# Advisory Visit

# River Glaven, Wiveton, North Norfolk

# 4th August, 2010

## 1.0 Introduction

This report is the output of a site visit undertaken by Tim Jacklin of the Wild Trout Trust to the River Glaven on 4th August, 2010. Comments in this report are based on observations on the day of the site visit and discussions with David Mostyn (River Glaven Fisheries Association).

Normal convention is applied throughout the report with respect to bank identification, i.e. the banks are designated left hand bank (LHB) or right hand bank (RHB) whilst looking downstream.

## 2.0 Catchment / Fishery Overview

The River Glaven Fisheries Association (RGFA) has fishing on the River Glaven in its lower reaches, upstream and downstream of Wiveton Bridge. This section of river has been the subject of a previous WTT Advisory Visit by Ron Holloway in 2002, the report of which can be read at www.wildtrout.org; an assessment of habitat improvement proposals was also carried out by Reef Consultancy around this time.

RGFA contacted WTT with concerns regarding the aquatic weed growth and accumulation of silt in the channel, and for advice on how these issues might be addressed. This section of the river is at the bottom of the catchment (which runs off the Cromer ridge of glacial sands and gravels) and has a very low gradient; in fact barges used to ply the lower Glaven from the sea at Cley as far as Wiveton. These factors mean that this part of the river is prone to the accumulation of fine sediment.

RGFA stock this section of river with farmed brown trout of 12-inches or more and there are small numbers of wild brown trout present. Other fish species include roach, eels, brook lamprey and a small run of sea trout. The Glaven is a chalkstream, hence has a good base flow and an alkaline pH which favours the growth of aquatic plants.

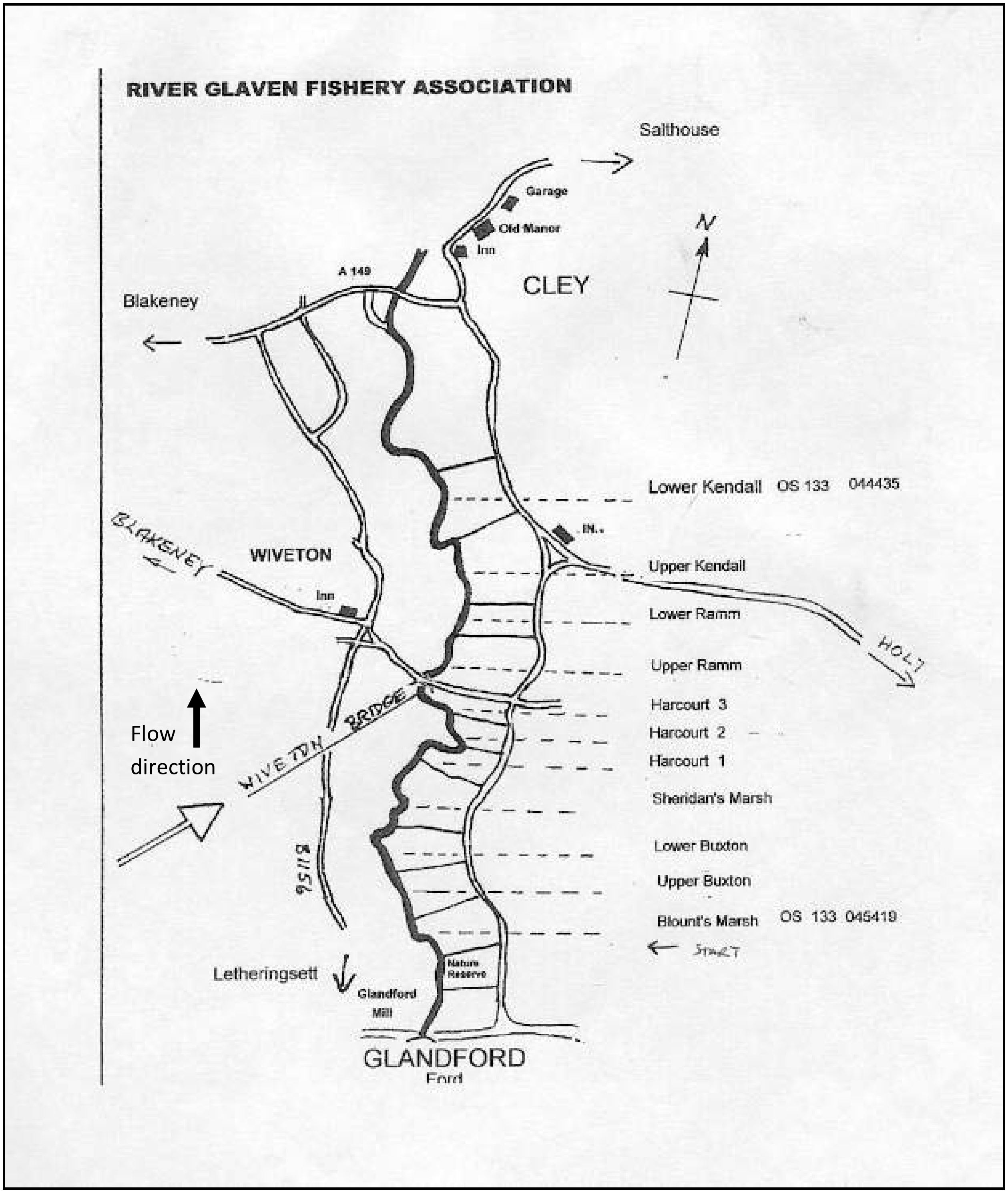



**Figure 1 Beat map of RGFA waters on the River Glaven**

## 3.0 Habitat Assessment

The upstream section of RGFA waters (above the poplar plantation and dyke on the right bank) are relatively narrow and have a reasonable flow velocity; there is also a reasonable amount of shade from bankside willows and nearby mature trees. This channel in this area has been previously narrowed (with faggot bundles), and three gravel 'riffles' introduced.

**Photo 1 Upstream limit of RGFA waters – note the deliberately narrowed channel, introduced gravels and degree of shading which all contribute to a relatively open channel.**

Some giant hogweed (*Heracleum mantegazzianum*) plants are present on the right bank here. This is an undesirable invasive species and should be controlled – for advice see http://publications.environment-agency.gov.uk/pdf/GEHO0410BSBR-e-e.pdf .

The two downstream riffles are acting as silt traps and large amounts of fine sediment have accumulated here and colonised with encroaching reedmace (*Typha latifolia*) which has recently been manually cut back by RGFA (Photo 2).

**Photo 2 Accumulated fine sediment and recently cut reedmace.**

Just below the downstream riffle a deep scour pool has developed, which was occupied by several trout (Photo 3).

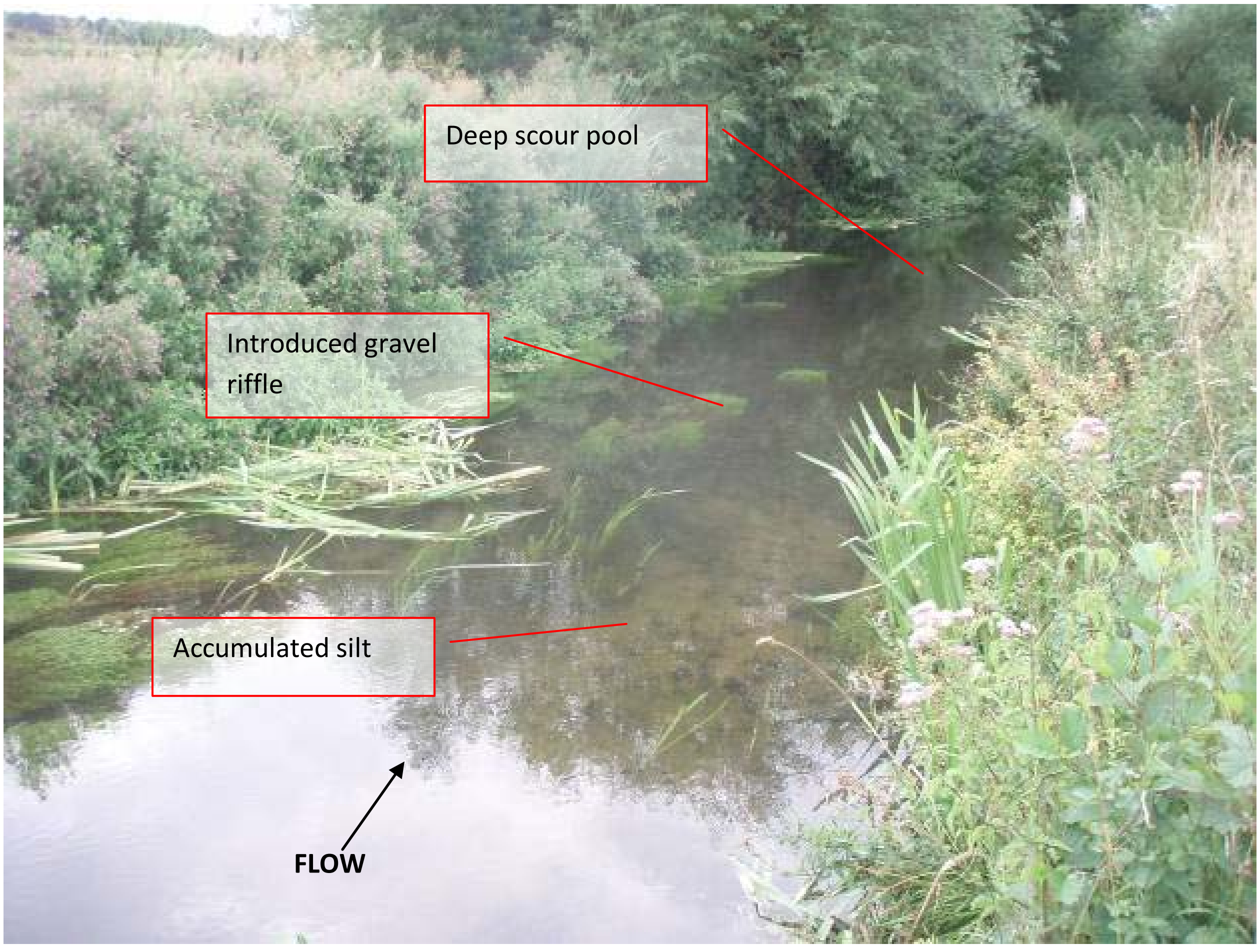



**Photo 3**

The Blount's Marsh and Buxton beats are shaded sections of the river with willows on the left bank and a mown path and the poplar plantation on the right bank (Photos 4, 5). The channel is relatively wide here and the bed comprised entirely of fine sediment. The aquatic weed growth is relatively light (dominated by starwort *Callitriche* sp.), although there has been some recent removal by hand.

This section is also the most recently maintained by machine, having been weed-cut in 2008. This probably accounts for the relative lack of encroaching emergent vegetation compared with other sections, although the shading may also contribute to this (something that needs to be considered given the imminent felling of the poplar plantation).

**Photo 4**

**Photo 5**

Downstream of the plantation (Sheridan's Marsh) there is a drainage dyke which was also cleared in 2008. Downstream of this point, the river becomes more open (less tree cover) and has not had any recent weed cutting operations. This is reflected in the dense growth of emergent and submerged aquatic plants (Photo 6).

**Photo 6**

A notable point with downstream progress is the subtle change in the nature of emergent vegetation in the margins of the river; the reedmace and burr-reed (*Sparganium erectum*) giving way to reed sweet-grass (*Glyceria maxima*), sedges (*Carex* sp.) and then to reed canary-grass (*Phalaris arundinacea*) – see sequence of photos 7 – 10 which progress downstream.

**Photo 7  Reedmace and burr-reed are initial colonists...**

**Photo 8  ...succeeded by reed sweet-grass...**

**Photo 9...sedge...**

**Photo 10...and reed canary grass.  Note the narrow channel width the river has achieved here (Lower Ramm) following a long lay-off from weed removal.  The vegetated berms supported the author's weight.**

This phenomenon reflects the length of time it has been on each section of the river since weed removal was last carried out. The river channel is generally over-wide on the RGFA waters and the following cycle occurs:

1. Overwide channel promotes slow flows and sediment deposition in the margins
2. Sediment in the margins colonised by reedmace and burr-reed
3. Emergent plants trap more sediment and become more consolidated, narrowing the river channel
4. Emergent plant community starts to change as margins become less wet (sedges and grasses); margins become more consolidated
5. Narrower central channel becomes deeper and more self-flushing of fine sediment
6. Dredging / weed-cutting operation removes margins, over-widening channel and returns cycle to stage 1.

## 4.0 Recommendations

The circumstances of the RGFA fishery, namely its position low down in a catchment with a sandy geology, the influence of the tidal control structures and the low channel gradient, means there will always be a degree of maintenance required to control weed growth and sediment accumulation and preserve angling access.

However, previous maintenance operations have perpetuated the over-wide nature of the river channel and the cycle of sediment accumulation and emergent weed re-colonisation described above. Continuing such maintenance is one option, but it involves a considerable ongoing expense.

Another option would be to narrow the river channel which would deter the growth of emergent plants like reedmace and promote a clearer, more fishable channel with a reduced need for maintenance; this could be achieved by active intervention (see Appendix 2 and 3, from WTT's Chalkstream Habitat Manual), or over the longer term by more targeted weed-cutting. The latter would involve only cutting approximately the middle third of the channel width and allowing naturally consolidated berms to develop, as has occurred on Lower Ramm; the current width of open water on Lower Ramm could be used as a guideline for channel narrowing further upstream.

Where weed cutting is carried out by mechanical means (hydraulic excavator), this should be done to minimise the impacts upon wildlife in and around the river channel. An Environmental Impact Assessment statement should be prepared and adhered to, and the methods of working made explicit to the machine operator. The areas for consideration are detailed in Appendix 1, following consultation with the Environment Agency Biodiversity Department. It is understood that RGFA are liaising with the Environment Agency regarding channel maintenance proposals and are obtaining the necessary permissions and consents.

It is recommended that RGFA obtain a copy of the WTT's Chalkstream Habitat Manual and use this as a basis for reviewing the management of the River Glaven in this reach.

## 5.0 Disclaimer

This report is produced for guidance only and should not be used as a substitute for full professional advice. Accordingly, no liability or responsibility for any loss or damage can be accepted by the Wild Trout Trust as a result of any other person, company or organisation acting, or refraining from acting, upon comments made in this report.

Appendix 1

Points for consideration in the preparation of and environmental impact assessment of weed cutting / channel maintenance. Prepared in consultation with Jez Wood, Environment Agency Biodiversity Officer.

**Consents**

Depending upon the nature of the works Flood Defence Consent may be required. If de-silting is proposed, then Flood Defence consent will be required; if only weed-cutting is to be undertaken then this would be regarded as maintenance and Flood Defence Consent would not be required. Contact Sarah Palmer at the Environment Agency Development and Flood Risk Team on 01473 706721 to discuss. Either way, it is good practice to consider the following points.

**Access/Landowner permission for the works**

Permission from the landowner to access the site and to dispose of the weed or silt on the banks is required.

**Waste Management/Exemptions**

If silt is removed from the river it is classed as waste and the works will need to be registered for an exemption. Any silt removed from the river must not be transported from the site, but placed along the riverbank from where it was removed. The following link will give further information regarding this exemption.

http://www.environment-agency.gov.uk/static/documents/Business/D1_deposit_of_waste_from_dredging_inland_waters_-_ag.pdf

This link is to the form which needs to be completed to register for a waste exemption.

http://www.environment-agency.gov.uk/static/documents/Business/WEX001v01Feb10_e-form_LCfinal_4.pdf

The agreement of the Environment Agency that the mobilisation of sediments will not affect the operation of flood gates is required. Liaise with Sophie Thomas, Operations Delivery Team Leader 01473 706622.

**Mussels in Blakeney Harbour**

A major issue at this site is that of the potential for contamination by silt and pollutants of the mussels in Blakeney Harbour due to the de-silting works. Mussels are regularly checked and graded according to quality. If they are found to be contaminated they will have their classification reduced which means the mussels will be sold at a reduced price, or they have to undergo a costly procedure to bring them up to standard. This obviously impacts on the livelihoods of the mussel fishermen.

Issues:

- There may be contaminants within the silt that are released due to the de-silting process which may directly affect the classification of the mussels;
- The mobilisation of the silt particles could lead to smothering of the beds further adding to the reduced value of the mussels;
- There is concern that short-term river management could jeopardise assessment of the mussels

A suitable methodology must be established for this operation. The applicant should contact the following in order to notify them of the proposed work and to agree the methodology:

- Blakeney Harbour Mussel Society Ltd
- Clare Kinsley – Shellfish Liaison Officer, North Norfolk District Council (01263 516240)
- Centre for Environment, Fisheries & Aquaculture Science (Cefas) (01502 562244)

The silt may require testing in order to determine whether there are any contaminants in the silt that could enter the water column which could directly affect the mussels. Potential contaminants are listed in the Shellfish Waters Directive. The de-silting work should be undertaken under strict time limits. The contacts above should be able to give advice as to the most suitable times to undertake the work.

A hessian (or similar) sheet should be positioned in order to catch the mobilised silt in order to prevent it from entering the harbour.

It may be necessary to monitor contaminants during the works.

**Breeding Birds**

The works should be undertaken outside of the breeding bird season, March – August inclusive. The applicant should be aware that birds and their nests are protected under the Wildlife and Countryside Act 1981 (as amended). As such it is an offence to kill, injure, or take any wild bird; take, damage or destroy the nest of any such bird while in use or being built, or take or destroy an egg of any such wild bird.

**Water Voles**

It is possible that water voles are present at this site and could be affected by the works. Water voles and their burrows are protected under the Wildlife and Countryside Act 1981 (as amended). As such it is an offence to deliberately, capture, injure or kill them or to damage, destroy or obstruct their breeding or resting places. It is also an offence to disturb them in their breeding or resting places. The applicant should establish whether water voles are present in or adjacent to the area, possibly by employing a suitably qualified ecologist. Guidance on undertaking a water vole survey is given in the Water Vole Conservation Handbook (2$^{nd}$ ed).

If water voles are found to be present in the area then the applicant must consider whether proposals can be amended to ensure that the work does not result in the commission of an offence, e.g. does not result in disturbance to water voles or result in loss of water vole burrows etc. If this is not possible then consideration is needed as to how the impacts on water voles can be minimised and whether action could be taken to remedy any adverse effects. If possible actions are identified, then those actions should be taken. Natural England should be contacted for advice and if there is any concern that an offence may be committed.

If the banks are to remain untouched by the operation a water vole survey may not be required. A central channel could be de-silted leaving the banks and a marginal area untouched. This will ensure that any burrows are left undamaged.

**Eels and Lamprey**

Eels and brook lamprey have been regularly found in this stretch. Brook lamprey are protected under the Habitat Regulations.

The silt that has been removed from the channel should be inspected for eels and lamprey and any that have been removed during the de-silting process should be returned to the river.

**General Fish Health Issues/Fish Spawning**

Coarse fish generally spawn between March and June/July. After this period fry are very vulnerable. In the warmer summer months there is a real danger of deoxygenation of the river due to silt mobilisation.

**Sea Trout Run**

Sea trout will potentially run in September and October, therefore this period should also be avoided.

**Otter**

Otters may be present in this area. They are a European Protected Species (EPS) & UK Biodiversity Action Plan (BAP) priority species. It is unlikely that there is a holt here, but if there is there should be no work undertaken nearby without a European Protected Species Licence (contact Natural England for advice). Otters are unlikely to be a constraint for this type of work, however, as a general rule, materials such as netting and cutting tools should not be left in the work area where they might entangle or injure otters which are often nocturnal.

**Pollution Prevention**

Pollution prevention guidelines should be followed in order to ensure that no pollutants enter the river during the construction phase of the works. Working practices should also always aim to minimise dangers to riparian species. Chemical spills should be cleaned up immediately.

**Crayfish**

The Glaven has a healthy population of native crayfish, however, they are highly unlikely to be present in this area. No mitigation is required.

# Restoring over-wide channels

## Issues

Past drainage activity (*see* **Gravel Rehabilitation** section), and the activity of grazing animals (*see* Managemeny of **Riparian and Instream vegetation** and **Protecting marginal habitat** sections) has resulted in the over-widening of many river channels. Low summer flows, often as a result of over-abstraction, can mimic the impact of over-widening.

As a result of these processes, instream habitat diversity is reduced, with the increase in cross-sectional area resulting from over-widening reducing water velocity within the channel, and promoting the deposition of fine sediments. The erosion of friable banks following damage by stock can compound these impacts.

The resulting silt laden, often shallow channels provide ideal growing conditions for a range of emergent and submerged vegetation. By reducing water velocity locally, these plant species tend to accumulate more sediment around their base, further degrading habitat for spawning and juvenile salmonids.

AN OVER-WIDE SECTION OF CHALKSTREAM........

........WITH ASSOCIATED DEPOSITS OF FINE SILT.

## Potential restoration options

All of the techniques described below rely on restoring the channel's cross-sectional area to an approximation of its 'natural width'. Changes in the abstraction regime, surface run-off patterns and climate variation mean that the selection of this cross-section can never be an exact science. The extent to which the channel should be narrowed can be decided by reference to hydraulic modelling based on detailed survey data (expensive), by reference to more 'natural' unaffected reaches of the river that occur locally (the most practical and preferred option) or by expert assessment from a river restoration specialist, and Environment Agency or Natural England staff.

In many cases, the width of the silt band preferentially deposited in the marginal zone of the river will provide a good indication of the desirable finished width of the channel. Whichever method is used, natural physical processes affecting the river will result in a degree of self-adjustment to the width of restored channels. The aim of restoration should be to use these natural processes to encourage the deposition of fine sediment ('silt') in marginal, low velocity areas, where it will consolidate, and help narrow the channel.

It is important that any narrowing undertaken has due regard to both the natural shape and form of chalkstream channels. Avoid uniformity, with respect to both the width and line of the narrowed river. Moderate sinuosity and a varied width along each section of river will not only make it visually more attractive but will also help in optimising its ecological value.

The selection of techniques to be adopted should be made with reference to the natural form of the river and the availability of suitable, locally occurring materials. Generally, this will mean making use of timber and brushwood derived from the coppicing, pollarding, singling or thinning of riparian and floodplain trees (*see* **Tree Management** section). The use of materials imported to site should be avoided where possible. If it is impossible not to use imported materials, consideration should be given to their geographic origin, and any manufacturing processes that have been used to produce the product. There is a responsibility on all scheme designers to try and minimise the carbon footprint and ecological impact of any project undertaken.

The selection of suitable techniques should also have due regard to the energetics of the river. Chalkstreams are characterised by their remarkably stable flow regime and relatively low energy. As such, all of the techniques detailed below would be suitable for installation in a chalkstream. It is important to note that all of them rely heavily on the establishment of strongly rooted marginal vegetation to optimise their stability and resistance to erosion. Timing of the installation of narrowing is thus fundamental. Ideally, work should be done in spring/early summer in order to optimise the growth of plants prior to high winter flows. Generally installation in the autumn or winter should be avoided as it risks significant damage to the narrowing occurring before adequate development of plant growth.

Similar concerns dictate the need for minimal shading of areas of narrowing. Where shading is significant, it may be necessary to trim branches of ambient light. Narrowing channels under a shaded canopy is likely to fail.

SELECTIVE COPPICING TO REDUCE SHADE AND PROMOTE NARROWING OF THE CHANNEL.

## Marginal narrowing

CREATING A NEW BANKLINE USING FAGGOTS AND UNTREATED STAKES.

### Natural wood

The use of natural wood, derived from locally occurring trees, encompasses possibly the simplest and most ecologically acceptable techniques that can be used to narrow river channels. It is likely that chain saws will need to be used in the execution of some of the techniques below. **Chainsaws have the potential to be fatal if used incorrectly; it is imperative that only suitably qualified and experienced personnel should use them. In addition, the health and safety of all other individuals on the working site must be ensured**.

### Use of brushwood

Brushwood arising from the cutting of trees, is a fantastic material, when used as a revetment. Its fine, 'feathery' nature reduces water velocity, promoting the deposition of fine sediment. Perhaps the best known method of using brushwood is as faggots. These are bundles of brushwood, bound together using string (ideally biodegradable sisal), to form faggots of around 2m in length and 0.3m in width. The faggots can then be installed along the agreed line for narrowing and held in place using untreated stakes (diameter 75mm-100mm) driven firmly at 0.6m centres into the riverbed. Some practitioners weave the faggots through the stakes, creating a robust and very attractive finish to the revetment. A simpler and equally robust approach is to force the faggots over the stakes, wiring them down once in position. It is important that the faggots are packed tightly down and are overlapped in the horizontal plane, in order to reduce the risk of erosion. A similar concern dictates that the upstream and downstream ends of the faggot bundles are adequately 'keyed' into the original bankline.

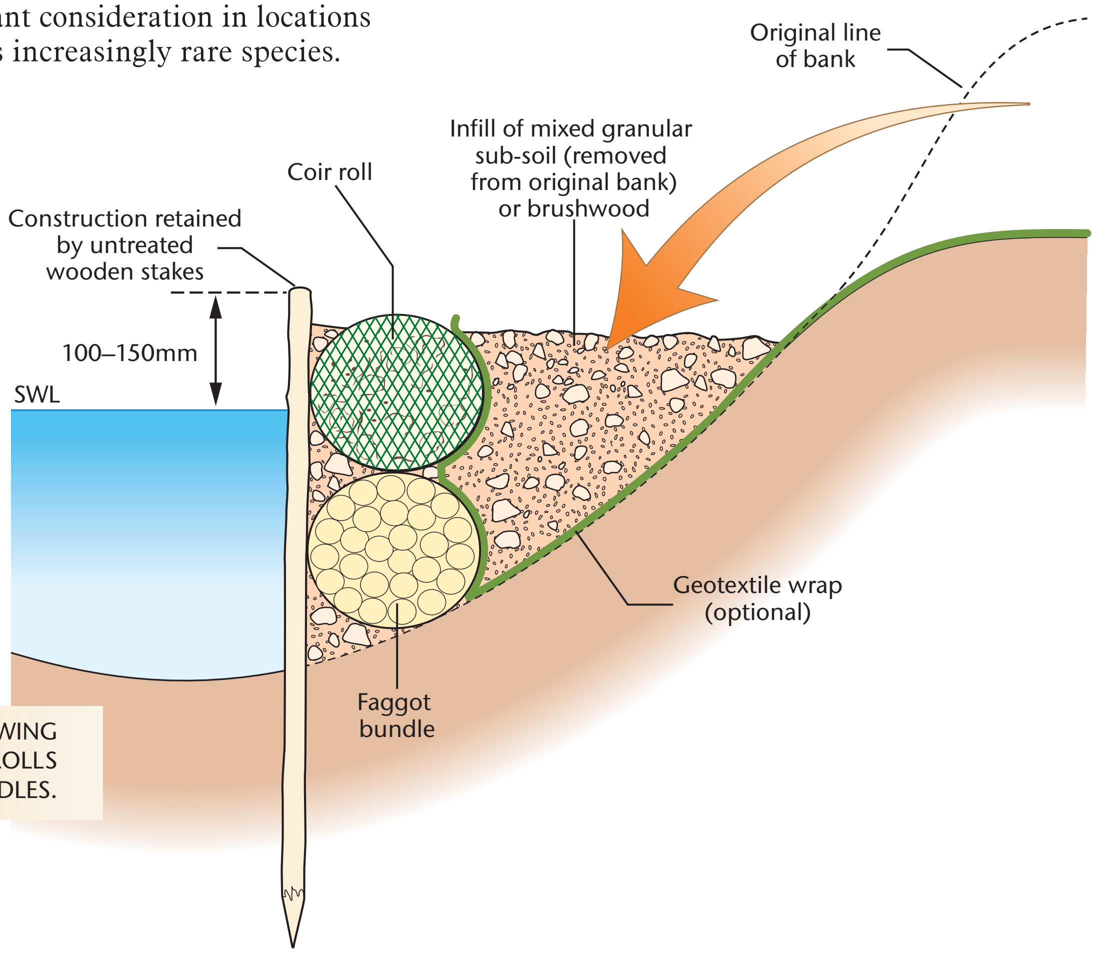
The area between the line of faggots and the original bank should be filled with excess brushwood, tightly tied or wired down to a matrix of stakes driven vertically. The brushwood backfill can then be 'seeded' with emergent vegetation such as sedge *Carex spp*., reed canary grass *Phalaris arundinacea*, reed sweet grass *Glyceria maxima* and yellow flag *Iris pseudacorus*. These and other naturally recruiting plants will grow into the faggot mass, helping to increase its stability. Whilst this is a good and cheap technique that can produce excellent establishment of marginal zones, it may not be suitable in areas where there are aesthetic considerations or concerns regarding wash out of accumulating sediment. In these situations, it may be necessary to use locally derived backfill to create a finished marginal shelf area as part of the enhancement scheme. Reprofiling of the banks (or 'cut and fill') can be used to both provide the necessary infill, and extend the width of the shallow waters edge shelf, suitable for the growth of marginal plants. The extensive use of chalk backfill can restrict access to burrowing water vole. This concern should therefore be a significant consideration in locations known to harbour this increasingly rare species.

## Use of heather bales and straw bales

Bales constructed from heather and straw (particularly linseed and rape straw) are of potentially great value for channel narrowing. They are relatively cheap, and are easy to transport and handle. They can be used in similar way to faggots, being held in place within a channel using wooden stakes. The loose weave of the bales provides a superb habitat for a range of macroinvertebrates that are also able to use the bales as a food source.

## Use of timber

(*see* **Use of Large Woody Debris** section)
Larger timber can be utilised for channel narrowing in a number of ways. Perhaps the simplest and most effective utilises some of the skills involved in hedge-laying. Where trees that respond well to coppicing (species such as ash *Fraxinus excelsior*, willow *Salix Spp*, alder *Alnus glutinosa*, field maple *Acer campestre* and hazel *Corylus avellana*) grow adjacent to the river, it is




'CUT AND FILL' NARROWING USING COIR ROLLS AND FAGGOT BUNDLES.

CUT AND HINGED TIMBER. NOTE CHANGE IN FLOW PATTERN DOWNSTREAM INDICATING SCOUR OF THE BED.

possible to partially cut through their trunks, and 'hinge' the partially severed trunks into the channel, where they can be laid roughly parallel to the flow. The trunks are then secured in position using wooden stakes firmly driven into the bed. By repeating this process for a number of trees, a robust revetment can be formed, with the finer branches of the trees reducing flow velocity and encouraging deposition of silt in the same way as faggot bundles. The matrix of timber will also provide excellent habitat for juvenile fish and many invertebrate species, whilst the reduction in shading resulting from felling of the trees will promote the growth of emergent vegetation in the accreting margins.

Where suitable trees are not available adjacent to the channel, trees can be cut from nearby locations, and placed into the channel. The trees should be firmly fixed in place using a combination of stakes and, where necessary, high tensile steel wire. The butt of each section of timber should be tied back to a firm anchor point on the bank to prevent wash-out in extreme flood events.

By selective hinging/felling and placement of trees, long sections of river can be narrowed relatively quickly and cheaply.

## Narrowing using coir fibre

There are a range of modern manufactured 'bioengineering' materials utilising coir fibre (derived from coconut husks). Of most interest are the so-called coir rolls (or logs). These comprise a densely packed 300mm diameter roll of coir, constrained within an 'envelope' of coarse polypropylene or jute mesh. The rolls are supplied in varying lengths, most commonly between 2m–3m. They can be purchased 'bare' or pre-planted with a range of well-established marginal plants at a density of at least 6 per linear metre.

NEWLY-NARROWED CHANNEL USING PREPLANTED COIR FIBRE ROLLS .

Coir rolls can be used as direct replacements for faggots. They are structurally strong, with the vegetation contained in pre-planted rolls rapidly growing into the backfill and sub-soil, dramatically increasing the erosion strength and stability of the revetment, whilst increasing its ecological value. This allows for direct backfilling to take place in areas where aesthetic considerations dictate. Degradation of the coir takes place over a number of years. In a well-designed scheme, the area of narrowing behind the coir will have stabilised sufficiently to function in its absence.

HYBRID GEOTEXTILE USED IN CONJUNCTION WITH WOODEN STAKES.

## Non-biodegradable and 'hybrid' geotextiles

Whilst it is generally desirable to use biodegradable geo-textiles in most situations, this may not always be possible. For instance, in locations with very high water velocities (e.g. below hatch pools), with very steep vertical banks or where burrowing Signal crayfish *Pacifasticus leniusculus* threaten the physical integrity of banks, it may be necessary to employ more robust geotextiles with increased longevity. In recent years, considerable use has been made of so-called 'hybrid' geotextiles. These comprise a hardwearing plastic geotextile, usually installed behind a covering of biodegradable coir or jute. This mix of materials can provide excellent structural strength, coupled with a good medium for the establishment of plants.

The use of non-biodegradable and hybrid geotextiles should not be contemplated without advice from river restoration professionals.

## Narrowing using causeways

The use of causeways to narrow channels is a well-established technique. It is of particular value where there are large water vole *Arvicola terrestris* colonies that could be threatened by traditional narrowing techniques, or where there is a requirement to undertake a dramatic narrowing of a channel that would require inordinate amounts of backfill material.

Two parallel lines of preplanted coir fibre rolls or faggots retained by untreated wooden stakes driven into the river bed, are used to establish the outline of the causeway. The centre of the causeway structure can then either be 'hard' filled, using locally excavated sub-soil retained behind a vertical coir/jute geotextile, or 'soft' filled, with densely packed brushwood firmly tied into place. Hard filling is more suited to areas exposed to faster water flow and hence erosion, or where the causeway is to be used to provide access to anglers fishing the water. Where hard filling is the preferred option, material can often be excavated from adjacent flood meadow areas, creating new areas of high quality habitat.

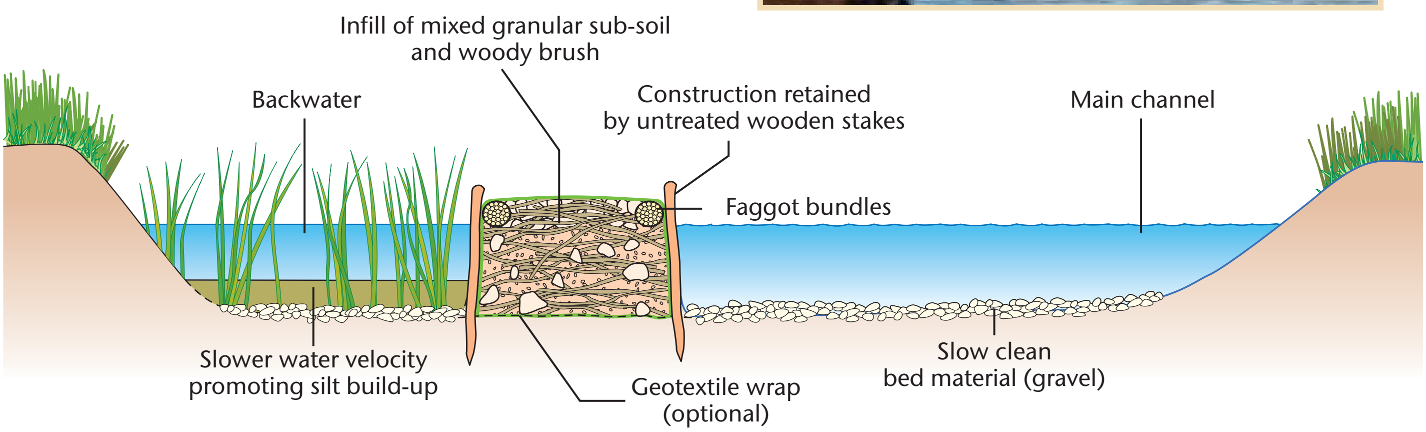
The upstream and downstream limits of the structure must be firmly keyed into the existing bankline. Water will be able to flow over the causeway and into the area behind over a range of discharges. By careful setting of the upstream and downstream bed levels during construction, limits can be set to these flows, creating potential low flow refuge areas for fish fry, amphibians and invertebrates.

The finished height of the causeway relative to summer water level is critical; too high and colonisation with emergent vegetation will be restricted, too low and the causeway will be permanently submerged. Ideally, the margins of the causeway should be set between 100mm-200mm above summer water level.

If access is required onto the finished causeway for angling or other purposes, particular attention should be paid to Health and Safety considerations.

RECENTLY COMPLETED CAUSEWAY. NOTE GEOTEXTILE WRAP.

*X-SECTION OF A TYPICAL CAUSEWAY SHOWING CONSTRUCTION.*



## Narrowing using mid-channel islands

An alternative strategy for channel narrowing is the generally underused option of the construction of small, mid-stream islands. Where islands have been created in order to narrow rivers, benefits include refuge areas for animals and plants. Remote from human disturbance and grazing, they may support different plant communities compared to more accessible banks.

Islands can be created from a range of materials, including faggot bundles, coir fibre rolls and locally derived granular material. Construction techniques are similar to those already described above.

Permanent, vegetated mid-channel islands are valuable habitats for otters (*Lutra lutra*), and water voles, providing secure sites for lying-up and breeding. This habitat is also of benefit to breeding ground nesting birds, such as mallard (*Anas platyrhynchos*), tufted duck (*Aythya fuligula*) and mute swan (*Cygnus olor*), whilst also providing additional shallow water edges for feeding birds.

MID-CHANNEL ISLANDS CONSTRUCTED ON THE RIVER GLAVEN.

## Narrowing using redistribution of instream gravel

This is a novel technique that has recently been used with great success on the River Darent in Kent. In essence, it involves the redistribution of uniform bed gravels in order to create a sinuous, more clearly defined and deeper channel.

By the careful use of hydraulic excavators, the gravel is manipulated locally to form elevated edge 'bunds'. Over time, these gradually recolonise with emergent vegetation, binding the new bank together.

GRAVEL REDISTRIBUTED WITHIN CHANNEL...

...AND RESULTING CHANNEL.

### Narrowing using groynes

The careful placement of upstream facing groynes constructed of timber, faggot bundles, stone and coir, can encourage deposition of fine sediment in marginal zones, encouraging channel narrowing.

The use of groynes is discussed more fully in the **Use of Large Wood Debris** and **Instream Structures** sections.

## Summary

| Technique | Advantages | Disadvantages |
|---|---|---|
| Faggot narrowing | Cheap if on-site materials are used. 'Natural' approach producing high ecological benefit. Additional benefit accrued from coppicing/pollarding in order to obtain materials | Faggot manufacture can be labour intensive. Large amount of material required per linear metre of channel narrowed. Material only be seasonally available. |
| Large timber narrowing | Cheap if on-site materials are used. 'Natural' approach producing high ecological benefit. Additional benefit accrued from coppicing/pollarding in order to obtain materials. Long lengths of bank can be enhanced with limited material. | Likely requirement for qualified chain saw operators. |
| Coir fibre narrowing | Quick and easy to install by semi-skilled work force. Good structural strength. Rapid establishment and high ecological value | Relatively high cost. Large carbon footprint of material. |
| Narrowing using causeways | Reduces impact on bankside habitat, particularly water voles. Provides additional habitat type, particularly if shallow water are created behind causeway. Excellent, relatively cheap technique if very significant narrowing is required. | Construction can be challenging in deeper water. Potential Health and Safety implications if access is required onto causeway for angling |
| Narrowing using mid-channel islands | No impact on bankside habitat. Provides an additional habitat type. | Construction can be challenging if water levels are high or depths excessive. Relatively expensive per linear metre constructed. |
| Redistribution of bed gravels | Relatively cheap and quick technique. Requires no imported materials. Very little impact on surrounding bank areas if work can be undertaken instream. . | Can cause significant short term impact on instream macrophytes and macroinvertebrates |

## Working Examples

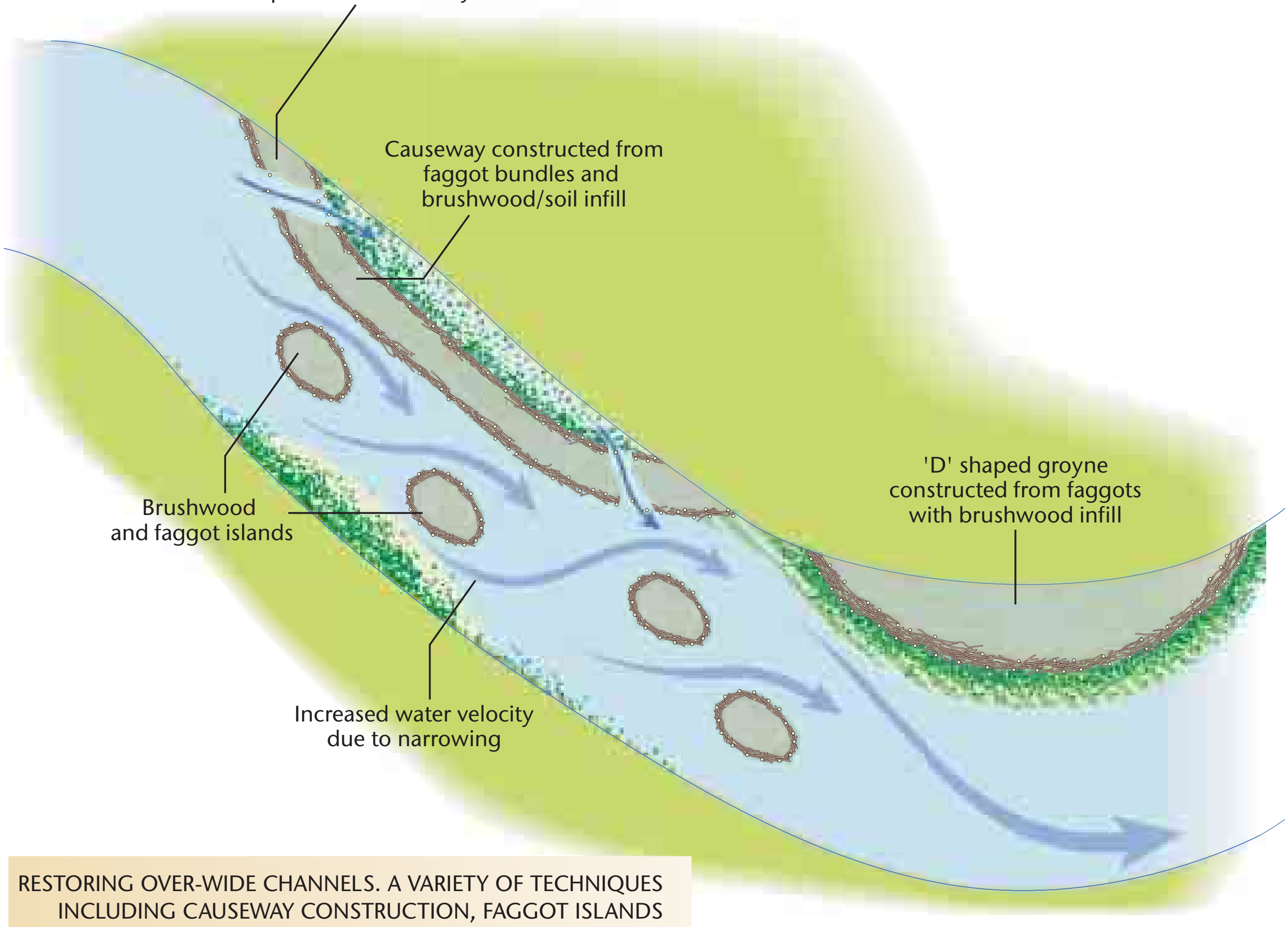
### River Avon at Woodford

This was one of the demonstration sites for the EU funded STREAM (Strategic Restoration And Management) project. A range of techniques was used to narrow the channel. These included the installation of a 100m long faggot causeway, infilled with chalk and brushwood to allow angler access. The causeway had lowered inverts at its upstream and downstream limits in order to create a low velocity backwater, whilst permitting flow to pass during high discharge events.

Existing mid-channel islands were reinstated, with a range of new islands constructed. Finally, marginal narrowing was created using a series of large 'D' shaped structures.

More detail of these works can be found at http://www.streamlife.org.uk/

VARIOUS METHODS OF CHANNEL NARROWING USED ON THE RIVER AVON AT WOODFORD.




RESTORING OVER-WIDE CHANNELS. A VARIETY OF TECHNIQUES INCLUDING CAUSEWAY CONSTRUCTION, FAGGOT ISLANDS AND 'D' SHAPED GROYNES HAVE BEEN USED TO NARROW THE CHANNEL AND INCREASE WATER VELOCITY.

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

A VARIETY OF PLANT SPECIES IN A CHALKSTREAM.

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.

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.

RIVER-KEEPERS WEED CUTTING.

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.

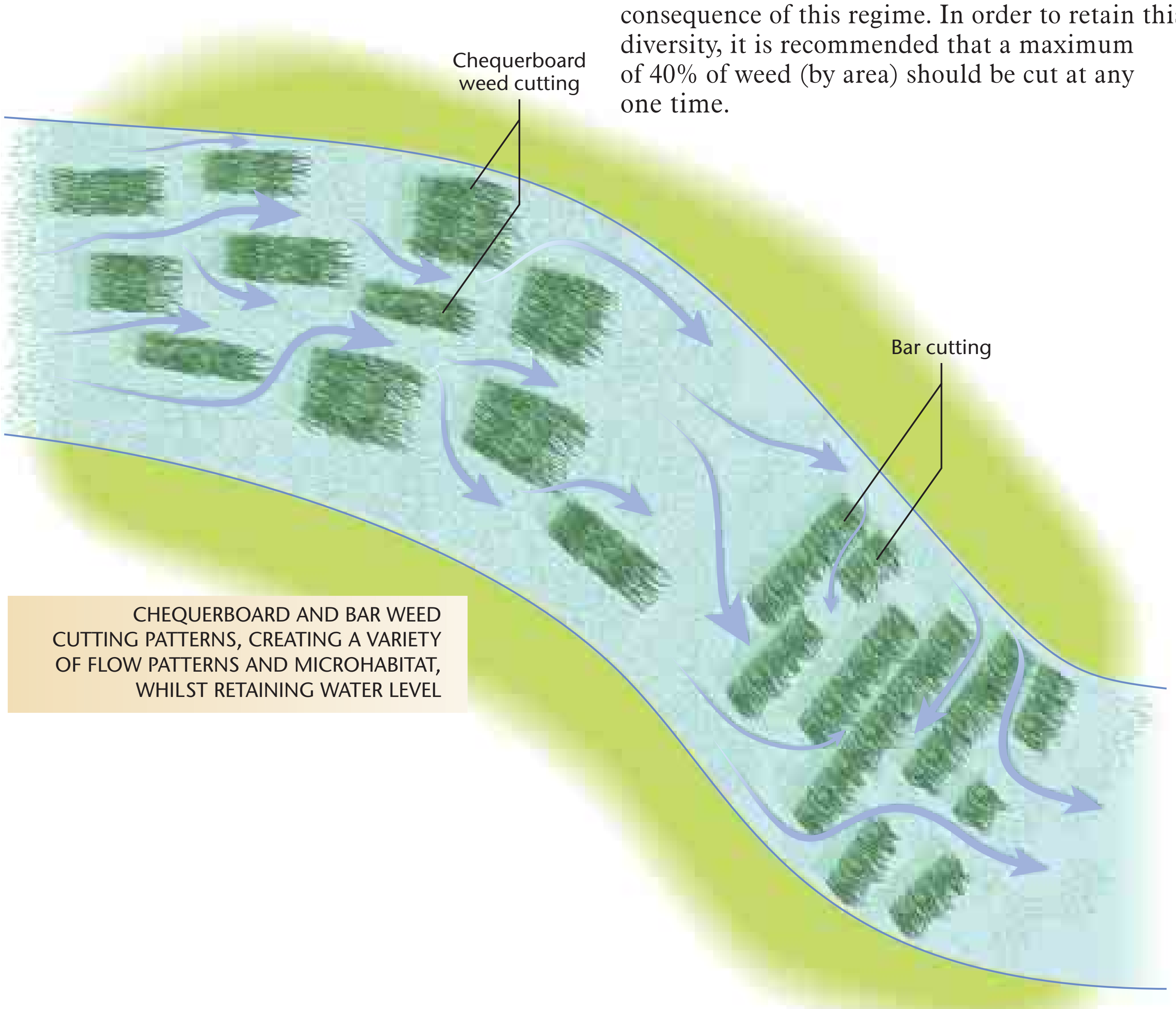
Selective cutting to totally remove "undesirable" species such as *Hippuris* (mare's tail) and *Schoenoplectus lacustris* (common club rush) should be undertaken with care. There are extensive invertebrate communities associated with these species. Indeed, some plants have more species of invertebrates 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).

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

## 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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NATURAL ENGLAND

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.

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.

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*).

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 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.

TREE SHADING RESTRICTING GROWTH OF MARGINAL AND INSTREAM VEGETATION.

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.

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.

**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

## 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 |