Management of Riparian and Instream Vegetation

Issues

Chalkstreams are generally relatively stable environments, both with respect to flow and temperature. This stability has, over time, resulted in a diverse mix of vegetation associated with them.

There is a long tradition of management of instream and marginal vegetation on chalkstreams. This may involve some or all of the following:

- regular cutting of instream vegetation
- cutting of access paths for anglers
- cutting and/or burning of the emergent fringing vegetation
- removal of marginal cress beds in the autumn
- cutting and trimming of bankside trees

(*see* **Tree Management**)

Vegetation is cut for a number of purposes. These include access (for passage of anglers and for casting), the maintenance of good instream habitat, and the control of river water level.

Potential management options

Cutting of instream vegetation

Instream weed is cut in order to maintain a good diversity of habitat and to control water level. The timing, amount, and pattern of weed cutting are vital factors affecting the growth of weed in the river.

Much of the research on weed cutting has focused on southern chalkstreams, where the role of water crowfoot *Ranunculus* in chalkstream ecology has been extensively studied. This plant grows rapidly, reaching maximum biomass by summer. Self-shading and water velocity on weed is thought to be the major factors limiting biomass. Stands of water crowfoot act to develop a range of microhabitats, with summer water depth increased by up to 80cm as a result of its growth. Water temperature within the plant stand may rise by 2°–4°C, whilst water velocity in the same location may fall to one tenth of the external velocities. Associated silt accumulations may make this increase more pronounced. Fragmentation of water crowfoot begins soon after reaching maximum biomass, with over 75% of plant material fragmented within three months and broken down and utilised in-situ.

The presence of submerged macrophytes, particularly water crowfoot, retains organic material, preventing it being washed downstream during the higher autumnal/winter flows. This both increases the fragmentation of organic litter near to its site of origin and prevents the accumulation of thick layers of silt on the riverbed.

The impact of cutting regimes on the growth of *Ranunculus* has been studied in detail. The commonly used pattern of spring and summer hand cutting generally results in only short-term control of growth. After cutting there is a rapid, synchronised growth in water crowfoot, as plants become free from the progressively poorer growth conditions and self-imposed burden of high biomass, which naturally leads to the collapse of undisturbed populations in late summer. Additionally, the roots of cut plants do not die back, but continue to grow in the autumn, thus increasing the probability of high over-wintering biomass earlier in the subsequent year.

The implications of these facts have a fundamental impact on the standard 'chequerboard' or 'bar' weed cutting patterns most often practised on

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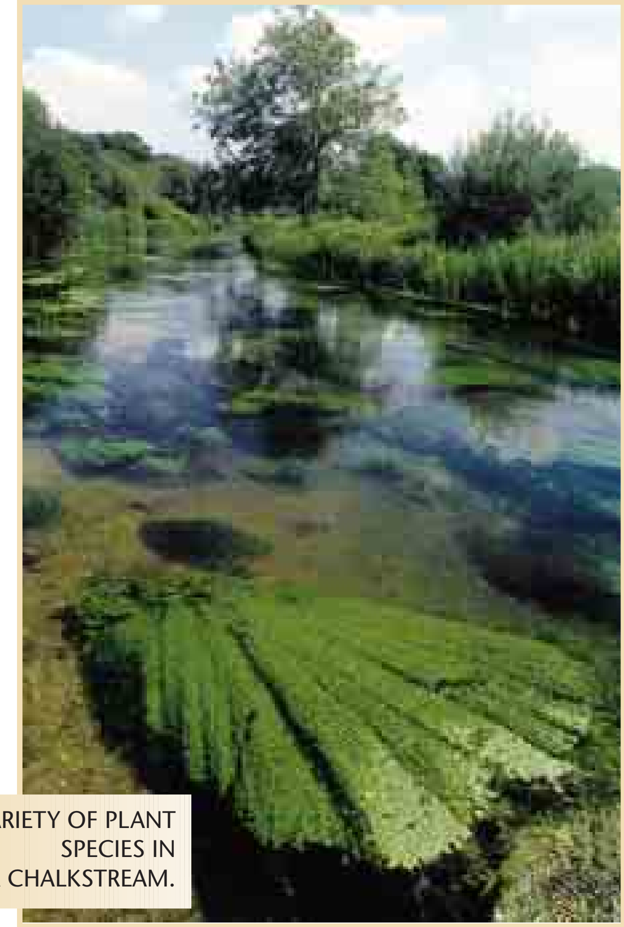
chalkstreams. In essence, this traditional approach to weed management stimulates the growth of water crowfoot, maintaining freshly growing stands throughout the fishing season. Care must to be taken however to avoid excessive cutting, as this can significantly lower the water level, leading to decreased habitat availability and increased water temperature and risk from avian predation, particularly during low flow periods.

A variety of weed species in a chalkstream

Research has also shown that that following a four year cessation of cutting on trial chalkstream reaches, the maximum biomass of *Ranunculus* declined to approximately 50% of that found when water crowfoot was regularly cut. However, following cessation of cutting, a wider, more extreme range of both dissolved oxygen and water temperature was apparent compared to unmanaged streams of a similar size. There is no indication that any of this increased variation was of a magnitude that could be damaging to stream ecology.



A VARIETY OF PLANT SPECIES IN A CHALKSTREAM.

A 'no-cut' policy may thus be of benefit in the longer term on rivers with a very heavy growth of water crowfoot.

Flowering signals the start of decline in the rate of growth of *Ranunculus*. Cessation of flowering coincides with maximum biomass. Flowering can thus be regarded as an indicator of the seasonal cycle and adaptation of the plant to average environmental conditions of that reach of river. Flowering generally commences earlier at upstream, spring fed river sites. Difference in timing of flowering has been recorded as between two and three months from source to estuary, on the River Piddle, Dorset.

RIVER-KEEPERS WEED CUTTING.

Heavy weed cuts sometimes take place following the end of the fishing season. The impacts of this type of management have also been extensively researched, with a reduction in the biomass of water crowfoot early in the following season the normal outcome, particularly in water with a depth of less than 0.7m. Very careful consideration should be given as to whether this is a sound management policy, before undertaking a weed cut after the senescent period for crowfoot.

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The removal of water cress, *Rorippa nasturtium-aquaticum* is routinely carried out, both to prevent the accumulation of associated marginal silt and as a pre-emptive flood management measure. The importance of cress to the river's ecology should not be underestimated. It provides good habitat for juvenile trout and is known to be effective at capturing nutrients. In addition the invertebrate fauna associated with water cress has been quantified, with a mean of 21 associated taxa found. Water cress and water crowfoot can be seasonally co-dominant and interact so that the biomass of each regulates the success of the other; as crowfoot dies back, cress growth increases and vice versa. This feedback mechanism helps to maintain water velocity in what would otherwise be an often over-wide channel. Timing of the autumnal increase in flow is the natural event regulating this interaction, with the impacts of weed cutting artificially affecting this balance. The removal of water-cress in the autumn/early winter (so-called 'edging-in') is thus not a recommended technique. Not only does it remove valuable invertebrate habitat, but it also threatens to destabilise the relationship between cress and water crowfoot.

The fate of weed following cutting is of great importance. Allowing the passage of weed down the watercourse as in the Test and Itchen, may permit invertebrates to migrate from the weed and hence remain in the river. However, the pre-set calendar of dates on which cutting may take place does impose an artificially rigid structure on fishery interests, perhaps making them cut weed when it may not need removal.

Removal of cut weed from the river adjacent to the site of cutting, reduces opportunities for associated invertebrates to drop off and remain in the watercourse; temporarily depositing it close to the water's edge allows mobile invertebrates to migrate back into the river. Leaving it here for longer periods can result in water pollution due to its breakdown. Risks associated with deoxygenation of the watercourse and the provisions of the Water Resources Act, 1991, also mean that cut weed should never be allowed to remain in the watercourse.

Selective cutting to totally remove "undesirable" species such as *Hippuris* (mare's tail) and *Schoenoplectus lacustris* (common club rush) should be undertaken with care. There are extensive invertebrate communities associated with these species. Indeed, some plants have more species of invertebrates living on them than does *Ranunculus*. Consequently, care should be taken to ensure that significant stands of all species should be allowed to remain; a 'monoculture' of *Ranunculus* is an undesirable outcome to any weed-cutting programme.

WEED-CUTTING (ABOVE), AND THE RESULTING APPEARANCE OF THE RIVER (LEFT).

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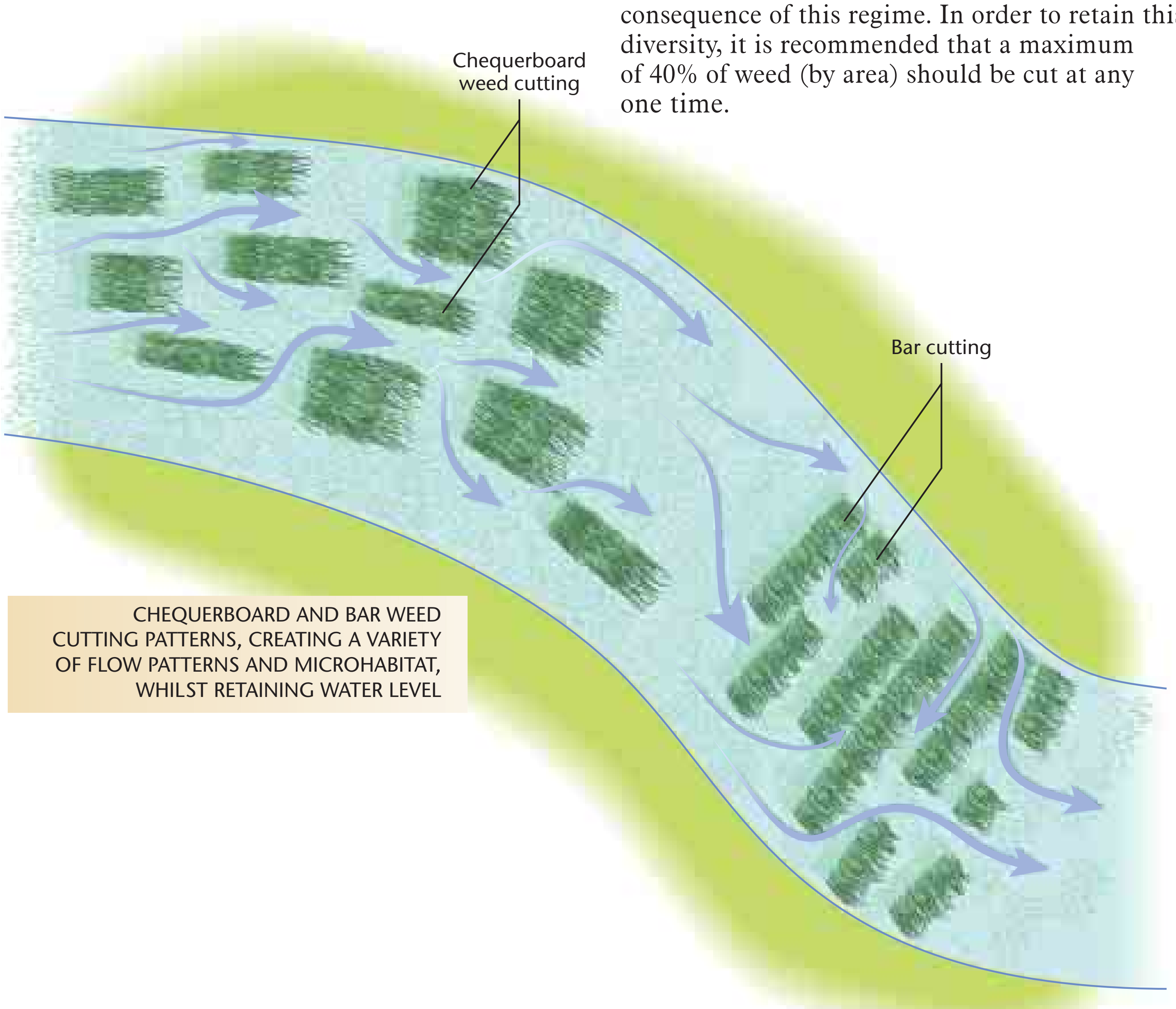
By altering the timing of cutting to avoid critical periods, impacts on particular species could be reduced. However, it is inevitable that cutting at any time of the year will affect one or more species. The extensive pre-emptive autumn cutting of *Ranunculus* and water cress carried out on some rivers, does produce benefits to flood defence and is financially efficient. However, reduction in over-winter vegetation cover, decrease in biomass of *Ranunculus* in the year following autumn cutting, possible changes to floral composition, impacts on invertebrates and lowering of autumn/winter river levels, all make this practice less desirable from an overall nature conservation viewpoint. Traditional hand cutting to the "side and bar" pattern during spring and summer probably represents the best compromise with respect to both fisheries and conservation interests.

There has been little research comparing the effects of manual and mechanical methods of weed cutting on stream ecology. However, mechanical cutting using either weed cutting boats or a Bradshaw bucket mounted on a hydraulic excavator, has the potential to remove greater amounts of weed in a less selective manner than manual methods. As a consequence, the use of such devices should be avoided, unless absolutely essential.

In conclusion, the key factors relating to the impact of weed cutting on nature conservation interests are timing and extent of the cut, along with species targeted. The long established history of weed cutting in the chalk and limestone streams suggests that much of the floral and faunal communities currently recorded are in part a consequence of this regime. In order to retain this diversity, it is recommended that a maximum of 40% of weed (by area) should be cut at any one time.



CHEQUERBOARD AND BAR WEED CUTTING PATTERNS, CREATING A VARIETY OF FLOW PATTERNS AND MICROHABITAT, WHILST RETAINING WATER LEVEL

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Impacts of vegetation control on other species

Timing of weed cutting is crucial. Fishery managers generally undertake cutting based on a visual judgement of the amount of aquatic weed present (which is not a good measure of their standing crop) and the need to complete the cut prior to the onset of the mayfly (*Ephemera danica*) hatch. The timing of the spring cut is significant for the survival of eggs of roach (*Rutilus rutilus*) that spawn in mid-May on clumps of water-moss (*Fontinalis antipyretica*). Exposure of these eggs to the air may occur as a result of lower water levels following a weed cut. Weed cutting has also been shown to be detrimental to brown trout fry, with other weed loving species such as perch (*Perca fluviatilus*) and pike (*Esox lucius*) also affected by weed cutting.

Excessive cutting prior to the winter period can significantly reduce the availability of winter cover for fish, leading to increased rates of predation, particularly by pisciverous birds. *Ranunculus* can also be significantly damaged by large mute swan populations in some rivers.

Invertebrate species can be affected by cutting, especially species with one generation that live on *Ranunculus* (e.g. grannom *Brachycentrus subnubilus*); these may be particularly affected by a cut occurring shortly after they become established.

Establishing Ranunculus

The abundance of *Ranuculus* in chalkstreams varies between years. In extreme cases, it can be eliminated from long reaches. In some cases, re-establishment can take place over time through natural downstream drift of weed fragments. However, in other instances, it may be advantageous or necessary to re-establish the plant artificially. A number of techniques have been tried, some with more success than others.

Those that have worked include:

- The use of brushwood 'snowshoes'. These are constructed from thin lengths of brushwood (generally willow due to its flexibility), woven into the rough shape and size (0.6m x 0.3m) of a snowshoe. They are fixed a few centimetres above the bed of the river using untreated wooden stakes. Floating weed fragments become entangled on the snowshoe, take root and grow on the structure.

SNOWSHOE.

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INSTALLATION OF SNOWSHOE.......

....WEED GROWTH ON SNOWSHOES

- Transplantation of *Ranunculus*. Legally, *Ranunculus* can be taken from a donor site in the wild, provided that the landowners permission is sought and is granted. Where possible, donor sites should located within the same river, or at least catchment. If this is not possible, *Ranunculus* may be transferred from another river system.

In all cases, freshly harvested (cut or pull from the river bed) *Ranunculus* should be used. Provided that the donor site has an abundance of *Ranunculus*, large volumes of material should be harvested. A one tonne trailer load of plants would not be excessive in order to repopulate a 500m section of river. The simplest way of planting *Ranunculus* at the donor site is to make a small hole (50-75mm diameter) in the riverbed using a metal stake. Take a sheaf of *Ranunculus*, fold the stems in half and push firmly into the hole. Close in the hole by 'heeling in' the surrounding bed material. Finally, place a series of stones over the newly planted root system to stop it pulling out of the bed. Planting can be carried out anytime from April-early June, ideally into a gravel/stone bed with a water depth of 150mm– 450mm.

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The newly introduced plants may need protection from grazing birds, particularly mute swans. Either cover the site with biodegradable string, stretched from bank to bank to form a 'net' covering the site, or use a metal basket to prevent access to birds. The latter method may allow birds to crop the vegetation when it grows through the basket. The mesh may also block with water borne detritus, cutting down flow velocity and increasing shading, both of which reduce the growth of plants.

FRESHLY PLANTED RANUNCULUS PROTECTED FROM WILDFOWL BY WIRE MESH BASKET.

Riparian vegetation management

Shade provided by riparian trees, particularly those on the south bank, is a vital component of stream ecology. Excessive shading can reduce instream and marginal vegetation cover to <10% of that found in unshaded sections of chalkstreams. As well as limiting plant photosynthesis, dense shade may reduce algal production and hence invertebrate and fish biomass. Dense shade resulting from conifer plantations has been shown to limit populations of invertebrates and trout, and stunt the growth of the latter.

The impact of shade on stream temperature is very important, particularly with likely forthcoming changes due to climate change. Temperatures in excess of 22.5°C may prove lethal to brown trout. Temperature can also affect growth rates, incubation times, and migration of salmonids. Temperatures outside the optimum range can also increase coarse fish mortality at the eyed egg stage. It is therefore vital to maintain a good balance between light and shade. Generally, 40–60% shading of a chalkstream is generally agreed to offer a reasonable compromise.

Riparian vegetation is vital to salmonids and other species of fish, providing instream habitat (tree root systems), food (terrestrial invertebrates) and overhanging cover. Cover is of particular importance when introducing stocked fish to a trout fishery. Without a suitable mix of overhanging and instream cover, it may prove difficult to maintain adequate stocks of introduced trout in a reach of river during the fishing season. Four times as many invertebrates fall into the water on tree-lined stretches compared to stretches having bare banks, the greatest biomass in one study deriving from sycamore, oak and alder respectively.

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SECTION OF CHALKSTREAM LACKING ANY RIPARIAN TREES.

Fallen leaves decay at different rates depending on species of origin. Invertebrate 'shredder' species show a general preference for those that decay fastest. The needles of coniferous trees are of less immediate use to invertebrates.

Riparian vegetation contributes to the regulation of river ecosystem dynamics. It controls surface run-off, provides organic matter to the river, stores water and reduce erosion by root stabilisation of banks. Studies show that riparian vegetation can significantly reduce nutrient concentration in surface water; forested wetlands studied in the USA removed some 45kgha^{-1}yr^{-1} of nitrate-N from subsurface run-off and 11 kg particulate organic-N in surface run-off.

River margin vegetation is an important habitat for a wide variety of birds, mammals, reptiles, amphibians and invertebrates. It is also a vital corridor for movement of species along river valleys. Otters find holts amongst the roots of bankside trees on many rivers. These roots are also important for specialised species of *Trichoptera* and *Ephemeroptera*. Undercut banks bound together by tree roots support a fivefold greater abundance of invertebrates than mid-stream habitats.

The management of riparian vegetation falls into three main categories; tree maintenance, marginal reed fringe cutting and herb layer/grass cutting.

The lopping of small numbers of individual branches to facilitate casting has limited impact on wildlife. Over zealous lopping may reduce valuable overhanging cover and supply of terrestrial invertebrates to the river. Coppicing and pollarding of trees are traditional and potentially valuable methods of managing trees (*see* **Tree Management**). Wildlife associated with coppiced trees depends on maintaining a diversity of light and shade, so blocks of trees should be cut in rotation. Wholescale coppicing along extensive lengths of bank is undesirable. The length of the coppicing cycle can vary between six and fifteen years, with a short cycle preventing development of mature trees, encouraging vigourous root growth and the dappled shade required by some specialist flora and fauna. This regime may well be suited to reaches of river where flyfishing is practised, allowing maximum room for casting. Species that can be successfully coppiced include hazel (*Corylus avellana*), alder (*Alnus glutinosa*), ash (*Fraxinus excelsior*) and various willows, including osier (*Salix viminalis*) and goat willow (*Salix caprea*).

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Pollarding is most commonly carried out on willows, ash and oak (*Quercus robur/petraea*) with regular pollarding prolonging the life of trees. Pollards can provide exceptionally rich wildlife habitats, with leaf litter accumulated under mature supporting growths of bramble (*Rubus fruticosus*), honeysuckle (*Lonicera periclymenum*) and rose (*Rosa sp.*). Owls, bats and ducks nest in the trees, which also support valuable insect and lichen communities. Cutting should be staggered, with only a third to a half of trees pollarded in any year. Frequency of pollarding can vary between five and thirty years, with the longer cycle allowing maximum development of the crown community, whilst a shorter cycle may suit angling needs best.

Unwanted timber and brush resulting from tree maintenance should be stacked to provide deadwood habitat or utilised in other habitat restoration projects. If burning of brush is carried out, it should take place at least 10m from the nearest tree or shrub and never on vegetated shingle, rock slabs or land of ecological interest.

If extensive bankside tree maintenance is required for angling access, efforts should be made to retain the far bank in a relatively unmanaged state. Unfortunately, this is only practical if both banks are owned by the same fishery; single bank ownership usually results in tree removal taking place on both sides of the river. In this circumstance, it may be possible to reach an agreement between the owners, so that cutting of

TREE SHADING RESTRICTING GROWTH OF MARGINAL AND INSTREAM VEGETATION.

trees for fishing access is staggered; cut areas on one bank are then opposite uncut sections on the other. In this way, total clearance of banks is prevented, whilst each bank has its own discrete sections of fishing, effectively free from interference from anglers on the opposite side of the river.

Dense bankside scrub provides a valuable habitat to many birds and mammals, especially otters. Where they exist, belts of continuous low scrub should be preserved on at least one side of the river. Dense, woody scrub can be usefully coppiced in blocks to promote strong regrowth and provide access for anglers. Any work should be carried out as late in the year as possible to avoid disturbance to otters.

Other riparian vegetation management centres on the cutting of access tracks/footpaths and the control of emergent aquatic species. Paths are generally 3-10 m wide and are created and maintained by mowing/strimming. This practice has the potential to rapidly and radically alter plant communities and therefore the habitat structure for associated fauna.

FAGGOT BUNDLES READY FOR INSTALLATION.

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Timing, frequency and pattern of cutting affect the species make up of the modified vegetation community. Cutting should be timed to produce minimum impact on riparian wildlife, whilst still allowing access for angling. Site-specific regimes should be agreed, with the aim of promoting species and communities of particular nature conservation interest, whilst allowing access during peak angling periods (April-June). Cutting in early summer (until July) prevents the spread of injurious weeds, reduces the dominance of vigourous grasses, stimulates grass regrowth, leading to the need for further cuts and encourages a denser sward. It may also impact on bird breeding success, reduce abundance and diversity of herb species and reduce habitat availability for invertebrates. Cutting after July retains habitat structure for animals, does not disturb nesting birds and promotes less grass production, reducing maintenance. Rotational cutting can be achieved by moving the line of cut footpaths during or between fishing seasons. This will certainly prove a possible management strategy where paths are relatively narrow, although it may prove more difficult where paths are wider, say 10m. In this circumstance, serious consideration should be given to reducing the width of the cut path. Providing two narrow paths, one near the waters edge and one, say 15-20m from it, not only reduces the impact of cutting in any one location, but allows anglers to move about the fishery without disturbing the fish, or other anglers.

MECHANICAL CUTTING OF VEGETATION.

Mechanical cutting of bankside vegetation

Continuous fringes of bank side vegetation not only provide valuable habitat for a range of species, but are also important in providing a wildlife corridor along rivers. For this reason, cutting of bankside margins should be restricted to the minimum necessary to allow angler access to the water. Excessive cutting should be avoided, as should the damaging practice of heavy cutting and 'edging in' of margins prior to the onset of winter species such as reed sweet grass *Glyceria maxima* and reed canary grass *Phalaris arundinacea* support a wide range of invertebrate species. Heavy pre-winter cutting of extensive stands removes valuable overwintering habitat for these invertebrates.

Chemical treatment of bankside vegetation

The herbicide glyphosate is approved for use on or near water. It is very effective for the treatment of emergent vegetation. It offers a relatively cheap and flexible means of controlling excessive growth. However as with all chemicals, it should be used with care. Professional advice should be sought from a BASIS registered advisor. Written consent is required from the EA for the use of glyphosate.

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Key points

Riparian vegetation management is a complex subject. Different management regimes can be applied to favour a variety of plant and animal species. Comments relating to management for fisheries purposes centre around the concepts of timing and extent of operations. Coppicing, pollarding, grass and marginal vegetation cutting should all be carried out on a rotational basis and during periods that minimise impacts to species associated with that habitat type. Single bank management should be practised where possible.

Non-native, invasive species

There are three main non-native invasive terrestrial plant species that have the potential to cause significant damage to native riparian vegetation. These are:

- Himalayan Balsam *Impatiens glandulifera*
- Giant Hogweed *Heracleum mantegazzianum*
- Japanese knotweed *Fallopia japonica*

All of these species have been introduced by botanical collectors from abroad. As with many non-native species, they have thrived in the absence of the natural predators, pests and diseases that control their abundance throughout their natural range. On many river systems, they cover large tracts of the bankside. Giant Hogweed has a directly damaging impact on humans; its sap causes the skin of anyone touching it to become photosensitive. This may result in very painful blistering of the skin, with severe cases requiring medical treatment. Great care should therefore be exercised when undertaking any bank work where Giant Hogweed is present.

The dense growth resulting from the invasive nature of all three species tends to shade out native flora, reducing its abundance and diversity. Further damage is caused by the almost total die back of the invasive species during winter. This leaves large areas of bare, exposed riverbank, which is very vulnerable to damaging erosion. This damage can be very significant, with many miles of some river systems affected.

Control of invasive plant species is not easy. The three key species can all recolonise via water borne seeds or vegetative fragments. Consequently, to be truly effective, any control programme needs to be co-ordinated on a catchment wide basis. Unfortunately, no organisation has duty to undertake such work. Angling groups must therefore generally operate at a local level, controlling plants on their own fishery. Himalayan Balsam plants can be cut at ground level before their flowering stage (June) or they can be pulled up by the roots and disposed of by composting or burning unless seeds are present. It should be possible to undertake limited control of stands of all three species using chemical control with the herbicide glyphosate. Treatment should be undertaken when the plants are actively growing. Japanese knotweed in particular will require co-ordinated treatment over a period of years. Note that the use of glyphosate or any other herbicide on or near water requires the consent in writing of the Environment Agency. Successful elimination of invasive plant species can result in areas of bare ground, liable to erosion. These areas may benefit from dense planting with native shrub species to increase soil stability.

Full advice on the control of non-native invasive plant species can be obtained from the
Centre for Aquatic Plant Management
http://www.ceh.ac.uk/sections/wq/CAPM1.htm

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Summary

Technique	Advantages	Disadvantages
Manual cutting	Selective cutting is easy. Physical effort involved limits extent of cutting. Weed can be cut to 'chequerboard' or 'side and bar' patterns, optimising habitat for trout.	Relatively slow. Cut weed needs removing from the river.
Mechanical cutting	Weed cutting boats remove weed from the river as part of their operation. Possible to cut in deeper water.	Very difficult to be selective. Tendency to cut and remove too much weed. Can lead to over-deepening of the channel.
Chemical control	Allows for a flexible and targeted control with little physical damage to banks. Relatively cheap to undertake.	Excessive use can be very damaging. Can only be used by qualified operatives.
Cutting of riparian vegetation	Improves access for angling. Can increase diversity of bankside flora if rotational cutting is undertaken.	Can remove habitat if too much vegetation is cut.
Cutting of riparian trees	Rotational coppicing and pollarding are methods of controlling stream shading. They can extend the life of trees. Brushwood and timber arisings can be used for enhancements.	Too much tree cutting can reduce shading and increase water temperature. Excessive cutting can remove valuable habitat for a range of species.
Extent and timing of cutting	Cutting prior to *Ranunculus* flowering can increase its biomass.	Cutting of *Ranunculus* following flowering can reduce its early season growth the following year. No more than 40% of submerged weeds (by area) should be cut at any one time.
Selection of species	Selective cutting of other species can favour *Ranunculus* growth.	Removal of species other than *Ranunculus* can reduce invertebrate diversity and abundance. Creation of *Ranunculus* 'monoculture' is not desirable.
Control of non-native species	Manual or chemical control can be used to reduce or eliminate these species locally.	Removal of invasive plants can leave lengths of bare banks liable to erosion (as can their non-treatment). Hand-pulling can be an expensive labour intensive operation

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