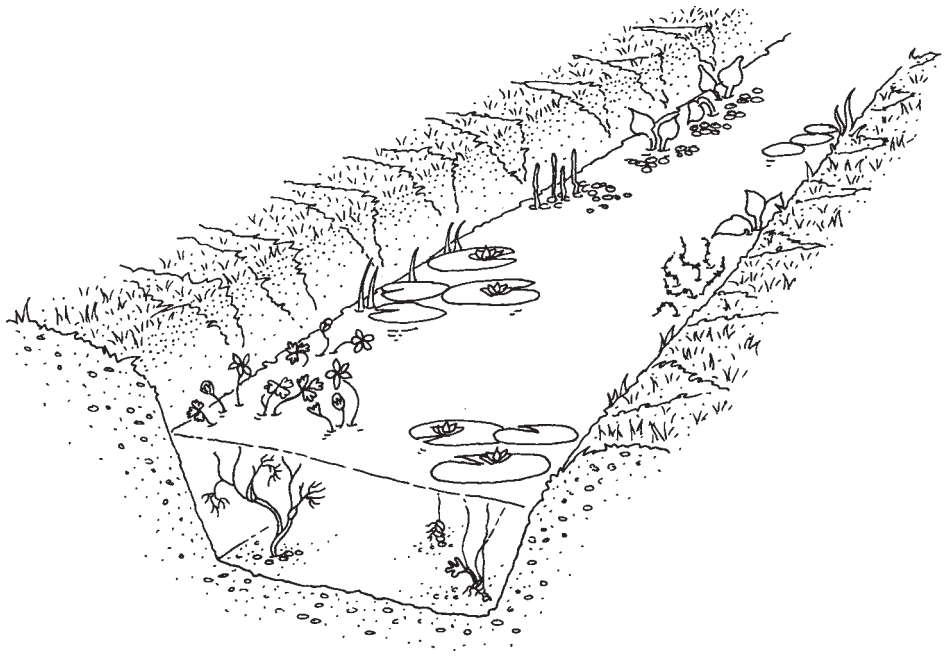
1 **Flood management effects** Maintains a predominantly open channel, with some limited impediment to water conveyance compared to complete clearance of the channel. If the channel is of a minimum size to meet flood conveyance needs then adoption of this technique may require relatively more frequent desilting.

Channel

Long-term maintenance

Technique
CL2

Re-establishment or re-distribution of aquatic plants



Size of watercourse All but the deepest.

Description Aquatic plants are planted in the channel at the completion of a desilting operation. The plants are of a more desirable type than the species removed during desilting. This technique is used where there were originally no suitable species within the drain pre-desilting that could have been left in the channel by a selective desilting technique.

Purpose: To foster wildlife. The aquatic plants may also act as a 'biological control', shading out or out-competing less desirable species and providing shelter for micro-invertebrates that feed on algae.

Method Plan in advance. Consult with wildlife advisers to identify a source of desirable species within the drainage system. These are dug out and moved to the channel that has been desilted, keeping the plants wet during transportation. This technique is feasible where the flow is minimal, the channel is large and a source of desirable species is close by.

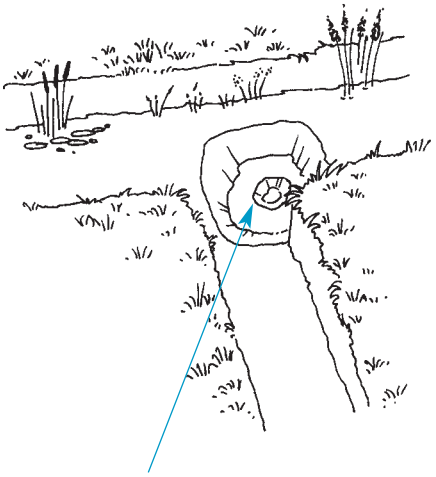
Channel

Long-term
maintenance

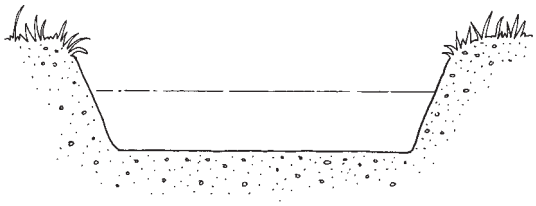
2 **Conservation advantages** Plant diversity is increased and this promotes a greater diversity of animals. The biological control effect may reduce the need for follow-up maintenance cutting, preserving continuity of the plant community.

2 **Flood management effects** Maintains a predominantly open channel. The introduced species may provide a stable community and sufficient shade so as to reduce the frequency or intensity of the follow-up maintenance cutting required.

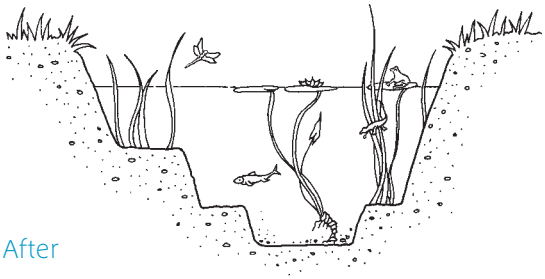
Creation of pools



Pond or bay cut in the drainage channel at a depth below the base level of the ditch



Before



After

Size of watercourse > 2 metres.

Description A deepening of the channel bed to form a pond at the junction of minor ditches. Land-take may be necessary and care exercised to retain bank stability.

Purpose To provide permanent deeper water in smaller watercourses, many of which have a reduced flow or dry out in summer.

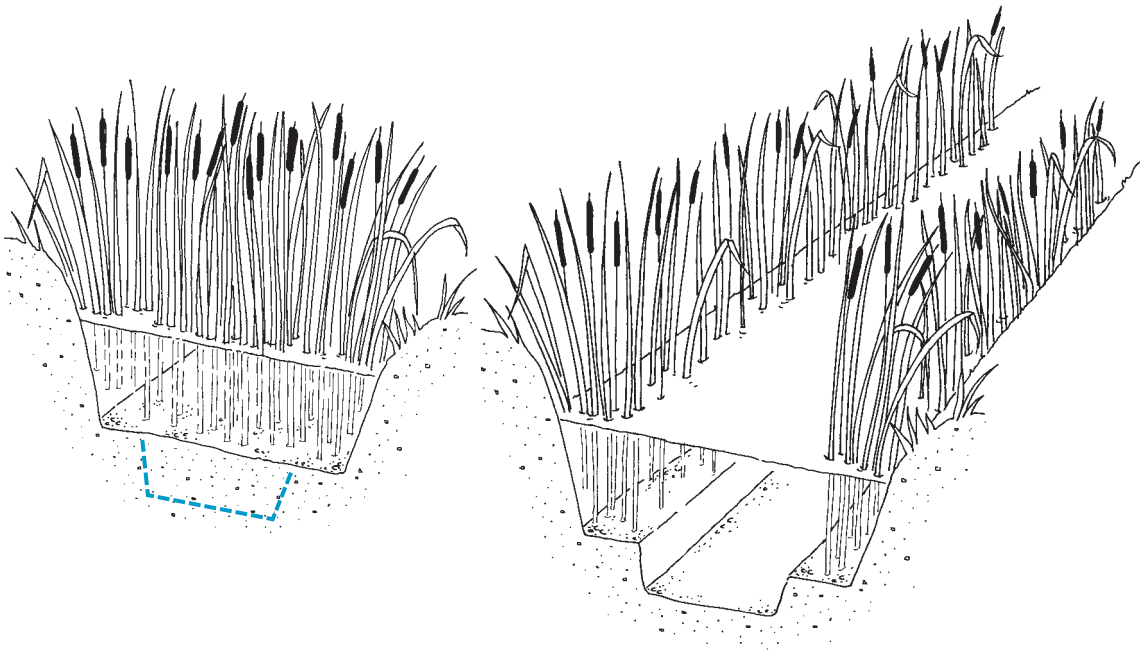
Method Create pool with excavator. Use spoil to increase the height of the banks or spread on adjacent land. The profile of the pool is important. Where space permits, the pool should have a stepped profile with the deepest water in the centre. Overhanging trees should be avoided as they will cause natural enrichment of the static water and reduce the abundance of invertebrates by shading the pond.

2 **Conservation advantages** Creates a refuge for amphibians, invertebrates and possibly fish where there is little residual summer water flow. Many wetland plants and animals cannot adjust to periodically dry conditions. The pools will provide a continuity of habitat for wetland plants and animals.

1 **Flood management effects** This provides no significant flood management benefits, but increases the capacity of the channel slightly.

Technique

CL4 Over-deepening the centre of the channel



Size of watercourse All, but not successful where there is substantial movement of bed material or where there is little water.

Description Creation of a deeper central channel so that depth is greater than that favoured by many vigorous emergent plants.

Purpose To retain the carrying capacity of a watercourse by slowing the rate of invasion by emergent plants into the centre of the channel.

Method Deepen the bed to prevent stands of adjacent emergent plants spreading into the deeper water. This technique may not always be the most appropriate conservation management for aggressive plant species such as reed sweet-grass and reed canary-grass. This method does produce a berm within the existing channel that will be covered or exposed, dependent on the water level. Extra land-take will not be necessary, but the berm can only be created if the channel has spare drainage capacity. Aquatic herbicides could be used instead to control the vegetation, but the technique of over-deepening creates greater habitat diversity.

2 **Conservation advantages** Retains the continuity of stands of emergent plants along the margins of the channel. This benefits invertebrates and provides potential fish spawning areas. It is a possible alternative to herbicide treatment.

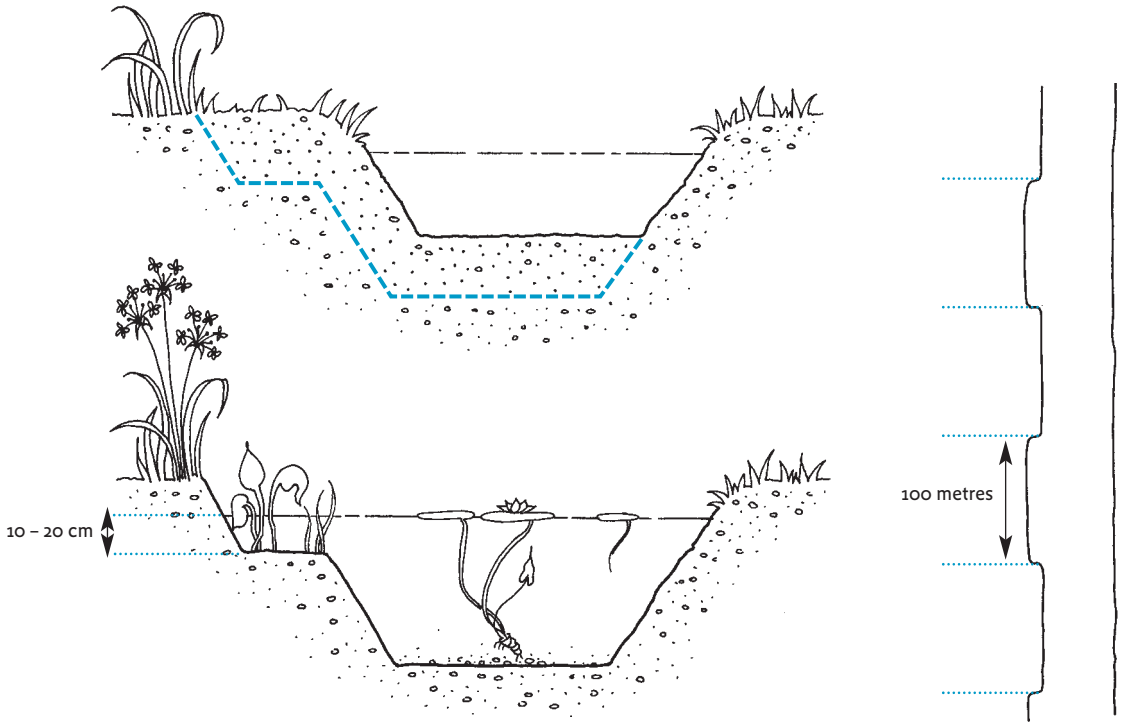
2 **Flood management effects** An open central channel is maintained for longer before maintenance action is required.

Channel

Long-term maintenance

Selective removal of waterplants to permit re-colonisation

Technique
CC1



Size of watercourse All.

Description A re-profiling that is planned and implemented in two phases. In the first phase alternate lengths of channel are re-profiled or retained un-worked. This results in alternate lengths where emergent and aquatic plants are retained in the channel and margins and lengths where they have been removed. Over time vegetation will re-establish in the re-profiled section. The retained areas are then re-profiled in the second phase.

Purpose To permit the re-colonisation by plants and animals from the undredged to the dredged section.

Method When re-profiling or deepening a channel, work on one side only. Work in approximately 100m blocks, leaving intermediate blocks of the same length untouched in the first phase. When worked stretches have recolonised satisfactorily (seeking advice from a suitably experienced ecologist if needed), re-profile the remaining sections. To increase the chances of re-colonisation, plant out newly-worked stretches with a selection of plants removed during reprofiling.

2 **Conservation advantages** The enlarged channel will be recolonised by species from nearby untouched sections. Re-colonisation will be more rapid and more likely to replicate the original communities. If past local experience has shown that there is rapid re-colonisation of desirable species then this technique is not required.

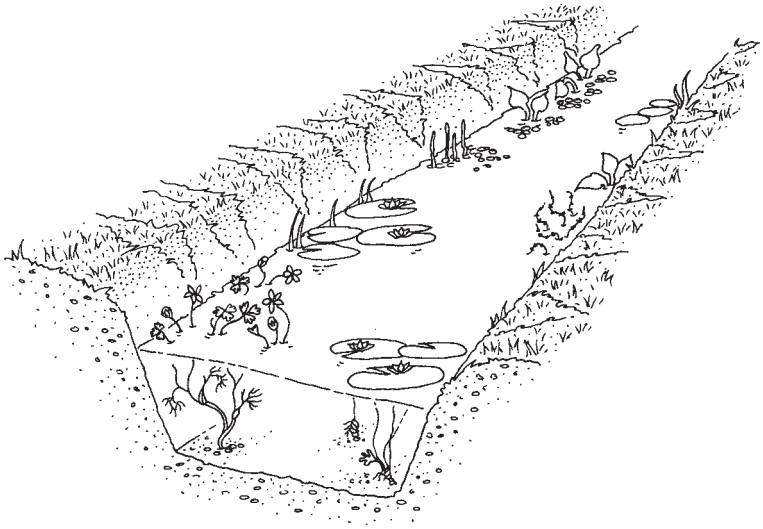
1 **Flood management effects** There are no flood management benefits beyond those that the channel re-profiling achieves.

Channel

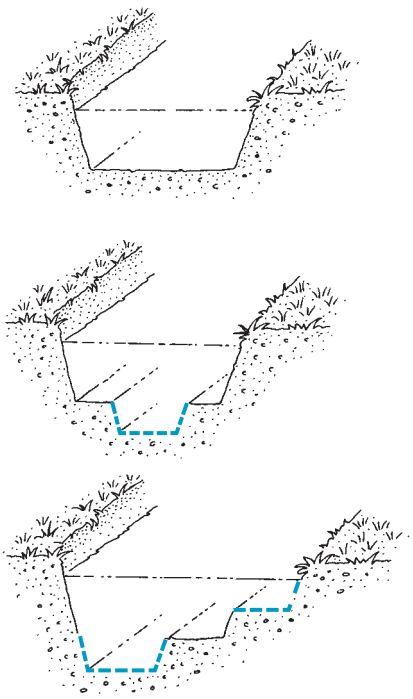
Capital works

Technique
CC2

Re-establishment or re-distribution of aquatic plants



Examples of profiles
that can be considered for the new or re-profiled channel.



Size of watercourse All but the deepest.

Description Aquatic plants are planted in the channel at the completion of the capital works on the watercourse. These works could be a major re-profiling of the channel, including the creation of a berm onto which plants could be introduced, or the creation of a new channel. This technique is used for new channels and where no suitable species exist within the drain being re-profiled that could be left in the channel by a selective working technique.

Purpose To foster wildlife. The aquatic plants may also act as a 'biological control', shading out or out-competing less desirable species and providing shelter for micro-invertebrates that feed on algae.

Method Plan in advance. Consult with wildlife experts to identify a source of desirable species within the drainage system. These are dug out and moved to the new or re-profiled channel, keeping the plants wet during transportation. This technique is feasible where the flow is minimal, the channel is large and a source of desirable species is close by.

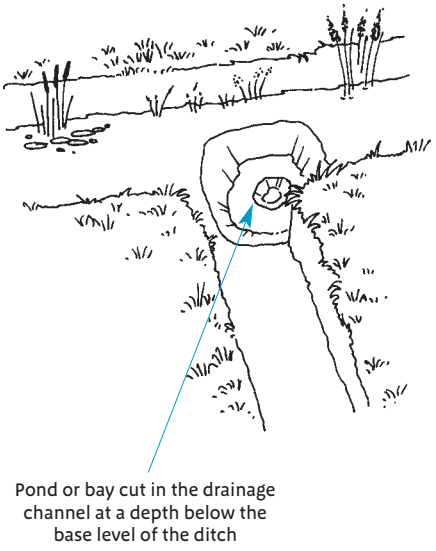
Channel

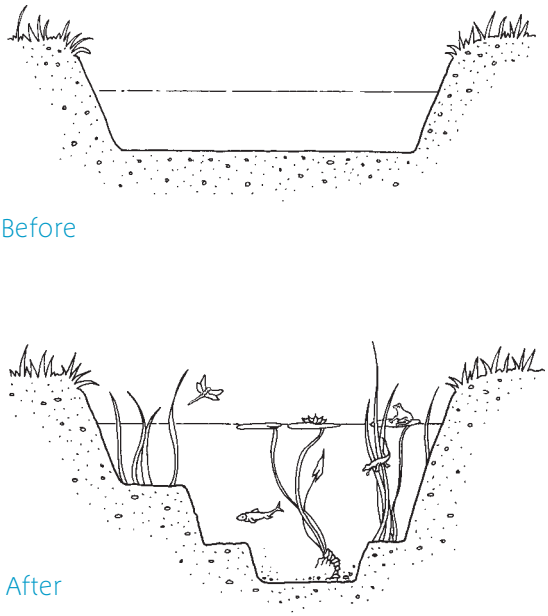
Capital works

2 **Conservation advantages** Plant diversity is increased and this promotes a greater diversity of animals. The biological control effect may reduce the need for follow-up maintenance cutting, preserving continuity of plant community.

2 **Flood management effects** Maintains a predominantly open channel. The introduced species may provide a stable community and sufficient shade so as to reduce the frequency or intensity of the follow-up maintenance cutting required.

Creation of pools





Size of watercourse > 2 metres.

Description A deepening of the channel bed to form a pond at the junction of minor ditches. Land-take may be necessary and care exercised to retain bank stability.

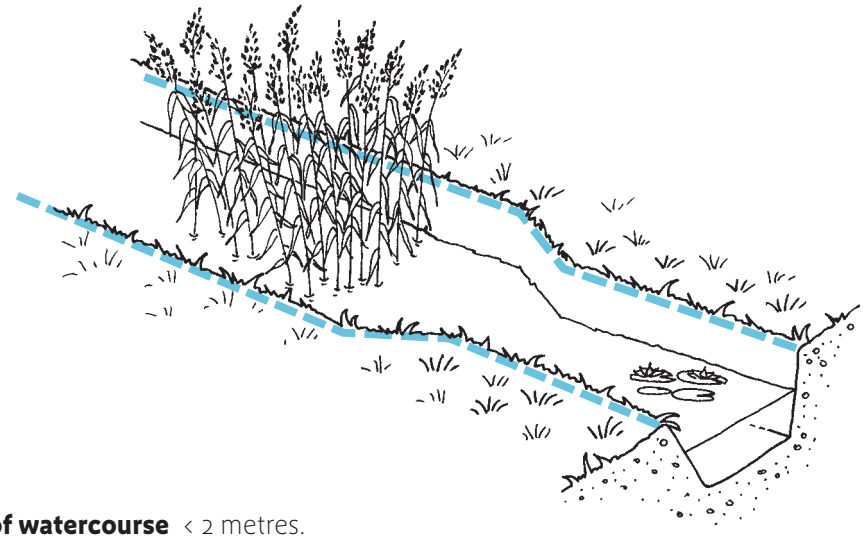
Purpose To provide permanent and deeper water on smaller watercourses, many of which have a reduced flow or dry out in summer.

Method Create pool with excavator. Use spoil to increase the height of the banks or spread on adjacent land. The profile of the pool is important. Where space permits, the pool should have a stepped profile with the deepest water in the centre. Overhanging trees should be avoided as they will cause natural enrichment of the static water and reduce the abundance of invertebrates by shading the pond.

2 **Conservation advantages** Creates a refuge for amphibians, invertebrates and possibly fish where there is little residual summer water flow. Many wetland plants and animals cannot adjust to periodically dry conditions. The pools will provide a continuity of habitat for wetland plants and animals.

1 **Flood management effects** This provides no direct flood management benefits.

Technique
CC4 Reedbed to reduce diffuse pollution

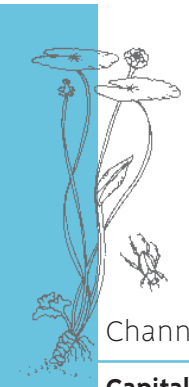


Size of watercourse < 2 metres.

Description A dense planting of common reed, through which flows water that is suffering sediment or nutrient pollution from diffuse sources such highways, hard-standings or agricultural run-off. The size and shape of the reedbed would be dictated by the volume of water and the level of enrichment that could occur.

Purpose To act as a natural filter of sediments and nutrients from diffuse sources. A reedbed can help remove sediments and excess nutrients such as nitrates and phosphates. By lowering nutrient levels, it can help to suppress algal growth lower down the system. However, at the scale described, this technique is not appropriate for treating point-source pollution, such as sewage effluent, to the standards that would be enforced by the Environment Agency. If such a scheme is envisaged then further advice should be sought.

Method Widen and re-profile the bed of the existing watercourse to form a long flat basin that holds water at a depth of between 0.25m and 0.5m. The basin will host the new reedbed. Plant with scoops of material from existing reedbeds, perhaps being dredged for other reasons, or purchase plants from centres specialising in reed for the water industry. A very shady site is not desirable as shade will depress reed growth. The lower end of the excavated section can be deepened to produce open water if desired. The reed growth needs to be cut and the cuttings removed regularly if the diffuse-pollution control function is to be retained. Cutting should take place in early autumn before most of the leaves fall in order to prevent them decaying and releasing nutrients back into the system. About a quarter of the reed area should be cut each autumn. It is important not to create a direct, open channel through the reedbed. The retained vegetation will act as a physical filter for sediments during winter periods.



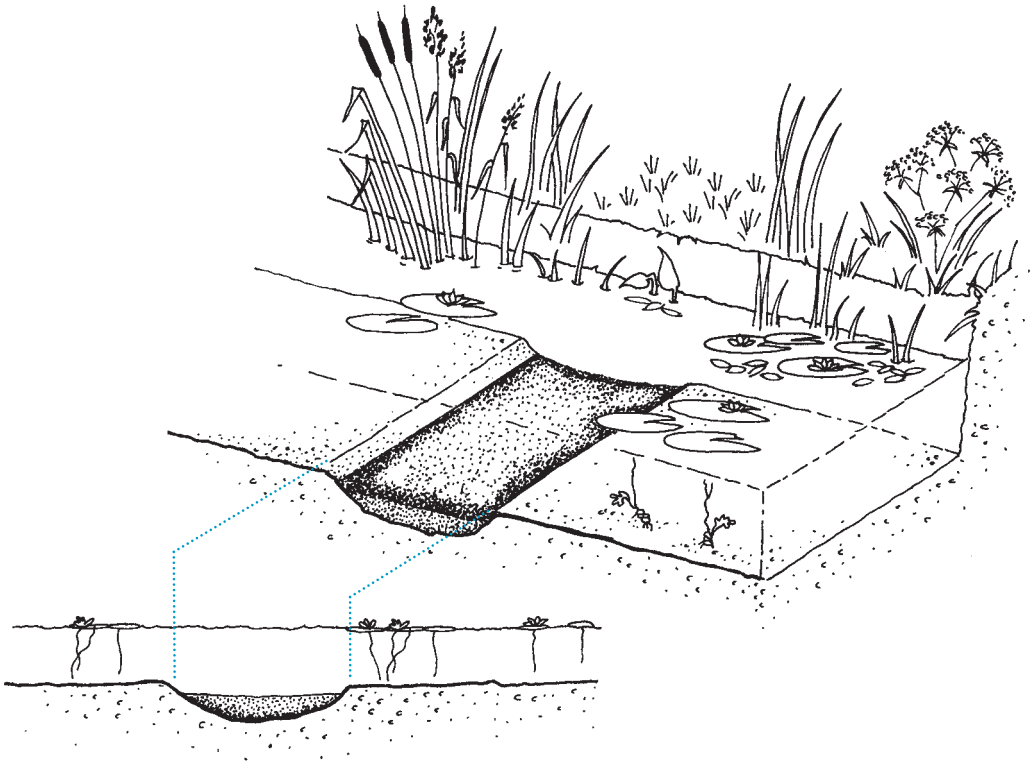
Channel

Capital works

3 **Conservation advantages** Removal of nutrients that favour algal growth. Excessive algal growth can often exclude desirable plants. A reedbed habitat is created which can be used by specialist birds such as reed bunting and reed warbler. The introduction of marsh plants around the reedbed such as purple-loosestrife, meadow-rue, lady's smock and marsh-marigold will be both beneficial to invertebrates and aesthetically pleasing.

1 **Flood management effects** A reduction of nutrient and sediment inputs may lead to gradual reductions in the need for channel maintenance management and extend the period between major desilting of minor watercourses.

Silt traps to reduce diffuse sediment pollution



Size of watercourse All.

Description Sites where sediment from diffuse sources can be encouraged to settle out and be selectively dredged.

Purpose To reduce the need for regular desilting operations over long lengths of channel. This may apply to locations where there are sediment inputs from areas of hardstanding and farm tracks. However, this technique is not appropriate for dealing with point-source suspended sediment pollution. Prevention of such pollution should be enforced by the Environment Agency. Silt traps slow the flow and silt will settle out when the flow is less than around 0.2 m per second.

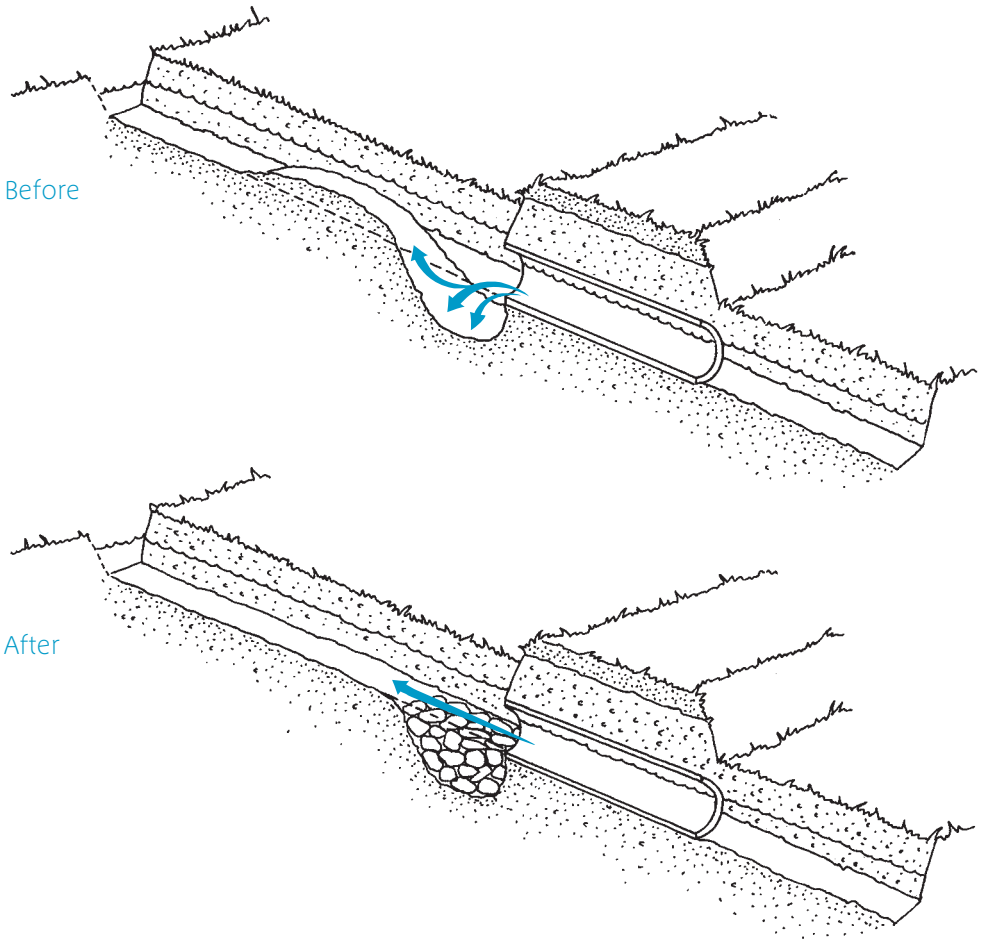
Method A site should be selected that is easily accessible to machinery on a regular basis. Sites should also have a natural accumulation of silt or a pool feature where silt can be encouraged to settle out. Such sites are often associated with bridges. A silt trap can be associated with the sluice technique. Silt traps need to be cleaned out regularly to prevent sediment going back into suspension. Thus, they should be designed to make dredging simple by having a firm and safe approach for machinery and an area nearby for depositing silt without damage to other interests. Removal of the silt from site will mean that it is deemed under regulations to be waste.

2 **Conservation advantages** Regular desilting operations are potentially confined to small lengths of the drainage channel allowing the remainder of the watercourse to develop a stable plant and animal community.

2 **Flood management effects** Confining the most rapid accumulation of silts to specific known and accessible areas makes maintenance simpler and reduces the risk of silt accumulation that reduces flood conveyance.

Technique

CC6 Stabilising of bed at culvert mouths



Size of watercourse All under 1 metre deep.

Description To stabilise the water flow at the mouth of culverts.

Purpose Reduce the erosive force of water flows that occur at a higher velocity at the mouth of culverts.

Method Introduce large stones into the channel immediately where the water leaves the culvert.

1 **Conservation advantages** These sites often develop good vertical banks and pools. Stabilising the exit should protect these features that would be removed by the use of gabions or concrete mattresses.

1 **Flood management effects** No direct flood management benefits but potentially reduces the need for further remedial works.

Channel

Capital works

Weirs and Sluices

© Aquatic Control Engineering

Size of watercourse All.

Description Regulation of water levels using a sluice.

Purpose To enable controlled management of the water level retained in a drainage channel and across the system more widely. Used to maintain high water tables in wet meadows for wetland birds. Sluices will also keep the water table high during peak crop growth. A sluice can create a high water level in a channel which acts as a wet fence for stock in grazing marsh systems.

Method Construct structure from wood or concrete or purchase pre-fabricated units. There are several designs including movable boards, rising gates or a tilting plate to permit water to run away faster in flood conditions. Sluices can provide fine control of water level management, particularly in sensitive areas such as Sites of Special Scientific Interest and nature reserves.

2 **Conservation advantages** Maintenance of high water tables or the maintenance of variable water tables on a field-by-field basis. High water tables will benefit fen and marsh, and can provide wet feeding areas in adjacent meadows for wetland birds. Aquatic plant and animal communities will benefit from a high and more stable water table.

Sluices can limit the 'ecological' connectivity within the drainage system and an assessment may be needed at specific sites of the need for a small bypass flow or fish pass. For instance, this may be needed at sites where the migration of elvers of the European eel is being promoted.

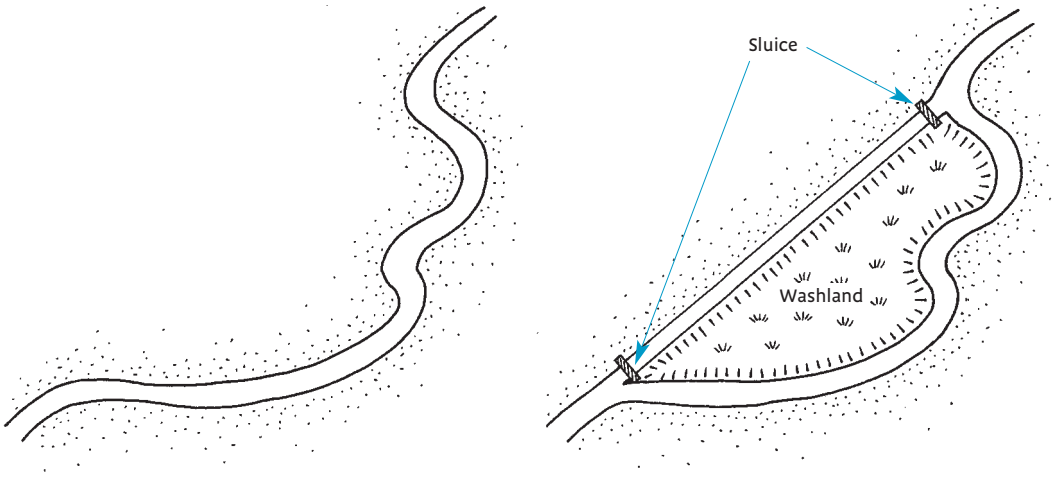
2 **Flood management effects** A sluice appropriately designed and constructed, and with suitable control can provide seasonal high water levels while still being able to respond to convey flood flows.

Channel

Capital
works

Technique

CC8 Washlands



Before

After

Size of watercourse All may have potential although larger watercourses are most likely to benefit from increased flood storage capacity.

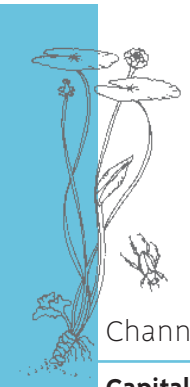
Description An area, frequently embanked, that receives flood flows by a watercourse over-spilling its channel or by the operation of a sluice.

Purpose To provide a temporary storage area for channels prone to flooding.

Method Applicable to areas where flooding is occurring more frequently than is appropriate for the land use due to inadequate capacity of the channel or wider drainage system. A site needs to be identified upstream of the area that floods where flood waters can be temporarily stored within a set of engineered embankments. The nature of the management of land within the washland is critical to realising its nature conservation potential. Extensive summer grazing gives the greatest wildlife gain.

3 **Conservation advantages** The creation of new washlands has enormous potential for conservation. Grassland, particularly wet grassland, has been reduced as a habitat in all parts of the country and the creation or restoration of such sites benefits breeding birds, plants and invertebrate life, and the winter feeding of waders and wildfowl.

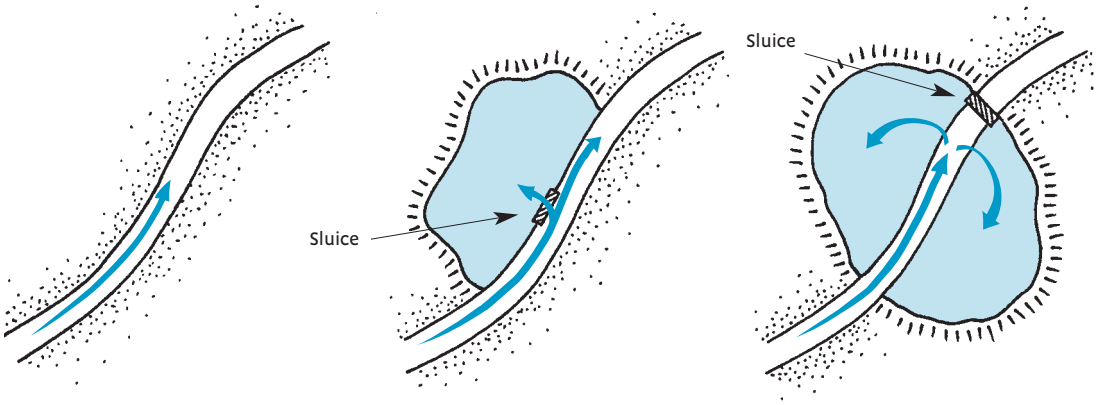
3 **Flood management effects** Additional flood storage capacity can make a significant difference to flooding frequency downstream. Consideration needs to be given to the relatively high engineering costs and sources of compensation payments for landowners. Land purchase may be an alternative.



Channel

Capital works

On-line and off-line flood storage ponds



Before

After with **Off-line** flood storage pond

After with **On-line** flood storage pond

Size of watercourse All watercourses where an increase in upstream storage capacity is feasible and could help reduce the risk of flooding downstream.

Description An excavated or embanked area where water flowing in a channel through the area is either 'backed up' by a sluice, weir or other control structure – an on-line storage pond. Alternatively, an area that receives water from an adjacent channel via a sluice – an off-line pond. In times of low flow the storage area can retain some water as a wetland feature or it can be dry and potentially provide a recreation area.

Purpose To provide a temporary storage area to prevent downstream flooding.

Method Identify a site where the storage of water during high water conditions will reduce the chances of flooding downstream. Create an excavated or embanked area with suitable inlet and outlet control structures to enable flood flows to be reduced.

3 **Conservation advantages** Prevents excess flooding of downstream habitats and the storage area itself can, with suitable planting and water management, be a new wetland habitat.

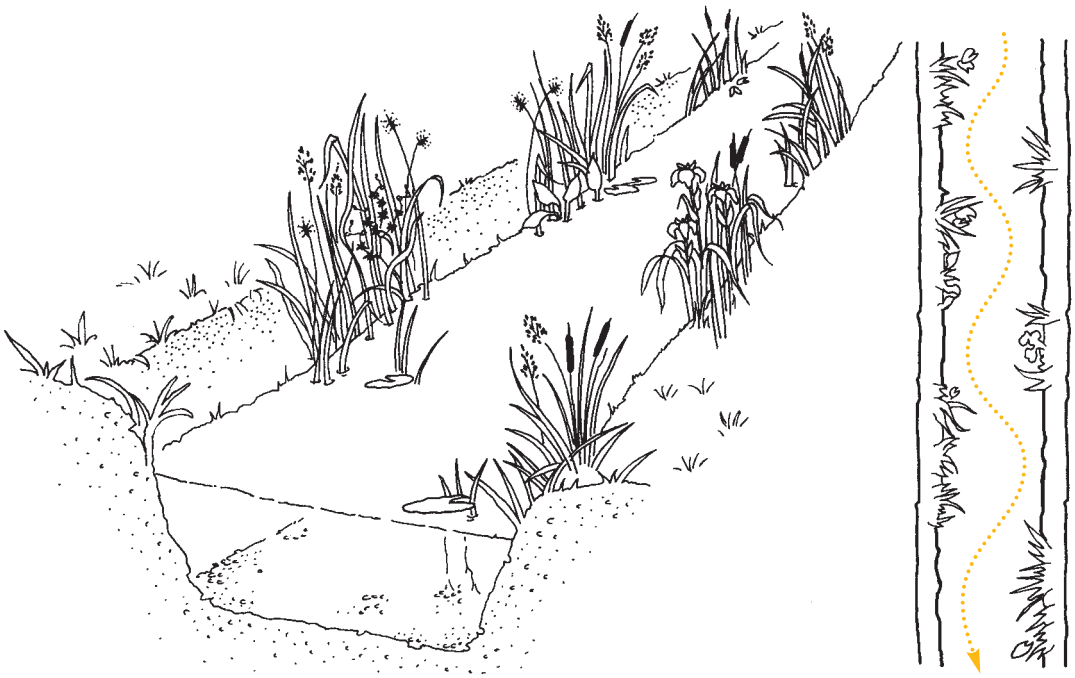
3 **Flood management effects** Controls run-off to reduce the risk of downstream flooding. Applicable to both rural and urban environments.

Channel

Capital works

Technique
MA1

Selective removal of emergent plants to give a sinuous effect



Size of watercourse > 2 metres.

Description Emergent plants are left in patches on alternate sides to give a sinuous route along the channel when coupled with Technique CA2.

Purpose To foster wildlife, particularly water voles, and provide, to a limited extent, reduction in erosion at the water line.

Method Cut the emergent fringe to leave plants in patches on alternate sides at the same time as aquatic plants are cut within the channel as described in Technique CA2.

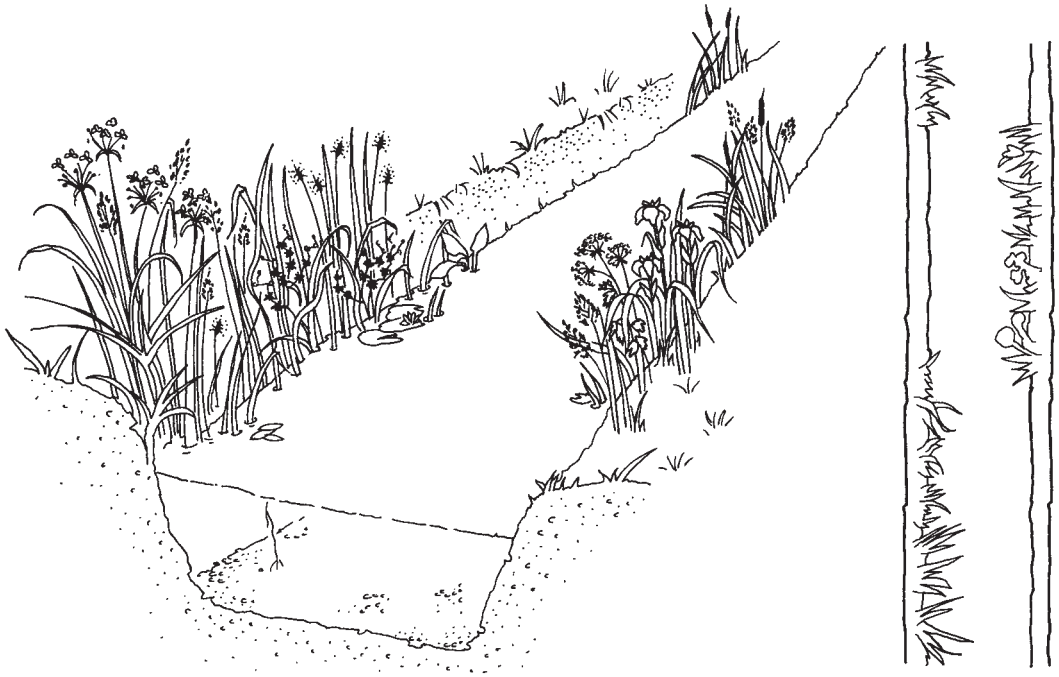
Margin

Annual
maintenance

1 **Conservation advantages** Provides patches of cover at the water line. Results in a more limited benefit than Techniques MA3 and MA4, but retains a more diverse vegetation structure with frequent interfaces between different stages of emergent vegetation regrowth.

1 **Flood management effects** Maintains the drainage channel margins in a predominantly open condition, limiting the impediment to water conveyance. Provides some reduction in erosion risk.

Selective removal of emergent plants



Size of watercourse All.

Description Particular patches of emergent plants are left according to their conservation value (e.g. BAP species) or aesthetic appeal (e.g. in highly visible locations).

Purpose To foster wildlife.

Method Survey the channel margins in advance to identify the location of high-value plants that will be left. Inform the machine operator what to leave (if the operator can identify the species) or provide a map of locations to be left uncut. Cut most of the emergent plants but select and leave uncut the targeted plants. This will require pre-planning to select the target plants (a process that can be informed by the IDB BAP) and specific training for operators or contractors to identify these plants.

2 **Conservation advantages** The deliberate retention of targeted species will increase the conservation value of the drainage system when BAP or rare species are chosen. It will also provide vegetation continuity and add structure to the margin, increasing the wildlife interest but providing more limited benefit than Techniques MA1, MA3 and MA4.

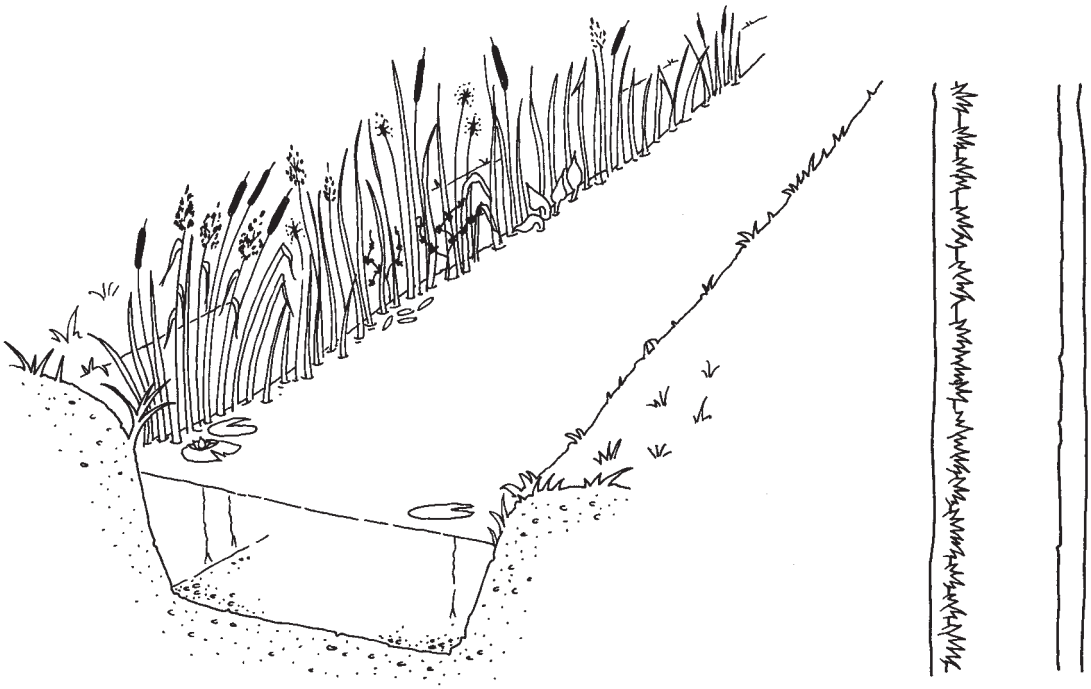
1 **Flood management effects** Maintains a predominantly open watercourse and limits the impediment to water conveyance. The degree of that impediment will depend on the extent to which patches of uncut vegetation are left.

Margin

Annual
maintenance

Technique

MA3 An emergent fringe on a single side



Size of watercourse > 2 metres.

Description A fringe of emergent plants is retained at the base of one bank.

Purpose To maintain bank stability by reducing the risks of erosion and provide continuity in vegetation cover at the water's edge along one side, particularly benefiting water voles.

Method Cut the emergent vegetation to leave a continuous fringe along the base of one bank. The cutting can be alternated between sides over a series of years.

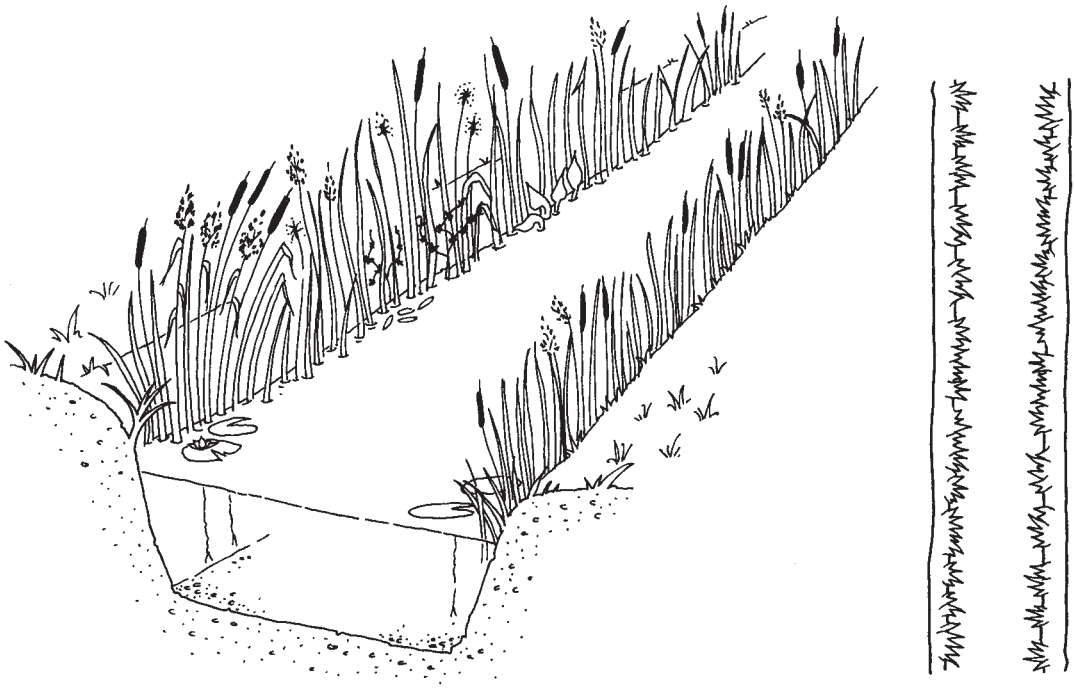
Margin

Annual
maintenance

1 **Conservation advantages** Retains a continuous cover of emergent plants along the water's edge. This is the critical zone for maintaining cover for water voles. The dead stems of emergent vegetation that persist through to the following year also provide cover for early nesting birds and habitat for invertebrates that over-winter as larvae or pupae within stems to emerge as adults in the following spring or summer. It also provides shelter in shallow water for fish fry.

2 **Flood management effects** Maintains a predominantly open channel and limits the impediment to water conveyance. Avoids damage to the toe of the bank by the excavator and reduces the risk of erosion at the water line that can lead to slumping or collapse.

An emergent fringe on both sides



Size of watercourse > 2 metres.

Description A fringe of emergent plants is retained at the base of both banks.

Purpose To maintain bank stability by reducing the risks of erosion and provide continuity in vegetation cover at the water's edge along both sides, particularly benefiting water voles.

Method Cut the emergent vegetation to leave a continuous fringe along the base of both banks.

2 **Conservation advantages** Retains a continuous cover of emergent plants along the water's edge. This is the critical zone for maintaining cover for water voles. The dead stems of emergent vegetation that persist through to the following year also provide cover for early nesting birds and habitat for invertebrates that over-winter as larvae or pupae within stems to emerge as adults in the following spring or summer. It also provides shelter in shallow water for fish fry. Provides double the benefit of Technique MA3.

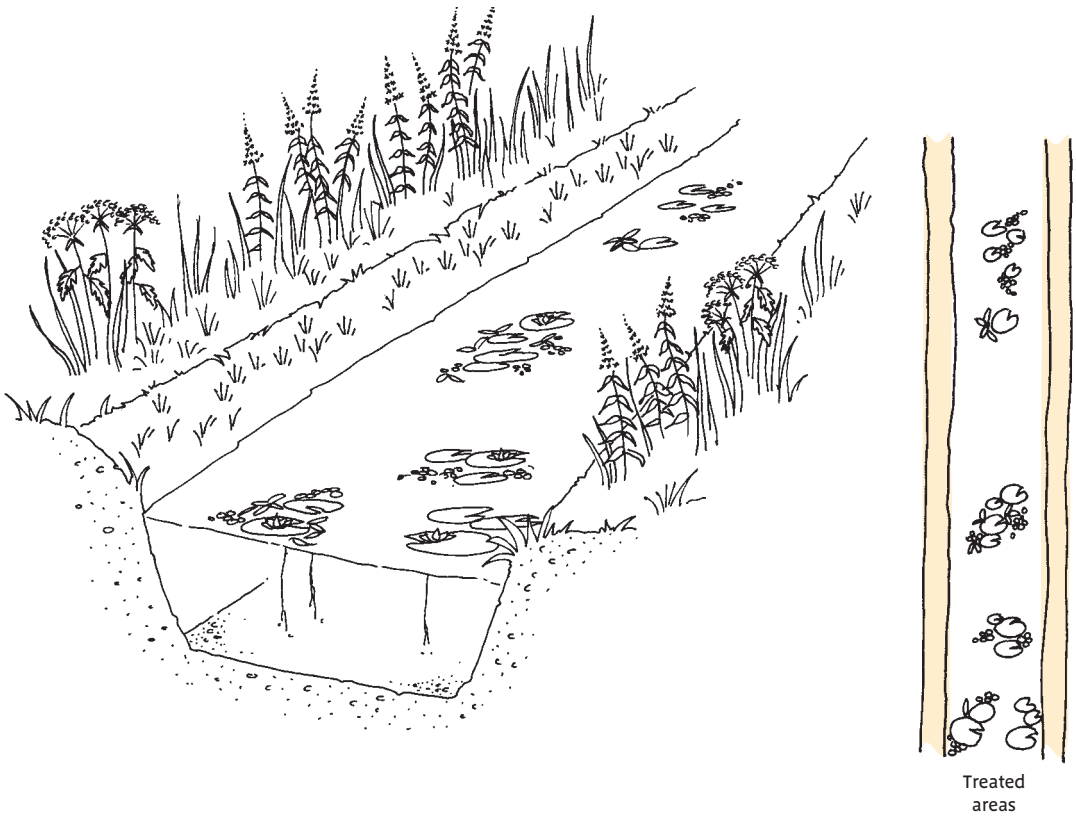
1 **Flood management effects** Maintains a predominantly open channel and limits the impediment to water conveyance (although the impediment is greater than with Technique MA3). Avoids damage to the toe of the bank by the excavator and reduces the risk of erosion at the water line that can lead to slumping or collapse.

Margin

Annual
maintenance

Technique
MA5

Herbicide application to maintain an open margin



Size of watercourse All.

Description Clearing emergent and marginal plants early in the year, coupled with treatment of the channel described in Technique CA7.

Purpose To cause minimal disruption to the drainage channel while ensuring efficient conveyance during the summer months. Excessive growth can be removed for part of the year.

Method Apply herbicide to selectively control emergent and/or marginal plants. Different herbicides affect the same species of plants differently. Consult the herbicide label and seek advice from a BASIS-qualified adviser.

Margin

Annual
maintenance

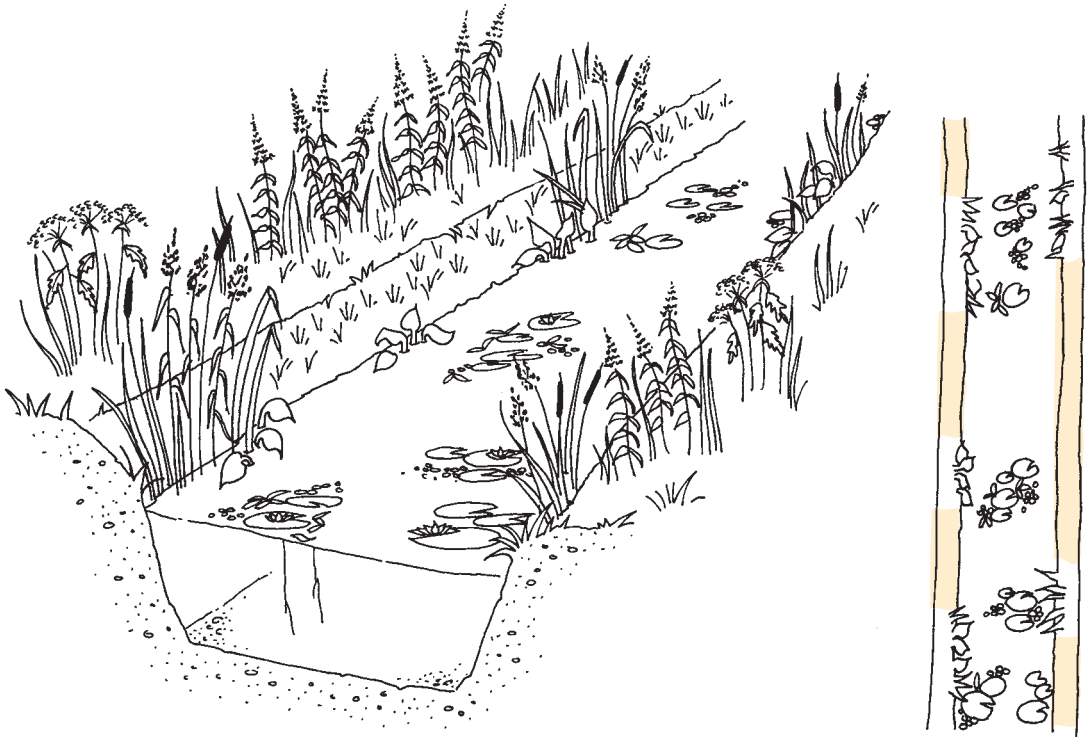
2 **Conservation advantages** Enables the ecology of the margins and bank of the watercourse to undergo minimal disruption. For example, nesting birds are able to complete the raising of their broods (usually over a two-week period) despite the vegetation dying off towards the latter part of the nesting cycle. The full nesting cycle for the common passerine species, e.g. reed bunting and reed warbler, takes 4-5 weeks to complete. However, birds are highly unlikely to begin building nests as the vegetation dies and so the circumstance should not arise where they are exposed to predators as the vegetation dies completely around the nest.

2 **Flood management effects** Ensures that the drainage channels critical for dealing with high summer flows are in appropriate hydrological condition in advance of such events.

There are strict procedures to follow when using herbicides in or near water. See the appendix on herbicides.

Herbicide application to maintain an open margin over selected reaches

Technique
MA6



Selective treatment

Size of watercourse > 2 metres.

Description Selective or partial clearing of emergent and marginal plants coupled with vegetation removal of aquatic plants in the channel.

Purpose There are two purposes:

- To avoid specific areas of vegetation, e.g. protected or rare plant and animal species and fish spawning areas.
- To clear or partially control of patches of marginal plants to ensure retention of drainage function while minimising disruption to the channel.

Method Apply herbicide to selectively control emergent and/or marginal plants. Different herbicides affect the same species of plants differently. Consult the herbicide label and seek advice from a BASIS-qualified adviser. For example, 2,4-D is suitable for broadleaved weed control and floating pennywort, leaving grasses including reeds and sedges unaffected.

2 **Conservation advantages** Uses the herbicide to maintain the drainage function while avoiding sensitive areas of plants or generally minimising disruption to the ecology of the margin of the channel.

2 **Flood management effects** Achieves the removal of stands of emergent and marginal plants, particularly dense stands, along sections of the drainage channel in order to maintain hydraulic function.

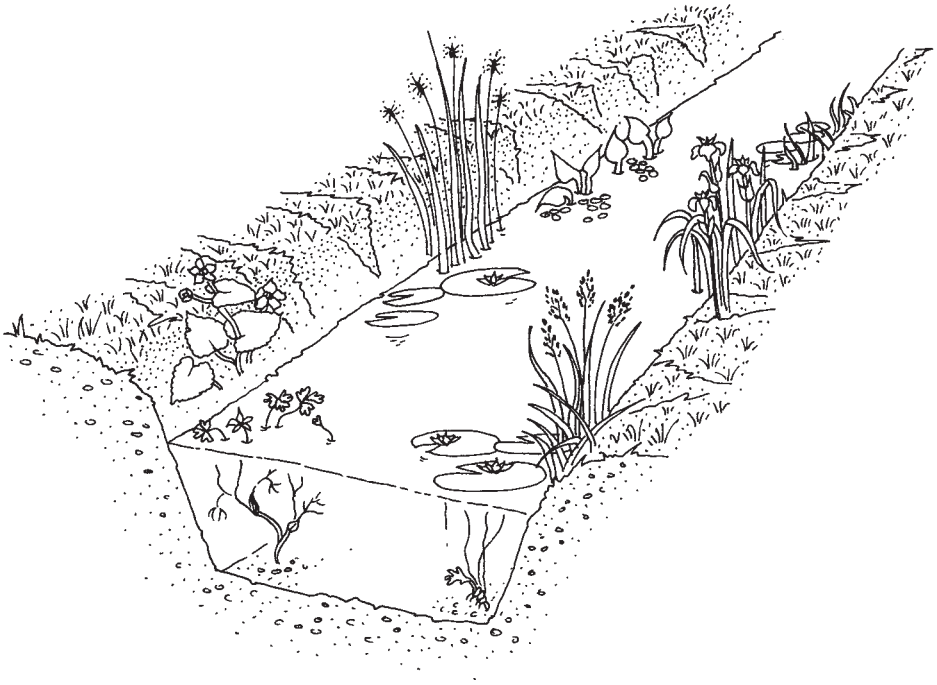
There are strict procedures to follow when using herbicides in or near water. See the appendix on herbicides.

Margin

Capital
works

Technique
ML1

Re-establishment or re-distribution of emergent plants



Size of watercourse All but the deepest.

Margin

long-term
maintenance

Description Emergent plants are planted in the margin of the drain at the completion of a desilting operation. The plants are of a more desirable type than the species removed during desilting. This technique is used where there were originally no suitable species within the drain pre-desilting that could have been left in the channel by a selective desilting technique.

Purpose To foster wildlife. The aquatic plants may also act as a 'biological control', shading out or out-competing less desirable species and providing shelter for micro-invertebrates that feed on algae.

Method Plan in advance. Consult with wildlife experts to identify a source of desirable species within the drainage system. These are dug out and moved to the channel that has been desilted, keeping the plants wet during transportation. This technique is feasible where the flow is minimal, the channel is large and a source of desirable species is close by.

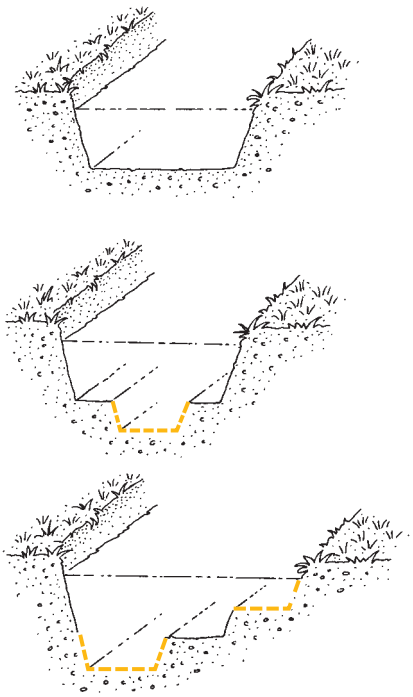
2 **Conservation advantages** Plant diversity is increased and this promotes a greater diversity of animals. The biological control effect may reduce the need for follow-up maintenance cutting, preserving continuity of plant community.

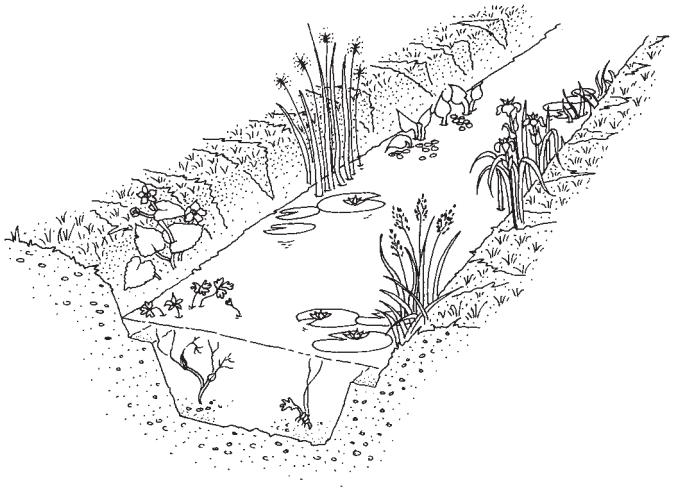
2 **Flood management effects** Maintains a predominantly open channel. The introduced species may provide a stable community and sufficient shade so as to reduce the frequency or intensity of the follow-up maintenance cutting required.

Re-establishment or re-distribution of emergent plants

Technique
MC1

Examples of profiles
that can be considered for the new or re-profiled channel.





Size of watercourse All but the deepest.

Description Emergent plants are planted in the margin of the drain at the completion of capital works. These works might be a major re-profiling of the channel, including the creation of a berm onto which emergent plants could be introduced, or the creation of a new channel. This technique is used for new channels and where no suitable species exist within the drain being reprofiled that could not, in preference to planting, be left along the margin by a selective working technique.

Purpose To foster wildlife. The emergent plants may also act as a 'biological control', shading out or out-competing less desirable species and providing shelter for micro-invertebrates that feed on algae.

Method Plan in advance. Consult with wildlife experts to identify a source of desirable species within the drainage system. These are dug out and moved to the new or re-profiled channel, keeping the plants wet during transportation. This technique is feasible where the flow is minimal, the channel is large and a source of desirable species is close by.

Margin

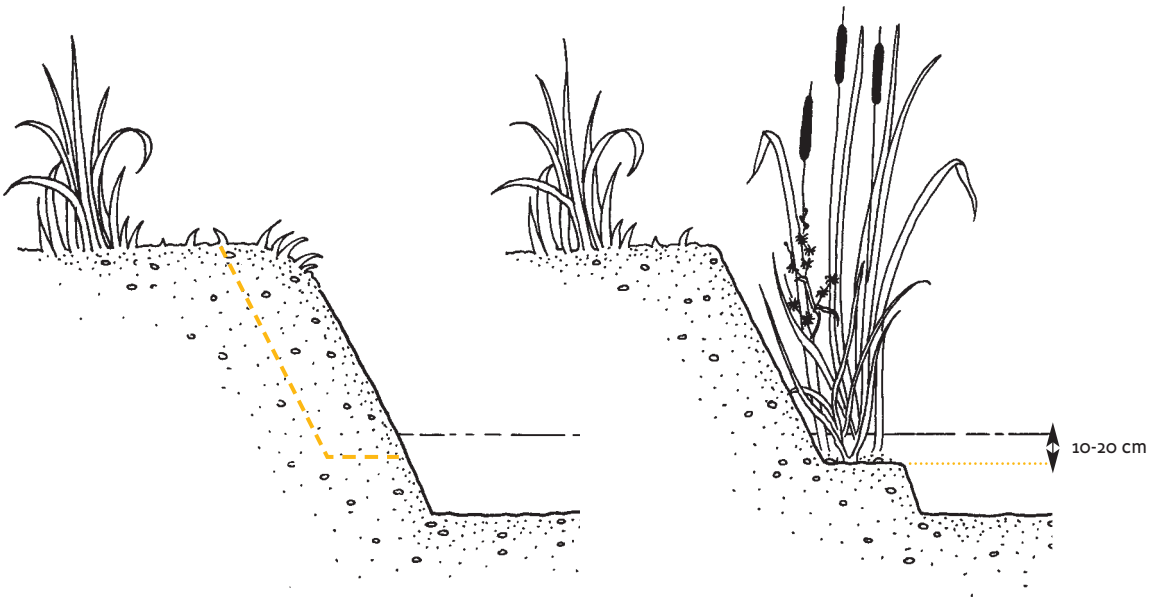
Capital works

2 **Conservation advantages** Plant diversity is increased and this promotes a greater diversity of animals. The biological control effect may reduce the need for follow-up maintenance cutting, preserving continuity of the plant community.

2 **Flood management effects** Maintains a predominantly open channel. The introduced species may provide a stable community and sufficient shade so as to reduce the frequency or intensity of the follow-up maintenance cutting required.

Technique

MC2 Submerged berm



Size of watercourse > 2 metres.

Description A submerged berm is a narrow ledge formed at the base of the bank just below the normal summer water level and is usually covered with marsh plants. It can be created on one or both sides of the watercourse depending on the width of the channel. This may mean land-take but some farmers may be prepared to co-operate with the drainage body if a management payment is made for the service provided.

Purpose To support emergent plants while ensuring drainage function is maintained in the main channel. Although the channel capacity is increased to store additional volumes of water during flood conditions, this technique does require extra land take.

Method Form the berm working from the same bank, setting it 10-20 cm below the normal retained summer water level. Remove existing vegetation and set aside for replanting or use spare vegetation from elsewhere. Avoid creating a berm that is absolutely level, briefing the machine operator that some unevenness (10-20 cm over 3-5 m lengths) is desirable. When replanting favour plants such as bulrush, sedges and bur-reed – rather than common reed, reed canary-grass and reed sweet-grass – to create diversity and reduce the opportunities for a monoculture to form.

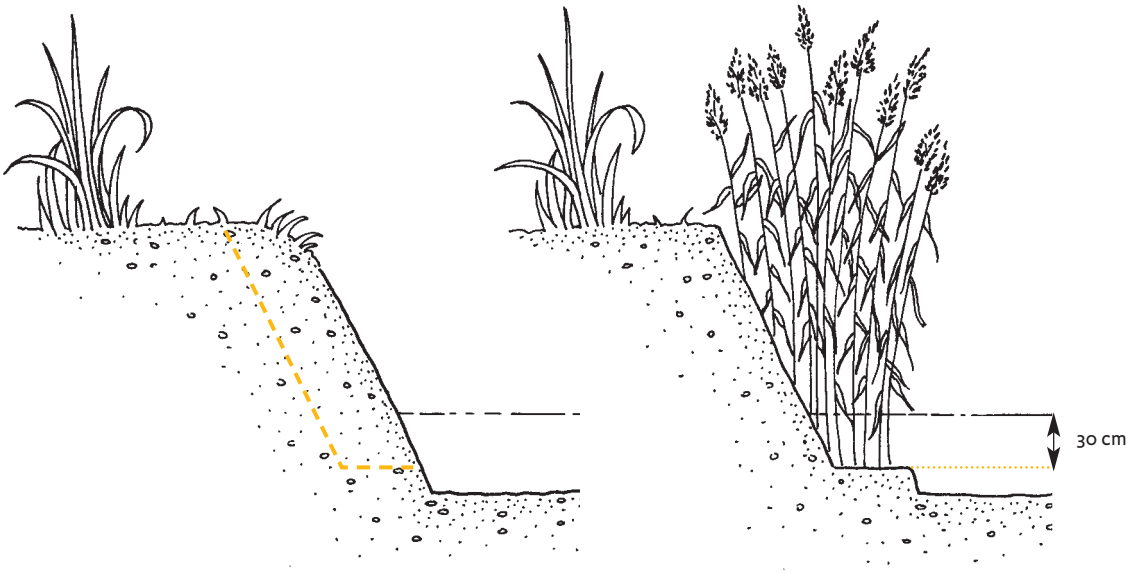
Margin

Capital works

2 **Conservation advantages** Emergent plants are established in a range of water depths. These provide food for invertebrates and support for insects such as dragonflies emerging from their aquatic state. A stable vegetation structure encourages water birds such as coot, little grebe and moorhen to breed. The different water depths will also favour different plants, creating a diverse habitat structure. Provides food and shelter for fish fry.

1 **Flood management effects**: Provides additional flood storage during times of high flow.

Submerged berm and linear reedbed



Size of watercourse > 2 metres.

Description A submerged berm is a narrow ledge formed at the base of the bank created on one or both sides of the watercourse depending on the width of the channel. It is set at a lower level than Technique MC2 to favour the growth of common reed. The creation of a berm may mean land-take but some farmers may be prepared to co-operate with the drainage body if a management payment is made for the service provided.

Purpose To create a linear reedbed while ensuring drainage function is maintained in the main channel. Although the channel capacity is increased to store additional volumes of water during flood conditions, this technique does require extra land take.

Method Form the berm working from the same bank, setting it around 30 cm below the normal retained summer water level. Choose stretches of watercourse without adjacent trees or hedges as these can shade and depress reed growth. Remove existing vegetation and set aside any common reed for replanting. To favour the growth and management of a monoculture of common reed the berm can be built level. Additional flood storage benefits can be gained by having wider sections of berm cut back from the channel (the reedbed does not have to be linear or continuous) but this will require agreement for the additional land take.

Subsequent management can permit the reed to colonise part way up the bank.

2 **Conservation advantages** Creation of a linear reedbed. The wider the berm and fringing reedbed created, the greater the likelihood of attracting specialist reed-nesting birds such as reed warbler. These birds like to nest over water but need the extra width of reedbed afforded by allowing the reed to grow up the banks. This provides screening from predators and disturbance.

1 **Flood management effects** Provides additional flood storage during times of high flow.

Margin

Capital
works

Technique
BA1

Cutting technique – targeting specific wildlife interest

© Natural England/Paul Glendell

Bank

Annual
maintenance

Size of watercourse > 2 metres.

Description Modification of the grass-cutting regime to suit an identified specific interest on the bank.

Purpose To ensure that the grass-cutting regime is tailored to identified specific interests. This may include lengths of bank where:

- The cuttings are removed so that the fertility of the soil is depleted or maintained at a low level to favour less productive and more visually attractive plant communities without affecting the stability of the bank.
- The time of the cut is set to allow specific plants to flower, set and ripen their seed.
- The time of the cut is set to allow breeding birds to complete their nesting cycle.

Method This will require a degree of pre-planning to identify where specific wildlife interests are known to occur in the same location from year to year. The IDB BAP is the recommended mechanism through which to plan and monitor this work. This may involve consultation with wildlife experts and potentially some new survey work. The method for the removal of cuttings is described in Technique B-A-3. Information on the timing of the nesting season for the species of bird most likely to be found nesting on drainage channel banks can be found in the appendices.

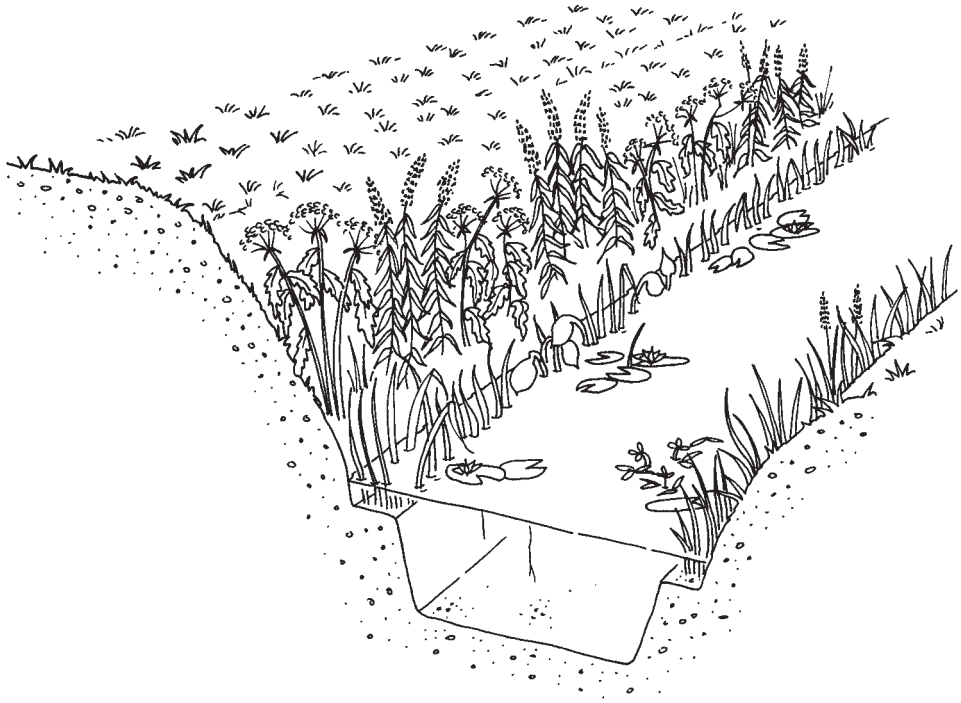
2 **Conservation advantages** Favours the maintenance and enhancement of target species' populations.

2 **Flood management effects** There should be no effects on conveyance in normal seasonal conditions; that is, with no major flood flows before the bankside vegetation is cut.

A cutting regime that requires no cutting in the spring and summer to favour a particular target species may not be appropriate in locations where conveyance is the priority because of the flood risk to people or property. Here the rare occurrence of intense or prolonged summer storm events may preclude a late cutting technique unless the drainage channel has considerable spare capacity.

Cutting technique – differential cutting parallel to the water line

Technique
BA2



Bank

Annual
maintenance

Size of watercourse > 2 metres.

Description Strips of vegetation running parallel to the water line up the bank are cut at different times and frequencies.

Purpose To create greater diversity of vegetation structure up the bank.

Method Cut the vegetation in strips parallel to the water line early in the season, avoiding cutting any vegetation at the water level that is important as water vole habitat (see Techniques such as MA3 and MA4) and leaving other strips uncut until the autumn, with all strips being cut in the autumn to maintain a grass dominated bank. Combinations include:

- Cutting a strip above the water line but not the crest of the bank.
- Cutting the crest and the access strip but not the side slope.

2 **Conservation advantages** Cutting in strips diversifies the habitat by having both long and short grass that favours different invertebrates and mammals. On the uncut strip it permits flowering plants to set and ripen seed before being cut. The interface between cut and uncut strips is where many birds hunt for invertebrate food, including seed-eating birds such as yellowhammer that feed their nestlings on particular invertebrates such as caterpillars and grasshoppers. The long grass is the 'production' area for the invertebrates and the short grass is where they are visible and accessible to birds.

2 **Flood management effects** May speed up cutting programme allowing the watercourses where flood conveyance is most critical to be managed at the optimal time. Cutting a strip above the water line but not the crest of the bank reduces the length of vegetation in areas of the channel where flood conveyance is most needed and leaves long vegetation where flood flows are highly unlikely to reach. Consideration should be given at each site as to whether leaving tall vegetation uncut on the bank crest would restrict a machine operator's sightlines and thus poses a safety hazard.

Technique
BA3

Cutting and removal of bankside grass and similar non-woody vegetation

Bank

Annual
maintenance

Size of watercourse All.

Description Specialist machinery is used to cut and then remove cuttings, place them in a less sensitive area or transport them from site for recycling via composting or biogas production.

© Chris Manning

Purpose To favour those plant species that only thrive in relatively low-nutrient conditions and that are subject to competition when soil nutrient status is high.

Method Use machinery that is able to cut the bank vegetation and then remove it from the bank, either depositing it on the top of the bank (usually along the line that the tractor is taking) or collecting it. Such machinery attachments include cutter bars and flails with rakes or conveyors. Machinery that collects, rather than just moves material, is more likely to be limited by the nature of the access route (width and slope). Collection also brings the problem of disposing of cut material that may now be classed as waste and therefore incur a disposal cost.

New equipment is continually being developed and a check should be made at regular intervals. Machinery is available that 'vacuums' the cut material but at present this appears unsuited to work in rural areas.

2 **Conservation advantages** Plants of higher conservation interest will be favoured over species that thrive under more nutrient-rich conditions, such as nettle, couch and false oat-grass. Cutting and removal avoids producing a thick mulch of cut vegetation that kills the underlying vegetation, leading to invasion by undesirable ruderal species.

Removal of cuttings should gradually reduce nutrient levels and may enable a switch from a spring-and-autumn cut to an autumn-only cut as the vegetation growth becomes less vigorous.

2 **Flood management effects** There should be no effect on conveyance and there may be benefits in favouring low-growing species that provide less resistance to flow during flood conditions. The slower growth of vegetation under lower nutrient conditions may lead to a saving in annual maintenance costs through less frequent cutting.

Cutting and removal avoids:

- Producing a thick mulch of cut vegetation that kills the underlying vegetation. This can lead to erosion, invasion by undesirable species and potential reduction of bank stability. Bank restoration works may then be needed.
- Entry of the cuttings into the channel, either shortly after cutting or during a flood event. The cut material may block culverts, or end up at the pumping station and require raking out and disposal.

Cutting technique – cutting by hand

Bank

Annual
maintenance

Size of watercourse All.

Description Use of personnel to manage sites by hand.

Purpose To deal with awkward sites or those needing special management.

Method Cut and remove cut material to the top of the bank.

2 **Conservation advantages** Opportunity for managing special sites with more flexibility and sensitivity, especially where trimming is important. Possibility of leaving short stretches uncut by mechanical means to be cut later by hand after flowers have set seed.

2 **Flood management effects** Enables a very selective approach to removing species of plants that may have a particularly adverse effect on flood conveyance.

A site risk assessment is needed to ensure safe working for operators, such as in the case of steeply sloping banks.

Technique

BA5 Cutting technique – hay cut

Bank

Annual
maintenance

Size of watercourse All.

Description The bankside grass is cut for hay.

Purpose To favour finer grasses and flowering plants that thrive under hay cutting regimes that remove nutrients from the system. The banks are managed to produce an income from the sale of hay, reducing the overall cost of managing the drainage system.

Method Cut for hay and remove as a crop, preferably in July. This permits most flowering plants to mature and set seed if any are present. The crop should not be fertilised other than by grazing animals which return nutrients through grazing the aftermath.

2 **Conservation advantages** Allows flowering plants to set and ripen seed, and increase in abundance at the expense of coarser species. An opportunity to restore nationally-scarce herb-rich grassland through the appropriate management. Unfertilised grass banks cut for hay will eventually develop communities of low-growing, low-productivity grasses that also favour colonisation by flowering plants.

2 **Flood management effects** Taller vegetation is removed in the summer in a cost-effective manner if a buyer for the hay can be found. The removal of the hay avoids leaving cut vegetation that kills the underlying vegetation. There is a risk of flood flows carrying off the hay before it is baled and removed. The removal of the hay brings the same nutrient removal benefits as Technique BA3.

Cutting technique – flail mowing

Bank

Annual
maintenance

Size of watercourse All.

Description Flail mowing of banks.

Purpose To manage the bank with a robust, easy-to-use machine.

Method Use of a tractor-mounted flail on the bankside vegetation. The macerated material is left *in situ*.

1 **Conservation advantages** The conservation advantages of flail mowing derive from the flexibility that this technique allows rather than from the nature of the vegetation cutting itself. It is a quick and reliable cutting technique that allows risk to be managed better. Some banks can be left to be cut later in the knowledge that if the need arises they can be dealt with rapidly by a readily-available machine that can also be easily contracted in.

2 **Flood management effects** A quick and reliable cutting technique for removing vegetation that may impede flood flows. It has disadvantages, including the smothering of bankside vegetation by cut material, leading to invasion by less desirable species and even bare ground and erosion. The cut material can fall into the watercourse and, if it sinks, can add to sediment loads. Any floating material is of a short length and less likely to block culverts and weed screens than material cut for hay.

Technique

BA7 Grazing

© Jon Reeves

Bank

Annual maintenance

Size of watercourse > 2 metres. If unfenced, the edges of smaller watercourses will be trampled and may require more frequent reprofiling.

Description Management of vegetation by livestock.

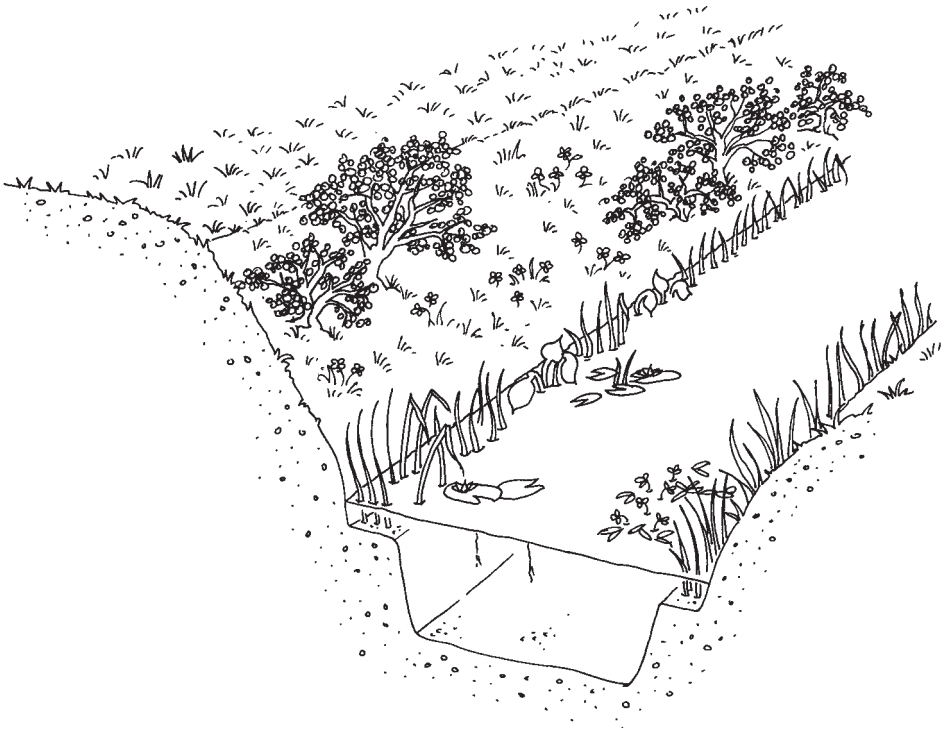
Purpose To reduce the problems of long-term maintenance on the larger watercourse only, although fencing may be an additional cost.

Method The banks are grazed using cattle on the larger drains and sheep or cattle on the smaller drains. Horses on their own graze selectively so need to be mixed with cattle. All animals can cause problems if the land is overstocked. Land needs to be rested periodically.

2 **Conservation advantages** When well-managed, grazing can reduce the dominance of coarse vegetation such as nettles and false oat-grass. The reduction in vegetation height occurs slowly, in contrast to cutting, and this favours invertebrates living in the sward. Grazing, especially by cattle, leaves a diverse structure that is beneficial to invertebrates. The dung from the grazing animals is an additional attraction to invertebrates and the animals that feed on them. The treading of channel margins can encourage desirable emergent plants and will encourage the growth of annual wetland-edge plants. It also provides a shallow margin in which wading birds can feed (especially their young) and the bare areas are attractive to specialist invertebrates. It should be noted that trampling of the margin can increase sediment inputs into the water and potential pollution in the form of nutrient enrichment.

2 **Flood management effects** The rate at which the vegetation is consumed can be controlled by stocking density. The aim can be to maintain a short sward on the banks throughout the summer, thereby maintaining optimum flood conveyance all year.

Bank cover – scrub



Bank

Annual
maintenance

Size of watercourse > 5 metres. Not applicable in channels taking high flood flows or in channels less than 5 metres wide.

Description Discrete patches of dense low shrub cover.

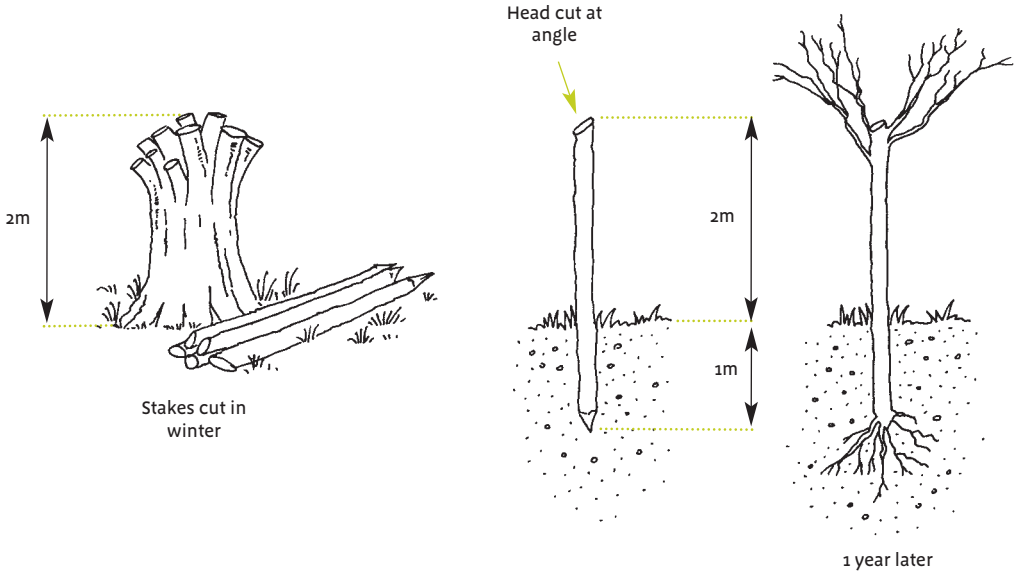
Purpose To suppress invasion of banks by undesirable tree species, such as sycamore, if adjacent to a plantation. Otherwise, no direct land-drainage benefit.

Method Encourage or plant suitable species such as bramble and blackthorn to form discrete blocks of dense cover on banks. This could be incorporated with the technique encouraging bankside trees. Such patches of scrub can encourage rabbits so their positioning could be critical.

2 **Conservation advantages** Such thickets are valuable as a terrestrial habitat for frogs, toads and newts. Dense cover also benefits the larger mammals such as fox, badger, otter and stoat. It also favours the larger waterbirds such as moorhens and possibly mallard. Scrub and bramble thickets are suitable breeding habitats for many birds, including whitethroats, blackbirds, wrens, song thrush, blue and great tit, and robin. The presence of small songbirds may in turn encourage bird predators such as sparrowhawks.

1 **Flood management effects** Scrub can be a major impediment to flood flows and can harbour animals such as badgers and rabbits that burrow in and destabilise banks. Rabbits will spread to neighbouring agricultural land, consuming crops. As a result the location of patches of scrub has to be carefully planned.

Technique
BA9 Pollarding willows



Bank

Annual maintenance

Size of watercourse All.

Description The cutting of crack or white willow trees at a height of approximately 2 metres to encourage a broom-headed appearance.

Purpose To foster wildlife. There is limited land-drainage benefit. Willow roots are good bank stabilisers and pollarding willow trees reduces the risk of large branches breaking off and falling into the watercourse. Reduction in bulk of the tree can make access for maintenance operations easier.

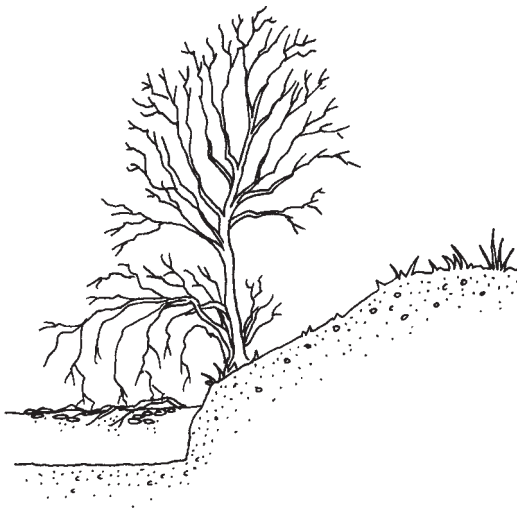
Method For trees that have been pollarded, cut back each pollard to the top of the trunk. Theoretically, any tree can be pollarded, although willow is the usual species. A specialist head attachment, sometimes called a 'tree shear', is available for hydraulic excavators for cutting limbs off a pollard and safely carrying them to an accessible part of the bank. This is quicker and potentially safer than cutting with a chainsaw.

New willow trees for the future creation of pollards can be planted using stakes. These should be preferably 20 cm in diameter and cut at the top at an oblique angle to shed water and prevent rotting. The stake should be 3 metres long with a metre planted into the ground. A height of 2 metres is necessary if machinery or stock are to have access to the bank base. Pollards of a lower height may be appropriate elsewhere.

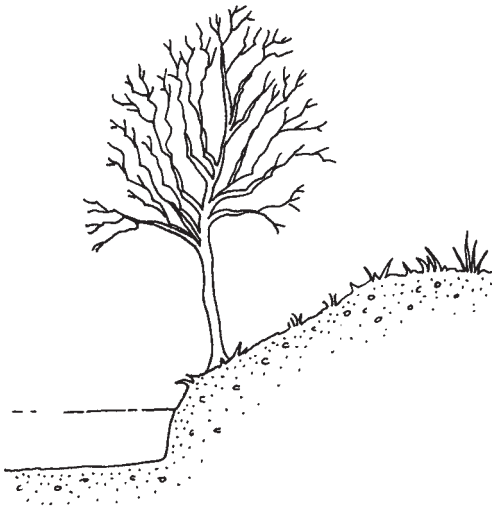
2 **Conservation advantages** Willows are rich in invertebrates for feeding bats and birds, and provide excellent roosting and nesting sites. They are also aesthetically pleasing and are characteristic of wetland landscapes. They traditionally acted as markers for fenland roads at times of flood.

2 **Flood management effects** If willows are already present pollarding reduces the risk of broken branches falling or whole trees toppling into watercourses and causing serious blockages. The reduction in the bulk of the tree can make access for maintenance operations easier.

Trimming of overhanging branches



Before



After

Bank

Annual
maintenance

Size of watercourse All.

Description Selective removal of lower branches that overhang the watercourse and catch flood debris.

Purpose The selective removal of branches reduces maintenance costs. Shading of the watercourse is retained thereby suppressing undesirable aquatic plant growth. Fish will continue to benefit from the invertebrates that fall into the water from the foliage.

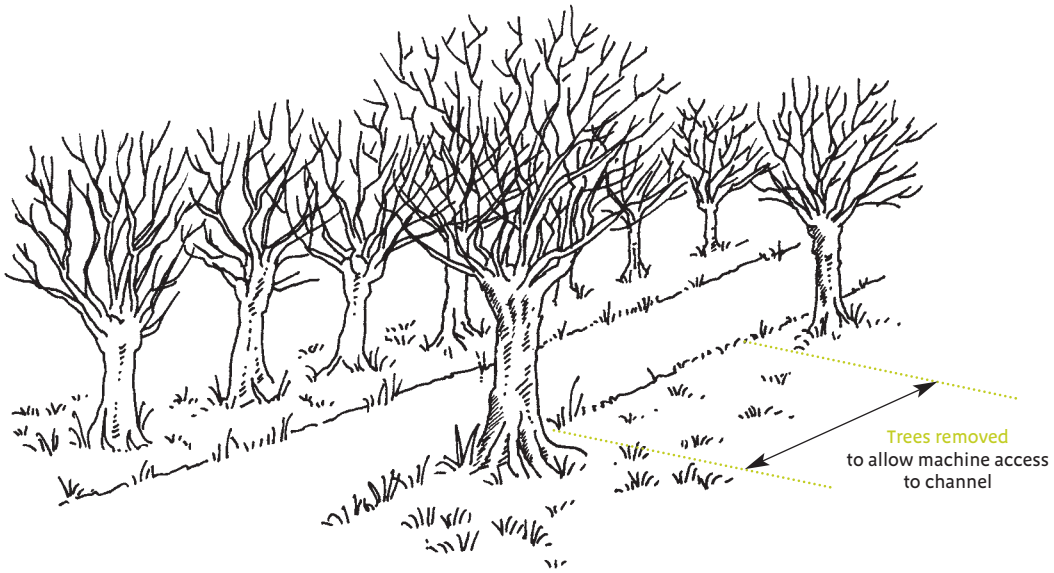
Method Remove only those branches which overhang the water and are actively affecting water-flow. Cut cleanly close to the trunk or main branch and avoid leaving snags or torn bark. Larger branches may be more suited to removal with a specialist cutting head, sometimes known as a 'tree shear', fitted to the arm of a hydraulic excavator.

2 **Conservation advantages** Trees and shrubs provide food and shelter for wildlife. The type of tree is often important. Native species have the richest invertebrate fauna. Some, such as willow and alder, are adapted to growing in damp situations and others, such as oak and ash, have extensive root systems that both bind the banks and provide niches for otter holts, bat roosts and bird nesting sites.

2 **Flood management effects** Selective removal of those branches that are overhanging the watercourse can reduce the risk of debris accumulating and impeding flood flows. Selective removal of branches may also reduce the risk of the tree falling into the channel and blocking flood flows.

Technique

BA11 Working between trees



Bank

Annual maintenance

Size of watercourse All.

Description The retention of selected bankside trees and the removal of others for machine access to the channel.

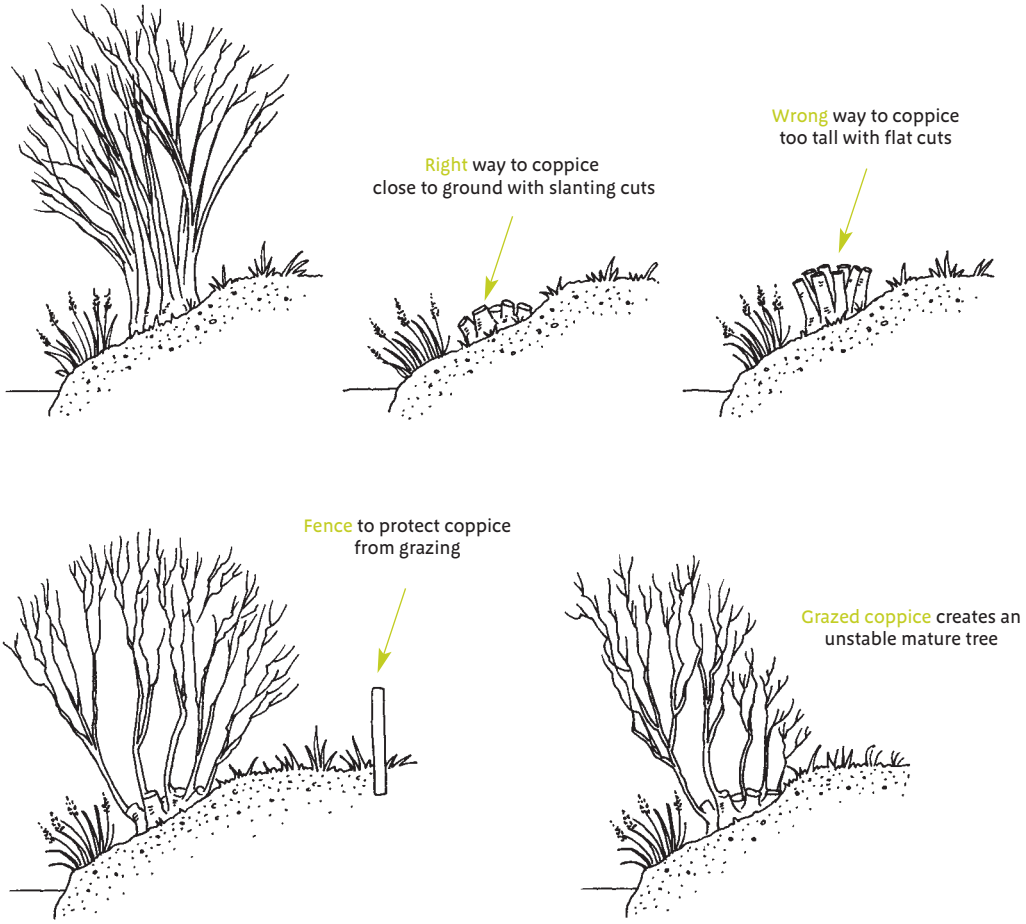
Purpose In some situations shade will act as a useful management tool by depressing undesirable aquatic plant growth. Also, some tree species stabilise banks with their roots. This technique may not be appropriate for all sites.

Method Where there is no alternative, carefully select trees for removal so as to allow access for machinery to function efficiently.

2 **Conservation advantages** The retention of mature or sapling trees supports birds and invertebrates. Invertebrates falling from overhanging branches may provide food for fish. They may also be the only trees present in an intensive agricultural landscape and can be aesthetically pleasing.

2 **Flood management effects** Trees within the flood channel can impede flood flows and selective removal will increase conveyance.

Coppicing



Size of watercourse All.

Description Rotational coppicing of shrubs and young trees where access for machinery is necessary.

Purpose The practice facilitates access for machinery. There is an additional long-term management cost if coppicing replaces the selective removal of trees, although coppice material may be saleable in some districts.

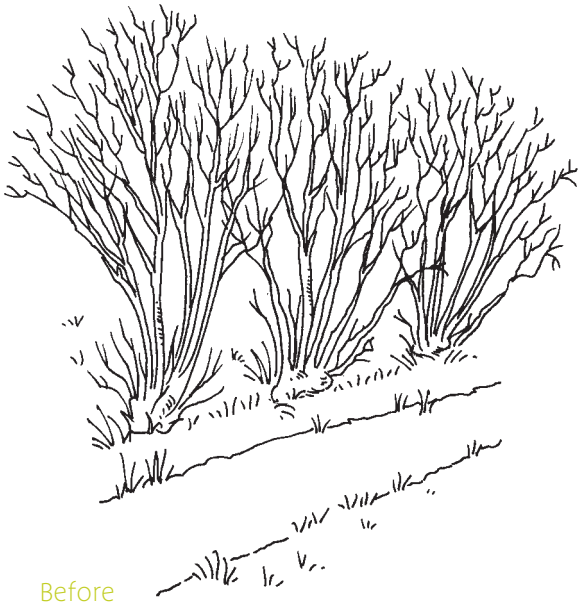
Method Cut trunks close to the ground using a slanting cut that sheds rainwater. Branches regenerate from the base or 'stool'.

2 **Conservation advantages** Coppiced shrub provides cover beside watercourses for birds and invertebrates. For example, moorhens roost in low branches and use dense cover as protection from predators.

2 **Flood management effects** Shrubs and trees within the flood channel can impede flood flows and coppicing can be a means to retain woody cover without allowing extensive growth. The multi-stemmed nature of a coppiced shrub or tree means that it may trap more debris than a larger, single stem.

Technique

BA13 Singling coppice



Before

After

Bank

Annual maintenance

Size of watercourse All.

Description Selection of single coppice stems to form trees.

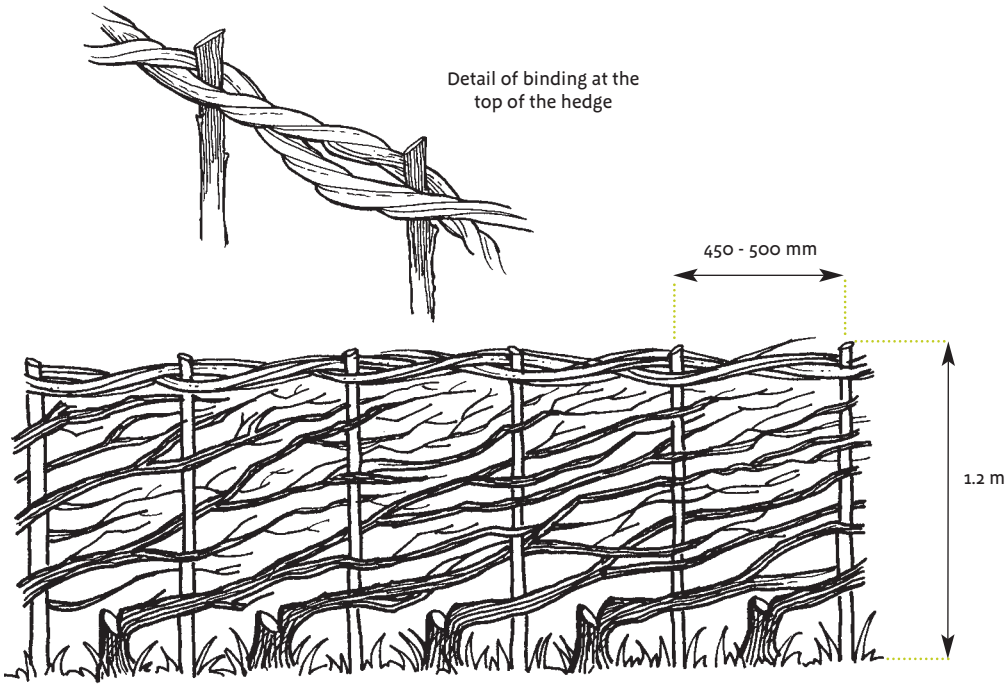
Purpose To improve access to the channel for machinery. Singling allows more light into the watercourse and decreases the volume of material to be disposed of during maintenance coppicing.

Method Select one or more vigorous stems of a coppice stool growing at a suitable angle away from the channel and remove the other stems. This will give a dominant trunk that will be easier to work around and potentially trap less debris than the multi-stemmed coppice stool. The resulting tree can be pollarded or re-coppiced at some future date.

2 **Conservation advantages** The tree and shrub cover is retained while permitting more light into the watercourse.

2 **Flood management effects** Shrubs and trees within the flood channel can impede flood flows, and singling can allow greater conveyance compared with a coppice stool. The single stem can be pollarded at a later date with the benefits described in Technique BA9.

Laying hedges



Bank

Annual maintenance

Size of watercourse All.

Description The laying of channel-side hedges in the traditional fashion.

Purpose To permit easier access for hydraulic machinery that can work over the top of the hedge. To prolong the working life of the hedge.

Method Use traditional hedge-laying techniques and styles appropriate to the local area. In some situations select suitable tree stems in the hedge and leave uncut, or plant ash saplings in the hedge. Both will provide a standard tree. Professional hedgelayers still exist and bodies such as the British Trust for Conservation Volunteers have groups of trained volunteers.

2 **Conservation advantages** More light will enter the watercourse and this will be an advantage where aquatic plant growth is desirable. Periodic laying also prolongs the life of the hedge, thickens the bottom, maintains its stock-proof nature, and provides cover for nesting birds.

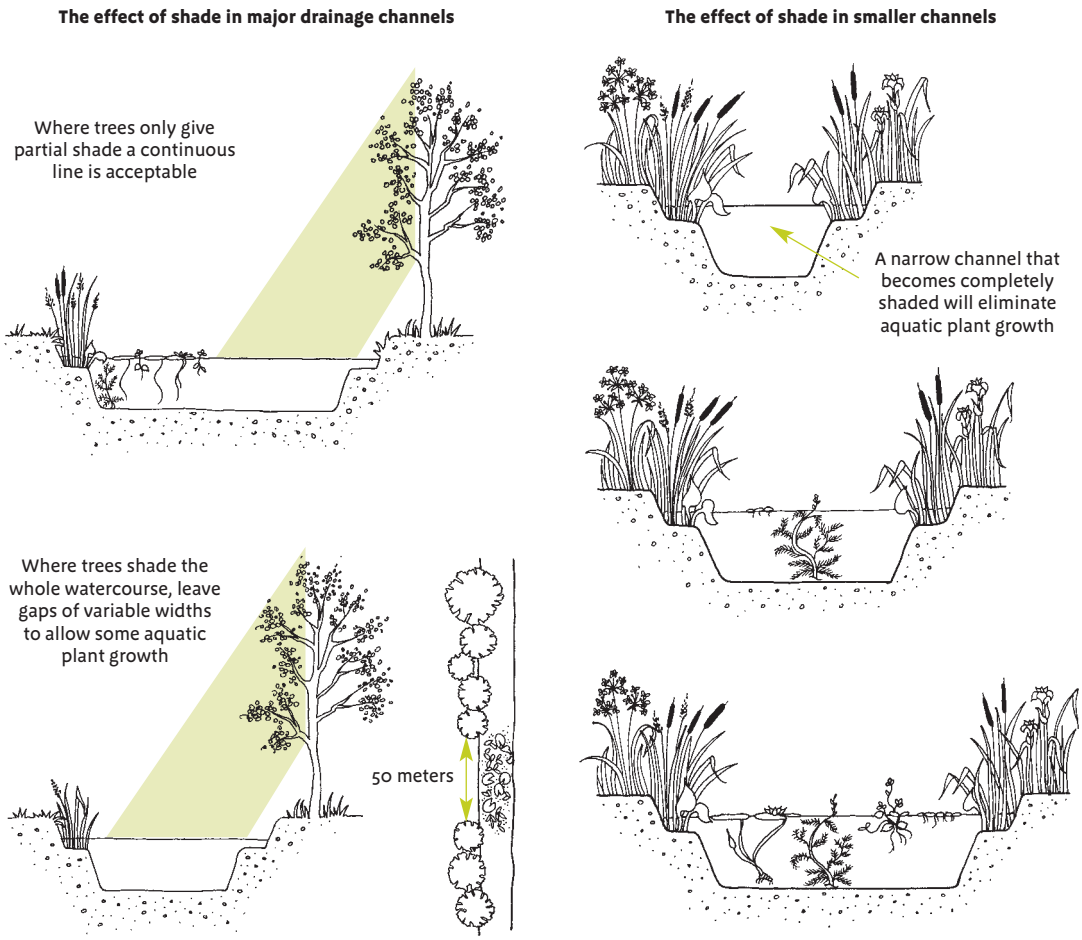
2 **Flood management effects** A hedge is likely to be well outside the flood channel and as a result its management tends not to directly affect flood conveyance. A well-laid and managed hedge may ease access for maintenance machinery.

Technique

BA15 Manipulation of shading

Bank

Annual maintenance



Size of watercourse All.

Description The use of shaded and unshaded sections of bank, to depress or eliminate aquatic plant growth in the shaded section and encourage plant growth in the unshaded section.

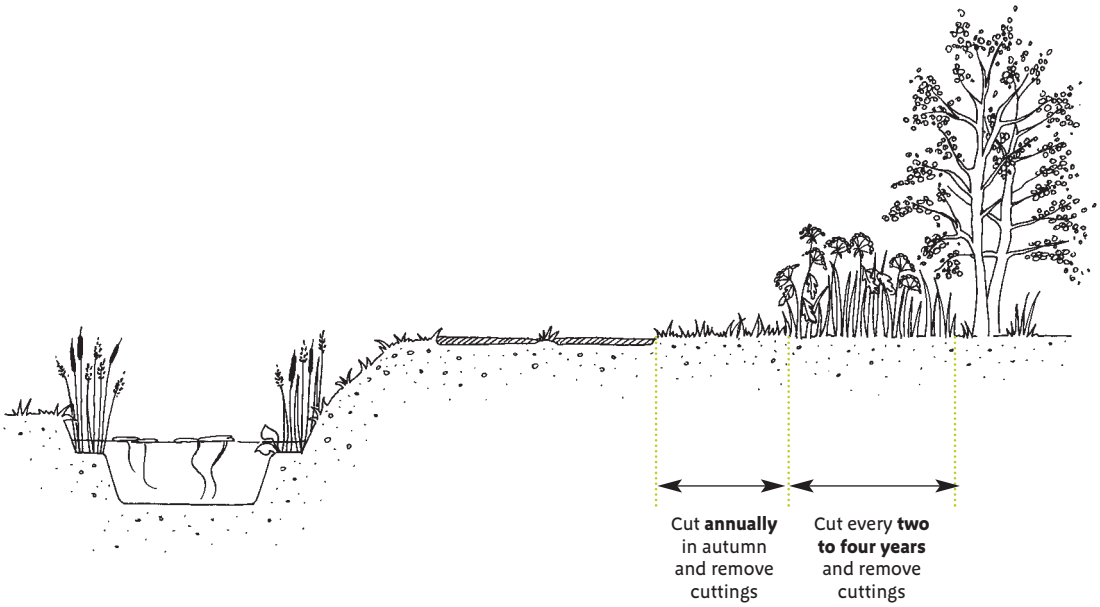
Purpose To create a greater diversity of conditions for plant growth.

Method Create shade over some sections by allowing trees and shrubs to grow in order to depress or eliminate plant growth, and manage trees and shrubs (using the techniques described in this chapter) to maintain open conditions in other sections. Managing for dappled shade may be sufficient in some instances to permit some aquatic plant growth without the channel becoming choked.

2 **Conservation advantages** Partial shading creates a diversity of habitat within the channel that can encourage a richer plant and animal community.

2 **Flood management effects** An open channel can be maintained with limited management input and there is no effect on flood conveyance if the shading trees are set back from the flood channel and not placed on banks where they may cause instability.

Management of drove roads



Bank

Annual maintenance

Size of watercourse All.

Description All access roads, some of which are of historic interest.

Purpose To foster wildlife.

Method Management by cutting and removal of the cut material is the ideal management. The timing of the cut and the number of cuts per year can be manipulated to increase the plant and insect interest.

On a wider drove alternate sides can be cut each year so that some grass tussocks remain over the winter, providing a refuge for invertebrates. On the widest droves a scrub strip or 'wood edge' habitat can be created on one or both sides by not cutting for two to four years and allowing it to scrub over temporarily.

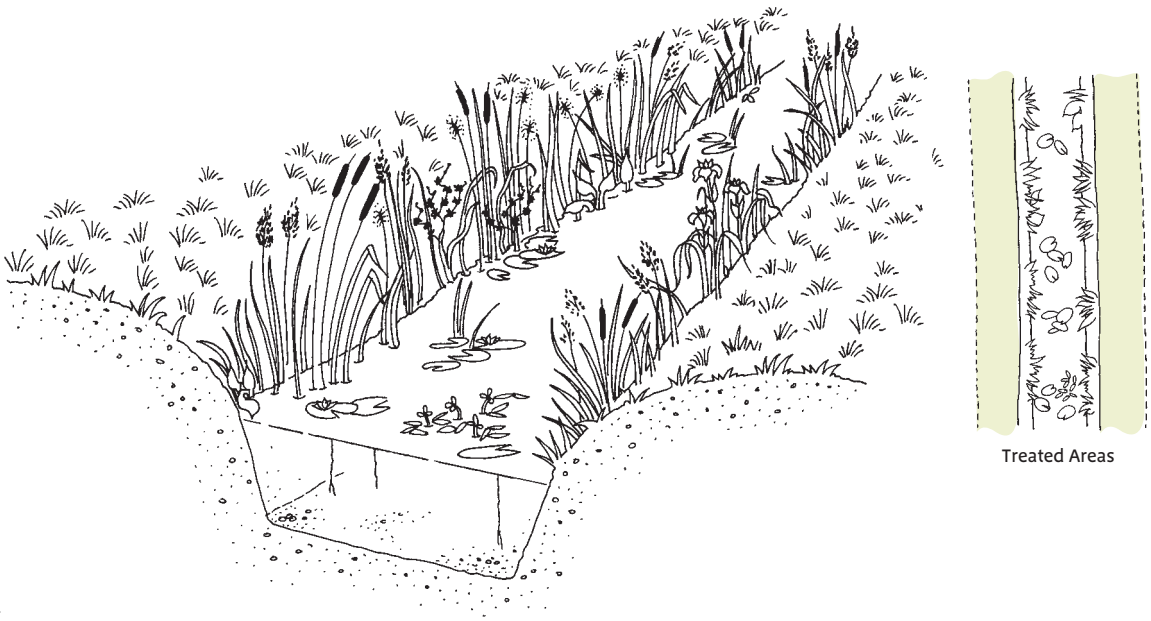
These earth tracks or 'droves' that border drainage channels may be managed by an IDB for a farmer, possibly as a courtesy gesture or in return for permission for access.

2 **Conservation advantages** A drove that is cut once only, towards autumn, will develop a more varied structure the following summer than a drove that is cut repeatedly through the growing season. This single cut is the equivalent to a hay cut and encourages a greater diversity of plants and invertebrates. Longer-term, rotational cutting encourages those species associated with scrub and wood edges such as birds, butterflies and mammals, such as bats.

0 **Flood management effects** The drove road is frequently outside the flood channel and so the nature of management will not affect flood conveyance.

Technique
BA17

Herbicide application to manage plants along the bank



Bank

Annual
maintenance

Size of watercourse Those drainage channels >2 metres critical to drainage after high rainfall in the summer.

Description Clearing bankside plants early in the year.

Purpose To cause minimal disruption to the drainage channel while ensuring efficient drainage function during the summer months.

Method Apply herbicide to control bankside plants. Different herbicides affect the same species of plants differently. Consult the herbicide label and seek advice from a BASIS-qualified adviser.

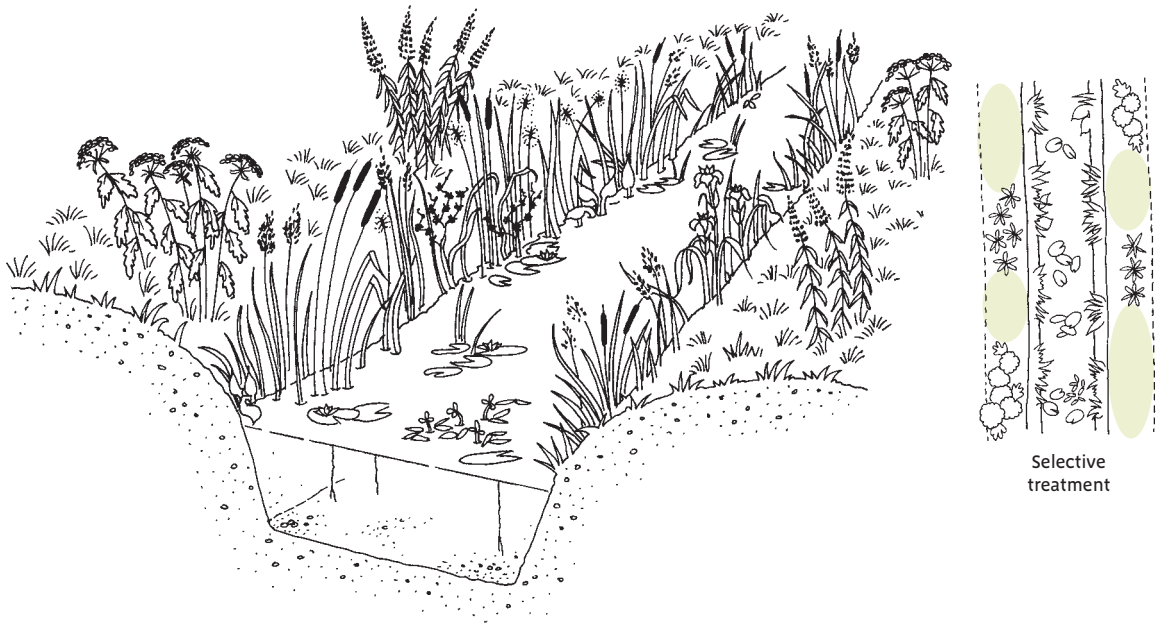
1 **Conservation advantages** Enables the ecology of the channel to undergo minimal disruption. For example, nesting birds are able to nest and raise their broods despite the vegetation dying off towards the latter end. It causes minimal disruption to water vole populations.

2 **Flood management effects** Ensures that the channels critical for dealing with high summer flows are in appropriate hydrological condition in advance of such events. Be aware of the risk of some herbicides, especially non-selective ones, creating bare areas that are then subject to erosion or invasion by undesirable plant species.

There are strict procedures to follow when using herbicides in or near water. See the appendix on herbicides.

Herbicide application to manage plants at selected sites along the bank

Technique
BA18



Bank

Annual
maintenance

Size of watercourse > 2 metres.

Description Selective clearing of bankside plants.

Purpose There are two purposes:

- To avoid specific areas of vegetation, such as protected or rare plant and animal species and nesting birds.
- To clear or partially control patches of plants to ensure retention of drainage function while minimising disruption to the bank.

Method Apply herbicide to selectively control bankside plants. Different herbicides affect the same species of plants differently. Consult the herbicide label and seek advice from a BASIS-qualified adviser. Differences in plant sensitivity enable the use of herbicides in a selective fashion. For example, Asulam is suitable for treating docks and bracken, leaving other species unaffected. Trees and shrubs can be selectively removed by a combination of felling and treating the stumps with herbicide.

2 **Conservation advantages** Uses the herbicide to maintain the drainage function while avoiding sensitive areas for plants or generally minimising disruption to the ecology of the channel. For example, leaving plants around reaches containing water vole burrows or a badger sett. Removal of shrubs and trees can open up the channel to the light encouraging submerged, floating, emergent and marginal plants.

2 **Flood management effects** Achieves the removal of stands of bankside plants, particularly dense stands, along sections of the drainage channel in order to maintain hydraulic function.

There are strict procedures to follow when using herbicides in or near water. See the appendix on herbicides.

Technique

BC1 Natural regeneration of banks

Bank

Capital works

Size of watercourse All.

Description Re-creation of natural grasslands on channel banks.

Purpose To stabilise bare soil on banks.

Method Permit a newly-formed bank to re-vegetate from the natural seedbank. Cut the young plants in the spring and autumn for two years and thereafter revert to an autumn cut. The cuttings should be removed.

Many newly-formed banksides may still contain a relict seedbank of former low-productivity grassland. This may be capable of forming a vegetation community that will stabilise and protect the bank. Seedbanks can be checked using a suitable conservation organisation. If it is found to be of interest and suitable, then savings can be achieved using this natural seed source.

This technique is unlikely to be acceptable in areas where it is known that bare ground rapidly colonises with creeping thistle, ragwort and other ruderal species that do not lead to the desired vegetation community.

2 **Conservation advantages** The seed bank may have lost some sensitive seeds over the years but most of the original stock should be present. This method will restore a proportion of the original bankside flora and this may be similar, part, to old meadow floras that existed prior to agricultural intensification in the area.

0 **Flood management effects** There are no direct flood management benefits.

Re-seeding banks

Size of watercourse All.

Description Re-creation of natural grasslands on channel banks.

Purpose To stabilise bare soil on banks. Although the initial cost of the seed of low-productivity grasses may be greater, the long-term maintenance costs should be reduced as dry matter production will be less. Alternatively, banks can be re-seeded with hay-seed mixtures from hay-meadow Sites of Special Scientific Interest.

Method Prepare a standard seedbed or, where this is not possible due to the slope, break up and roughen the surface soil using a bucket with teeth or by chain harrowing. This is to permit seeds to lodge, rather than roll down the slope, and find niches for germination. On steep slopes the seed will have to be either broadcast or introduced in a sowing medium. The latter will increase the cost but should ensure a better take. Sowing mediums include substances such as a foam based on woodpulp, sand, sawdust and agricultural meal. In all cases cut in spring and autumn for two years and thereafter revert to an autumn cut. Remove the cuttings.

If purchased from a merchant the seed should be specified as consisting of native species (not improved cultivars for agricultural use) and of local provenance. There are suppliers who abide by the Flora Locale Code of Practice on native seed sourcing.

Bank

Capital works

2 **Conservation advantages** It is calculated that 95 per cent of the country's diverse grasslands have been lost with changes in cultivation to arable and more intensive grass leys. This dramatic reduction in area has had a severe impact on invertebrate populations and their associated predators, such as bats and birds. The establishment of bankside stretches of grassland with mixed grasses and herbs offers new opportunities for invertebrates to recover their range.

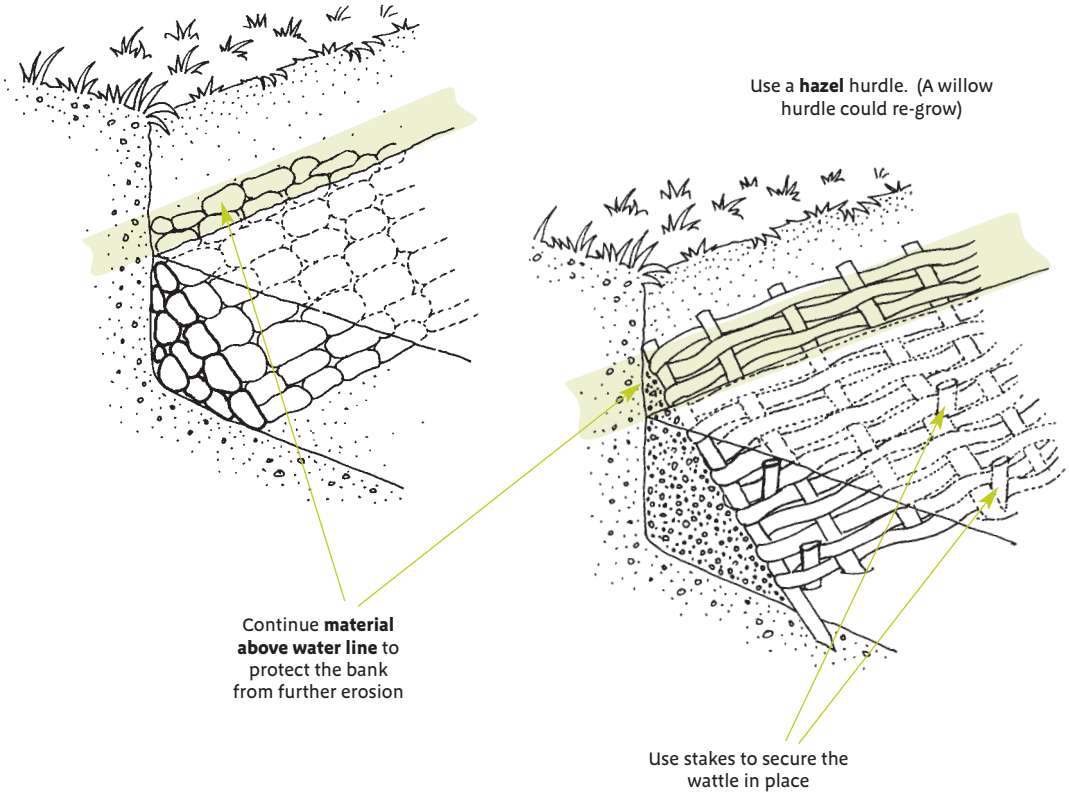
0 **Flood management effects** There are no direct flood management benefits.

Technique

BC3 Retention of vertical banks

Bank

Capital works



Size of watercourse Shallow channels > 2metres. More applicable to natural watercourses.

Description The retention of physical features such as vertical banks.

Purpose To foster wildlife.

Method Retention of naturally receding vertical banks that occur on bends, or below weirs and culverts. Maintain by non-intervention or limited stabilisation at the toe of the bank.

If the bank is receding into land of no consequence then it could be left to follow its natural course. If it is necessary to stabilise it then this can be done by deflecting the current away from the toe of the bank and protecting the bank with stones or staked wattles (see Technique BC4). Avoid using vertical sheet piling as this destroys habitats.

2 **Conservation advantages** Keeps potential nesting sites for kingfishers and sand martins. It is also valuable for solitary bees and other burrowing invertebrates.

0 **Flood management effects** There are no direct flood management benefits.

Stabilising banks using natural or prefabricated materials

Technique
BC4

Size of watercourses All.

Description Natural materials used to stabilise banks can include bundles of wood (faggots), wattle, shrubs, trees and stone. Prefabricated materials presently on the market include:

- Flexible mats of pre-cast concrete blocks.
- Interlocking concrete shapes.
- Mats of bitumen-impregnated geotextiles.
- Biodegradable mats of natural fibre sown with appropriate plant species.

Purpose To protect banks prone to scour or slippage and to repair banks where slippage or erosion has occurred.

Bank

Capital works

Method The method applied varies with the material used:

Faggots: Prepared from hawthorn, hazel or fruit tree branches to give a bound bundle about 1m long and 30cm in diameter. Can be used as a current deflector at the toe of the bank, staked in place, or as a component of a reinforced earth bank or bed. In the latter use, first remove bank material to three or four faggot's depth and store. Lay a line of faggots along the cut bank and just below bed level. Cover with soil then lay a second line offset to give the correct bank profile. Stake at intervals with 1.2m to 1.8m stakes. Cover with soil and repeat to give three or four layers of faggots, finishing with soil.

Wattle: Drive stakes more than 2m long into the base of the bank in a staggered, double row. Weave freshly-cut, and therefore pliable branches of willow or hazel between them to a height above the high water level. Fill in with soil behind and plant to stabilise the surface. Willow stakes will sprout if used, which would give greater protection to a toe particularly affected by scour. Common reed can be planted in front of the wattle to establish a plant fringe and deflect the current.

Trees and shrubs: Plant at base or top of bank, using alder, willow or sallow where the soil is waterlogged, and hawthorn in drier conditions higher up the bank. Manage by a selection of the pruning, coppicing and pollarding techniques described in this manual.

Stone: Place at the toe of an undercut bank, using stones sufficiently large to remain unmoved by the current. Can be placed in wire baskets to give greater stability while still retaining many niches for invertebrates and vegetation.

Prefabricated materials: The method to be applied depends on the proprietary products purchased. The installation and management instructions should be followed.

Conservation advantages Table 5.3 compares the nature conservation advantages and disadvantages, if any, of the various natural and prefabricated materials.

Flood management effects No flood management benefit in addition to the stabilisation that is produced.

Stabilising banks using natural or prefabricated materials

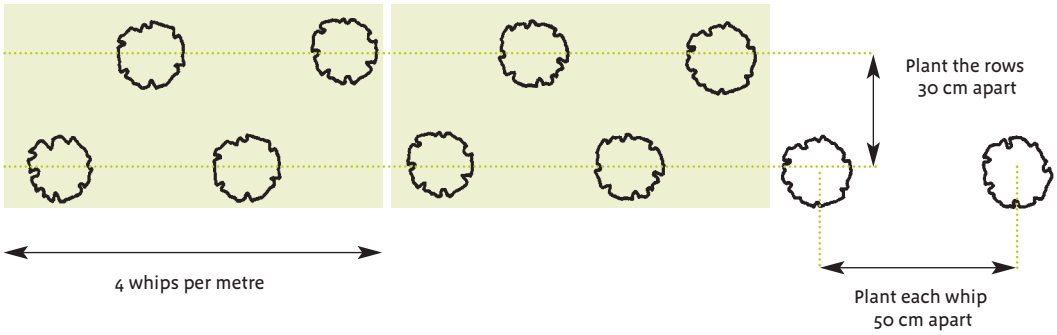
Material	Advantages	Disadvantages
Natural		
Faggots 2 1	Natural material containing many niches for invertebrates.	
Wattle 2 1	Natural material containing many niches for invertebrates. Willow stakes may root.	
Trees/shrubs 2 1	Grow into valuable large habitats. Management options flexible – coppicing, pollarding, etc.	
Stone 1 1	Some niches for invertebrates.	Prevents access to bank for burrowing.
Pre-fabricated		
Interlocking concrete 0 1	Some designs provide niches for plants and animals.	Some designs do not provide niches for plants and animals.
Sheet piling 0 1		Prevents access to bank for burrowing. No niches for plants or animals.
Sown fibre mats 2 1	Grow into a valuable natural habitat.	

Table 5.3 - Comparison of natural and prefabricated materials

The use of faggots and wattles also gives an income to those owning and managing coppice woodlands, which are important wildlife habitats in their own right.

= Biodiversity = Flood Risk Management

Hedgerow planting



Bank

Capital
works

Size of watercourse All. Applicable where the adjoining land is owned by a drainage authority or there is agreement with the landowner.

Description Planting of a hedge.

Purpose To create habitat for wildlife, provide material for faggots and enhance the landscape.

Method Rotavate or similarly prepare the ground for planting. Hawthorn whips (plants 0.5 m in height) should be planted 0.5 m apart in a staggered double row 30 cm apart. Planting through a black plastic sheet, although unsightly until hidden by foliage, provides very effective weed suppression and greatly enhances the establishment of the hedgerow.

2 **Conservation advantages** The hedge provides new habitat for nesting birds and a nectar source for insects. It also provides a natural material for bank reinforcement. If possible plant the hedge on the north side of the watercourse so as not to shade the channel. Alternatively plant on the east or west side, but not on both banks.

0 **Flood management effects** No flood management benefit.

Technique

BC6 Introduction of bushes and trees

Bank

Capital works

© Rob Cathcart

Size of watercourse Large fen drains are particularly appropriate although not where these are embanked and carry water at a level higher than the adjacent land.

Description Introduction of trees and shrubs to diversify the habitat.

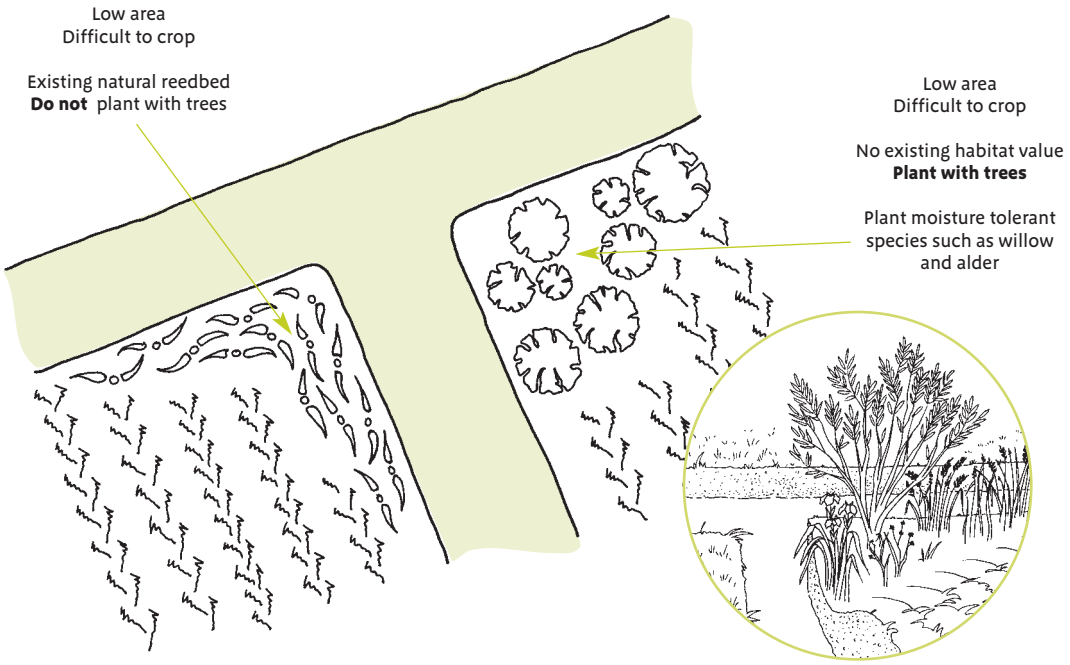
Purpose To foster wildlife.

Method Plant bushes or trees on one bank, avoiding planting on the south side so as to completely shade the channel. Assess the conservation value of the bank and channel to ensure that any planting is not to the detriment of existing high-value habitats, such as herb-rich grassland, reedbeds and channels with rare aquatic plants. When the channel contains rare aquatic plants that need to be free of shade, then trees should be planted at least one tree height away from the edge of the watercourse. In such circumstances, no more than 25 per cent of the channel length should support trees.

2 **Conservation advantages** Introduces a diversity of habitat and structure. Trees provide roosting and nesting sites and a rich source of food. The shelter created by trees can be of particular value to bats, which avoid open expanses when moving around.

0 **Flood management effects** No flood management benefit.

Planting of trees or shrubs at drain junctions



Bank

Capital works

Size of watercourse All.

Description Planting of trees and shrubs at drain junctions.

Purpose To foster wildlife.

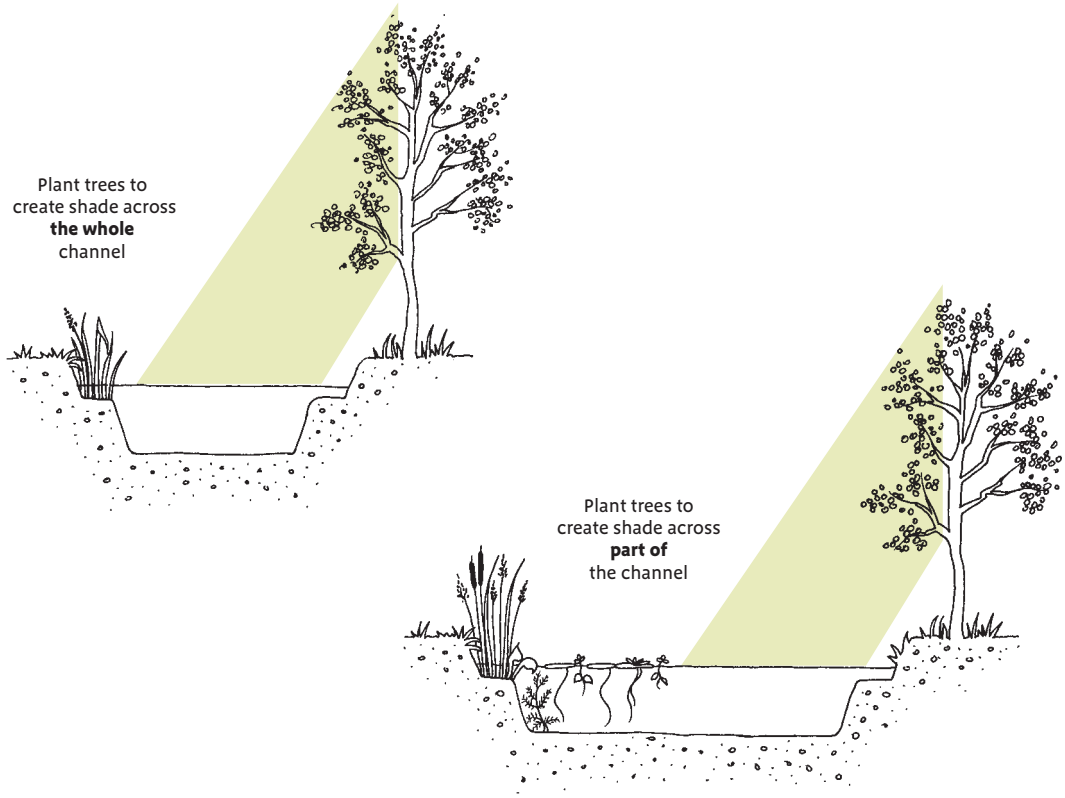
Method At the junctions of drainage channels, plant up awkward corners that the landowner finds difficult to cultivate. This should not be coupled with the creation of pools at the same site or it will impede access for maintenance machinery. Assess the conservation value of the bank and channel to ensure that any planting is not to the detriment of existing high-value habitats such as herb-rich grassland, reedbeds and channels with rare aquatic plants. When the channel contains rare aquatic plants that need to be free of shade, then trees should be planted at least one tree height away from the edge of the watercourse. In such circumstances, no more than 25 per cent of the channel length should support trees.

2 **Conservation advantages** Adds diversity of habitat to areas of arable land where there may be few other areas of trees and shrubs. Trees provide roosting and nesting sites and a rich source of food. The shelter created by trees can be of particular value to bats – they avoid open expanses when moving around.

0 **Flood management effects** No flood management benefit.

Technique
BC8

Planting and managing trees as biological controls for vegetation



Bank

Capital works

Size of watercourse All.

Description Trees planted beside or at a defined distance from the watercourse to provide control of vegetation growth by shading.

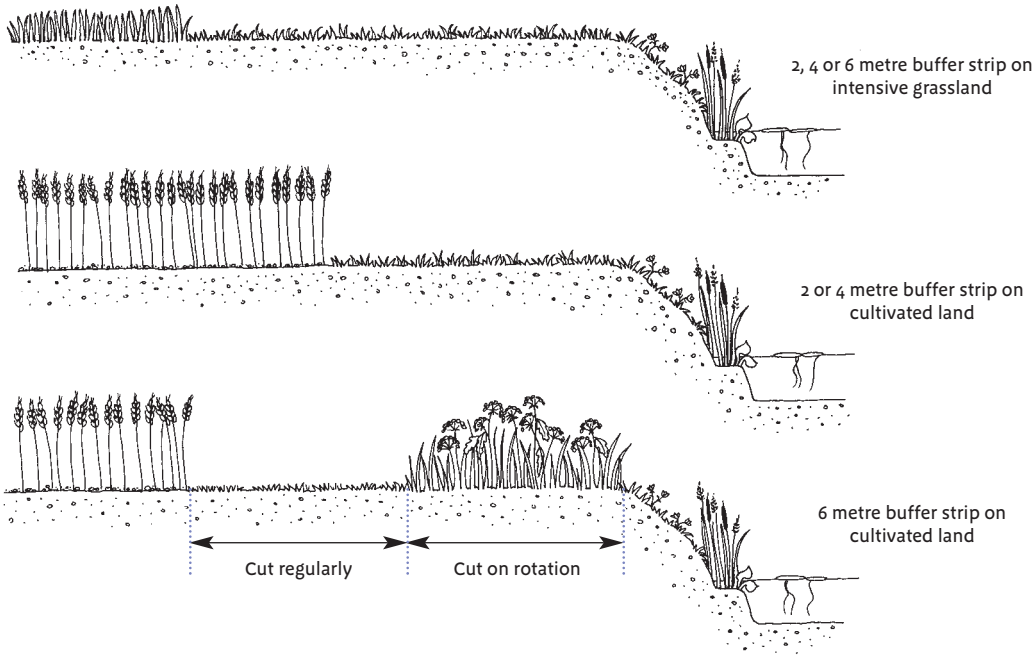
Purpose To reduce the growth of vegetation in the channel or along the margins by shading in order to prevent vegetation growth impeding the conveyance of flood flows.

Method Plant trees on the bank to cast shade to reduce the growth of emergent and aquatic plants. Assess the conservation value of the bank and channel to ensure that any planting is not to the detriment of existing high value habitats such as herb-rich grassland, reedbeds and channels with rare aquatic plants.

2 **Conservation advantages** Trees add diversity to the watercourse corridor, providing roosting and nesting sites and a rich source of food. Shading to reduce vegetation growth can be an alternative to cutting techniques and herbicide applications that may be more damaging in some circumstances.

1 **Flood management effects** Vegetation reduction by shading reduces the need for more active management intervention that can be more costly. Careful selection of locations is required to avoid unwanted impacts from planting trees adjacent to channels.

Buffer strips on the bank tops



Size of watercourse All.

Description Strips of land set back from the bank top where the intensity of agricultural management is greatly reduced.

Purpose There are a number of purposes:
- To promote long-term stability of the bank slope.
- To protect those habitats that occur on bank tops.
- To create additional habitats funded by agri-environment schemes.
- To protect the channel from diffuse agricultural pollution.
- To deliver environmental benefit on a strip of land that cannot be intensively farmed due to cross-compliance restrictions.

Method Create strips of land that are un-cropped or cropped with reduced inputs in accordance with the prescriptions in the relevant agri-environment schemes.

These strips can only be created by agreement with the landowners or occupiers. It is an initiative that can be encouraged by drainage authorities through their contacts with the farming community.

2 **Conservation advantages** The banks of greatest wildlife interest are those where the soil is impoverished in agricultural terms. Leaving a strip untreated with herbicide or fertiliser acts as a buffer zone for the bank slope. Not ploughing close to the edge also prevents the bank from becoming destabilised. Repair work is reduced and this minimises the frequency of major disruption to the continuity of plant communities. Disturbance can open up opportunities for less desirable ruderal communities to develop.

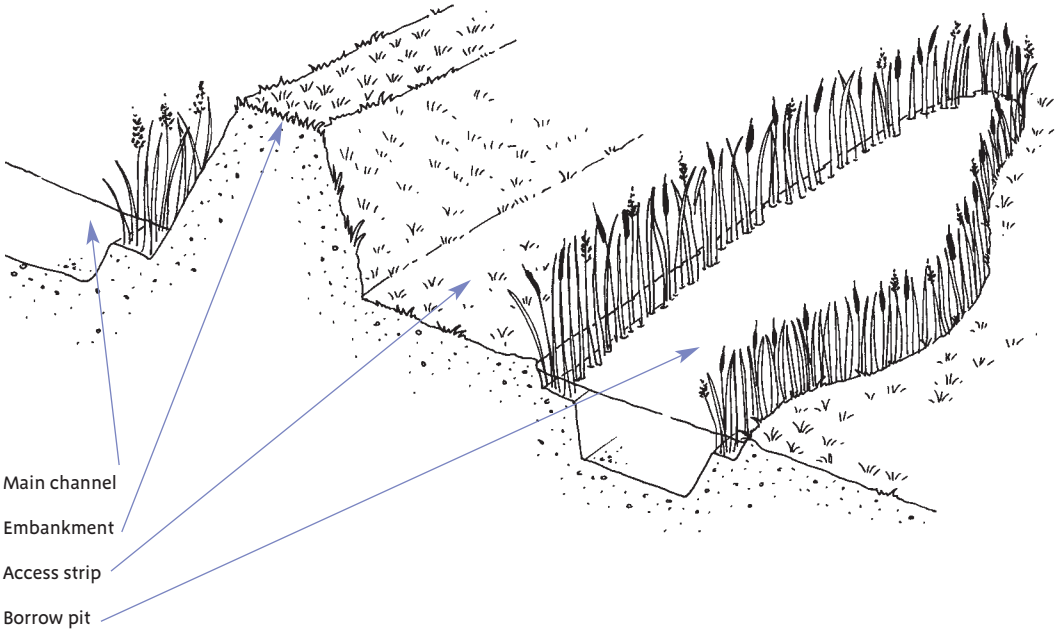
O **Flood management effects** The buffer strips are outside the flood channel except in the event of extreme out-of-bank flooding, and so will not deliver direct flood management benefits. However, buffer strips can have an important role in providing access strips for watercourse maintenance.

Technique

OC1 Borrow pits

Outside

Capital works



Size of watercourse Only relevant to channels with flood banks or adjacent to sea defence banks.

Description Pits excavated to provide spoil.

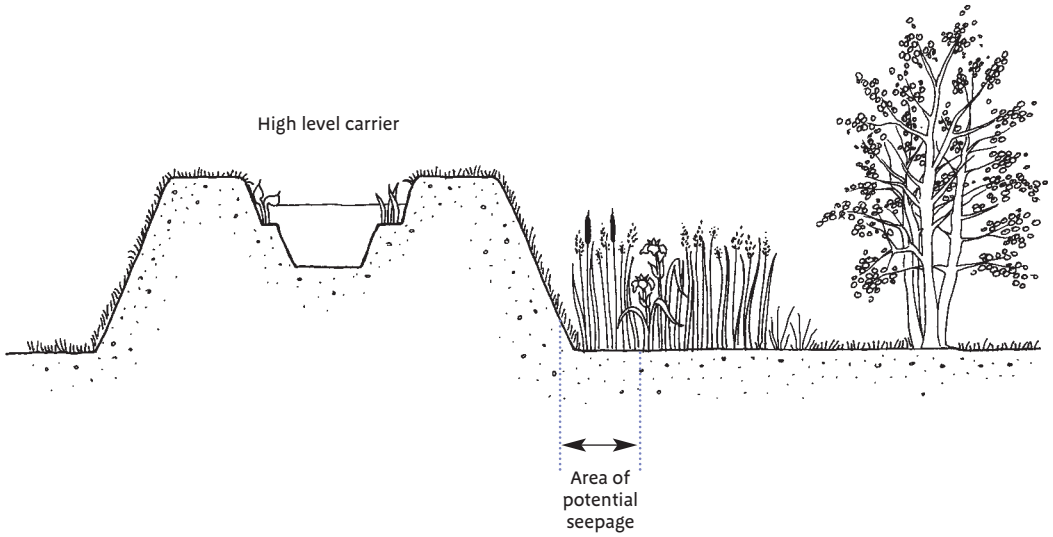
Purpose To create new habitat for wildlife while winning material locally to create, restore or enlarge flood banks.

Method Excavate pit with an irregular shape and profile, including berms and banks with a variety of profiles. Existing pits with an oblong shape and vertical sides all round could be re-worked to create a greater variety of shape and profile. Material should not be won from areas that are already wildlife-rich habitats. In the case of sea defence banks, material should not be won from the saltmarsh as this is a valuable habitat in its own right. Removing material may also accelerate the rate of saltmarsh erosion.

3 **Conservation advantages** Creates a new stillwater habitat within the drainage system of great value to a wide variety of wildlife. Borrow pits can normally be isolated from the drainage system. Where the system suffers from high sediment and nutrient loads, the borrow pit provides an area of clear, low-nutrient water that may be colonised by scarce plants and invertebrates that cannot survive in the main channels.

0 **Flood management effects** No additional flood management benefit beyond that produced by the flood bank creation, restoration or enlargement.

Creation of willow carr



Size of watercourse Those carriers that are above the adjacent land.

Description Water may seep through the base of an embankment of a high level carrier providing an excellent habitat for the development of wet vegetation.

Purpose To dry out wet areas caused by water seepage.

Method Plant willows or alders in those areas subject to seepage. Assess the conservation value of the wetland area created by the seepage to ensure that any planting is not to the detriment of existing high-value habitats such as herb-rich grassland or fen. It is essential that the trees are not planted close to the bank as the roots may weaken it.

3 **Conservation advantages** Creates small patches of wet woodland in areas where such habitat is scarce. Birds ands bats benefit in particular from the provision of cover, abundant invertebrate prey and nesting and roosting opportunities.

0 **Flood management effects** No direct flood management benefit.

Techniques for habitats beyond the channel

This section provides an overview of information sources on techniques to maintain and enhance habitats that occur outside but adjacent to the IDB drainage channel system. There are a number manuals that describe in detail the techniques for specific habitats. Rather than repeat that detail here, this section provides a guide to finding that information.

Many of the techniques that have been described in this chapter can be applied to the smaller ditches and drains that are managed by landowners and occupiers. Chapter Seven also considers the opportunities that may be available to landowners and tenants for biodiversity enhancement, ranging from sympathetic ditch management to large-scale wetland habitat creation.

The habitats commonly found adjacent to IDB systems can be broadly divided into:

1. Rivers that have water levels managed by water control structures and are subject to management programmes similar to those for drainage channels considered in this manual.

2. Floodplain habitats influenced by the management of drainage channels, particularly water levels in the channels and flooding regimes. These habitats include:
   - Wet grassland
   - Reedbed
   - Fen

Water levels are of critical importance in sustaining these habitats and in most instances a Water Level Management Plan will be required.

3. Smaller ditches that are under landowner and tenant control, and which may be located in:
   - Arable land
   - Intensive grassland
   - Wet grassland

4. Habitats and features on land immediately adjacent to the drainage channel that are not influenced by water level management or flooding regimes. These include:
   - Field margins
   - Hedgerows

5. Developed land within which flood storage areas and other Sustainable Drainage Systems (SUDS) may have been constructed. These may include:
   - Filter strips and swales, which are vegetated features that store and drain surface water and thereby mimic natural drainage.
   - Basins and ponds that store excess water after rain and allow controlled discharge to avoid flooding.

Sources of information on techniques for these habitats

Wetlands as a suite of habitats

Eades, P., Bardsley, L., Giles, N. & Crofts, A. (2003). *The Wetland Restoration Manual*. The Wildlife Trusts, Newark.

Environment Agency, Natural England and Countryside Council for Wales (2007). *Understanding Water for Wildlife: Assessing the Eco-hydrological Requirements of Habitats and Species*. Environment Agency, Bristol.

Merrit, A. (1994). *Wetlands, Industry and Wildlife*. The Wildfowl and Wetlands Trust, Glos.

Wheeler, B.D, Gowing, D.J., Shaw, S.C, Mountford, J.O & Money, R.P. (2004). *Ecohydrological Guidelines for Lowland Wetland Plant Communities*. Eds A.W. Brookes, P.V. Jose and M.I. Whiteman. Environment Agency (Anglian Region), Peterborough.

Rivers

Ward, D., Holmes, N. & Jose, P. (1995). *The New Rivers and Wildlife Handbook*. The Royal Society for the Protection of Birds, Beds.

River Restoration Centre (2002). *Manual of River Restoration Techniques – 2002 Update*. The River Restoration Centre, Bedford.

Armstrong G.S., Aprahamian M.W., Fewings G.A., Gough P.J., Reader N.A., & Varallo P.V. (2004). *Environment Agency Fish Pass Manual: Guidance notes on the Legislation, Selection and Approval of Fish Passes in England and Wales*. Environment Agency, Bristol.

Wet grassland

Benstead, P., Drake, M., Jose, P.V., Mountford, O., Newbold, C. & Treweek, J. (1997). *The Wet Grassland Guide: Managing floodplain and Coastal Wet Grasslands for Wildlife*. RSPB, Sandy.

Mountford, J.O. & Cooke, A.I. (2003). *Guidelines for the Management and Restoration of Lowland Wet Grassland*. Defra, London.

Reedbed

Hawke, C.J. & Jose, P.V. (1996). *Reedbed Management for Commercial and Wildlife Interests*. Royal Society for the Protection of Birds, Sandy, Beds.

Ponds

Williams, P., Biggs, J., Whitfield, M., Thorne, A., Bryant, S., Fox, G. & Nicolet, P. (1999). *The Pond Book – A Guide to the Management and Creation of Ponds*. Ponds Conservation Trust, Oxford.

Grasslands other than wet grassland

Crofts, A. and Jefferson, R.G. Eds. (1999). *Lowland Grassland Management Handbook*. 2nd edition. English Nature and The Wildlife Trusts, Peterborough.

Arable farmland

Winspear, R. and Davies, G. (2005). *A Management Guide to Birds of Lowland Farmland*. RSPB, Beds.

Andrews, J. and Rebane, M. (1994). *Farming and Wildlife: A Practical Management Handbook*. RSPB, Beds.

Hedges and related habitats

Bacon, J. Ed. (2003). *The Scrub Management Handbook: Guidance on the Management of Scrub on Nature Conservation Sites*. FACT.

Woodland

Forestry Commission (1994). *The Management of Semi-natural Woodlands: 1. Lowland Acid Beech and Oak Woods*. Forestry Commission Practice Guide. Forestry Commission, Edinburgh.

Forestry Commission (1994). *The Management of Semi-natural Woodlands: 2. Lowland Beech–Ash Woods*. Forestry Commission Practice Guide. Forestry Commission, Edinburgh.

Forestry Commission (1994). *The Management of Semi-natural Woodlands: 3. Lowland Mixed Broadleaved Woods*. Forestry Commission Practice Guide. Forestry Commission, Edinburgh.

Wet woodland

Eades, P., Bardsley, L., Giles, N. & Crofts, A. (2003). *The Wetland Restoration Manual*. The Wildlife Trusts, Newark

Bogs

Brooks, S. and Stoneman, R. (1997). *Conserving Bogs: The Management Handbook*. The Stationary Office, Edinburgh.

Saltmarsh and coastal lagoons

Bamber, R.N., Gilliland, P.M. & Shardlow, E.A. (2001). *Saline Lagoons: a Guide to their Management and Creation (Interim Version)*. Saline Lagoon Working Group.

Nottage, A.S. and Robertson, P.A. (2005). *The Saltmarsh Creation Handbook: A Project Manager's Guide to the Creation of Saltmarsh and Intertidal Mudflat*. RSPB and CIWEM, Beds.

Development (SUDS)

Woods Ballard, B. and Kellagher, R. (2007). *The SUDS Manual*. CIRIA, London.

Woods Ballard, B. and Kellagher, R. (2007). *Site Handbook for the Construction of SUDS*. CIRIA, London.

Further reading and information

CEH (in press 2008). *Aquatic Weed Control Best Practice Guidelines*. Aquatic Weed Control – A revision of R&D Technical Report W111. CEH Aquatic Plant Management Group, Oxon.

RPS (in press 2008). *Invasive Species Management for Infrastructure Managers and the Construction Industry*. C679. CIRIA, London.

CEH (undated). *Information Sheets for the Control of Aquatic and Riparian Plants*. www.nerc-wallingford.ac.uk/research/capm/information%20sheets.htm. CEH Aquatic Plant Management Group, Oxon.

Leaving a fringe of marginal vegetation uncut provides essential cover for species such as water vole.

Six

Survey and monitoring

Introduction

This chapter describes the approaches that can be taken to survey and monitoring. In this guidance, 'survey' refers to recording the distribution and numbers of particular species or groups of species, or the area and quality of habitat. 'Monitoring' refers specifically to a survey that is undertaken to record the outcome of a particular activity or to assess features against a standard. The planning and delivery of monitoring will differ from survey in that it is designed to identify if the particular objectives or targets of the activity are being achieved.

The key stages in undertaking survey and monitoring are:

- Setting aims and objectives.
- Planning the investigation, including methods, parameters to be recorded and resources required.
- Carrying out the investigation (desk study or field work).
- Data recording, storage and analysis.
- Communication of results.
- Actions prompted by the results.

Surveys

Prior to conducting or commissioning a survey, an assessment should be made of the amount and quality of relevant information that is available from the IDB's own records or from data held by organisations such as Natural England and Local Biological Records Centres. Relevant information may have been collected as part of the IDB Biodiversity Action Plan process. Certain types of information may need to be collected afresh each year rather than relying on existing information. This is the case for protected species information that may be required in advance of works that might potentially damage habitat or nesting sites.

It is likely that the species and habitat information required to undertake flood risk management works will be very similar to the biodiversity information used for the preparation of an IDB BAP. The advice below therefore follows very closely the guidance produced by ADA, Defra and Natural England for the Biodiversity Audit component of the IDB BAP.

Conducting or commissioning a desk study

The first stage is a desk-based exercise to collate existing information relevant to the IDB's area of operation and the programme of works or specific improvement works proposed. A great deal of information may already be held by the IDB and additional data can be obtained from external bodies such as Local Records Centres (LRCs) or LBAP partner organisations. The most recent and accurate data available should be given the greatest weight and very old data needs to be treated with caution. This consultation with data holders is likely to identify information gaps and this is in itself an important part of the desk-study process, allowing prioritisation of the need for new survey work.

A number of types of information need to be collated for the site or area within which a specific or programme of works is proposed, including:

- Details of nature conservation sites
- Habitat information
- Species information

Nature Conservation Sites

Information should be collated on nature conservation sites, including non-statutory sites, located in the drainage district, along with any details of the site's interest features that are relevant to the IDB. For example, it should be noted if the site has a Water Level Management Plan (WLMP) or has water-dependent habitats or species. Local Natural England staff should be able to supply the statutory site information and local Wildlife Trust staff or the local planning authority the non-statutory site information.

Habitats

The IDB should assemble information on the habitats in its district or the area within which the works are proposed. This will include a mix of broad habitat types, UK BAP priority habitats and local priority habitats. The aim should be to gain an understanding of the distribution of water-dependent habitats within the area and not a comprehensive database of habitats where these are not affected by water management. As a minimum the IDB should know the location of:

- Any UK BAP priority habitats in the drainage district or at the site of the works proposed.
- Other habitats which are of local conservation importance, locally threatened, locally rare or locally distinctive/characteristic.

Common toad: one of many amphibians that rely on the beneficial management of ponds and small watercourses.

Species

The IDB should assemble information on species recorded in the area concerned. This should include, as a minimum:

- Any species specifically protected by legislation.
- Any UK BAP priority species.
- Other species which are of local conservation concern, locally threatened, locally rare, or locally distinctive/characteristic.

Sources of information

Information sources for species and habitat locations include:

- Natural England and the Environment Agency.
- UK BAP Priority habitat maps available on Natural England's Nature on the Map website (www.natureonthemap.org.uk).
- Biological datasets accessible through the National Biodiversity Network Gateway website (www.searchnbn.net).
- Habitat and species location records held by the Local Biological Record Centre.
- Information held by non-governmental conservation organisations, such as the local Wildlife Trust, the Royal Society for the Protection of Birds, Plantlife, and Buglife.
- The Local Biodiversity Action Plan produced by the LBAP partners, normally on a county basis.
- Regional Biodiversity Audits. These have been produced for most regions in England, providing information on the priority BAP habitats and species that are important regionally, but also often listing species that are not national priorities but have a regional significance.
- Phase 1 habitat surveys and more detailed surveys and reports conducted in conjunction with specific capital projects (held by the IDB or the Environment Agency) or developments by third parties (often submitted to the local planning authority to accompany the planning application).

Conducting or commissioning simple surveys

If existing data does not provide the information required, consideration will have to be given to gathering data through a new survey specifically designed to answer the questions that the IDB has posed. This may often be the case when information is required on the location of protected or highly mobile species, and needs to be known in advance of maintenance or capital works.

Where the desk study provides very little up-to-date information, perhaps about a large area subject to a programme of maintenance works, consideration may need to be given to a two-stage survey process:

- Scoping survey.
- Detailed, targeted species survey(s).

A scoping survey

A scoping survey identifies where there is potential for particular species to occur, based on habitat quality, habitat features and the signs left behind by some species. In many cases, it does not prove the presence of a particular species and it does not quantify the size of any population present. It is a survey that can be conducted at any time of the year and is valuable in defining where more detailed and resource-intensive surveys may be required.

Detailed species surveys

Many of the detailed survey methods have particular seasons during which they can be carried out most effectively or reliably. A consequence is that planning for such detailed surveys needs to be done well in advance to avoid delaying planned works until the correct survey season comes around. These seasonal timings are summarised in Table 6.1 for the protected species most likely to be of interest to IDBs.

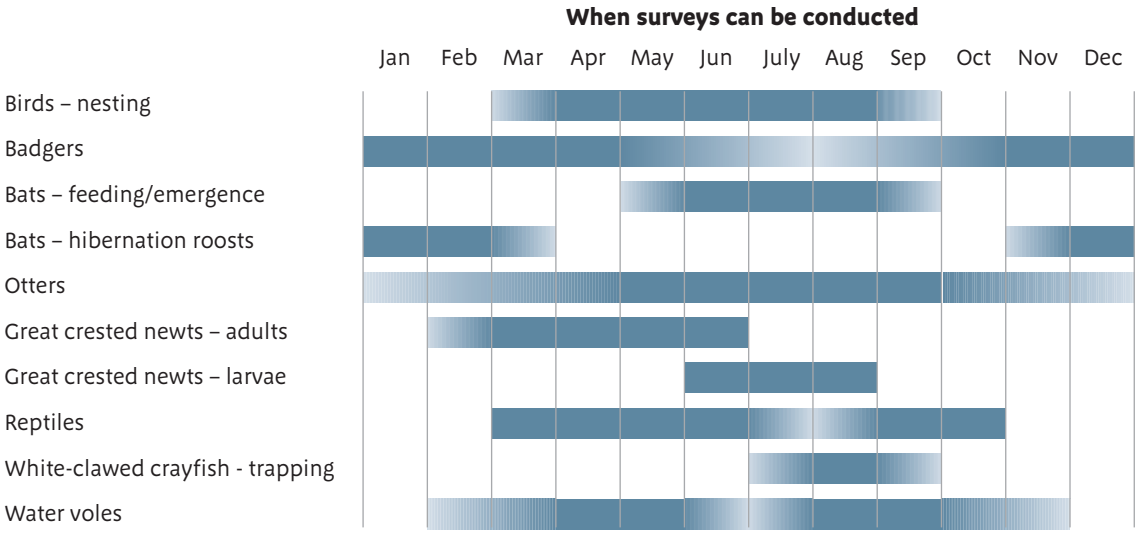


Table 6.1 – Survey seasons for protected species

Not possible
Sub-optimal
Optimal

A month is identified as sub-optimal for a survey mainly because of the reduced ability of the method to detect the presence of the target animal. This might be because the target animal is less active or the signs harder to detect. There is some potential to compensate for this reduced efficiency by expending greater effort in the survey.

For surveys of non-native or invasive plants, seasonal timings also need to be considered. Seasonal timings for surveys of non-native or invasive species of most interest to IDBs are set out in Table 6.2.

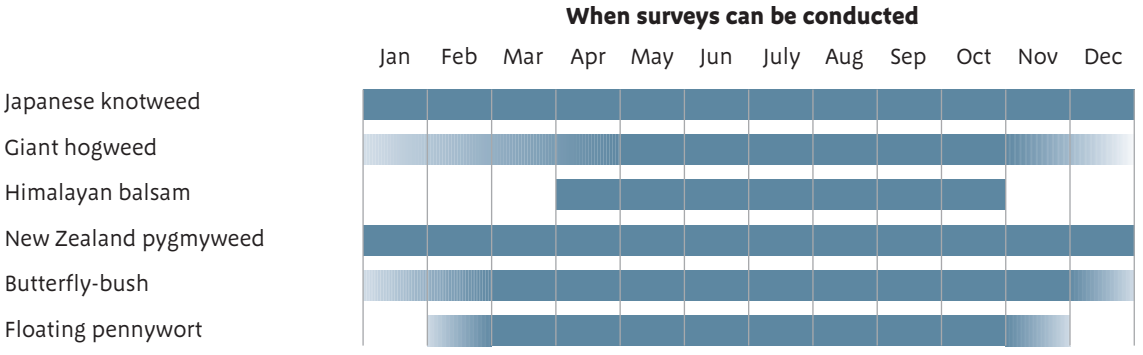


Table 6.2 – Survey seasons for non-native or invasive plants

Not possible
Sub-optimal
Optimal

It is evident that, in a number of cases, a planning period of twelve months in advance of specific works is likely to be needed to arrange for surveys to be conducted in the optimal period.

Where the survey technique involves the intentional disturbance, capture or the handling of a protected species then a licence is normally required. An application for such a licence is made to Natural England. Set out below is a description of whether or not a licence is needed to carry out a survey of protected species and under what circumstances:

Nesting birds

To look briefly into the nest of most birds does not require a licence, the exception being a limited list of species on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). For all species, including those on Schedule 1, proof of occupation can usually be gained by observation from a distance and this should be sufficient for an IDB's needs. Should it prove necessary to inspect the nest of a Schedule 1 species then a licence will need to be applied for from Natural England. The full and updated list of Schedule 1 birds can be accessed from the 'species designation database' on the JNCC website (www.jncc.gov.uk). Schedule 1 bird nests that are most likely to be encountered along drainage channels are:

- Barn owls – nesting in hollow trees, nest boxes and buildings. A licence would only be needed if there was a reason to actually look in at the nest.
- Kingfishers – nesting in a bank. Although a licence could be requested to look into the tunnel nest of a kingfisher, it is suggested that no attempt should be made to inspect the nest as this is highly likely to damage it without the use of specialist equipment such as an endoscope. Occupation of a nest site can be proven by watching from a distance in the breeding season.

Badgers

The standard survey method of looking for setts and signs of occupation and activity in an area does not require a licence.

Bats

The internal inspection of voids in buildings such as lofts, holes in trees and crevices in the brickwork of structures such as bridges that are known, or strongly suspected to contain roosting bats will require a licence.

Otters

Closely inspecting, especially seeking to look into a known otter holt will require a licence.

Great crested newts

A licence is required where a survey method is used that will disturb or capture great crested newts, including torching, netting and bottle trapping. Since the recommended survey protocol requires such techniques to be attempted in the relevant conditions, it is unlikely that an adequate survey can be carried out without a licence.

Reptiles

No licence is required to carry out the standard habitat refuge survey of the common reptiles likely to be encountered along drainage channels – common lizards, slow worms and grass snakes.

Water voles

The standard survey method of looking for burrows and signs of occupation and activity in an area does not require a licence.

White-clawed crayfish

The trapping of white-clawed crayfish requires a licence from Natural England and consent from the Environment Agency under their bye-laws.

Who should undertake the survey?

The surveyor should be competent in the identification of the species or habitat that is being targeted. As explained above, the surveyor may also need to hold a protected species licence. The surveyor should also be confident in the surveying techniques required, including mapping and, possibly, the use of Global Positioning Systems (GPS).

It may be possible for IDB staff to be trained to become competent in carrying out surveys rather than seeking volunteer help from local wildlife groups or contracting a specialist consultant. Acquiring the skills necessary to undertake a useful survey takes time. Training can be helpful at the beginning and needs to be followed by direct experience. Training recommendations for detailed survey and assessment include:

- Shadowing an experienced surveyor.
- Taking a short course in identification, mapping and assessment.
- Using an experienced surveyor to quality-assure your work.

If a contractor is to be used, consider a check on their competency, including:

- Previous experience in the identification and survey of the species or habitat involved.
- An understanding of habitat types and their associated species.
- Membership of an appropriate professional body, most probably the Institute of Ecology and Environmental Management (IEEM).
- Experience in survey and mapping techniques, ideally supported by GPS and a Geographical Information System (GIS).
- Ability to produce appropriate outputs, e.g. reports or maps, to an agreed timetable.

Action should be taken to ensure that any new biological data from habitat or species surveys are shared with the Local Biological Records Centre and the local biodiversity partnership.

Monitoring

An IDB is most likely to need a monitoring programme to assess the effectiveness and efficiency of the following:

- Mitigation actions associated with works.
- Biodiversity Action Plan delivery.
- Water Level Management Plan delivery.

Monitoring requires that the actions being assessed have had clearly defined objectives and a set of targets or indicators set for them. The monitoring information gathered by fieldwork or activity recording should follow a method that is:

- Determined by the information needs of the targets or indicators.
- Comparable, and preferably identical, to the method that determined the baseline or starting point. Without this feature it is impossible to assess reliably the change, or lack of it, from the baseline.
- Ideally a standard method applied elsewhere by the IDB or other conservation bodies with whom comparisons can be made and data shared.
- Cost-effective.
- In proportion to the resources expended on the actions being monitored.
- In proportion to the conservation status of the site, habitat or species being monitored.

For monitoring the IDB BAP it is recommended that an indicator approach be taken. Well-chosen indicators are able to give a measure of progress without the need to resort to an extensive survey programme.

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Frogbit *Hydrocharis morsus-ranae*

Further reading and information

Bat Conservation Trust (2007). *Bat Surveys – Good Practice Guidelines*. Bat Conservation Trust, London.

Chanin, P. (2003). *Monitoring the Otter* Lutra lutra. Conserving Natura 2000 Rivers Monitoring Series No. 10. English Nature, Peterborough.

English Nature (2001). *Great Crested Newt Mitigation Guidelines*. English Nature, Peterborough.

Environment Agency (2003). *A Guide to Monitoring Water Levels and Flows at Wetland Sites*. 2nd edition. Environment Agency, Bristol.

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Seven

Opportunities for landowners and tenants

Introduction

The network of drainage channels managed by drainage authorities represents only a small proportion of the ditches and drains that occur across lowland England. There is a very large number of small ditches that are managed by landowners and occupiers, and this network can make a major contribution to providing wildlife habitats across the countryside. There is the opportunity through sympathetic management for these smaller watercourses and seasonally-flooded channels to increase wildlife value without reducing their ability to carry water off the farm. There is also the potential for some of this management to be funded by Environmental Stewardship, particularly the Entry Level Stewardship (ELS) scheme.

Some landowners and occupiers have under their management part, or the whole of, a SSSI or land immediately adjacent to a SSSI. Improvements to the management of land that benefits the SSSI is potentially eligible for funding by the Higher Level Stewardship (HLS) component of Environmental Stewardship (ES). There are also HLS options that support wetland restoration and creation for land outside the SSSI network.

IDBs are being encouraged to help landowners and occupiers to access such funding by considering how IDB channels and structures can be managed to achieve the water level conditions required and, if necessary, to investigate the need for any additional water level management structures to achieve the conditions sought in a HLS application.

Management of landowner drainage ditches

There are significant differences between field ditches and drains in grassland and those in arable land, including in their structure and the amount and quality of water. Grazing maintains a diverse sward structure on the bank side and provides areas of bare mud. Often high water levels are maintained to provide drinking water for the livestock and so that the channels act as 'wet fences'. In arable areas the banks tend to be steeper and bankside vegetation is managed by cutting or the use of herbicides. In the periods between cuts, the tall bankside and emergent vegetation will shade the channel and its vegetation to a greater extent than along a grazed field. The steep slope and depth of the bank in arable areas compared to a ditch in a grazed area can also mean a greater degree of shading. In arable drains and ditches water will not be deliberately maintained at a high level, except where water is held back in summer for irrigation. Water quality is often affected by cultivation of adjacent land. This can include nitrate in solution and phosphates attached to suspended solids resulting from erosion and run-off.

Without a permanent presence of water or, at the very least, damp conditions, none of the true wetland plants will survive or become established. Where water is present there is a tendency for emergent plants to progressively colonise open water, compete with submerged vegetation and reduce species diversity. In ditches with shallow water this can be very rapid, often within one season. Retention of water and regular management by a combination of vegetation cutting and

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Reed warbler: careful management of reeds and tall emergent vegetation is important to protect nests and young.

sediment removal is therefore necessary. In dry ditches, there is no water to slow down the succession from grassy vegetation to tall herbaceous vegetation and scrub, so cutting to maintain a clear channel is often required every year.

Techniques for the management of such field ditches include many of those in Chapter Five on management techniques for IDBs. Appendix 3 summarises those techniques that are applicable to small drainage channels and these should be considered in addition to the following guidance on management of field ditches.

The optimum frequency and timing of cutting bankside vegetation will vary according to the particular conservation objectives, the size of the ditch, and possibly the slope and orientation of the ditch as well. Where enhancement of floating and submerged plants is sought, cutting in late winter to early spring (March) will tend to delay the spring re-growth of bankside vegetation and reduce shading of the open water. Adopting this management practice, rather than cutting in late summer or just after harvest, is likely to be more important in narrow ditches and those with steeper banks. The orientation of the ditch will also have some effect on the outcome of such management. Narrow north-south running ditches receive more sunlight falling on the water surface than those orientated east-west.

Plant species diversity along the banks and at the water margin (where water is present) can be maintained by cutting annually (in late winter-early spring) or twice a year (in autumn and again in late winter-early spring). Cutting only once every two years or not at all risks the banks and margins becoming dominated by the more aggressive and coarse species of grasses and, if there is no cutting in the long term, by shrubby plants.

There may be some sections of ditch or the bank where the objective might be domination by reeds for birds such as reed and sedge warblers and reed bunting, or the creation of a strip of scrub above flood levels. In these cases, not cutting except on long rotations would be appropriate. Nevertheless, leaving reed fringes uncut for many years can lead to the invasion by shrubby plants and the

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Pollarded willows: a habitat that supports a host of bird and invertebrate life and is a defining feature of many wetland landscapes.

eventual loss of reeds. A rotational cutting of reed is appropriate, cutting every year where water flows are critical and in a two to five-year rotation outside of such critical areas.

Cutting tall emergent vegetation, including stands of reed between March and September will damage the nests and kill the young of breeding birds such as reed and sedge warblers and reed bunting. Similarly, the cutting of bankside vegetation prior to or close to harvest will damage those birds' nests present and prevent birds from having second broods. Second broods are often vital for maintaining populations. Such cutting will also remove the vegetation within which the harvest mouse suspends its summer nest. To minimise damage to wildlife, bankside vegetation should be cut on one ditch side only, and sides cut in rotation (e.g. once every two to six years) to ensure good structural variation. Landowners and occupiers should ensure that they are familiar with the legislation on protected species, which is set out in earlier chapters of this manual.

The cutting of bankside vegetation in the autumn, winter or early spring is much less damaging to wildlife, including invertebrates, than that carried out in the summer. Cutting during the summer removes the cover, food and nectar sources of many invertebrates, which in turn provide food for breeding birds. Cutting in the winter will remove the over-wintering sites for hibernating adults, immobile larvae, pupae or eggs of some species. To permit over-winter survival of invertebrates some stretches of bankside and emergent vegetation should be left uncut, applying a two-year rotation with alternate banks cut each year.

Some shade from overhanging shrubs and other vegetation is acceptable and the shrubs and trees do themselves provide a diversity of habitat, bird nesting sites and shelter for flying insects during windy conditions. Overhanging vegetation and shrubs should not be allowed to develop though along previously unshaded ditches.

Maintaining some water in small field ditches that would normally dry out in late spring or summer will provide great benefits through promoting the survival of aquatic plants species and providing moist conditions suited to many soil invertebrates. This in turn will provide food for insect eating

birds, including those who for most of the year feed on seeds but feed their nestlings a protein-rich diet of insects. This can be achieved by the installation of cheap shallow (20-30cm high) dams (bunds) in the ditch. In some circumstances installation may require bye-law consent from the Environment Agency or IDB so this should be checked with the operating authority in advance. Such low bunds will have no deleterious effect on field drainage provided that it does not cause the piped drain outfalls to be submerged.

An additional enhancement of the structure of field ditches is the introduction of shallow margins or berms. These provide habitat and greater opportunities for the colonisation of marginal plants than with steep banks. A shallow slope and/or a berm will provide a gradual transition from wetland and marginal communities through to drier grassland. Where there is a steep slope the zone of transition is much narrower.

The use of uncropped strips alongside ditches, financed by the Entry Level Stewardship component of Environmental Stewardship should be given serious consideration. This will provide a potential buffer against spray and fertiliser drift into the ditch, create or increase the area of terrestrial habitat for wildlife and help stabilise the ditch banks.

Opportunities under Environmental Stewardship

Environmental Stewardship is the agri-environment scheme in England that has developed from, and is now superceding the Countryside Stewardship Scheme (CSS) and the Environmentally Sensitive Areas (ESA) Scheme. Environmental Stewardship has three elements:

- Entry Level Stewardship (ELS)
- Organic Entry Level Stewardship (OELS)
- Higher Level Stewardship (HLS)

Set out below is a summary of the main management improvements that are available to a landowner or occupier as part of these schemes. Since the detail of the schemes is subject to regular review, an overview is provided here and further information should be sought from Natural England or the Defra website.

Entry Level Stewardship

This is a 'whole-farm scheme' open to all farmers and land managers. Acceptance into the scheme is guaranteed provided the applicant can meet the scheme requirements. ELS aims to encourage large numbers of farmers and land managers across England to deliver simple yet effective environmental management that goes beyond the cross-compliance requirement to maintain land in Good Agricultural and Environmental Condition (GAEC). Applicants choose from a 'menu' of options that have different values of points attached to them and the applicant has to achieve a total of 30 points per hectare of land entered. There are no additional payments under ELS for exceeding the points total.

The land management options that are relevant to fields situated alongside drainage channels include:

- Ditch management – both sides.
- Ditch management – one side.
- Hedgerow management – can be combined with the ditch management options.
- Buffer strips on cultivated land.
- Buffer strips on intensive grassland.
- Management of high-erosion risk cultivated land.

Organic Entry Level Stewardship

This is a 'whole-farm scheme' similar to ELS, open to farmers who manage all or part of their land organically.

Higher Level Stewardship

This scheme aims to deliver significant environmental benefits in high priority situations and areas, as described in each local targeting statement (available from Natural England). An HLS application is, under most circumstances, combined with ELS or OELS options. HLS is competitive in entry and a successful application is not guaranteed. Support is provided in the refining of the application, and agreements are tailored to local circumstances.

The five primary objectives of HLS are:

1. Wildlife conservation.
2. Maintenance and enhancement of landscape quality and character.
3. Natural resource protection.
4. Protection of the historic environment.
5. Promotion of public access and understanding of the countryside.

There are two secondary objectives where spin-off benefits are sought from management designed to achieve the five primary objectives. These are:

- Flood management.
- Conservation of genetic resources.

An application requires a formal assessment of the features on the land, submitted in the form of the Farm Environment Plan. Natural England staff score the application against the local targeting statement. If the application passes this initial assessment then a site visit will be made and discussions held on any necessary modifications.

For existing wetland sites, and where wetland creation is proposed, the potential complexity of management may require that a detailed management plan is prepared as part of the HLS application. This possibility should be discussed with Natural England in the early stages of considering a HLS application. The need for any modifications to water control structures or new structures within an internal drainage district would need to be discussed with the IDB. There may be a need to consider effects wider than the application site, including effects on flood risk management. Natural England and Defra have encouraged IDBs to take a positive role in this process and under some circumstances funding may be available for the IDB to carry out strategic studies of potential changes to water level management.

The land management options that are relevant to water dependent habitats include:

- Species-rich, semi-natural grassland – maintenance, restoration and creation.
- Wet grassland for breeding waders – maintenance, restoration and creation.
- Wet grassland for wintering waders and wildfowl – maintenance, restoration and creation.
- Semi-improved or rough grassland for target species – maintenance restoration and creation.
- Traditional water meadows – maintenance and restoration.
- Ponds of high wildlife value – maintenance.
- Reedbeds – maintenance, restoration and creation.
- Fen – maintenance, restoration and creation.
- Lowland raised bog – maintenance and restoration.

Supplements are available for hay-making, raised water levels, inundation grassland and for group applications on some of the above land management options. Funding is also available for a range of capital works.

Facilitating schemes

There are a number of factors that will may help the establishment of Environmental Stewardship and principally HLS schemes that seek to maintain, restore and create wetland habitats within internal drainage districts. These are:

- Defra and Natural England are seeking to have 95 per cent of SSSIs in favourable condition by 2010.
- SSSIs are targeted by HLS.
- Wetland habitats are targeted by HLS.
- IDBs have prepared Water Level Management Plans for SSSIs.
- IDB BAPs are expected to provide for the enhancement of BAP priority habitats and species.
- IDBs are being encouraged to help landowners and occupiers to access funding from Environmental Stewardship.

Funding may be available for the IDB to carry out strategic studies of potential changes to water level management and preliminary studies for works necessary to deliver a WLMP.
Funding for new water level management structures may be available through the Capital Works Plan to an HLS applicant where it aids management on the potential agreement land.

Funding for new water level management structures may be available to an IDB where the proposed structure is on their adopted watercourse and the result of the management of that new structure would be to deliver the objectives of a WLMP and favourable condition of a SSSI.

Whilst HLS has a competitive application process, these factors taken together mean that a well-planned proposal for the maintenance, restoration or creation wetland habitats within an internal drainage district has a high probability of scoring sufficient points to pass on to the detailed assessment and negotiation stage. It also means that there is a potential partnership in existence to support and facilitate a successful application by a landowner or occupier.

Further reading and information

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The Wetland Vision partnership website www.wetlandvision.org.uk. The partnership includes English Heritage, the Environment Agency, Natural England, the Royal Society for the Protection of Birds and the Wildlife Trusts.

Appendix one

Glossary

Annex 1 birds
An Annex to the Birds Directive that lists species or sub-species of birds that are the subject of special conservation measures across the European Union. The classification of Special Protection Areas (SPAs) is one of the main measures taken for these species.

Annex 2 species
An Annex to the Habitats Directive that lists species of plants and animals (but not birds) that are endangered and have a high proportion of their world population in the European Community. The Habitats Directive requires that Special Areas of Conservation are designated for these species.

Annex 4 species
An Annex to the Habitats Directive that lists species of plants and animals (but not birds) that are endangered, vulnerable, rare or endemic in the European Community and in need of strict protection. They are protected from killing, disturbance or the destruction of their habitat.

Appropriate assessment
A step in the decision-making process for plans and projects required under Regulation 48 of The Conservation (Natural Habitats, &c.) Regulations, 1994. The purpose of the appropriate assessment is to determine whether it can be concluded that proposals would not adversely affect the integrity of a European conservation site.

Back-ditch
The back-ditch (or borrow, soak or soke dyke) is a channel created when a flood embankment or seawall is built, with the material for the flood defence structure being won from the adjacent land to leave the channel.

Biodiversity Action Plan (BAP)
A plan of action to conserve and enhance habitats or species. There is a UK BAP and Local BAPs that operate at the county level. IDBs are also committed to developing Biodiversity Action Plans. For further information consult the BAP website www.ukbap.org.uk.

Birds Directive
In 1979, the European Community adopted Council Directive 79/409/EEC on the conservation of wild birds. The Directive provides a framework for the conservation and management of wild birds in Europe.

Borrow dyke
See back-ditch.

Catchment Flood Management Plan (CFMP)
Catchment Flood Management Plans are large-scale strategic plans for the integrated and sustainable management of flood risk in river catchments for the benefit of people and the developed and natural environment.

Competent authority
Any Minister, Government department, public or statutory undertaker, public body of any description or person holding a public office, that makes a decision affecting a European Site. For WLMPs, this includes local authorities, Internal Drainage Boards and the Environment Agency.

Conservation objectives
Objectives that need to be achieved to maintain or restore to favourable conservation condition the features for which a Site of Special Scientific Interest or European site was designated. Each set of conservation objectives is accompanied by site-specific attributes that help define favourable condition (commonly referred to as favourable condition tables).

Environmental Impact Assessment (EIA)
The process by which the likely impacts of a project upon the environment are identified, collated, measured and assessed to determine their significance. The assessment helps to maximise positive effects and mitigate negative effects during project design.

European site
A site that has been designated as a site of international nature conservation importance, either as a Special Protection Area (SPA) or a Special Area of Conservation (SAC). In England, this also includes a candidate Special Area of Conservation (cSAC) and Ramsar sites.

Favourable condition
A Site of Special Scientific Interest (SSSI) is in favourable condition when the conservation objectives for the site are being achieved. Natural England monitors a range of attributes, related to the ecological requirements of the site's interest features, in order to make this assessment. Where an SSSI is also a European site, this assessment is an important indicator of the contribution the site makes to the favourable conservation status of the habitats and species it supports (see below).

Favourable conservation status
The condition in which a natural habitat or species listed in the Annexes of the Habitats Directive or Birds Directive is capable of sustaining itself in the long term across its natural range.

Floodplain
An area through which watercourses run and over which floodwater naturally extends. The extent and depth of flooding over a floodplain will vary and depend on the severity of the flood.

Flood storage area
An artificial structure designed to store floodwater in order to mitigate flooding downstream. This storage can be on-line, where all water flows through the storage area and impounding is controlled by a dam and sluice structure, or off-line, where flow diverted from the river is controlled by a weir or sluice.

Habitats Directive
The 1992 European Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. This requires Member States to introduce measures to protect species listed in the Annexes. The 169 habitats listed in Annex I of the Directive and the 623 species listed in Annex II are to be protected by means of a network of sites – Special Areas of Conservation (SACs). These sites, along with Special Protection Areas (SPAs) classified under the Birds Directive, form a network of protected areas known as Natura 2000.

Highland carrier
Watercourses that convey drainage water coming from higher in the catchment across or around a lower, drained area of land and having little or no connection with the drainage network of that drained area.

Integrity of a European site
Integrity is defined as the coherence of a site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified.

Main river
Watercourses defined on a 'Main River Map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers.

Natura 2000
The network of protected areas – Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) – established respectively under the Habitats Directive and the Birds Directive.

Operating authority
A body with powers to undertake management of flood risk, coastal erosion risk and water level management. This includes the Environment Agency, local authorities and Internal Drainage Boards.

Ordinary watercourses
All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewers) and passages through which water flows but which do not form part of a Main River.

Propagules
A collective term for the various structures that plants use to reproduce. It applies to seeds and spores, and parts of a plant that serve as means of vegetative reproduction, such as corms, rhizomes, tubers and turions.

Ramsar site
An area of land, normally already identified as a SSSI, whose wetlands qualities, habitats or species, are recognised as being of international importance through classification as a Ramsar site under the Ramsar Convention.

Schedule 1 species
A Schedule to the Wildlife and Countryside Act 1981 that lists birds for which the offences of intentionally killing, injuring, or taking these birds, their eggs or nests is the subject of special penalties. There are also offences of disturbing these birds at their nests, or their dependent young.

Schedule 5 animals
The Act makes it an offence (subject to exceptions) to intentionally kill, injure, or take, possess, or trade in any wild animal listed in Schedule 5, and prohibits interference with places used for shelter or protection, or intentionally disturbing animals occupying such places. The Act also prohibits certain methods of killing, injuring, or taking wild animals.

Schedule 8 plants
The Act makes it an offence (subject to exceptions) to pick, uproot, trade in, or possess (for the purposes of trade) any wild plant listed in Schedule 8, and prohibits the unauthorised, intentional uprooting of such plants.

Significant effect
Where a plan or project is likely to affect a European site, it is necessary to decide whether or not it would have a significant effect. If there is any doubt, the operating authority must consult Natural England.

Site of Special Scientific Interest (SSSI)
Sites of Special Scientific Interest (SSSI) are the best examples of our natural heritage of wildlife habitats, geological features and landforms. An SSSI is an area that has been notified as being of special interest under the Wildlife and Countryside Act 1981.

Soak or soke dyke
See back-ditch.

Special Area of Conservation (SAC)
A site of European importance for habitats and/or species, designated in accordance with the EU Habitats Directive. A cSAC is a candidate site, but is afforded the same legal status as a SAC in England.

Special Protection Area (SPA)
A site of European importance for birds, designated in accordance with the EU Birds Directive. A pSPA is a proposed site, but is afforded the same status in UK policy terms as if confirmed.

Strategic Environmental Assessment (SEA)
The application of an environmental impact assessment process to the more strategic tiers of decision-making policies, plans and programmes. It is required in specific circumstances though EC Directive 2001/42/EC.

Succession
A natural process of change in plant communities. In the case of drainage channels, it is usually the change from a very open channel immediately after vegetation or silt clearance to a more vegetated channel. Channel management can effectively arrest or reverse this succession in order to maintain required standards of flood conveyance or storage capacity.

Sustainable Drainage Systems (SUDS)
A range of management practices, control structures and other facilities designed to accommodate the drainage of surface water from an urban area in a way that more closely resembles the run-off from a natural site.

Washland
Usually an area of floodplain surrounded by artificial banks that, in a flood event, fills with water and provides temporary storage of flood water and flows.

Water Framework Directive (WFD)
EC Directive 2000/60/EC on integrated river basin management. The WFD sets out environmental objectives for water status based on ecological and chemical parameters, arrangements for river basin administration and planning, and a programme of measures in order to meet the objectives.

Water Level Management Plan (WLMP)
A document setting out water level management objectives in a defined floodplain area, very often a SSSI.

Wetland
An area where the water table is either seasonally or permanently high. Wetlands naturally occur in river valleys where drainage is impeded either by topography or soil structure. The Ramsar Convention defines wetlands as: "An area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt including areas of marine water, the depth of which at low tide does not exceed 6m."

Appendix two

List of scientific names

Plants

Ash	*Fraxinus excelsior*
Australian swamp stonecrop	*Crassula helmsii*
Beech	*Fagus sylvatica*
Blackthorn	*Prunus spinosa*
Bramble	*Rubus fruticosus*
Butterfly-bush	*Buddleja davidii*
Common ivy	*Hedera helix*
Canadian pondweed	*Elodea canadensis*
Common nettle	*Urtica dioica*
Common reed	*Phragmites australis*
Couch grass	*Agropyron repens*
Crack willow	*Salix fragilis*
Curly pondweed	*Lagarosiphon major*
Cut-grass	*Leersia oryzoides*
Dwarf stonewort	*Nitella tenuissima*
False oat-grass	*Arrhenatherum elatius*
Floating pennywort	*Hydrocotyle ranunculoides*
Floating water-plantain	*Luronium natans*
Frogbit	*Hydrocharis morsus-ranae*
Giant rhubarb	*Gunnera tinctoria*
Giant hogweed	*Heracleum mantegazzianum*
Greater water-parsnip	*Sium latifolium*
Grass-wrack pondweed	*Potamogeton compressus*
Great tassel stonewort	*Tolypella prolifera*
Hawthorn	*Crataegus monogyna*
Hazel	*Corylus avellana*
Himalayan balsam	*Impatiens glandulifera*
Holly-leaved naiad	*Najas marina*
Horse-chestnut	*Aesculus hippocastanum*
Japanese knotweed	*Fallopia japonica*
Lesser bearded stonewort	*Chara curta*
Oilseed rape	*Brassica napus* L. ssp. *oleifera*
Pedunculate oak	*Quercus robur*
Parrot's-feather	*Myriophyllum aquaticum*
Pillwort	*Pilularia globulifera*
Ribbon-leaved water-plantain	*Alisma gramineum*
Scots pine	*Pinus sylvestris*
Sharp-leaved pondweed	*Potamogeton acutifolius*
Slender stonewort	*Nitella gracilis*
Sweet chestnut	*Castanea sativa*
Tassel stonewort	*Tolypella intricata*
Tubular water-dropwort	*Oenanthe fistulosa*
Walnut	*Juglans regia*
Water fern	*Azolla filiculoides*
Water hyacinth	*Eichhornia crassipes*
Water lettuce	*Pistia stratiotes*
Water primrose	*Ludwigia grandiflora*
White willow	*Salix alba*

Amphibians

Common toad	*Bufo bufo*
Great crested newt	*Triturus cristatus*

Reptiles

Adder	*Vipera berus*
Common lizard	*Lacerta vivipara*
Grass snake	*Natrix natrix*
Slow worm	*Anguis fragilis*

Fish

Allis/Twaite shads	*Alosa alosa/fallax*
Atlantic salmon	*Salmo salar*
Brown/Sea trout	*Salmo trutta*
European eel	*Anguilla anguilla*
River lamprey	*Lampetra fluviatilis*
Sea lamprey	*Petromyzon marinus*
Smelt	*Osmerus eperlanus*
Spined loach	*Cobitis taenia*

Mammals

American mink	*Mustela vison*
Badger	*Meles meles*
Brown rat	*Rattus norvegicus*
Harvest mouse	*Micromys minutus*
Otter	*Lutra lutra*
Water shrew	*Neomys fodiens*
Water vole	*Arvicola terrestris*

Invertebrates

A diving beetle	*Laccophilus poecilus*
A weevil	*Stenopelmus ruinasus*
Depressed river mussel	*Pseudanodonta complanata*
Desmoulin's whorl snail	*Vertigo moulinsiana*
Fen raft spider	*Dolomedes plantarius*
Fine-lined pea mussel	*Pisidium tenuilineatum*
Freshwater pearl mussel	*Margaritifera margaritifera*
Large-mouthed valve snail	*Valvata macrostoma*
Lesser silver water beetle	*Hydrochara caraboides*
Little ramshorn whirlpool snail	*Anisus vorticulus*
Marsh fritillary	*Eurodryas aurinia*
Medicinal leech	*Hirudo medicinalis*
Narrow-mouthed whorl snail	*Vertigo angustior*
Norfolk hawker	*Aeshna isosceles*
Shining ramshorn snail	*Segmentina nitida*
Signal crayfish	*Pacifastacus leniusculus*
Southern damselfly	*Coenagrion mercuriale*
Swallowtail	*Papilio machaon*
White-clawed crayfish	*Austropotamobius pallipes*

Bats

Barbastelle bat	*Barbastella barbastellus*
Bechstein's bat	*Myotis bechsteinii*
Brandt's bat	*Myotis brandtii*
Brown long-eared bat	*Plecotus auritus*
Common pipistrelle	*Pipistrellus pipistrellus*
Daubenton's bat	*Myotis daubentonii*
Greater horseshoe bat	*Rhinolophus ferrumequinum*
Greater mouse-eared bat	*Myotis myotis*
Grey long-eared bat	*Plecotus austriacus*
Leisler's bat	*Nyctalus leisleri*
Lesser horseshoe bat	*Rhinolophus hipposideros*
Nathusius' pipistrelle	*Pipistrellus nathusii*
Natterer's bat	*Myotis nattereri*
Noctule bat	*Nyctalus noctula*
Serotine bat	*Eptesicus serotinus*
Soprano pipistrelle	*Pipistrellus pygmaeus*
Whiskered bat	*Myotis mystacinus*

Birds

Bearded tit	*Panurus biarmicus*
Bewick's swan	*Cygnus columbianus bewickii*
Bittern	*Botaurus stellaris*
Cetti's warbler	*Cettia cetti*
Coot	*Fulica atra*
Curlew	*Numenius arquata*
Dark-bellied brent goose	*Branta bernicla*
Gadwall	*Anas strepera*
Garganey	*Anas querquedula*
Grasshopper warbler	*Locustella naevia*
Greylag goose	*Anser anser*
Kingfisher	*Alcedo atthis*
Lapwing	*Vanellus vanellus*
Mallard	*Anas platyrhynchos*
Marsh harrier	*Circus aeruginosus*
Marsh warbler	*Acrocephalus palustris*
Moorhen	*Gallinula chloropus*
Mute swan	*Cygnus olor*
Pochard	*Aythya ferina*
Reed bunting	*Emberiza schoeniclus*
Reed warbler	*Acrocephalus scirpaceus*
Sedge warbler	*Acrocephalus schoenobaenus*
Shoveler	*Anas clypeata*
Snipe	*Gallinago gallinago*
Song thrush	*Turdus philomelos*
Spotted crake	*Porzana porzana*
Teal	*Anas crecca*
Tufted duck	*Aythya fuligula*
Water rail	*Rallus aquaticus*
Yellow wagtail	*Motacilla flava*

Appendix three

Index to techniques by channel size

The techniques described in Chapter 5 are not suitable for application to all watercourses. Table A3.1 identifies those techniques that are best suited to small (narrower than 2 metres) or medium-to-large (wider than 2 metres) watercourses, or which could be applied to both. The techniques are also categorised by their suitability for annual maintenance or long-term maintenance and capital works. The techniques that apply outside the channel corridor are not included here.

Applied in the annual maintenance programme

Technique	Reference	< 2 metres	> 2 metres
Selective removal of aquatic plants to permit recolonisation 1	C-A-1		■
Selective removal of aquatic plants to permit recolonisation 2	C-A-2		■
Selective removal of aquatic plants to permit recolonisation 3	C-A-3	■	■
Selective removal of aquatic plants to permit recolonisation 4	C-A-4	■	■
Leaving headwaters untouched	C-A-5	■	■
Biological control of water fern (*Azolla*) using a weevil	C-A-6	■	■
Herbicide application to maintain an open channel	C-A-7		■
Herbicide application to maintain an open channel over selected reaches	C-A-8		■
Selective removal of emergent plants to give a sinuous effect	M-A-1		■
Selective removal of emergent plants	M-A-2	■	■
An emergent fringe on a single side	M-A-3		■
An emergent fringe on both sides	M-A-4		■
Herbicide application to maintain an open margin	M-A-5	■	■
Herbicide application to maintain an open margin over selected reaches	M-A-6		■
Cutting technique – targeting specific wildlife interest	B-A-1		■
Cutting technique – differential cutting parallel to the water line	B-A-2		■
Cutting and removal of bankside grass and similar non-woody vegetation	B-A-3	■	■
Cutting technique – cutting by hand	B-A-4	■	■
Cutting technique – hay cut	B-A-5	■	■
Cutting technique – flail mowing	B-A-6	■	■
Grazing	B-A-7	■	■
Bank cover – scrub	B-A-8		■
Pollarding willows	B-A-9	■	■
Trimming of overhanging branches	B-A-10	■	■
Working between trees	B-A-11	■	■

Technique	Reference	< 2 metres	> 2 metres
Coppicing	B-A-12	■	■
Singling coppice	B-A-13	■	■
Laying hedges	B-A-14	■	■
Manipulation of shading	B-A-15	■	■
Management of drove roads	B-A-16	■	■
Herbicide application to manage plants along the bank	B-A-17		
Herbicide application to manage plants at selected sites along the bank	B-A-18		
Buffer strips on the bank tops	O-A-1	■	■

Applied in the long-term maintenance or capital programme

Technique	Reference	< 2 metres	> 2 metres
Scalloping vegetation and underlying silt to create meanders	C-L-1		■
Re-establishment/re-distribution of aquatic plants	C-L-2	■	■
Creation of pools	C-L-3		■
Over-deepening the centre of the channel	C-L-4	■	■
Re-establishment/re-distribution of emergent plants.	M-L-1	■	■
Selective removal of waterplants to permit recolonisation	C-C-1	■	■
Re-establishment/re-distribution of aquatic plants	C-C-2	■	■
Creation of pools	C-C-3	■	
Reedbed to reduce diffuse pollution	C-C-4	■	
Silt traps to reduce diffuse sediment pollution	C-C-5	■	■
Stabilising of bed at culvert mouths	C-C-6	■	■
Sluices	C-C-7	■	■
Washlands	C-C-8		■
On-line and off-line flood storage ponds	C-C-9		■
Re-establishment/re-distribution of emergent plants	M-C-1	■	■
Submerged berm	M-C-2		■
Submerged berm and linear reedbed	M-C-3		■
Natural regeneration of banks	B-C-1	■	■
Re-seeding banks	B-C-2	■	■
Retention of vertical banks	B-C-3		■
Stabilising banks using natural or prefabricated materials	B-C-4	■	■
Hedgerow planting	B-C-5	■	■
Introduction of bushes and trees	B-C-6		■
Planting of trees or shrubs at drain junctions	B-C-7	■	■
Planting and managing trees as biological control for vegetation control	B-C-8	■	■

Table A3.1 – Management techniques by channel size

Herbicides

Available herbicides

Currently, there are four herbicides approved for use to control vegetation in or near water. These herbicides, range of use and associated information are provided in Table A4.1.

Herbicide	Branded names	Plant groups for which is it suitable	Comments
Glyphosate	Roundup Biactive	Non-selective	Systemic herbicide, non-persistent
2,4-D amine	Herboxone Weedone Depitox	Broad-leaved plant species on banks	Systemic herbicide, no longer subject to a patent and may be found under a number of brand names
Asulam	Azulox	Bracken and docks near water	Systemic herbicide
Dichlobenil	Casoron	Non-selective	Residual herbicide, available as slow-release formulation

Table A4.1 – Herbicides approved for use in or near water

For up-to-date guidance on the herbicides currently approved for use in or near water, contact the Pesticides Safety Directorate at www.pesticides.gov.uk.

Timing of spray applications on emergent plants

Spray applications are most effective in mid to late summer. Spraying later is not advised as the plants are starting to die back. This means that the herbicide is not translocated effectively from shoots to roots or rhizomes. Common reed can be controlled effectively when sprayed as early as mid-May.

Governing legislation and precautions

In order to use herbicides safely, the manufacturer's guidance must be followed, with all product labels read carefully and their instructions followed on usage and restrictions. Protective clothing and equipment appropriate to a given chemical must be used. It is also important to ensure that weather conditions are suitable for the use of chemicals, as wet and windy weather can affect the effectiveness of the herbicides and put neighbouring land, including crops at risk.

Before any pesticide can be used, sold, supplied, advertised or stored, it must be approved for use under the provisions of the Control of Pesticides Regulations 1986 (as amended), made under the

Food and Environment Protection Act 1985. Approval of agricultural pesticides (known as plant protection products) is carried out by the Pesticides Safety Directorate (PSD) and non-agricultural pesticides are approved by the Health and Safety Executive (HSE).

All those applying pesticides are required by law to take all reasonable precautions when using them to protect the health of human beings, creatures and the environment. Advice on how to meet these responsibilities is given in the statutory code of practice (Defra 2006).

Everyone who uses pesticides must have adequate guidance, instruction or training for their correct use. This includes holding an appropriate National Proficiency Tests Council (NPTC) certificate of competence in the case where the person applying the pesticide is not the owner or occupier of that land.

A number of pesticides are covered by the COSHH regulations. For these products, before use an employer or self-employed person must carry out a suitable and sufficient assessment of the likely risks to health. This will help identify the measures needed to protect the health of any person who could be harmed.

The Environment Agency must issue written agreement for any applications in or near water via form WQM1.

Sources of Information and further reading

Defra (2006). *Pesticides: Code of practice for using plant protection products*. (PB11090). Defra, London.

Common ragwort *Senecio jacobaea*

Appendix five

Key species for Internal Drainage Boards

This appendix contains two lists that identify species that merit consideration for enhancement by IDBs in their operational planning and management activities.

UKBAP species with a high association with drainage channels

Table A5.1 contains all those species listed as having a high association with drainage channels or ditches in Appendix 2 of the IDB BAP guidance publication *Internal Drainage Board Biodiversity Action Planning: Guide to Producing IDB Biodiversity Action Plans* (ADA, Defra and Natural England 2008).

Water vole	*Arvicola terrestris*
Otter	*Lutra lutra*
Reed bunting	*Emberiza schoeniclus*
European eel	*Anguilla anguilla*
Spined loach	*Cobitis taenia*
Great crested newt	*Triturus cristatus*
Fen raft spider	*Dolomedes plantarius*
a diving beetle	*Laccophilus poecilus*
Shining ramshorn snail	*Segmentina nitida*
Little ramshorn whirlpool snail	*Anisus vorticulus*
Narrow-mouthed whorl snail	*Vertigo angustior*
Pillwort	*Pilularia globulifera*
Ribbon-leaved water-plantain	*Alisma gramineum*
Floating water-plantain	*Luronium natans*
Tubular water-dropwort	*Oenanthe fistulosa*
Grass-wrack pondweed	*Potamogeton compressus*
Greater water-parsnip	*Sium latifolium*
Tassel stonewort	*Tolypella intricata*
Great tassel stonewort	*Tolypella prolifera*

Table A5.1 – UKBAP species with a high association with drainage channels

Species of principal importance for Biodiversity in England relevant to the freshwater sector

Under the provisions of Section 41 of the Natural Environment and Rural Communities Act 2006, a list of Species of Principal Importance for Biodiversity in England has been produced. From within that list species have been identified for particular attention in the freshwater sector by statutory bodies, including IDBs, when carrying out their functions. This list is set out in Table A5.2.

Further information about species of principal importance for the freshwater sector can be found on the UKBAP website at www.ukbap.org.uk.

Water vole	*Arvicola terrestris*
Otter	*Lutra lutra*
Dark-bellied brent goose	*Branta bernicla*
Bewick's swan	*Cygnus columbianus bewickii*
Reed bunting	*Emberiza schoeniclus*
Yellow wagtail	*Motacilla flava*
Curlew	*Numenius arquata*
Lapwing	*Vanellus vanellus*
Allis/Twaite shads	*Alosa alosa/fallax*
European eel	*Anguilla anguilla*
River lamprey	*Lampetra fluviatilis*
Smelt	*Osmerus eperlanus*
Sea lamprey	*Petromyzon marinus*
Atlantic salmon	*Salmo salar*
Brown/Sea trout	*Salmo trutta*
Common toad	*Bufo bufo*
Grass snake	*Natrix natrix*
Great crested newt	*Triturus cristatus*
White-clawed crayfish	*Austropotamobius pallipes*
Norfolk hawker	*Aeshna isosceles*
Southern damselfly	*Coenagrion mercuriale*
Freshwater pearl mussel	*Margaritifera margaritifera*
Fine-lined pea mussel	*Pisidium tenuilineatum*
Depressed river mussel	*Pseudanodonta complanata*
Large-mouthed valve snail	*Valvata macrostoma*
Desmoulin's whorl snail	*Vertigo moulinsiana*
Cut-grass	*Leersia oryzoides*
Pillwort	*Pilularia globulifera*
Floating water-plantain	*Luronium natans*
Tubular water-dropwort	*Oenanthe fistulosa*
Grass-wrack pondweed	*Potamogeton compressus*
Greater water parsnip	*Sium latifolium*
Great tassel stonewort	*Tolypella prolifera*

Table A5.2 – Species of principal importance for the freshwater sector

Management for BAP priority plant species in drainage channels

1 Submerged and floating plants

Common name	Scientific name	UKBAP	Other	IUCN category
Grass-wrack pondweed	*Potamogeton compressus*	Yes	NS	EN
Floating water-plantain	*Luronium natans*	Yes	NS, Sch8, Ann II, AnnIV, App1	LC
Holly-leaved naiad	*Najas marina*	Yes	Sch8	
Sharp-leaved pondweed	*Potamogeton acutifolius*	Yes	NR	CR
Dwarf stonewort	*Nitella tenuissima*	Yes		EN
Slender stonewort	*Nitella gracilis*	*Yes*		VU
Tassel stonewort	*Tolypella intricata*	Yes		EN
Great tassel stonewort	*Tolypella prolifera*	Yes		EN
Lesser bearded stonewort	*Chara curta*	Yes	NS	

Table A6.1 – Status of submerged and floating plant species

EN National Red Data Book Endangered, **VU** National Red Data Book Vulnerable, **CR** National Red Data Book Critically Endangered, **LC** National Red Data Book Least Concern, **NR** Nationally Rare occurring in less than 16 10km grid squares nationwide, **NS** Nationally Scarce occurring in 16-100 10km grid squares nationwide, **Sch8** Schedule 8 of Wildlife and Countryside Act, **App1** Appendix 1 of the Bern Convention, **Ann II/IV** Annex II and IV of the Habitats Directive, and **UKBAP** BAP priority Species.

Distribution

Grass-wrack pondweed: Concentrated around central England with a few sites on the Welsh border and Norfolk coast.

Floating water-plantain: Occurs at sites in north Wales, West Midlands and northwest England. It has also been introduced to a few sites in Norfolk and Scotland.

Holly-leaved naiad: Limited to the Norfolk Broads.

Sharp-leaved pondweed: Occurs along the coast of southeast England and the Norfolk Broads.

Dwarf stonewort: Occurs at two sites in Anglesey and one in Cambridgeshire.

Tassel stonewort: Found at several sites in East Anglia and at sites in Gloucestershire, Somerset and Worcestershire.

Great tassel stonewort: Occurs at sites in Cambridgeshire, Somerset, Sussex and Gloucestershire.

Slender stonewort: Has a wide distribution with sites from Cornwall to Scotland.

Lesser bearded stonewort: Widespread in East Anglia with a few scattered sites in Cornwall, Wales and Scotland.

Habitat

Sharp-leaved pondweed, glass-wrack pondweed and floating water-plantain all occur in mesotrophic water, but floating water-plantain can also grow in nutrient-poor oligotrophic water and sharp-leaved pondweed in slightly nutrient-rich eutrophic water. Holly-leaved naiad occurs in shallow brackish water in coastal fens and reed swamps. The Charophyte species occur in a range of habitats: dwarf tassel and great tassel stoneworts grow in calcareous and alkaline ditches, canals and ponds and slender stonewort occurs in boggy sphagnum pools, highland lakes, clay pits, springs, ditches and ponds. Lesser bearded stonewort can be found in calcareous water on peaty or sandy soil, flooded dune slacks and dune pools and rarely in clay pits, old peat cuttings and ditches.

Life cycle

All of the submerged and floating vascular plant species are perennial, apart from holly-leaved naiad, which is an annual. This species has seeds with a hard coating, which may need to be broken before germination, possibly by gut passage through wildfowl. Grass-wrack and sharp-leaved pondweeds have underground stems or 'rhizomes', fruit freely and produce over-wintering buds or 'turions', but sharp-leaved pondweed does not colonise new habitats. Floating water-plantain produces suckers or 'stolons', and produces non-opening, self-fertilising flowers in deep water, but flowers freely on mud. All of the Charophyte species are annuals, although slender and lesser bearded stonewort both can behave as perennials. Slender stonewort has spores that appear to be able to germinate at any time of the year, but lesser bearded stonewort spreads mainly vegetatively by bulbils. Dwarf stonewort can survive as spores during periods of drought and tassel stonewort is able to withstand ice-cover and produces ripe spores as early as April or May. Plants then often disappear by early July. It can occur as either a winter or spring annual, but great tassel stonewort occurs as a spring annual.

Floating water-plantain *Luronium natans*

Risk factors

- Reduced ditch water levels due to lack of appropriate management, such as vegetation clearance and sediment removal.
- Encroachment by emergent and marginal vegetation and loss of open water due to lack of appropriate management, such as vegetation clearance and sediment removal. Many submerged species are restricted to open water in the early stages after ditch clearance and require periodic clearance to maintain this early successional state. Stonewort species are particularly sensitive to a lack of disturbance as they are easily displaced by more competitive vegetation.
- Shading by floating species such as broad-leaved pondweed and duckweed due to lack of floating vegetation clearance.
- Over-frequent management of ditches, such as repeated cutting or dredging during the growing season, can negatively affect the growth of some species, in particular holly-leaved naiad.
- Creation of uniformly deep channels through dredging may prevent some species from re-colonising due to a lack of light.

Management options

Management options that will potentially benefit these submerged and floating species include the selective removal of water plants to permit re-colonisation (Techniques CA1-4, CC1). Creating deeper pools and channels benefits submerged species by creating a refuge for aquatic plants during times when conditions are drier (Techniques CL3, CL4, CC3). Sluices (Techniques CC7) can be used to regulate water levels and create a more stable water table to benefit submerged and floating species. Other options that might be beneficial are reedbed purification treatments and silt traps (Techniques CC4, CC5) that remove excess silt and nutrients respectively and allow greater diversity. Options that allow an increase in emergent plant species are potentially harmful, as emergent species may compete with the submerged species (Techniques CA5, MA3, MA4, MC2, MC3). Options that manage the banks can also have a detrimental effect on aquatic species, especially if the channel is small. An increase in shade can also be detrimental to aquatic plants, therefore options that allow trees and shrubs to grow along the banks in smaller channels are not preferred (Techniques BA8, BA15, BC5, BC6).

2 Emergent species

Common name	Scientific name	UKBAP	Other	IUCN category
Ribbon-leaved water-plantain	*Alisma gramineum*	Yes	Sch8, NR	CR
Greater water-parsnip	*Sium latifolium*	Yes	NS	EN
Tubular water-dropwort	*Oenanthe fistulosa*[1]	Yes		VU
Floating water-plantain	*Luronium natans*	Yes	NS, Sch8, AnnII, AnnIV, App1	LC

Table A6.2 – Status of emergent plant species

EN National Red Data Book Endangered, **VU** National Red Data Book Vulnerable, **CR** National Red Data Book Critically Endangered, **LC** National Red Data Book Least Concern, **NR** Nationally Rare occurring in less than 16 10km grid squares nationwide, **NS** Nationally Scarce occurring in 16-100 10km grid squares nationwide, **Sch8** Schedule 8 of Wildlife and Countryside Act, **App1** Appendix 1 of the Bern Convention, **Ann II/IV** Annex II and IV of the Habitats Directiv, and **UKBAP** BAP priority Species.

[1]May also occur in marginal habitat

Distribution

Ribbon-leaved water-plantain: Confined to two sites, in Worcester and Lincolnshire.
Greater water-parsnip: Scattered sites in southern and eastern England.
Tubular water-dropwort: Widespread across lowland England.
Floating water-plantain: Occurs at sites in north Wales, West Midlands and northwest England. It has also been introduced to a few sites in Norfolk and Scotland.

Habitat

Ribbon-leaved water-plantain grows in shallow, eutrophic water at the edges of fenland drains. It can also grow at the edges of lakes and rivers. Both greater water-parsnip and tubular water-dropwort grow amongst emergent vegetation: greater water-parsnip at the edge of ditches and in reed swamp in base-rich water, and tubular water-dropwort by rivers, canals, streams, ditches, lakes and ponds. Floating water-plantain occurs in oligotrophic to mesotrophic waters and can grow in both shallow and deep water.

Life cycle

All species are perennial, although ribbon-leaved water-plantain can behave as either an annual or a short-lived perennial and regenerates from buried seed after disturbance. Both tubular water-dropwort and floating water-plantain spread by suckers or 'stolons' and by seed.

Risk factors

- Competition from marginal or aquatic species due to lack of appropriate ditch management, such as vegetation clearance.
- Reduced ditch water levels due to lack of appropriate management, such as vegetation clearance and sediment removal.
- Alteration of water levels, for instance by dredging, during the flowering and seeding period (particularly ribbon-leaved water-plantain).
- Competition from other tall emergent species, such as common reed *Phragmites australis*, due to lack of cutting or grazing of emergent vegetation. Species such as ribbon-leaved water-plantain require the maintenance of early successional emergent vegetation, dominated by either other low-growing species or with areas of open water or mud.
- Over-grazing or cutting of emergent vegetation, such as repeated cutting or dredging during the growing season, which may not allow species time to recover. Over-cutting may also increase water movement in the channel, leading to erosion of sediment.
- Creation of uniformly deep channels through dredging may remove shallow areas required by emergent species.
- Dredging large sections of ditch channel and margins at one time as this removes a large proportion of propagules, such as seeds and rhizomes, which are required for regeneration. Many emergent species recover only slowly after dredging, as their rhizome system has to recover. This may take up to three years for some species.

Management options

Management options that potentially benefit the species are the selective removal of water plants to permit re-colonisation (Techniques CA1-4, CC1), as well as options such as reedbed purification treatments and silt traps (Techniques CC4, CC5) that remove excess silt and nutrients respectively and allow greater diversity. Options that allow the increase in emergent species (Techniques CA5, MA3, MA4, MC2) are beneficial unless they only benefit the dominant species, which then compete with smaller emergent plants, whilst Technique CL4 is likely to benefit smaller emergents over the larger more dominant species. As with the management of submerged and floating species, options that manage the banks can also have a detrimental effect on aquatic species especially if the channel is small. Allowing an increase in shading can also be detrimental to emergent species, so options that allow trees and shrubs to grow along the banks in smaller channels are not preferred (Techniques BA8, BA15, BC5, BC6).

Tubular water-dropwort *Oenanthe fistulosa*

3 Marginal Species

Common name	Scientific name	UKBAP	Other	IUCN category
Cut-grass	*Leersia oryzoides*	Yes	NR, Sch8	EN
True fox-sedge	*Carex vulpina*	Yes	NR	VU
Creeping marshwort	*Apium repens*	Yes	NR, Sch8, AnnII, AnnIV, App1	VU
Floating water-plantain	*Luronium natans*[1]	Yes	NS, Sch8, AnnII, AnnIV, App1	LC
Three-lobed water-crowfoot	*Ranunculus tripartitus*	Yes	NS	EN
Divided sedge	*Carex divisa*	Yes	NS	VU
Fen ragwort	*Senecio paludosus*	Yes	NR, Sch8	CR
Marsh stitchwort	*Stellaria palustris*	Yes		VU
Fen violet	*Viola persicifolia*	Yes	NR, Sch8,	EN
Long-leaved threadmoss	*Bryum neodamense*	Yes	NR, Sch8,	
Spreading-leaved beardless-moss	*Weissia squarrosa*	Yes	NS	VU

Table A6.3 – Status of marginal plant species

EN National Red Data Book Endangered, **VU** National Red Data Book Vulnerable, **CR** National Red Data Book Critically Endangered, **LC** National Red Data Book Least Concern, **NR** Nationally Rare occurring in less than 16 10km grid squares nationwide, **NS** Nationally Scarce occurring in 16-100 10km grid squares nationwide, **Sch8** Schedule 8 of Wildlife and Countryside Act, **App1** Appendix 1 of the Bern Convention, **Ann II/IV** Annex II and IV of the Habitats Directiv, and **UKBAP** BAP priority Species.

[1]May also occur in submerged and emergent habitats

Distribution

Cut-grass: Occurs at five sites in southern England.

True fox-sedge: Sites in south east England and scattered sites in Gloucester, Oxfordshire and Yorkshire.

Creeping marshwort: Found at sites in Oxfordshire and Buckinghamshire, Scotland, south east Yorkshire, Norfolk and Suffolk.

Floating water-plantain: Occurs at sites in north Wales, West Midlands and northwest England. It has also been introduced to a few sites in Norfolk and Scotland.

Three-lobed water-crowfoot: Occurs at sites in Cornwall, south Devon, south Wales, Herefordshire, Kent, Sussex and Surrey.

Divided sedge: Occurs mainly in southern and eastern England with a few scattered sites elsewhere.

Fen ragwort: Found at five fenland sites in East Anglia.

Marsh stitchwort: Occurs at sites across Britain, especially East Anglia and southern England.

Fen violet: Only found at three sites, two in Cambridgeshire and one in Oxfordshire.

Long-leaved threadmoss: Found at scattered sites around northern Britain.

Spreading-leaved beardless-moss: Occurs at sites in central England.

Habitat

The channel margin habitat of these species is typically flooded or wet in winter and dry in summer. Fen ragwort and marsh stitchwort grow in tall-herb, fen vegetation at the edges of ditches that are flooded in winter. Marsh stitchwort also grows in marshes and wet grassland. The other species are restricted to areas of low vegetation cover. Cut-grass grows on nutrient rich mud which has been poached by grazing animals, such as cattle. True fox-sedge grows in open marginal vegetation on heavy clay soils (also occasionally in standing water) and divided sedge is found on the edge of brackish ditches. Three-lobed water-crowfoot and fen violet occur in areas of bare mud. Three-lobe water-crowfoot grows in shallow, seasonal waterbodies which are dry during the summer, and fen violet prefers damp peaty or clayey, base-rich soils in seasonally wet fens.

Fen violet *Viola persicifolia*

Long-leaved threadmoss grows on wet calcareous soil in ditches, dune slacks, fens and lake margins. Spreading-leaved beardless-moss grows on moist, exposed, non-calcareous clay, loam and mud on ditch margins, pools and woodland rides.

Life cycle

All of the marginal species are perennials, apart from three-lobed water-crowfoot, which is an annual that takes advantage of seasonally dry ditches and pools. Fen ragwort is long-lived but seed set is poor. Fen violet has seeds that are long-lived and true fox-sedge fruits freely. Cut-grass, divided sedge and marsh stitchwort all produce rhizomes and spread vegetatively. Long-leaved threadmoss and spreading-leaved beardless-moss disperse via spores.

Risk factors

- Increase in summer water levels leading to loss of suitable habitat and encroachment by emergent vegetation.
- Decrease in winter water levels, for instance through a lack of dredging in the adjacent channel, leading to encroachment by competitive terrestrial vegetation and scrub.

Particular risks to marginal plants that grow in sparse vegetation or on bare mud:

- Shading by tall vegetation due to lack of vegetation cutting or grazing.
- Lack of bare ground for propagule germination, resulting from lack of periodic cutting, dredging or grazing.

Particular risks to marginal plants that grow in tall-herb fen vegetation:

- Over-grazing or cutting of vegetation, particularly during the growing season.
- Cutting of large sections of ditch margin at one time, particularly if during the growing season, as this removal will prevent seeding.

Three-lobed watercrowfoot *Ranunculus tripartitus*

Management options

Plants that grow in areas of bare mud or sparse vegetation are adversely affected by management techniques that increase the number of tall plants. Species that occur in bare mud are also harmed by management techniques that effect the shape and structure of the bank, but they benefit from grazing (Technique BA7) which helps to poach the margins and allow these species to colonise. They also benefit from techniques that maintain a low vegetation height, such as Techniques BA2, BA3, BA4 and BA5.

Marginal plants that occur in tall herb and fen vegetation are harmed by excessive or damaging cutting methods (Techniques BA6, BA7), shrub and tree encroachment (Techniques BA8, BA15, BC5, BC6, BC7) and changes in bank structure (Techniques BC3, BC4). They benefit from methods that reduce disturbance and competition (Techniques CA5, BA2-5, BC1, BC2) and increase stability (Techniques BC4).

Further reading and information

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Management for non-native and invasive plants

Introduction

This appendix summarises the approaches and techniques that may be applied to the management of non-native and invasive plant species that most frequently occur in drainage channels. A broad habitat classification has been applied to these species, dividing them into those species that occur within the water of the channel or its wet margin, and those species that occur on the banks of the drainage channel. The species considered are:

Bankside

Giant rhubarb *Gunnera tinctoria*
Giant hogweed *Heracleum mantegazzianum*
Himalayan balsam *Impatiens glandulifera*
Japanese knotweed *Fallopia japonica*

Giant rhubarb

Giant hogweed

Himalayan balsam

Japanese knotweed

Channel or wet margin

Australian swamp stonecrop *Crassula helmsii*
Canadian pondweed *Elodea canadensis*
Curly pondweed *Lagarosiphon major*
Floating pennywort *Hydrocotyle ranunculoides*
Parrot's-feather *Myriophyllum aquaticum*
Water fern *Azolla filiculoides*
Water hyacinth *Eichhornia crassipes*
Water lettuce *Pistia stratiotes*
Water primrose *Ludwigia grandiflora*


© Dr Chris Gibson
Australian swamp stonecrop


© Dr Chris Gibson
Canadian pondweed


© LanGuard/Alistair Mason
Curly pondweed


© RPS/Olaf Booy
Floating pennywort


© Parsons Brinckerhoff/Helen Parish
Parrot's-feather


© LanGuard/Alistair Mason
Water fern


© Dr Chris Gibson
Water hyacinth


© RPS/Max Wade
Water lettuce


© CEMAGREF/Alain Dutartre
Water primrose

Species	Distribution	Growth form	Life cycle
Australian swamp stonecrop	Widespread	Submerged with emergent form	Flowers annually in spring/summer
Canadian pondweed	Widespread	Submerged	Little variation through the year
Curly pondweed	Widespread	Submerged	Little variation through the year
Floating pennywort	Concentrated in the south-east of England but spreading rapidly	Floating on surface of slow-flowing or still water	Little variation through the year
Parrot's-feather	Widespread	Submerged with emergent forms	Little variation through the year
Water fern	Widespread	Floating on surface of slow-flowing or still water	Colour varies between between green in spring/summer and red through autumn/winter
Water hyacinth	Limited distribution but likely to become more common as winter temperatures increase	Floating on surface of slow-flowing or still water	Flowers annually in in spring/summer
Water lettuce	Limited distribution but likely to become more common as winter temperatures increase	Floating on surface of slow-flowing or still water	Little variation through the year
Water primrose	Limited distribution and subject to an eradication programme	Submerged with emergent forms	Flowers annually in spring/summer

NB. There is no legal status for the species above

Table A7.1 – Invasive plant species of channels and the wet margins

Basic information about the species occurring in the channel or along the wet margin is summarised in Table A7.1 and about species occurring on the bank in Table A7.2. The column that refers to legal status presents the position for England in April, 2008. The listed status may well change.

Management overview

Management of non-native and invasive species can adopt a preventative approach, seeking to control or suppress a species, or it can aim to achieve eradication. The approach should be developed for the specific drainage system and plant species in question and could include:

- Identification of potential sources of non-native and invasive plant species.
- Prevention – stopping a drainage system from becoming infested by an invasive species.
- Eradication – completely removing a particular species from a drainage system.
- Control or suppression – managing or reducing the population of the species in a drainage system but not completely removing it.

The aim should be achievable within the budget available. Any control or eradication effort that stops short of completion as a result of a lack of funding is likely to be wasted as the target species will usually quickly re-colonise.

Species	Legal status	Distribution	Life cycle
Giant rhubarb	-	Limited distribution concentrated in south-west England	Perennial, inconspicuous flowers. Spreads by seeds and rhizomes
Giant hogweed	Wildlife & Countryside Act Schedule 9	Widespread	Bi-annual. Shoots in spring, white flowers in summer following year. Seeds in late summer and dies back over winter leaving holes. Seeds are only part of plant with potential to spread
Himalayan balsam	-	Widespread	Annual. Shoots in spring, pink-white flowers in summer. Seeds in late summer-autumn and dies back later autumn/winter. Seeds are only part of plant with potential to spread but are encased in explosive seed pods triggered by disturbance.
Japanese knotweed	Wildlife & Countryside Act Schedule 9	Widespread	Perennial. Shoots in spring, white flowers in late spring-summer. Foliage dies back late autumn leaving dry canes. Live stems have potential to spread, as do rhizomes.

Table A7.2 – Invasive plant species of drainage channel banks

While priorities will be specific to each site, it is anticipated that in most cases the following sequence should be followed:

- Identify any immediate health hazards posed by invasive species and mitigate them (e.g. install warning signage and erect barriers to prevent access).
- Identify and, where possible, stop or reduce any activity that may be encouraging the invasion or spread of invasive species in the drainage system.
- Where possible, identify currently active pathways for introduction of invasive species and attempt to block them.
- Plan and implement management priorities

Implementing a control strategy

The principles of implementing a control strategy are:

- Take into account both the individual plants that have invaded the drainage system and their propagules (i.e. seeds).
- Tailor specific management to the species. For example, Himalayan balsam and Japanese knotweed are tall, flowering plants found along river banks, but one relies on seeds for reproduction and the other on fragments of rhizome. One is an annual and the other is a perennial. Thus, they require very different control strategies.

Life cycles and management approaches

In general, plants reproduce either by seed or by vegetative growth, where parts or fragments of the plant are able to regenerate into new plants. The precise methods used should inform the management undertaken. In some cases, a plant may reproduce using both methods so dual management approaches will be required.

Reproduction by seed

Seeds in the ground or in the sediment of waterbodies that could germinate and grow in future seasons are known collectively as the seed bank. The invasive species' manager will need to make an assessment of the seed bank for each plant and adopt a control strategy to deal with it. Key information includes:

- Distance seeds are able to travel from the parent plant.
- Length of time that seeds remain viable in the ground or sediment.
- Conditions that seeds need to germinate and grow.

Some plants live longer than two years and maybe able to produce seeds year after year (perennial plants), however some plants die after they set seed. Those plants that die after setting seed may live only a year before setting seed (annual plants), whereas others may live for two years (biennial). This characteristic can often be used to the advantage of a management strategy by simply preventing plants from flowering and seeding, for example, cutting off the flower or seed head. If this is sustained, the population will eventually be eradicated. The length of time taken to eradicate the population is linked to the life expectancy of the seed bank. It should be noted that, in some case, annual or biennial plants that are prevented from setting seed by regular cutting may continue to grow in subsequent years. These should either be allowed to set seed and the seeds gathered, for example, by enclosing the seed heads in bags, or be subject to repeated control over a number of years to eventually exhaust the plant's ability to re-grow. For perennial plants, it is not sufficient to cut off the flowers or seed head. Instead, it is necessary to kill the plant in addition to any plants that germinate and grow from the seed bank.

Vegetative reproduction

Some plants are able to grow from fragments of stem, root or rhizome (underground stem) material broken from the parent plant. Re-growth is not usually possible from leaves or flowers. Fragmentation is often caused by human disturbance of the plant, but may also be caused by wind, water or animal activities.

Where vegetative reproduction is the only method of reproduction, there is no long-term seed bank to control. However, it is important to ensure that any control strategy takes into account all of the plant material as any small fragment left may be able to re-grow into a new plant. It is essential that any control method does not accidentally cause fragmentation of the plant and therefore facilitate accidental spread (see below).

Control techniques

Set out below are the most commonly used techniques to control invasive and non-native plants. Each method includes a note on whether it is appropriate for the control of adult plants, seeds or vegetative re-growth.

Cutting and mowing

Often used for slow-growing invasive plants to stop them from blocking access, reducing aesthetic appeal, blocking driver's sight lines or removing an obstruction to flow in a canal or river. This is rarely effective as an eradication method as plants will generally re-grow following cutting. Eradication is only achieved by regularly cutting or mowing plants which eventually exhausts their rootstock (the energy held within the roots of the plant to support new growth). As a result, eradication by cutting can take several years and may not work at all for some species, e.g. aquatic plants for which it is very difficult to remove all cut material. Cutting does not impact on the seed

bank but, if carried out regularly, can prevent young plants growing from the seed bank into adult plants. Cutting plants that re-grow by vegetative reproduction is not recommended as new fragments can be easily spread. Regular cutting can have a significant impact on a habitat not normally cut or grazed. Cutting of the margins and banks is included in Techniques MA1, MA2, MA3, MA4, BA1, BA2, BA3 and BA4. Giant hogweed is a serious hazard to human health and contact with any sap-containing part of the plant can result in burns. These burns can cause painful blistering and scarring. Because of this, at no time should this plant be cut using a hand held strimmer or brush cutter.

Flail mowing

Similar to mowing, flail mowing can be more effective as the flail damages the base and sometimes the roots of plants. The result is that some plants may be killed and others may take longer to re-grow. Flail mowing, if carried out regularly, can stop young plants that emerge from the seed bank growing into adult plants. Flail mowing plants that re-grow by vegetative reproduction is not recommended as new fragments can be easily spread. Flail mowing can have an adverse affect on other habitats and ground structure and should not be considered where this is undesirable. Technique BA6 describes flail mowing.

Excavation

Excavation is a highly effective but rarely used strategy as it is an expensive and intrusive form of control. Excavation can quickly remove adult plants from a site, including any fragments of the plant that may re-grow through vegetative reproduction. Disposal of excavated material must be undertaken carefully and has specific legal compliance needs and high costs. If present, it is possible to excavate the seed bank from a site. However in order to do so, the extent and depth of the seedbank should be established.

Seed removal and prevention of flowering or seeding

Seed removal is used to prevent seeds from establishing and can in some cases be used to control adult plants. Where plants naturally die after one year (annuals) or a few years (biennial), the removal of seeds may lead to the eventual eradication of the population. Methods to prevent seeding include cutting off the flowering heads by mowing. It is essential to carry out this cutting before the seeds mature unless the seed heads are to be collected. The use of herbicides or cutting can prevent the plant from flowering or seeding by killing the plant.

Herbicides

There is only a limited number of herbicides available for controlling plants in or adjacent to water (see the Appendix on herbicide use). Effectively used, herbicides can be an efficient form of control. Herbicides will rarely have an impact on seeds in the seed bank and so follow-up treatments are required to tackle new growth. Techniques CA7, CA8, MA5, MA6, BA17 and BA18 cover the use of herbicides in the channel, the margin and the banks of watercourses.

Burial

Burial is a process used to deal with excavated material and is used to prevent re-growth, either by seed or by vegetative re-growth of plant material. By burying contaminated material at depth on a site it is removed from the light, nutrients and other growth requirements. If left buried, the material is likely to decay over time and eventually die. However, for seeds and some plant material this may take many years. The depth of burial required to prevent re-growth and the

length of time before death varies between plants and should be assessed before using this control method. Following burial, material should be protected from digging works that may unearth them.

Grazing

Regular grazing is an effective method of keeping various species under control, for example, giant hogweed and Japanese knotweed. The range of animals used is wide, including goats, horses, sheep and cattle. Where grazing is already part of the management of the land adjacent to a drainage channel its implementation can be more straightforward and cost-effective. Technique BA7 describes grazing.

Shading

Black polythene sheeting, geotextiles and other materials that stop light passing through them can be used to suppress plant growth. The sheeting is placed over the plants to be controlled with a generous overlap and firmly weighted down to prevent it being blown away. Some suppression can also be achieved by manipulating the extent of shade created by marginal plants and bankside bushes and trees. This approach is described in techniques BA15 and BC8.

Biological control

Using a herbivore or disease to control a plant is an attractive approach. Examples of it being put into practice in the UK are few, although research is being undertaken to find bio-control agents that meet the stringent criteria that need to be met before they can be considered for release. Successful biological control has been developed for water fern using a weevil and this is described in Technique CA6.

Managing invasive plants in the channel and wet margins

The major risk associated with species occurring in the channel or along the wet margin is that small fragments of aquatic plants, which can be created by management action, can easily disperse and establish further down the channel. Many of the management techniques applied to the channel or its margin for flood risk management and nature conservation purposes can cause disturbance and spread invasive species. The technique that causes the least disturbance is herbicide application. Suppression can be achieved by the manipulation of shading using marginal plants, bushes and trees. After aggressive control techniques that remove all plant material, consideration will need to be given to the introduction of desirable species to provide a vegetation community that might inhibit further invasion.

Managing invasive plants on the bank

The major risk associated with species occurring on the bank is that intermittent or regular disturbance of the natural vegetation community during flood risk management activities can provide sites for establishment of invasive species. These activities are also likely to facilitate the spread of invasive species, either by increasing seed dispersal in the case of giant hogweed and Himalayan balsam or by creating viable fragments of stems from Japanese knotweed. The technique that causes the least disturbance is herbicide application. Suppression can be achieved by the manipulation of shading using bushes and trees. After aggressive control techniques that remove all plant material, consideration will need to be given to the introduction of desirable species to provide a vegetation community that might inhibit further invasion.

Preventing spread during management

In some cases, invasive species can be accidentally spread as a result of improper use of management techniques. For plants, this is usually where viable fragments or seeds of the plant are accidentally spilled or spread by machinery, vehicles or personnel movement.

Measures to help prevent spread include:

- Contain the invasive species on site.
- Educate staff, contractors, landowners and occupiers and the general public about the need to prevent spread.
- Prevent access to the invaded area (e.g. install fencing or signs).
- When disposing of plant material or seeds ensure relevant species guidance is followed and never introduce viable material into an uncontaminated area. It should be noted that there maybe legal obligations relating to the disposal of material.
- On completion of management, inspect the area for signs of remaining invasion. Where appropriate, provide a monitoring period over which to do this.
- Ensure all machinery, vehicles and tools are cleaned appropriately before leaving the contaminated area and ensure personnel have cleaned any clothing, footwear or other equipment before leaving.

The movement of materials and equipment between drainage systems can facilitate the spread of invasive species. Particular care should be taken when transferring soils or any live plant materials. Water-borne plants in particular may attach to equipment that has been used in the water and these should be thoroughly cleaned before moving between sites in different catchments.

Implementing a prevention strategy

A drainage system that has been subject to a control programme should be monitored to ensure there is no re-invasion. This may occur as the result of incomplete control where some vegetative material or seeds remain to re-colonise the area, or from external sources. The appropriate monitoring period will be dictated by the anticipated length of time required for a plant to re-grow.

Following successful control, it is important to ensure that invasive species are prevented from re-colonising the drainage system. This is particularly important when the control process has caused disturbance of the habitat on site, which may leave areas vulnerable to invasion.

Prevention is based on:

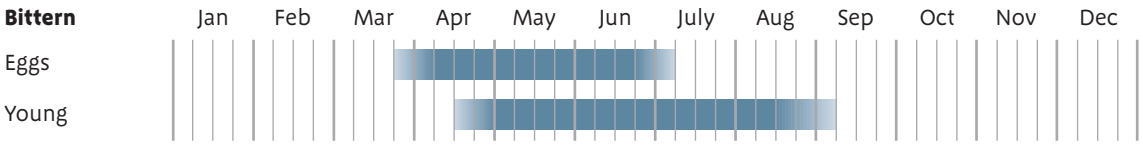
- Identifying those species that might pose a threat to a drainage system.
- Assessing the sources of these species.
- Assessing the pathways by which invasion might occur.
- Assessing the nature of the habitats in the drainage system and along any pathway or corridor that might be a route for invasion.

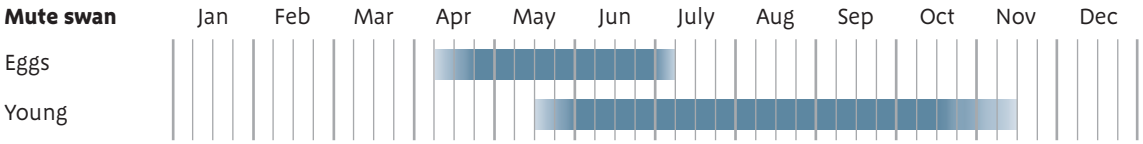
The aims of preventative management should include:

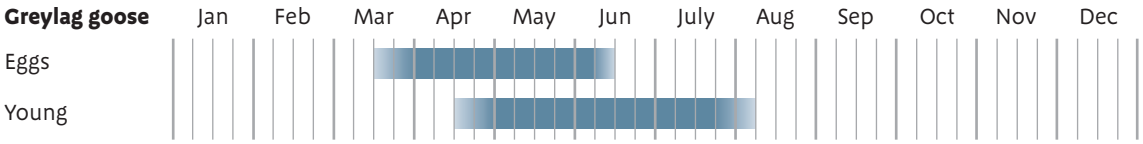
- Removing the sources of invasive species or ensuring that invasive species are contained within the source.
- Disrupting the pathways in order to prevent invasive species arriving in the drainage system in the first place.
- Maintaining or modifying habitat in the drainage system to prevent or reduce the likelihood of the species establishing itself should pathway disruption fail or be unfeasible.
- Undertaking surveillance of the drainage system to pick up any invasion at an early stage, and to mount a rapid response to eliminate the species before it has had chance to reproduce or spread.

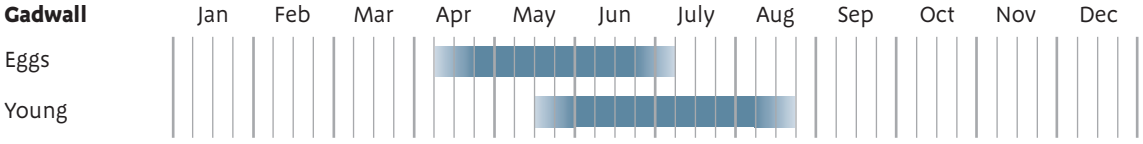
Bird nesting seasons

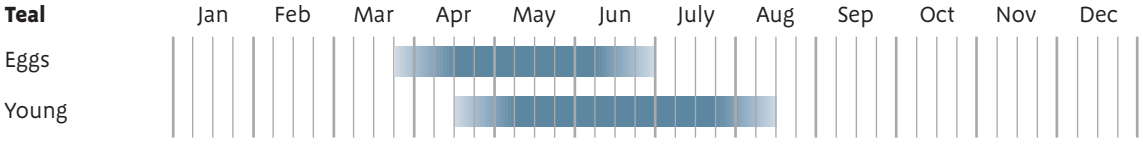
The tables below show the nesting seasons of birds associated with drainage channels in lowland England. The solid-coloured boxes indicate the normal range and the lighter-coloured boxes the possible occurrences. The information used is from Cramp, S. Ed. (1977-1993). *The Birds of the Western Palaearctic*. Oxford University Press, Oxford.

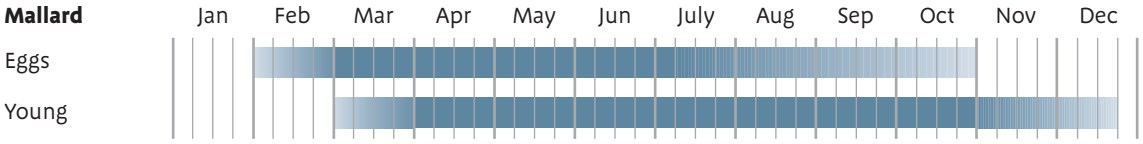


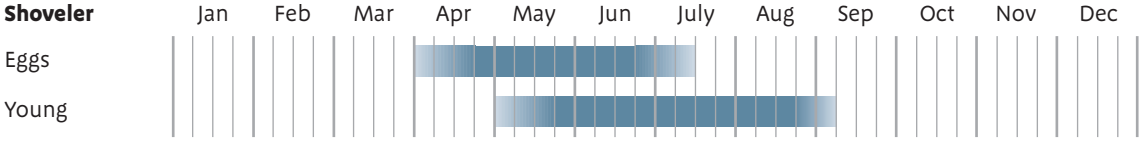


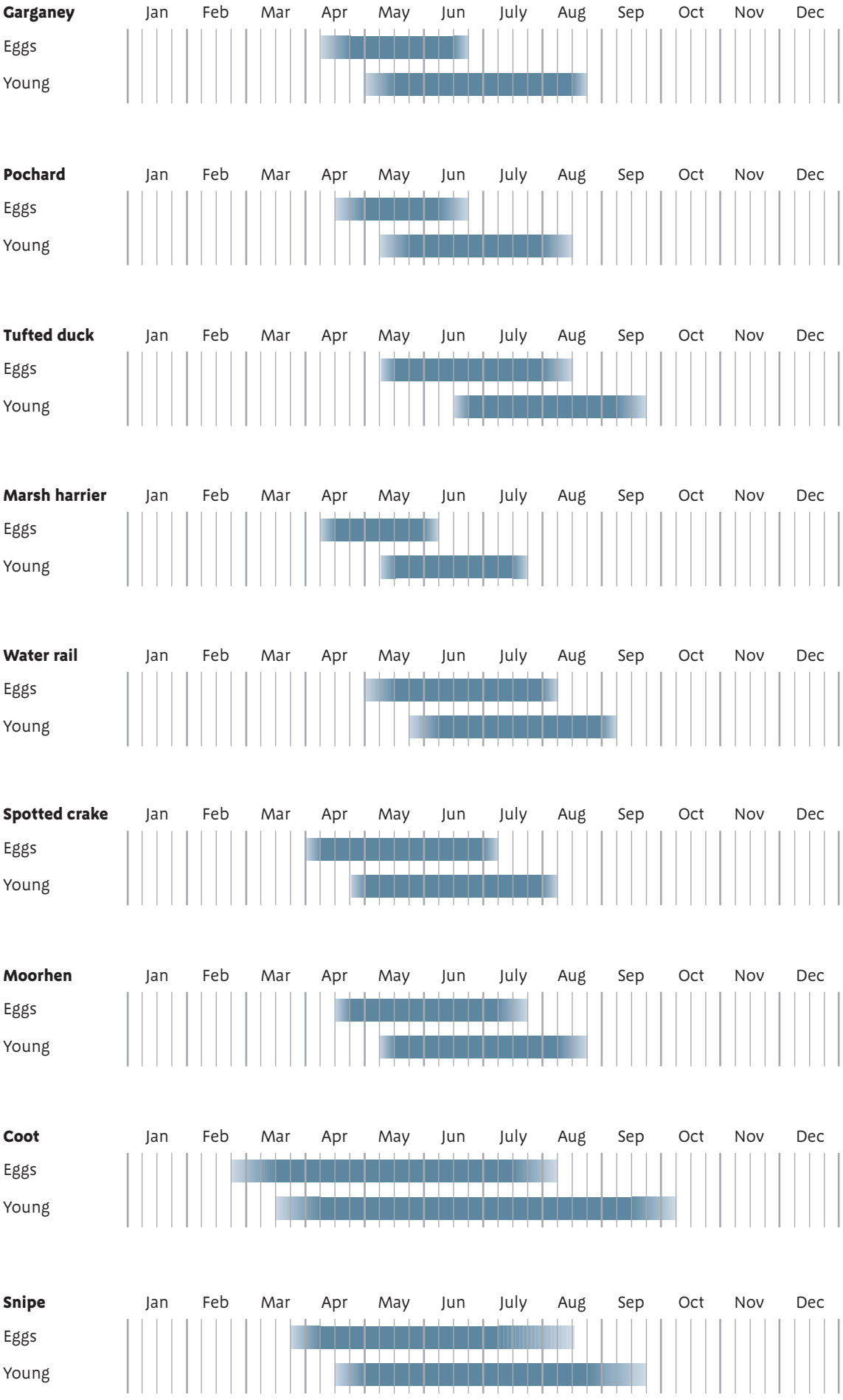











Garganey
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Pochard
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Tufted duck
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Marsh harrier
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Water rail
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Spotted crake
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Moorhen
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
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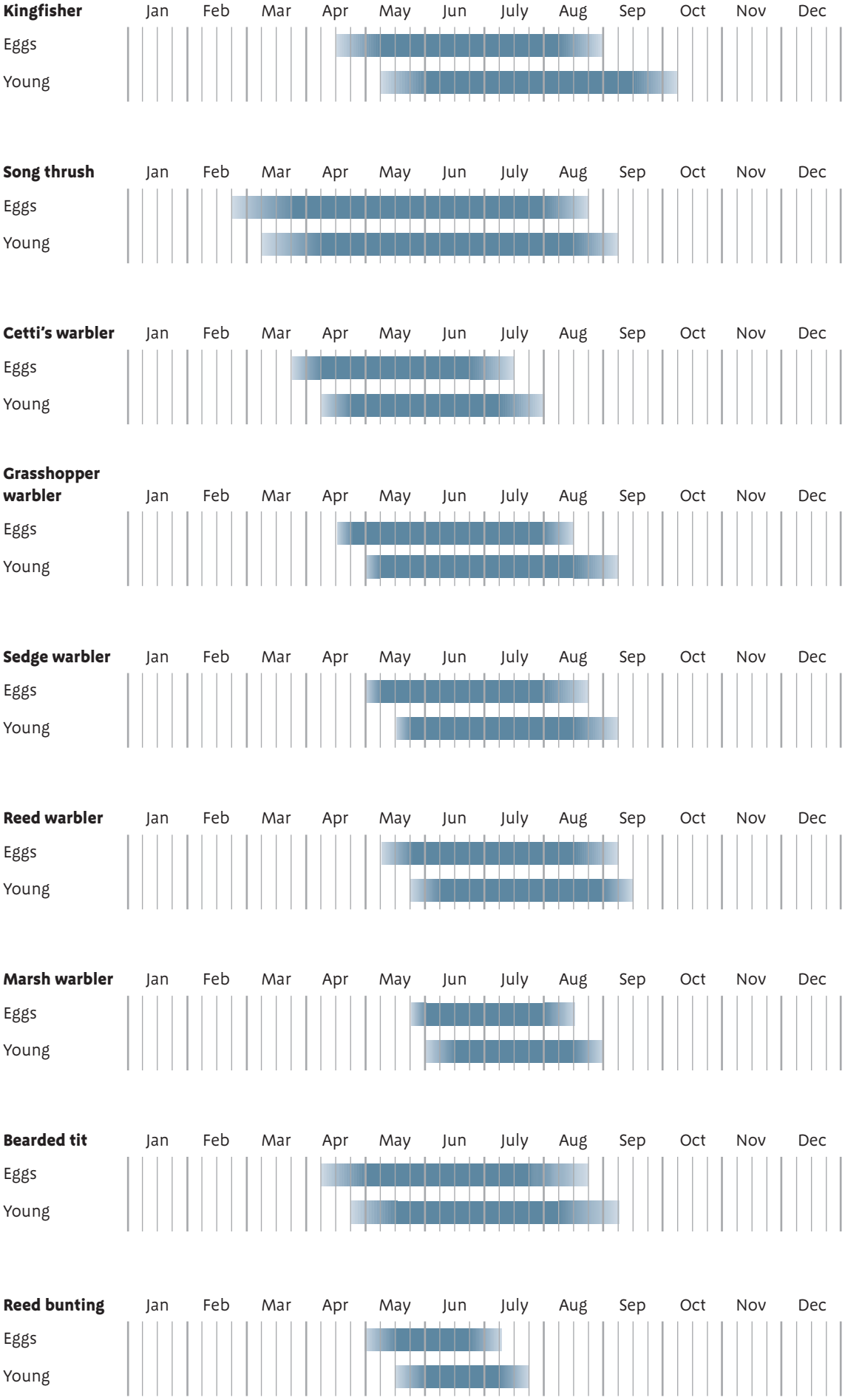
Eggs
Young
Snipe
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young


Kingfisher
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Song thrush
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Cetti's warbler
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
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Grasshopper warbler
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Sedge warbler
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Reed warbler
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Marsh warbler
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Bearded tit
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young
Reed bunting
Jan Feb Mar Apr May Jun July Aug Sep Oct Nov Dec
Eggs
Young

Appendix nine

Protected species guidance

This appendix brings together in one place information on the following protected species that is dispersed across various chapters of the manual:

Badgers
Bats
Great crested newts
Nesting birds
Otters
Reptiles
Water voles
White-clawed crayfish

The information is presented in a standard format, with the following topics covered:

- Legal protection
- Licensing requirements
- Survey methods
- Actions
- Management techniques
- Further reading and information

The Actions section describes measures for fulfilling the requirements of the species' protected status. The Management Techniques section provides information on any specific techniques that can be applied to enhance populations within the drainage district in addition to those detailed in Chapter 5.

Badger

Legal protection

Badgers and their setts are protected under various legislation, drawn together under the Protection of Badgers Act 1992. This makes it an offence to:

- Wilfully kill, injure, take, possess, or cruelly ill-treat a badger, or to attempt to.
- To interfere with a sett by damaging or destroying it.
- To obstruct access to, or any entrance of, a badger sett.
- To disturb a badger when it is occupying a sett.

Licensing requirements

For management works

There is provision within the legislation to allow action to be taken under a licence from Natural England for the purpose of any operation (whether by virtue of the land Drainage Act 1991 or otherwise) to

maintain or improve any existing watercourse, or to construct new works required for the drainage of land. Drainage Boards can apply for licences for specific improvement works and annual licences for maintenance works.

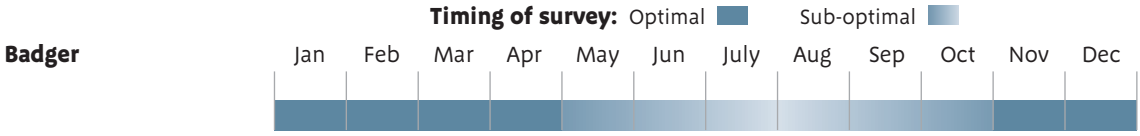
For surveys

The standard survey method of looking for setts and signs of occupation and activity in an area does not require a licence. However, surveys should be carried out by appropriately experienced ecologists.

Survey methods

The survey consists of a systematic search for signs of badger in all areas of potential habitat that might be affected by proposed works or management actions. Where engineering works are proposed this area should be extended out 30m from the limit of the proposed works.

The optimal time for survey is November to April when territories are most actively marked and the vegetation is at its lowest and least dense. Survey should be avoided from May to October because the vegetation may hide entrances to setts and signs. If survey must be done in these months then additional effort may be required and it may not prove conclusive if areas cannot be searched effectively.



Hedgerows, earth banks, ditch and channel banks, woodland and scrub habitats should be searched for signs of sett-building activity, including latrines, scats and hairs close to sett entrances, discarded bedding, and spoil heaps from recent digging. Badger paths/runways under boundary fences and hedges should be searched for stray hairs. Follow badger paths through vegetation to ascertain if they lead to any setts.

Walk along linear features such as boundary hedges, ditches, walls and fences because badgers focus territory marking effort on these features. The distinction should be made between latrines – faeces deposited in pits which are used to mark the clan's territory – and scats which are single faeces.

Grassland areas should be surveyed for footprints, latrines, scats, snuffle holes and distinctive runways through the vegetation.

The results of the survey should be presented as a map showing the locations of all activity recorded. The accompanying report should describe the number, location and level of activity of each hole in every sett located. The other signs recorded should be described to provide an indication of the amount of activity on a site and possibly information as to the number of separate populations (clans) present.

In cases where a sett has been identified by the initial survey described above, the proposed works would affect a sett and mitigation action would be necessary. A more detailed type of survey would therefore be required. This is a 'bait-marking survey' that establishes the territory size of badgers associated with a sett and the boundaries for the different badger 'clans' present on the site. This more detailed survey should be contracted to a specialist.

Actions

The preferred approach is to avoid the risk of damage to badger setts by:

- Avoiding the intentional creation of sett-building habitat in areas where regular access is required for management purposes.
- Avoiding the unintentional development of sett-building habitat through changes in vegetation management programmes in areas where regular access is required for management purposes.

Where a sett already exists, the first consideration should always be how to avoid damage to the sett by modifying the location, design and execution of the works, particularly the use of machinery that will eliminate the risk of disturbance to the sett. Examples of such modifications include:

- Using lighter-weight machinery close to the sett (even using manual labour if suitable).
- Avoiding percussive piling techniques.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. This can include temporary or permanent closure of the sett. This can be a time-consuming process involving additional surveys to establish the number of animals using the sett and can require specialist input. Natural England should be consulted about the proposed sett closure. The necessary licence should be applied for from Natural England.

In the case of having to carry out emergency works:

- Minimise the extent of excavation or other ground-moving works.
- Work with machinery so as to avoid driving over sett entrances. Visibly mark their location.
- Leave any sett entrance holes open to allow animals to escape.
- If pulling material back over a sett entrance, temporarily block it with a bag of straw with a long line attached so that it can be re-found and removed after the day's work is completed.
- Ensure tunnels are not likely to collapse or be further damaged during work.
- If possible, use hand tools to dig into setts.
- Excavate using a series of shallow cuts to allow animals to escape and minimise the chance of an accidental kill.

Management techniques

No additional, specific management techniques are proposed.

Further reading and information

Badger groups website: www.nfbg.org.uk

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Natural England (2007). *Badgers and Development*. Natural England, Peterborough.

RSPCA (1994). *Problems with Badgers?* RSPCA, Horsham, West Sussex.

Bats

Legal protection

In England and Wales bats are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (the Habitats Regulations). Under the Habitat Regulations bats are classed as European protected species and therefore given the highest level of protection. The Habitats Regulations make it illegal to:

- Deliberately capture, injure or kill a bat.
- Deliberately disturb a bat in such a way as to be likely significantly to affect the local distribution or abundance of bats or the ability of any significant group of bats to survive, breed, rear or nurture their young.

- Damage or destroy a bat roost.
- Possess or transport a bat or any part of a bat.
- Sell (or offer for sale) or exchange a bat.

Bats have become exempt from many of the provisions of the Wildlife and Countryside Act 1981 (as amended). However, bats are still protected under Section 9(4)(b) and (c) and (5) of the Wildlife and Countryside Act. This means that, in addition to the provisions of the Habitats Regulations, it is also illegal under the Wildlife and Countryside Act to:

- Intentionally or recklessly disturb any bat whilst it is occupying a bat roost.
- Intentionally or recklessly obstruct access to a bat roost.

A roost is defined as 'any structure or place which a bat uses for shelter or protection'. As bats tend to re-use the same roosts, legal opinion is that a roost is protected even if the bats are not there all the time.

Licensing requirements

For management works

If bat roosts are present, it may be possible to arrange the work in such a way as to avoid committing offences, though in some cases it may be necessary to apply for a licence from Natural England where bats are likely to be disturbed or where roosts will be affected.

For surveys

The internal inspection of voids in buildings such as lofts, holes in trees and crevices in the brickwork of structures such as bridges that are known or strongly suspected to contain roosting bats must be carried out by a suitably experienced ecologist with an appropriate bat licence.

Survey methods

Surveys for bats can take a number of forms:

- Activity survey
- Roost survey – daytime search of buildings and other artificial structures
- Roost survey – daytime assessment of trees
- Roost survey – searching cavities in potential tree roosts
- Emergence surveys
- Autumn swarming surveys

Activity Survey

Bat activity surveys aim to identify species present, their foraging areas and flight paths to give an insight into how bats use an area and its relative importance.

The minimum requirement for an activity survey is three visits during April to September (optimum period between June and August), carried out over at least two months. At least one of the surveys should comprise a dusk and a dawn survey within one 24-hour period. When it is known that the proposal for the site will adversely impact on one or more of the following habitat features (which are likely to be important for local populations of bats), the site should be visited six times over a three-month period (during April to September):

- Mature, semi-improved, broadleaved woodland.
- Riparian habitat.
- Ditches and channels.
- Pasture.
- Intact hedgerows, especially those connecting either water features patches of woodland, or other hedgerows.

Where existing information indicates that one of the following bat species may be present, the area should be surveyed twice per month from May to September (inclusive): greater horseshoe, lesser horseshoe, barbastelle, Bechstein's.

The site should be visited in daylight to plan the transect route that will be walked in the evening. The route should follow linear features that could be used as flight paths, and should cover areas of potential foraging habitat. Transects should be planned so that the route can be covered within 2 to 3 hours after sunset.

Bat activity surveys should only be undertaken when conditions are favourable: air temperature above 8°C, in calm conditions (Force 3 or less) and precipitation no more than light rain. Surveys should commence 30 minutes before sunset and should continue for between 2 to 3 hours after sunset to cover the period peak bat activity. Surveyors must maintain a slow walking pace throughout the survey.

A minimum of two surveyors is required. Each surveyor should have at least one bat detector, of which one should be a frequency division or time expansion detector. When surveying for horseshoes or barbastelles, a time expansion detector should always be used. On all other surveys, a time expansion detector should be used whenever possible, otherwise a frequency division detector should be used.

For bat activity surveys that are not targeted at finding a specific species, the detector should be set at around 34kHz. If two detectors are available, one should be set at 27-30kHz and the other should be set at around 45kHz. For surveys targeted at specific species, the frequency should be tuned accordingly.

When a bat is heard, the following information should be recorded:
- The species of bat.
- The time.
- Its direction of flight (if observed).
- If feeding activity or social calls were heard.
- The surveyor's position.
- Any other relevant information.

Reporting should include:
- A site map showing the transect route.
- The habitats present on the site.
- The time.
- The species and location of each bat pass.
- If the bat was seen, the location of its flight.
- If feeding or social calls were heard.

Roost survey – daytime search of buildings and other structures

Structures may be surveyed at any time of the year to determine whether there is any bat interest. Structures with the potential to be used as hibernation sites must be surveyed in December, January or February (optimum). At some times of year it might be difficult to survey conclusively some external features as weather conditions may have obliterated the evidence. Therefore, some structures may require summer surveys (e.g. emergence surveys – see below). Some structures such as mines and barns might be used as hibernation sites. A site-specific safety assessment should be carried out of the structure to determine if it is safe to access.

At the commencement of the survey, record site details including:
- Structures – numbers, location, approximate age, type of construction and fabric.
- Details of the site landscape – trees, vegetated areas, water features, linear features, lighting.
- The wider environment – connectivity, habitat fragmentation.

The exterior of the structure should be examined first for features that would give bats access into it and potential roost locations. These should be recorded on a sketch of the structure. The interior of the structure should then be surveyed. All areas must be included in the survey unless there is no access or access is unsafe. When these situations arise the areas affected and the reason for lack of access must be recorded. The structure should be searched for bats and evidence of bats (droppings, feeding remains, scratch marks, fur-oil staining and dead bats). Angled mirrors and/or an endoscope are useful for searching in crevices. They are particularly useful for surveys of timber-framed barns, where the mortise joints can be difficult to inspect. If the structure is a building with a chimney, search around it in the roof space and also look on the floor below the ridge beam for droppings.

Roost survey – daytime assessment of trees

An assessment of the potential of the tree may be made from the ground and each tree split into one of four categories: No/negligible potential, Low potential, High potential or Confirmed. The signs that a tree has bat roost potential are:

- Trees with scratch marks and/or staining that could indicate the presence of a bat roost.
- Trees that meet the criteria for 'Veteran trees' (Read 2000).
- Oak, ash, beech, sweet and horse chestnut, walnut or Scots pine with holes, crevices and/or dense ivy cover that are located within or on the edge of woodland or within a large hedgerow.
- Trees of any species with holes, cracks or crevices that appear to provide potential roosting sites but may be less suitable because of a less favourable location.

The signs that a tree has no roost potential are:

- Small or immature trees with none of the features listed above. These can include trees with ivy cover on a young tree as these have low bat roost potential.

Reporting should be in the form of a map with accompanying written details of the roost potential of each tree, indicating for each tree what signs have been observed that place the tree in a specific category.

Roost survey – searching cavities in potential tree roosts

Tree cavity searches are carried out during the day and can be carried out at any time of the year. Access to cavities may be gained through use of a ladder or by climbing the tree with specialist equipment. Site-specific safety assessments will need to be carried out and trained specialists used for tree climbing.

Bat occupation of a cavity can be revealed by the presence of droppings in or around the crevice, scratch marks or oil stains from the bat's fur. However, bats often leave no sign of their presence. Evidence of occupation by bats can be very difficult to find in trees. Small numbers of bats may not leave claw marks or oil stains, and droppings can be washed away.

If it is accessible and safe to do so, potentially suitable roost spaces should be examined to confirm that conditions inside the tree are actually suitable for bats and to look for bats or evidence of them. To do a thorough search of cavities inside a tree requires a torch and angled mirror and/or an endoscope or small infrared camera.

Emergence surveys

This type of survey is used when access to the potential roosting places is not possible and to identify where bats are entering and exiting a roost. This type of survey is also useful for investigating how many and what species of bat are using a known roost. It may not be possible to determine the species or the size of the colony from the droppings in a cavity.

The minimum requirement is for 3 surveys during May to September (optimum period May to August). At least one of the surveys should comprise a dusk-and-dawn survey within one 24-hour period.

For dusk emergence, surveyors should be at the survey point 15-30 minutes before sunset and should stay for 2-3 hours after sunset. For dawn return, surveyors should be in place outside the potential roost 1.5 to 2 hours before sunrise and finish the survey 25 minutes after sunrise.

Each surveyor must have a bat detector tuned to around 30-40 kHz (unless targeting specific species). Bats may have more than one exit from the roost, and surveyors may need to be stationed on all sides of a structure where potential bat access exists. Night vision equipment may be needed as some species emerge well after dark in areas that are poorly lit.

A plan of the site should be sketched prior to starting the survey. All bats seen and heard during the survey should be noted along with their direction of the time and any other relevant information. Reporting should include the location, time and species of bats calling.

Autumn swarming surveys

In the autumn, bats swarm around historical and potential hibernation sites, such as around the mouth of caves. Potential sites should be surveyed for swarming activity between August and October, with one survey per month. Sites should be surveyed from sunset until 3 or 4 hours after sunset. Bats do not usually start swarming until 1.5 hours after sunset. However, bats may well be roosting in the site and be observed emerging. The results of any bat surveys should be sent to relevant Local Biological Records Centre and where one does not exist, to the local Bat Group.

Actions

The risk of unknowingly destroying a bat roost, blocking access to a bat roost or killing bats using a roost through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting roosting bats.

2 If the location is likely to support roosting bats, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of year, identifies that the site is not a bat roost then proceed with the works as proposed.

3b If the survey identifies the site as a bat roost, or roost use cannot be ruled out, then the first consideration should always be avoidance of damage to the roost. This is often possible through careful location and design of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve destruction of the roost and its replacement away from the affected area. The replacement roosting feature will need to be established before the works commence. Establishing the nature and scale of replacement roost creation can be a time-consuming process requiring specialist input. Natural England should be closely consulted at the early stage of the development of the proposed roost replacement. Their comments should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial proposal.

The presumption in any acceptable roost replacement programme is that the population of the bats affected remains at a favourable conservation status in the area. Without this statutory requirement being likely to be fulfilled it is unlikely that a licence will be granted.

In the case of having to carry out emergency works to buildings or trees that are known to be bat roosts and that have been made unsafe by subsidence, flood damage or erosion, only undertake the minimum work to make the structure safe, until advice is received from Natural England.

Management techniques

Habitat creation and management techniques for bats are included within the individual techniques detailed in Chapter 5.

It is possible to provide roosting sites for bats by the installation of bat boxes and details are given below. The construction of larger structures to act as winter hibernation roosts is a more demanding project that requires detailed and specialist input and is not included in this appendix (see Mitchell-Jones & McLeish 2004 for further details on creating larger or more complex roost sites).

Bat boxes can be erected on trees and buildings to provide roosting opportunities. However, they should not be seen as an alternative to natural roosting sites such as tree-holes, old buildings and caves. Typical bat box designs provide summer roost sites. The standard boxes lack the required insulating properties to make them suitable as hibernation sites. Boxes can be an important resource to bats where good feeding habitat is otherwise lacking in suitable roosts.

There are many designs available for DIY construction or purchase. Boxes can be made or purchased of untreated softwoods, but commercially available boxes made of 'woodcrete' (a mixture of wood shavings and cement) have the advantages of better thermal insulation, resistance to rot and resistance to damage by woodpeckers and squirrels.

The siting of bat boxes is important. Exposed sites should be avoided. Boxes should be at least 4m from the ground and species such as the noctule are more likely to be attracted to boxes placed at 5m or 6m above the ground. Boxes should be sited with the front facing south-west to south-east. This ensures that the box warms up during the day. Boxes facing other aspects may be used and a common practice is to site three boxes on a single tree, all with different aspects. This gives the bats a choice of roost sites with different environmental conditions.

Occupation of the box is not guaranteed. Box schemes in the UK have recorded occupancy rates varying from 10-40 per cent with some rare cases of 70 per cent or more. The factors affecting occupancy include type and colour of box (boxes painted black absorb more solar radiation, this increases the internal temperature and can make the box more attractive to bats), geographic location, season and weather conditions. Boxes may only be used for short periods by a small number of bats. Occasionally boxes are used as maternity sites and larger numbers of bats (40+) can be found in a single box.

Further reading and information

Bat Conservation Trust (2007). *Bat Surveys – Good Practice Guidelines*. Bat Conservation Trust, London.

Forestry Commission (2005). *Woodland Management for Bats*. Forestry Commission Publications, Wetherby.

Mitchell-Jones, A. J. and McLeish, A P. (2004). *The Bat Workers' Manual*. 3rd Edition. JNCC, Peterborough.

Natural England (2007). *Bats: European Protected Species*. Natural England Species Information Note SIN010. Natural England, Peterborough.

Read, H.J. (2000). *Veteran Trees: a Guide to Good Management*. English Nature, Peterborough.

Stebbings, R.E. & Walsh, S.T. (1991). *Bat boxes: a Guide to the History, Function, Construction and Use in the Conservation of Bats*. The Bat Conservation Trust, London.

Great crested newt

Legal protection

In England and Wales great crested newts are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (the Habitats Regulations). Under the Habitat Regulations great crested newts are classed as European protected species and therefore given the highest level of protection. The Habitats Regulations make it illegal to:

- Deliberately capture, injure or kill a great crested newt
- Deliberately disturb great crested newts in such a way as to be likely significantly to affect the local distribution or abundance of great crested newts or the ability of any significant group of such newts to survive, breed, rear or nurture their young
- Damage or destroy a great crested newt breeding site or resting place
- Possess or transport a great crested newt or any part of such a newt
- Sell (or offer for sale) or exchange a great crested newt

Great crested newts have become exempt from many of the provisions of the Wildlife and Countryside Act 1981 (as amended). However, great crested newts are still protected under Section 9(4)(b) and (c) and (5) of the Wildlife and Countryside Act. This means that, in addition to the provisions of the Habitats Regulations, it is also illegal under the Wildlife and Countryside Act to:

- Intentionally or recklessly disturb any great crested newt whilst it is occupying a structure or place which is uses for shelter or protection
- Intentionally or recklessly obstruct access to any structure or place which any great crested newt uses for shelter or protection

Licensing requirements

For management works

There is provision within the legislation to allow actions, which would otherwise be illegal, to be carried out under a licence from Natural England. Licences for management work can be issued for the purpose of preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment. Licences can only be issued where there is no satisfactory alternative and where the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range. Details can be found on the Natural England website:
www.naturalengland.org.uk/conservation/wildlife-management-licensing

For surveys

A licence is required from Natural England where a survey method is used that will disturb or capture great crested newts, including torching, netting and bottle trapping. Since the recommended survey protocol requires such techniques to be attempted in the relevant conditions, it is unlikely that an adequate survey can be carried out without a licence.

Survey methods

Surveys for great crested newts can take a number of forms:

- Bottle trapping
- Egg Searching
- Netting
- Torch counts

Bottle trapping

Bottle trapping is a technique that can be used to confirm the presence and to estimate the abundance of great crested newts. It is particularly suited to ponds where the water is too turbid, or the vegetation too thick for torch surveys.

Bottle trapping should be carried out between March and May. To confirm presence/absence only, four visits are required, of which two should be between mid-April and mid-May. Once newts are found, visits can cease. To estimate population size (as required when a licence for mitigation works is being sought), six visits are required, of which a minimum of three should be between mid-April and mid-May.

Traps are constructed from 2-litre plastic bottles, the neck being cut off and inverted into the body of the bottle to create a non-return funnel. Traps are secured in a pond by cutting a small cross-slit on opposite sides through which a bamboo cane is inserted. Traps should be placed around the water's edge, with the trap opening completely submerged, and facing into the deeper water with the entrance to the trap located near as possible to the pond substrate. The rear of the trap should be inclined upward and a bubble of air held in the trap. The traps should be set at or shortly before dusk, and checked early the following morning. For normal survey purposes, English Nature (2001) recommends a minimum trap density of 1 trap per 2m of shoreline, but place more if possible – the greater the number of traps, the more robust the results. Careful note must be made of the location of the traps, to ensure that all are checked and recovered.

Water in ponds can fluctuate with rainfall, and it is important that the traps are sufficiently well anchored that they do not float off, and that consideration be taken to whether the water levels may rise and fill the air bubble inside the bottle trap. If this is likely, either the traps should not be set, or be checked as soon as possible. Traps should not be set when the night time air temperature falls below 5°C, and trapping should not be done when it is very hot, as this increases the risk of mortality. Traps should not be left for longer than 15 hours overnight (preferably no more than 12 hours), and should be checked before 11am (earlier on warm days/nights and ideally after dawn). The positioning must be secure to prevent the bottle tilting and losing the air bubble.

Egg searching

This technique is the best way to determine the presence of a breeding population as it requires little disturbance and eggs are reasonably easy to find in daylight. It cannot be used to estimate abundance of great crested newts.

Egg searches can be done between mid-April and mid-June, although breeding is weather dependent, and may start later in cooler years, or in areas further north (dates are based on lowland England). To confirm presence, four visits are required, of which two should be between mid-April and mid-May. Once eggs are found, visits can cease.

Newts wrap their eggs in folds of vegetation, which can then be unwrapped and the eggs identified. Vegetation used can either be live or dead, and they will use a variety of plant species, e.g. Potamogeton or Typha, or detritus such as plastic bags. The vegetation will be firmly creased, and even post breeding these creases should be noticeable. Great crested newt eggs are a yellowy colour and larger than those of the other two smaller native species; for further information on their identification consult Langton et al. (2001).

Should there be no suitable vegetation in the pond, artificial 'egg strips' of 1-2cm wide strips of plastic bin-liner can be staked into the pond. These may be used by great crested newts, and presence can be confirmed that way. The location of the strips must be noted, and they must be removed from the pond only once all larvae have hatched and become independent.

The pond vegetation should not be excessively disturbed during the search. If the purpose of the survey is to detect presence only, once the first egg is found, the search should be halted.

Netting

Netting is suitable for assessing presence/absence of great crested newts. Since it can give poor results, especially in turbid and well vegetated water, torch counts and bottle trapping are preferred.

Netting can be done between March and May, although it can also be used to confirm the presence of larvae in a waterbody in late summer (August). To confirm presence/absence of great crested newts four visits are required, of which two should be between mid-April and mid-May. Once great crested newts are found, visits can cease.

Use a robust long-handled net to sweep through the water over the vegetation around the pond edge and examine the net contents. Newt handling should be kept at a minimum, and they should be released immediately post identification. Ideally identify the newts in the net.

Netting can damage both the newts and the habitat, so care should be taken not to excessively disturb the pond, and the newts should be treated gently. In particular, the gill membranes on the larvae can be damaged.

Torch counts

This technique can be used to assess presence/absence of great crested newts. It is the best method to assess the population size of great crested newts where the pond is not over-vegetated or turbid.

Torch counts should be done between March and May. To confirm presence only, four visits are required, of which two should be between mid-April and mid-May. Once newts are found, visits can cease. To estimate population size, six visits are required, of which a minimum of three should be between mid-April and mid-May.

The best method, where access is practical, is to walk around the pond edge slowly once, scanning the water margins with a torch (1 million candlepower) for amphibians. The numbers of male, female and juvenile newts should be recorded. The positions of all great crested newt individuals seen are to be recorded on a map of the waterbody.

Torch survey results are weather dependent, and should not be carried out when the night time air temperature is below 5°C. Surveys should not be carried out when there is wind or rain as this disturbs the water surface and makes it difficult to see the newts below the water surface, strongly biasing the results downwards.

Actions

The risk of unknowingly killing great crested newts or destroying habitat used by great crested newts through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting great crested newts.

2 If the location is likely to support great crested newts, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of the year, identifies that the site is not used by great crested newts then proceed with the works as proposed.

3b If the survey identifies that the site is used by great crested newts, or use cannot be ruled out, then the first consideration should always be avoidance of damage to the site. This is often possible through careful location and design of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve trapping and removing or excluding great crested newts from the site, and the destruction or damage of the site and its replacement away from the affected area. The replacement habitat will need to be established and the great crested newts moved before the works commence. Determining the size of

the population to be moved and establishing the replacement habitat can be a time-consuming process. Natural England should be closely consulted at the early stage of the development of the mitigation proposal. Their comments should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial proposal.

The presumption in any acceptable great crested newt translocation or exclusion programme is that the population of the newts affected remains at a favourable conservation status in the area. Without this statutory requirement being likely to be fulfilled it is unlikely that a licence will be granted.

Management techniques

No additional, specific management techniques are proposed.

Further reading and information

English Nature (2001). *Great Crested Newt Mitigation Guidelines*. English Nature, Peterborough.

Gent, A. and Gibson, S. Eds. (1998). *Herpetofauna Workers Manual*. JNCC, Peterborough.

Langton, T., Beckett, C. and Foster, J. (2001). *Great Crested Newt Conservation Handbook*. Froglife, Halesworth, Suffolk.

Nesting birds

Legal protection

The Wildlife and Countryside Act 1981, as amended by the Countryside and Rights of Way Act 2000, makes it an offence to:

- Kill, injure or take any wild bird.
- Take, damage or destroy the nest of any wild bird while it is being built or in use.
- Take or destroy the eggs of any wild bird.

Special penalties exist for offences related to species listed on Schedule 1, for which there are additional offences of disturbing these birds at their nests, or their dependent young.

There are certain exemptions to this, notably in respect of wildflowl, game birds and various species which may cause damage.

Licensing requirements

For management works

There is provision within the legislation to allow action to be taken under a licence from Natural England. This does not include facilitating routine management work and therefore it is important that such work is planned so as to avoid impacts.

For surveys

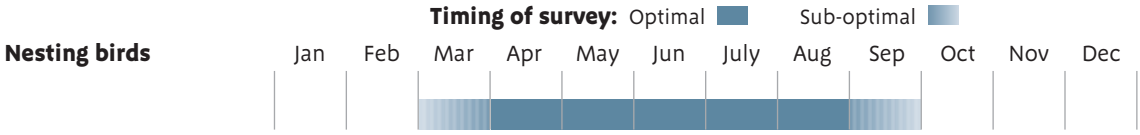
All surveys should be undertaken by an appropriately experienced ornithologist. To look briefly into the nest of most birds does not require a licence, the exception being a limited list of species on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). For all species, including those on Schedule 1, proof of occupation can usually be gained by observation from a distance and this should be sufficient for an IDB's needs. Schedule 1 bird nests that are most likely to be encountered

along drainage channels are barn owls nesting in hollow trees, nest boxes and buildings and kingfishers nesting in a bank.

Survey methods

A survey can be carried out to attempt to locate any birds' nests during the breeding season. This will only be practical where the area for the proposed works is limited or, if on a larger area, the extent of features likely to contain nests is limited.

The period over which birds are most likely to be found nesting is summarised below. More detailed information on nesting periods, provided for each species likely to be found nesting on or adjacent to a drainage channel, is provided in Appendix 8.



The approach to locating nesting birds during the breeding season is set out below. These actions should be undertaken in the period one to three days in advance of the proposed works.

1. Observe the length or area concerned from a distance, either from a concealed position or from a vehicle, looking for adult birds returning to particular locations carrying food for young or the incubating adult. Also listen for the calls of young begging for food. In good weather 30-60 minutes should be devoted to this action over each visible reach, concentrating on those features and vegetation types in which birds would nest. In poor weather a longer period may need to be given. Note any features that will allow the nest to be located more precisely on a close approach.
2. Approach the area or site slowly and quietly watching for birds walking, swimming or flying away from possible nesting sites and listening for birds giving alarm calls. Note any features that will allow the nest to be located more precisely by a detailed search. Where there are species that have nests attached to floating and emergent vegetation an approach from the water (by boat or wading where safe to do so) may be more effective.
3. Carry out a detailed search of any areas where the observation from a distance and during the approach indicated that a bird might be nesting. In these areas if it is possible to part the vegetation by hand or with a stick and see clearly through the vegetation that there is not a nest present then they can be marked as free of nesting birds on the ground and on a plan which is provided to the machine operators. Where there are species that have nests attached to floating and emergent vegetation a search from the water (by boat or wading where safe to do so) may be more effective. If it is not possible to see clearly into the vegetation (particularly the case with bramble thickets) then the area cannot be declared free of nests and should be marked as such on the ground and on a plan which is provided to the machine operators.
4. Machine operators should be instructed to leave any section of watercourses or site uncut or uncleared with a buffer of 5m for most nests, extending to 10m for the common birds of prey. If a nest of a species listed on Schedule 1 of the Wildlife and Countryside Act is found or suspected then there should be specific consultation with Natural England over the size of this buffer.
5. During the cutting or clearing operation of the marked nest-free areas, machine operators should be instructed to maintain a close watch for birds rising from the vegetation ahead of them as they work and must investigate all sightings.

If there is to be a gap of more than three days between this nest-searching exercise and the cutting or clearance operation then there should be a resurvey following the above procedure.

This nest-searching procedure is time-consuming, requires a skilled naturalist familiar with the signs of nesting birds and good weather in which birds are more likely to be observed, particularly feeding young. It is strongly advised to carry out relevant operations and advance clearance outside the bird nesting season in preference to the nest-searching approach.

Actions

The preferred approach is to avoid the risk of damage to birds' nests, their eggs and young by:

- Avoiding the intentional creation of suitable nesting habitat in areas that may require intensive management to tackle high flood risk.
- Avoiding the unintentional development of suitable nesting habitat through changes in vegetation management programmes in areas that may require intensive management to tackle high flood risk.
- Avoiding the annual growth of nesting habitat in areas that may require intensive management to tackle high flood risk, i.e. having a programme of early and repeated cutting in such locations.

The practice of early and repeated cutting should only be undertaken as an exception, and in circumstances where there is an established flood risk to people and property. Alternative solutions should also be considered, including works to increase the capacity of the channel, where this is feasible. Where a programme of early and repeated cutting is undertaken, then the IDB should endeavour to off-set the loss of potential nesting habitat by creating additional nesting habitat elsewhere within the drainage system. Where the early-and-repeated cutting approach is being considered it should be discussed in advance with Natural England, ideally presenting the proposals within an annual maintenance programme for the sub-catchment or drainage district.

Where it has not been possible to avoid works in the nesting season and/or to undertake the pre-nesting season vegetation clearance, consideration can be given to attempting to locate any birds' nests during the breeding season. The survey approach is described above.

Management techniques

Habitat creation and management techniques for birds are included within the individual techniques detailed in Chapter 5.

It is possible to provide nesting sites for birds by the installation of boxes. There are many designs available, with the style, materials and siting being specific to different types of birds and their nesting habits. A guide to nestboxes for the more common species that will use boxes is du Feu (2004) and a near comprehensive guide to the construction and siting of nestboxes for birds in the UK is du Feu (1993). This is now out of print but its content that is not repeated in du Feu (2004) is available from the BTO website www.bto.org.

Of particular relevance to drainage channels is the potential to create nesting sites for barn owl, kingfisher and sand martin. Detailed information on barn owl boxes can be obtained from Dewar & Shawyer (2001). The creation of access points for kingfisher through steel sheet piling alongside an IDB channel is detailed in Carson (2008). The construction of a nesting cliff with tunnels for sand martin is described in Andrews & Kinsman (1990).

Further reading and information

Andrews, J.H. and Kinsman, D. (1990). *Gravel Pit Restoration For Wildlife*. RSPB, Sandy.

Carson, C. (2008 in draft). *Giving Biodiversity an Edge: A Guide to the Management of Drainage Channels for Biodiversity for the Internal Drainage Boards of the Middle Level of the Fens*. Middle Level Commissioners, March.

Dewar, S. and Shawyer, C. (2001). *Boxes, Baskets and Platforms: Artificial Nest Sites for Owls and Other Birds of Prey*. Hawk and Owl Trust, London.

du Feu, C. (1993). *BTO Guide 23: Nestboxes*. BTO, Thetford.

du Feu, C. (2004). *BTO Nestbox Guide*. BTO, Thetford.

Gilbert, G., Gibbons, D.W. and Evans, J. (1998). *Bird Monitoring Methods: A Manual of Techniques for Key UK Species*. RSPB, Sandy.

Otter

Legal protection

In England and Wales otters are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (the Habitats Regulations). In the following description 'otter holt' includes hovers and couches, which are otter resting places above ground. Artificial holts are not considered as holts under the legislation until they are known to be used by otters. The Habitats Regulations make it illegal to:

- Deliberately capture, injure or kill an otter
- Deliberately disturb an otter in such a way as to be likely significantly to affect the local distribution or abundance of otters or the ability of any significant group of otters to survive, breed, rear or nurture their young
- Damage or destroy an otter holt
- Possess or transport an otter or any part of any otter
- Sell (or offer for sale) or exchange an otter

Otters have become exempt from many of the provisions of the Wildlife and Countryside Act 1981 (as amended). However, otters are still protected under Section 9(4)(b) and (c) and (5) of the Wildlife and Countryside Act. This means that, in addition to the provisions of the Habitats Regulations, it is also illegal under the Wildlife and Countryside Act to:

- Intentionally or recklessly disturb any otter whilst it is occupying a holt
- Intentionally or recklessly obstruct access to a holt

Licensing requirements

There is provision within the legislation to allow actions, which would otherwise be illegal, to be carried out under a licence from Natural England.

For management works

There is provision within the legislation to allow actions, which would otherwise be illegal, to be carried out under a licence from Natural England. Licences for management work can be issued for the purpose of preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment. Licences can only be issued where there is no satisfactory alternative and where the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range.

Management work should therefore be planned to avoid any direct impact on otters and therefore avoid the need for a licence.

For surveys

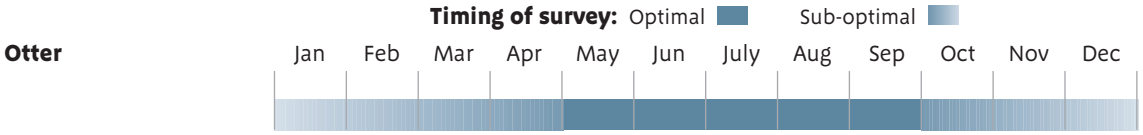
The following surveying activities do not, in the view of Natural England, require a licence as they should not lead to an offence if you act responsibly and with due diligence:

- Walking river banks or wading along the river to look for signs of otters (spraints, footprints, holts). This could include walking past known holts and carrying out a brief exterior examination.
- Stopping to examine potential otter holts (as there is no intention of disturbing an otter). However, if an otter is seen or signs suggest one is present you should withdraw immediately.
- Watching a known holt from a distance or from concealment to see if it is occupied, providing there is no intention of disturbing the otter.

However a licence is required for detailed and prolonged examination of a known otter holt that would cause disturbance to any otters present. Such activities include use of intrusive methods i.e. using probes inside the holt, or remaining at the holt once there is good reason to believe that an otter is present.

Survey methods

Otters are active throughout the year and thus otter surveys can be carried out at any time of the year. The optimal period is between May and September when water levels are less variable and signs of otter activity most likely to persist. Surveys should not be carried out during periods when there is heavy rain as this can wash away signs. Ideally, there should be a period of at least five days without rain before surveying. Weather conditions should be recorded because it may affect the survey.



Otter presence is determined by searching for the following field signs:

- Spraints
- Footprints
- Feeding remains
- Holts and dens
- Couches
- Cub play areas.

Spraints

Spraints (faeces) are used by otters as scent markers and are deposited in prominent places within the watercourse corridor and inside lie-up sites and holts.

Surveys should search for spraints on rocks, tree stumps, ledges under bridges and any other protruding or prominent natural or artificial features along the bank of the watercourse. Where there is nowhere for the otter to leave their spraints, they will often scrape sand or soil into a platform or make a grass twist and then leave a spraint on top.

Spraints have a sweet musky smell (described as freshly mown hay or jasmine tea), the size can vary from a tiny blob or smear to a 6cm long compacted cylindrical dropping and the colour ranges from black or dark greenish when fresh to ashy grey. Mink have droppings that are similar to otter's but they have an unpleasant odour and they are more uniform in shape and taper at the ends. The number of spraints seen should be recorded and split into categories: Dried fragmented (Df), Dried intact (Di); Not fully dry (Nd).

Where there are bends in a watercourse otters may leave it and walk over ground to 'cut off the corner', so when undertaking a survey note any signs that they are using terrestrial habitat. Well-used paths may have spraints at intervals along them.

Footprints

An otter footprint should show five toes arching around a large pad and the claw marks and webbing may also be visible. When only three or four toes are visible they can be distinguished from other tracks as they are asymmetrical, i.e. the left half is not the mirror image of the right. The width is 4-8cm wide. Mink also have five toes but the footprints are more pointed and the width is smaller, around 3-3.5cm (Woodroffe 2001; Environment Agency 1999).

Surveys should pay close attention to soft substrates at the water margin as this will usually be the most likely place to find footprints.

Feeding remains

Feeding remains are usually fish, crayfish and sometimes frogs. Otters may also eat birds, molluscs, crustaceans and small mammals. Feeding remains are difficult to distinguish from those left by other predators unless other signs are nearby.

Holts and dens

Holts are often difficult to find. Look for tree-root systems (the entrance may be underwater), holes in banks, undercut banks, or beneath piles of rocks, logs, flood debris, in drains, caves, even buildings. Reedbeds may be used for resting, breeding and feeding.

Couches

Couches or lay-ups are resting places above ground usually in reedbeds, tall-herb vegetation and scrub, especially bramble and blackthorn. Look for flattened vegetation, or vegetation that has been bitten off or pulled up.

Cub play areas

Cub play areas may be visible around a breeding site. Signs include a well-worn path around a tree, a circle up and down the bank or 'slides' down banks.

Actions

The preferred approach is to avoid the risk of damage to otter holts by:

- Avoiding the intentional creation of a holt or holt building habitat in areas where regular access is required for management purposes.
- Avoiding the unintentional development of holt building habitat through changes in vegetation management programmes in areas where regular access is required for management purposes.

Where a holt already exists the first consideration should always be how to avoid damage to the holt by modification to the location, design and execution of the works.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve destruction of the holt and its replacement away from the affected area. The replacement holt will need to be established before the works commence. Natural England should be closely consulted at the early stage of the development of the proposed holt replacement. Their comments should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial proposal.

The presumption in any acceptable holt replacement programme is that the population of the otters affected remains at a favourable conservation status in the area. Without this statutory requirement being likely to be fulfilled it is unlikely that a licence will be granted.

Management techniques

Habitat creation and management techniques suitable for otters are included within the techniques detailed in Chapter 5.

It is possible to provide artificial holts for otters. Of particular relevance to drainage channels and IDB operations is the design of artificial otter holts used by the Middle Level Otter Recovery Project (Carson 2008).

Further reading and information

Carson, C. (2008 in draft). *Giving Biodiversity an Edge: A Guide to the Management of Drainage Channels for Biodiversity for the Internal Drainage Boards of the Middle Level of the Fens*. Middle Level Commissioners, March.

Chanin, P. (2003). *Monitoring the Otter* Lutra lutra. Conserving Natura 2000 Rivers Monitoring Series No. 10. English Nature, Peterborough.

Chanin, P. (2003). *Ecology of the European Otter*. Conserving Natura 2000 Rivers, Ecology Series No. 10. English Nature, Peterborough.

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Natural England (2007). *Otter surveys – When do I need a licence?* Natural England, Peterborough.

Environment Agency (1999). *Otters and River Habitat Management*. Environment Agency, Bristol.
Liles, G. (2003). *Otter Breeding Sites: Conservation and Management*. Conserving Natura 2000 Rivers

Conservation Techniques Series No. 5. English Nature, Peterborough.

Woodroffe, G. (2001). *The Otter*. The Mammal Society, London.

Reptiles

This guidance note covers adders, grass snakes, slow worms and common lizards which are the species most likely to be encountered by an IDB exercising its powers on a watercourse.

Legal protection

Adders, grass snakes, slow worms and common lizards receive partial protection under Section 9 of the Wildlife and Countryside Act 1981, as amended. This makes it an offence to:

- Intentionally kill or injure any individual.

Licensing requirements

For management works

Where the translocation of a population of one of the species listed above is proposed then Natural England should be consulted as a matter of good practice. A licence is not needed to capture or

disturb these species or to damage their habitat. However, the animals themselves are still protected so it is important to ensure that the animals are not injured or killed.

For surveys

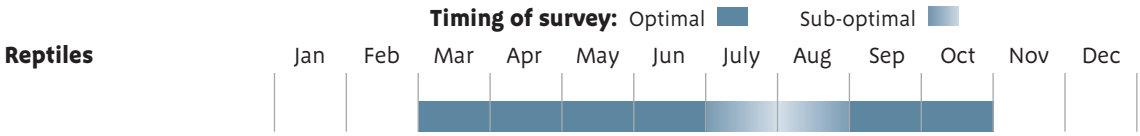
No licence is required to carry out the standard 'refugia' survey of the common reptiles likely to be encountered along drainage channels – common lizards, slow worms and grass snakes.

Survey methods

Surveys for reptiles can take two forms:

- Refugia
- Direct observation

The survey period below applies to both types of survey.



Refugia

Sheets of corrugated iron and roofing felt of approximately 0.5m^2 are placed in areas deemed suitable for reptiles at a density of around 25 to 50 refugia per hectare. These are then checked on a number of successive days for reptiles which may use them for basking and sheltering underneath.

The four common species of reptile will use refugia made both of metal and roofing felt, and a mixture of both within a site survey is preferable. However, choice of material depends on availability, access to the site, level of human disturbance and site topography. If the sheets have to be carried a long way or if human disturbance is likely then roofing felt may be preferable as it is lighter and easier to camouflage. But if the site is very overgrown then metal may be better as this flattens the vegetation and is often easier to find.

Refugia should be placed in likely basking spots (unshaded patches next to cover), in areas of long grass and next to potential hibernation sites (piles of rubble or logs, or disused rabbit burrows). When placing refugia early in the season it is important to take into consideration the growth rate of the surrounding vegetation. What appears as short open vegetation ideal for basking in during early spring may quickly become swamped by bracken or nettles by the summer. As well as this resulting in the refugia being of little use as basking areas, it can mean the refugia are difficult to locate. Refugia should be kept away from public footpaths as reptiles are vulnerable when they are sheltering under them. The refugia should be numbered and their locations marked on a map to ensure they are all checked and removed at the end of the surveys. Discarded debris, such as fallen fence posts or road signs which act as refugia, should also be lifted and checked under for any evidence of reptiles. These objects should be returned to their original position once they have been checked.

Seven visits should be made to check all refugia. Checking refugia can be carried out from March to October but the optimal periods are when cooler weather is more frequent and reptiles have a greater need to bask. These visits should be carried out on seven separate days. Checking refugia should not be carried out in heavy rain, strong wind or when the temperature is below 10°C.
A record of the weather during each survey visit should be made. When temperatures are too high (20°C+ on clear sunny day) the necessity for reptiles to bask diminishes as temperatures can be maintained without prolonged periods of basking. A mixture of rain and sun can provide good detection rates.

Refugia should be approached slowly and cautiously, and, if possible, viewed from a distance as reptiles will often bask on top of the sheet and may quickly disappear as you approach the refugia. Reptiles found on or under refugia should be identified, but not caught or handled. When all the surveys are completed, ensure that all refugia are removed from the site.

Recording should include a note of species found, time, sheet number and location taken. The weather conditions of each visit should also be noted.

Direct observation

Refugia as a survey method should not solely be relied on as some species such as common lizard generally use refugia less frequently than other species. Reptile surveys should therefore combine both the checking of refugia with direct observation of the surrounding area. The following features are often preferred sites for reptiles:

- Embankments
- Slopes
- Log and rock piles
- Compost heaps
- Board walks
- Dry stone walls
- Rides or paths through scrub and woodland
- Sun traps

These areas should be approached slowly and cautiously and if possible surveyed from a distance using binoculars. When carrying out surveys it is important to keep the sun behind you or to your side so that the area you are searching is in full sun. If an animal is disturbed on approach it is worthwhile making a note of the area and returning after 10 minutes have elapsed as reptiles will often return to a basking area after being disturbed.

Actions

The risk of unknowingly killing reptiles through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting reptiles.

2 If the location is likely to support reptiles, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate time of the year, identifies that the site is not used by reptiles then proceed with the works as proposed.

3b If the survey identifies the site is used by reptiles, or use cannot be ruled out, then the first consideration should always be avoidance of actions that might lead to the killing of reptiles. This is often possible through habitat management in advance of the works, a translocation of the reptiles or careful location and design of the works.

If a modification to the site or nature of works is not practical or cost-effective then other mitigation methods should be explored. There are two options most widely applied. They both involve the identification of land that can be managed to improve its quality as habitat for reptiles in advance of the proposed works being undertaken. They also both involve moving reptiles when they are active. The options differ in where that land is located and how the reptiles are moved to it

i) If the improved habitat is immediately adjacent to the proposed works then the reptiles can be persuaded to move to it by the progressive, phased strimming of the vegetation on the site of the works to make it unsuitable for reptiles. At the same time any structures that might be used for winter hibernation should be taken apart by hand. Once the habitat on the works site is unsuitable and reptiles have been given sufficient time to move, it should be fenced to prevent movement back.

ii) If the improved habitat is separated from the proposed works by a natural or artificial barrier then the reptiles will have to be trapped and translocated. The efficacy of trapping is enhanced by appropriate fencing to prevent immigration on to the site, by the phased strimming of the vegetation on the site and the manual dismantling of any hibernation structures. Once all the reptiles have been trapped the works can proceed or if there is to be a period before the works, the fencing monitored and maintained.

Neither of these procedures requires a licence but it is recommended that Natural England is consulted about the method statement.

Management techniques

No additional, specific management techniques are proposed.

Further reading and information

Gent, A. and Gibson, S. Eds. (1998). *Herpetofauna Workers Manual*. JNCC, Peterborough.

English Nature (2004). *Reptiles: Guidelines for Developers*. English Nature, Peterborough.

Water vole

Legal protection

The water vole is protected under the Wildlife and Countryside Act 1981 (as amended). An amendment to the legislation came into force in April 2008, extending the protection to the animal itself. The result is that it is an offence to:

- Intentionally kill, injure or take water voles.
- Intentionally or recklessly damage, destroy or obstruct access to any structure or place used for shelter or protection.
- Intentionally or recklessly disturb water voles whilst occupying a structure or place used for that purpose.

Water voles are not listed on the European Habitats Directive 1992 and so are not protected by the Conservation (Natural Habitats, etc.) Regulations 1994 (as amended). A licence is therefore not required under those Regulations.

Licensing requirements

For management works

There is no provision under the Wildlife & Countryside Act 1981 for licensing what would otherwise be offences for the purpose of development, river or drainage maintenance or land management. Such activities must be covered by the defence in the Act that permits otherwise illegal actions if they are the incidental result of a lawful operation and could not reasonably be avoided. Where actions are proposed that will potentially cause disturbance to water voles or loss of burrows then it is important that it only proceeds after alternatives have been considered and discounted otherwise an offence will be committed. Where actions are likely to be undertaken which will impact on water voles then it must be planned to ensure unnecessary damage is avoided and all reasonable steps are taken to minimise the impacts on water voles.

In some circumstances it may be in the best interest to capture water voles and move then to a different location. The trapping of water voles will require a licence from Natural England as it can not be covered by the defence as the capture of water voles is not considered as 'incidental'. Licences can

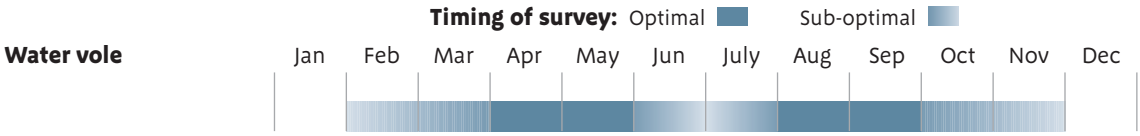
be issued for conservation purposes to trap water voles in situations where other possibilities to retain water voles on site have been fully considered and discounted and where the actions would produce a conservation benefit to the water voles.

For surveys

The standard survey method of looking for burrows and signs of occupation and activity in an area does not require a licence. Surveys should be undertaken by an experienced ecological surveyor.

Survey methods

The optimal period for a water vole survey, when breeding territories are frequently marked by latrines, is from April to September, with lush vegetation growth in June and July making survey less productive in this period.



All areas of potential water vole habitat along a watercourse or waterbody are searched looking for characteristic signs of water vole:

- Visual sightings and sounds of voles entering the water.
- Droppings: 8-12mm long, cylindrical, blunt ends and symmetrical.
- Latrines: often flattened piles of old droppings topped with fresh ones.
- Tunnel entrances: 4-8cm wide and usually wider than high. There is no need to use a probe to inspect a tunnel to discover if a water vole is present.
- 'Lawns' around tunnel entrances.
- Feeding stations or chopped vegetation with characteristic 45° feeding marks.
- Paths and runs at the water's edge or in vegetation.
- Footprints in mud – toes spread in a star shape with first and last toes at approximately 180°.

Where possible banks should be inspected from the water channel rather than from the bank top as this increases the probability of detecting signs.

The number of field signs in each length of watercourse or waterbody should be ranked as abundant, frequent, scarce or none. The presence or absence of mink, otter and brown rat should also be recorded, with their relative abundance noted for discrete areas of the site.

Actions

The risk of unknowingly destroying water vole burrows and killing water voles in those burrows through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting water voles.

2 If the location is likely to support water voles, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate season, identifies that water voles are absent then proceeding with the works as proposed.

3b If the survey identifies water vole presence, or cannot rule out their absence, then the first consideration should always be avoidance of habitat damage. This is often possible through careful siting and design of the works.

It is clearly not the intention of the legislation to prevent the work of IDBs and those who carry out riparian management or flood defence work in areas used by water voles. However, careful

consideration needs to be taken as to whether any of the proposed management actions will impact on water voles.

If a modification to the site or nature of works can be shown to be impossible or unreasonably difficult, then other mitigation methods should be explored. These usually involve either temporary or permanent translocation of water voles away from the affected area. This is a time-consuming and expensive option requiring specialist input. The Environment Agency and Natural England should be closely consulted at the early stage of the development of the proposed translocation. The comments of these agencies should be addressed and the necessary licence should be applied for from Natural England after any modifications to the initial translocation proposal.

The presumption in any acceptable water vole mitigation scheme is that, by the end of the project, at least an equal quantity and quality of occupied habitat will remain on the site or adjacent, as that which existed when water vole presence was identified. Without this objective being likely to be fulfilled it is unlikely that a licence for a translocation will be granted. Ideally, more habitat or higher quality habitat than previously existed can be incorporated into the design of the proposed works.

In the case of having to carry out emergency works:

- Minimise the extent of excavation or other ground-moving works.
- Work with machinery so as to avoid driving over burrows. Visibly mark their location.
- Leave any burrows open to allow animals to escape.
- If possible use hand tools to dig into areas with burrows.
- Excavate using a series of shallow cuts to allow animals to escape and minimise the chance of an accidental kill.

Management techniques

Habitat creation and management techniques for water voles are included within the individual techniques detailed in Chapter 5. The techniques emphasise the value of leaving a strip of vegetation at the water level to provide habitat for water voles.

Water voles suffer from considerable predation by American mink and this is considered to be one of the major factors in the recent decline of the water vole. Survey, monitoring and control of American mink is possible using signs of their presence, such as droppings, footprints and remains of kills, followed by trapping or shooting. A recent development has been the use of a floating raft developed by the Game Conservancy Trust (GCT). These rafts have been found to be considerably more effective at detecting mink than looking for signs. In trapping mode, the rafts have been found to be more effective than bankside traps. Full details of their use are given in GCT (2007). The main elements of use are:

- The raft contains a removable tracking tray filled with absorbent foam, covered with a layer of clay and sand mixed together to form a paste. The foam wicks water up from underneath the raft keeping the paste permanently moist so that it will record the tracks of visiting wildlife.
- The rafts are positioned amongst emergent vegetation at the edge of the watercourse and tethered to riverside shrubs or to an anchor post.
- In the monitoring phase each raft is checked three times, at two-week intervals. Once checked, the tracking substrate is smoothed using a wetted spatula for re-use.
- On larger watercourses, rafts should be spaced about 1 km apart as this should allow any mink to access at least one raft. In areas crossed by a network of ditches, the recommendation is one raft per square km excluding ones on main water carriers.
- Trapping is carried out using a live-cage trap within the tunnel of a raft. A trapping period of a maximum of ten days is recommended with daily checks of the trap.

Further reading and information

ADA and Natural England (2007). *National Guidance For Internal Drainage Boards: Mitigation Measures for Water Voles*. ADA, Surbiton and Natural England, Sheffield.

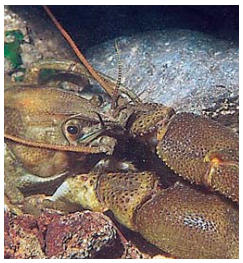
Game Conservancy Trust (2007). *The GCT Mink Raft*. GCT, Fordingbridge.

Natural England (2008). *Technical Information Note – TIN 042 Water Voles and Development: Licensing Policy*. Downloadable from www.naturalengland.org.uk/conservation/wildlife-management-licensing/leaflets

Natural England (2008). *Water Voles – the Law in Practice. Guidance for planners and developers.* Downloadable from www.naturalengland.org.uk/conservation/wildlife-management-licensing/leaflets

Natural England (2008). *Do I Need a Licence to Survey for Water Voles?* Downloadable from www.naturalengland.org.uk/conservation/wildlife-management-licensing/leaflets

Strachan, R. and Moorhouse, T. (2006). *Water Vole Conservation Handbook: Second Edition*. Wildlife Conservation Research Unit, Oxford.



White-clawed crayfish

Legal protection

The white-clawed crayfish is partially protected under Schedule 5 of the Wildlife and Countryside Act 1981, as amended. This makes it an offence to:

- Intentionally take (capture) white-clawed crayfish.

Licensing requirements

For management works

Crayfish spend the daytime sheltering among boulders, tree roots and in crevices (including artificial structures such as gabion baskets, bridges and walls) and 'taking' can very easily occur during maintenance or capital works on watercourses and associated structures. Where it is intended to catch crayfish to remove them temporarily from a watercourse or channel prior to the commencement of works, then a licence will be required from Natural England and bye-law consent for trapping is required from the Environment Agency.

For surveys

The trapping, including temporary handling of white-clawed crayfish requires a licence from Natural England and consent from the Environment Agency under their bye-laws.

Survey methods

The method applied in the survey is dependent on the waterbody or watercourse that is to be surveyed. The following methods are applicable in the following circumstances:

- Shallow water, bed visible, moveable in-channel refuges e.g. cobbles.
  Use the 'active, manual search' method.
- Shallow water, bed visible, predominantly fixed or bank refuges.
  Use the 'active, manual search' method supplemented with 'night-viewing'.
- Deep and/or turbid water.
  Use the 'drawdown' method or the 'trapping with baited traps' method.

Active search

This is the best method to use in suitable habitats. It involves manually searching potential crayfish refuges. These can be under stones and tree roots and in vegetation. It is only effective in clear, shallow water (<60cm deep) and when the weather conditions are calm and the water surface stable. Used selectively in appropriate conditions, the method can be used to register the presence of crayfish. Selectively searching for 45 minutes or more will be necessary to detect a population of crayfish at low densities, higher densities should be detected quicker. Estimates of population size can be obtained by systematically searching a defined area (e.g. by quadrat) of the survey site for a known time period (e.g. 30-60 minutes for a 10mx0.5m transect). It is recommended to carry out surveys of the site on at least two occasions, usually with more than a week between each visit. A standard effort by time (SET) search is the usual measure of effort for crayfish surveys.

Night viewing

This method involves slowly walking the survey area shining a high-powered torch into the water and observing the channel bed for potential crayfish activity. Night-viewing will only record crayfish that are active at night, which tends to consist mainly of adults. This method can be used to cover larger areas of water body than is possible with active searching so is more reliable for detecting crayfish at moderate to low densities. It can be a good way to see crayfish whose refuges are inaccessible by day and provides a quick estimate of the density of active animals. The method is dependant on having clear, calm water and a channel/bank that is safe enough to wade/walk along. This technique should be used to supplement other methods and should not be used in isolation.

Drawdown

This is only feasible on small contained waterbodies, channels or canals where water levels can be controlled. The site is dewatered to encourage crayfish in bankside refuges to emerge. Crayfish emerge within half an hour of being exposed. Potential refuges on the bed can also be examined more easily.

Trapping

Trapping is the only way of finding crayfish in watercourses that are too deep or turbid for manual/visual searches. This method is only to be used where no other survey method can be undertaken.

The most common method is to use plastic mesh traps with a funnel entrance that are baited with scraps of fish or cat food. The funnels are set in the early evening and inspected the following morning. Trapping efficiency is low as it only records the larger, active animals, especially males. This means it will not detect crayfish populations at moderate to low densities unless many tens of traps are used. A density of one trap per 5m in favourable habitat will normally be sufficient to detect crayfish, especially if trapping is carried out over several nights.

If water voles or water shrews are known to be present in the survey area DO NOT use standard funnel traps. Use another survey method or use water vole-friendly traps. Standard crayfish funnels are known to trap and drown water voles and water shrews.

Hygiene precautions during surveys

Precautions are required to prevent the spread of Crayfish Plague (*Aphanomyces astaci*). All sites known to support white-clawed crayfish should be sampled with clean and dry or disinfected equipment. All equipment used at sites known to contain signal crayfish or other non-native crayfish must be disinfected and dried out thoroughly before it is used at other sites. If a catchment has a population of signal crayfish or other non-native crayfish, it is preferable to survey any areas that only have white-clawed crayfish prior to those known to have non-native crayfish.

Actions

The risk of unknowingly killing white-clawed crayfish or destroying habitat used by white-clawed crayfish through flood risk management works should be avoided by:

1 Assessing the likelihood of the location supporting white-clawed crayfish.

2 If the location is likely to support white-clawed crayfish, carrying out a survey in advance of potentially damaging works.

3a If the survey, carried out by a suitable method at an appropriate season, identifies that the site is not used by white-clawed crayfish then proceed with the works as proposed.

3b If the survey identifies that the site is used by white-clawed crayfish, or use cannot be ruled out, then the first consideration should always be avoidance of damage to the site. This is often possible through careful location and design of the works.

If a modification to the site or nature of works is shown to be impossible or unreasonably difficult then other mitigation methods should be explored. These usually involve trapping and removing white-clawed crayfish from the site, the destruction or damage of the site and its replacement away from the affected area. The replacement habitat will need to be established and the white-clawed crayfish moved before the works commence. Natural England and the Environment Agency should be closely consulted at the early stage of the development of the mitigation proposal. Their comments should be addressed and the necessary licence and consent applied for from them after any modifications to the initial proposal.

Management techniques

No additional, specific management techniques are proposed.

Further reading and information

Holdich, D. (2003). *Ecology of the White-clawed Crayfish* Austropotamobius pallipes. Conserving Natura 2000 Rivers, Ecology Series No.1. English Nature, Peterborough

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The Association of Drainage Authorities (ADA) is the membership body for organisations involved in water level management, including Internal Drainage Boards, Environment Agency Regional Flood Defence Committees, the Northern Ireland Rivers Agency, local authorities and suppliers. On behalf of its members, ADA works with Government and a wide range of other organisations to develop policy, legislation and guidance on best practice for the flood risk and water level management sectors.

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