THE NATIONAL TRUST

Guidance

THE MANAGEMENT OF FRESHWATER FISHERIES

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SUMMARY

The Management of Freshwater Fisheries provides guidance on the management of National Trust fisheries for their ecological and recreational value.

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1	***Fishing for both game and coarse species is welcomed by the Trust, where it already takes place, subject to the Trust's prime objectives.*** The following guidance should ensure that fishing does not damage the Trust's prime objectives, including nature conservation and other forms of access.	**1.0;** **2.2.2**
2	***The Trust wishes to promote fish communities appropriate to the type of water body in question, with recruitment sufficient to maintain the fishery without artificial stocking.***	
	Inappropriate species may need to be removed, eg carp in soft-bottomed lakes, or rainbow trout in fisheries where coarse species or brown trout would be more natural. Otherwise, native fish, including predators, should be left, eg grayling, pike and eels.	**2.3.3**
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5	***Essential steps in the effective management of fisheries are surveys of fish and preparation of Fishery Management Plans.*** Many sites are without such assessments at present.	**3.0**
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7	***Fishery management will need to incorporate site-specific rules.***	**6.0** **2.2.2**

For example:
Anglers' expectations should be matched to the ecology of the water body. The Trust should resist requests for large catches or catches of an un-naturally wide range of species.
Exploitation of fish in salmonid waters should be controlled. **6.1.1**
The number of anglers should be limited **6.1.2**
Close seasons should be maintained. **6.1.4**
Excessive use of baits should not be allowed, and livebait prohibited. **6.1.7**

8 ***Letting arrangements should promote the Trust's purposes, the rules of the fishery and the fishery management plan.*** **7.0**

The Trust should not relinquish control of a fishery without an agreed Management Plan, break clauses and reviews. Letting arrangements should contain provision for day tickets, to ensure wherever possible wider public access to Trust fisheries. Corporate leases and letting for commercial purposes, where the primary objective is commercial gain, are not compatible with the Trust's objectives for its fisheries.

1.0 INTRODUCTION

As one of the largest landowners and land managers in England, Wales and Northern Ireland, the National Trust manages a significant number and variety of freshwater fisheries. ***Fishing, for both game and coarse species, is welcomed, where it already takes place, subject to the Trust's prime objectives, namely conservation of the landscape, nature conservation and historic value of the property.*** This principle is stated in *Open Countryside*[39], the National Trust's Access Review. It is one of many principles contributing to the Trust's access policy.

The management of fishing and fisheries can have both beneficial and damaging impacts on the freshwater environment. This report contains the Trust's current guidance on fishery management so that fishing can continue with minimal damage to the environment.

1.1 Compilation and use of this report

The first edition of this report was written in 1999 following visits to National Trust fisheries and gathering of information by other means. This second edition has been revised to take account of experience with Trust fisheries to 2003. Seventeen Trust fisheries served as case studies, for which application of the principles could be tested. Progress is summarised below.

Overall the principles hold good, and the changes in this new report have been minor. However, implementation has been disappointing, especially in the areas identified.

The main recommendations are shown throughout the text in ***bold italics***. The points made in each major section are summarised in a text box at the end of the section. References are numbered and listed in Appendix D.

1.2 Summary of changes in National Trust fishery management 1999-2003

The main conclusion from the assessment is that there are still many sites where fishing is damaging the Trust's prime objectives – particularly nature conservation.

Good progress has been made in fishery Management Planning and survey for fisheries, and various damaging activities have stopped or declined, such as fertilising, liming and pesticide application in water, herbicide use on aquatic vegetation, close mowing of banks and predator control. This is good. However, overall it cannot be said, as it was in *Open Countryside*[39], that fishing is a positive force for environmental improvement. The main problems are:

- sites are still overstocked, and stocked with inappropriate species
- there is still too much reliance on stocking, rather than on natural fish communities;
- lack of knowledge of the fisheries, and lack of staff time to gather appropriate information means that the guidelines on these topics are not promoted to clubs or fishermen;
- water quality problems are still acute in many water bodies – fish contribute to these, but so do inappropriate land-use and other sources of pollution.
- river channel habitats are still poor.

2.0 FISHERIES AND THEIR PLACE IN THE AQUATIC ECOSYSTEM

2.1 Water bodies and their ecological value to the Trust

As indicated in Section **1.0**, the Trust owns and manages a wide variety of freshwater aquatic habitats. Since one important purpose of ownership is their nature conservation value, this section outlines features of nature conservation value that the Trust may wish to promote. Unfortunately, many of these features are absent or poorly represented in individual water bodies at present, but collectively throughout the Trust the potential is great.

Freshwater habitats are probably more subject to modification by artificial disturbance than any other suite of habitats: land-use change many miles distant can have a profound effect on a water body. Elements of 'naturalness' are of most value in freshwater conservation. These and other features of value include the following:

All freshwater habitats

- Water chemistry which reflects the geology of the catchment and valley or basin;
- inputs of nutrients and sediment as natural as possible;
- natural, seasonal fluctuations in water levels (absence of dams, weirs, etc.)
- water supply reflecting geology and climate, not significantly affected by abstraction, increased input from land drainage or other modifications;
- native fauna and flora characteristic of the type of water body in question, for example oligotrophic (nutrient-poor), naturally eutrophic (nutrient-rich), or mesotrophic (intermediate);
- dissolved oxygen in adequate supply for characteristic fauna and fauna;
- native aquatic macrophytes (water plants excluding most algae) present, and an appropriate variety of species;
- emergent vegetation fringes, or adjacent swamp or fen areas, which act as water and sediment filters and function as part of the freshwater system;
- fish communities, where present, relatively unaffected by man;
- water body part of a system of wetlands and semi-natural habitats.

Physical features, vegetation, invertebrates, amphibians, fish, mammals and birds can all provide criteria for evaluation.

Lakes and ponds

- Zonation of vegetation (submerged, floating, emergent);
- high plant species diversity (except in naturally nutrient-poor waters), especially a good number of *Potamogeton* pond-weeds;
- extensive reedswamp fringes;
- diversity of physical features - variation in substrate type, depths, shade, etc.;
- undisturbed lake sediments.

Rivers

- Flow characteristics allowing 'natural' erosion, transport and deposition, including flooding;
- range of in-channel features appropriate to the reach and type of river (islands, braided sections, meanders, bars, cascades, etc.).

Specialist survey will often be necessary to investigate and evaluate these features (see Section **3.2**).

Water bodies which are SSSIs must be in Favourable Condition by 2010. Each site is assessed against a published list of attributes, including attributes similar to those listed above. Attributes relating to fish species and stocking are included. To be in favourable condition fish stocking must not conflict with conservation objectives, nor must there be large populations of bottom feeding fish, nor introduced species affecting the native wildlife.

2.2 Fishery types, definitions and management principles

2.2.1 Fishery types and definitions

A fishery is defined as a community of fish living in a water body.

Ecologically, the fishery has an intrinsic worth and in its own right is as important as, for instance, the bird community occupying a wood. There are 38 species of freshwater fish native to the UK and at least 12 introduced species. Of these, several including the lampreys (*Lampetra spp.)*, bullhead (*Cottus gobio*) and the Atlantic salmon (*Salmo salar*) are rare and increasingly threatened and are therefore included in the EC Habitats and Species Directive. 25 species of fish are listed in the UK Biodiversity Action Plan as globally threatened or declining. The National Trust's Lake District lakes supporting vendace (*Coregonus albula)*, schelly (*Coregonus lavaretus)* and Arctic charr (*Salvelinus alpinus)* are examples of sites of particular value for rare fish.

Fish have long been redistributed by man, for commercial or recreational reasons, or simply to 'diversify' a local fish fauna. Water bodies with fish communities relatively unaffected by man are of particular value, and may have populations of genetic significance.

Other features that may be of particular value relating to the ecological fishery are rich assemblages of fish species, and representative native fish populations, characteristic of the water body and area of the country in which they occur[38].

Conversely, some water bodies, especially those of an ephemeral nature, are of particular ecological value due to the absence of fish in them.

The 'ecological fishery' also has a key role in the monitoring of water quality. All too often, the first outward sign of a pollution incident is a number of dead and dying fish in the water. On a more subtle level, fish are excellent accumulators of a number of ecotoxins. Careful histological and ecotoxicological examination of fish tissue can often reveal sub-lethal, chronic water quality issues. Recent examples include the discovery of oestrogenic substances in many watercourses.

The ecological fishery is exploited by man and as such can support either a **recreational** or a **commercial** fishery, or both. The **commercial fishery** is here defined as fish capture, by whatever means, solely for financial gain. This fishery encompasses activities such as netting for salmon and fyke netting for eels. A few commercial fisheries may exist on Trust properties. However, management with commercial gain as the primary objective is not likely to be compatible with Trust purposes in freshwaters, and so will need to be evaluated (see Section **3.3**).

Generally, the Environment Agency through the Salmon and Freshwater Fisheries Act (1975) and associated byelaws will control commercial exploitation.

Of more significance to most Trust properties is the **recreational fishery.** Recreational fishing is defined as that which is undertaken for recreational means using rod and line. This is the domain of the angler.

The value of recreational angling in the UK is substantial. The National Angling Survey undertaken in 1994[30] found that the estimated 3.3 million recreational anglers in Great Britain spent a total of £3.3 billion pounds annually on fishing. Similar values were found in a more recent assessment by the Environment Agency[48]. This clearly indicates the monetary value of the recreational fishery in Great Britain. However, it does not place a value on the wider socio-economic value of recreational fishing. From its early impact on many lives (who has not caught minnows in a net?) to its impact on whole communities and the countryside, recreational fishing exerts a considerable influence.

Freshwater recreational angling is split into two main codes: game fishing and coarse fishing. The former group of anglers pursue the salmonid species (brown trout (*Salmo trutta)*, rainbow trout (*Oncorhynchus mykiss)*, sea-trout, salmon and grayling (*Thymallus thymallus*) whilst the latter fish for species such as carp (*Cyprinus carpio)*, chub (*Leuciscus cephalus*), pike (*Esox lucius*) and barbel (*Barbus barbus)*.

A wide range of recreational fishery types can be found in Britain. Major categories include:

X **Self-sustaining salmonid fisheries.** These can exist in rivers or lakes, with anglers exploiting naturally reproducing stocks of trout, salmon or grayling. Fish are either killed or increasingly, returned to the water (so-called ‘catch and release’).
X **Stocked salmonid fisheries.** Again, these can occur in rivers or lakes, with augmentation stocking of salmon or trout carried out for angling. If badly planned this has the potential to cause ecological disruption (see Section **5.0**).
X **Self-sustaining coarse fisheries.** River or lake fisheries, in which anglers exploit naturally reproducing stocks of coarse fish. These fish are not generally killed and are returned to the water after capture.
X **Stocked coarse fisheries.** These are fisheries in which either the species composition or stock density are manipulated to meet anglers’ expectations. At their most benign, this stocking may be as mitigation for an ecologically damaging episode, such as a fish kill following a pollution or drought. If properly planned stocking of this kind poses little ecological threat. However, the heavy, regular stocking undertaken in many commercial fisheries may be unacceptable to ecological interests (See Sections **2.3** and **5.0**).

2.2.2 Management principles for fisheries

As stated in the Introduction, the National Trust’s guiding principle for the management of freshwater fishing is as follows:

Fishing, for both game and coarse species, is welcomed, where it already takes place, subject to the Trust's prime objectives, namely conservation of the landscape, nature conservation and historic value of the property (see *Open Countryside*[39]).

Guidelines for the management of fisheries form the main content of this report, underpinned by the guiding principle above, and by the following management principles:

a) The Trust wishes to promote ***fish communities appropriate to the type of water body in question*** (see Section **2.3.3**)***, with recruitment sufficient to maintain the fishery without***

artificial stocking (see Section **5.1** *et seq*)**.** Inappropriate species may need to be removed and numbers regularly controlled. Otherwise, ***native fish should be left, including predators, eg. pike, grayling and eel.***

b) To achieve self-sustaining fisheries, ***not only will direct management of the fishery need to be appropriate, but so will land-use and habitat management within the catchment, and good water quality will need to be protected*** (see Section **4.0**).

c) Overstocked fisheries are a common cause of poor water quality. At present there are many sites which are overstocked, and in which ***stock densities need to be controlled*** (see Sections **2.3.1** and **2.3.2**)

d) ***Essential steps in the effective management of fisheries are surveys of fish and preparation of Fishery Management Plans.*** Many sites are without such assessments at present (see Section **3**).

e) ***Where fishing does not already take place, it should only be permitted after an ecological evaluation of the water body, an assessment of the likely impacts of fishing and the preparation of a Fishery Management Plan.*** In some circumstances, the existing state or ecological value of the waterbody may, on balance, mean that the development of a fishery is undesirable (see Section 2.3.4). At other locations, it may be feasible to develop a sustainable fishery without prejudicing the ecological value of the site.

f) ***The ecological fishery should not be expected to be self-funding***, as is sometimes the case at present. Rather it should be regarded like other ecological assets of the Trust, such as heathlands and downlands, which are not expected to 'pay their way'. Furthermore, substantial sums of money are invested in the maintenance of these habitats, without expectation of a financial return. The same should apply to the Trust's aquatic resources; ***recreational fishing should not be expected to be the sole funder of management work on water bodies.***

g) ***Anglers' expectations should be matched to the ecological constraints of the water body***. All too easily, anglers' expectations of the water they are fishing are unrealistic. For example, they may wish to either catch (and in the case of salmon and trout, kill) more fish, or to catch an increasing and unnaturally wide range of species. This can lead to over-cropping of fish, with an associated threat to the long-term viability of the stock. In addition, pressure to increase stock density or introduce previously absent species may result in significant changes to the ecology of the water (see Section **2.3** below). Preventing such undesirable outcomes may simply involve better explanation of the Trust's purposes, but in some circumstances, it may mean finding new angling tenants whose aspirations for the fishery match those of the Trust.

h) ***The management of recreational fishing needs to incorporate site-specific rules, so that exploitation can be controlled*** (see Section **6**). For example, cropping of fish stocks, particularly salmonid species, should be strictly regulated to protect their long-term sustainability. The numbers of anglers should be limited; close seasons maintained and excessive use of baits controlled and livebaits prohibited.

i) ***Letting arrangements should promote the Trust's purposes and the Fishery Management Plan. The Trust should not relinquish control of a fishery without an agreed***

Management Plan, break clauses and reviews. Letting arrangements should contain provision for day tickets, to ensure wherever possible wider public access to Trust fisheries. Corporate leases and letting for commercial purposes, where the primary objective is commercial gain, are not compatible with the Trust's objectives for its fisheries (see Section **7**)**.**

2.3 The role of fish and fishing in the aquatic ecosystem

2.3.1 The effects of fish and fishing

There is a widespread and increasing recognition that high densities of coarse fish can have direct and significant impacts on freshwater quality and benthic habitat. This is most noticeable in still waters, although some of the effects described may manifest themselves in large impounded rivers or canals.

Fish have the potential to affect freshwater ecosystems by various mechanisms[2,13,25,34,40]. They are able to eat a wide range of animals and plants, including macrophytes (macroscopic plants), phytoplankton (microscopic algae), vertebrates, macro-invertebrates (larger invertebrates such as caddis flies, mayflies and shrimps etc), zooplankton (smaller and microscopic invertebrates such as *Daphnia*) and dead organic material.

High densities of certain species, especially carp and bream (*Abramis brama*), disturb soft bed sediments. This loosens and mobilises sediments, increasing turbidity and reducing light penetration, which together act to significantly reduce the amount of submerged water plants present. Sediment stirring also releases nutrients into the water. In addition, the feeding behaviour of the fish uproots macrophytes, further reducing their abundance.

Death and decline of macrophytes have undesirable consequences. The death and decay of these plants, together with the mobilisation of sediments, results in an increased concentration of nutrients is available in the water body. This is utilised by algae, which proliferate and grow, further reducing light penetration. These algae are normally predated on by zooplankton such as *Daphnia spp.* However, in a heavily stocked water body, the zooplankton numbers are reduced by grazing fish, with a result that algal density is free to increase dramatically.

In addition, loss of macrophytes means loss of refuges where zooplankton can hide from predators, further depleting zooplankton populations. Loss of macrophytes also reduces oxygen levels leading to stagnation.

Increased nutrient availability further exacerbates these problems by increasing fish fry survival and hence recruitment to the fishery. It can be seen that in combination, the impacts resulting from high densities of some coarse fish have the potential to turn clear, macrophyte dominated still waters into turbid waters, with extensive blooms of algae. The impacts of these changes are well-documented [25,34] and include:

- loss of diversity and abundance of submerged macrophytes;
- a reduction in the diversity and abundance of macroinvertebrate species;
- an increase in the fluctuations in dissolved oxygen, including very low levels;
- a decrease in the growth rate of individual fish;
- an increased incidence of fish disease problems;
- in extreme circumstances, an increase in fish mortality, often on a large scale.

A further well-documented consequence of high fish stock densities is that some fish species, including perch (*Perca fluviatilus*), bream and carp, compete successfully with ducklings for limiting supply of invertebrate food. The result of this is that the fledging success of the ducklings is reduced in heavily stocked waters.

Heavily stocked waters are also associated with high numbers of recreational anglers. These bring their own challenges to the management of the fishery, including bankside erosion, damage to fringing vegetation (which itself plays an important rôle in providing harbourage for zooplankton, and in the case of trees shading and cooling the water), and the introduction of large amounts of bait.

Many other factors are impacting adversely on water bodies (see Section **4**) which will compound the deleterious effects of fish, but the implications of these findings are clear; ***in order to prevent damage to freshwaters, fish stock levels and species need to be controlled***.

The benefits of fish removal to reverse the deleterious impacts of overstocking (so-called biomanipulation) have been proven in a number of studies[25,34]. By selective removal of a percentage of the fish stock, rooted macrophytes have been re-established, macroinvertebrate diversity increased and water clarity improved.

The presence of people fishing can cause disturbance to birds, and there can be conflicts with other recreational uses such as walking along riverbanks.

2.3.2 Coarse fish stock densities

Recommendations for stock density and species composition in a recreational fishery, in which ecological diversity is also required, vary. An assessment by the Environment Agency[44] shows that most natural coarse fisheries (which are rare) have a biomass of <250 kg/ha. Furthermore, a study of shallow lowland lakes has shown that a threshold in fish biomass exists, between 150 and 250 kg/ha, above which submerged macrophytes cannot be sustained. For lowland coarse fisheries, a standing crop of up to 250 kg/ha is suggested, comprised mainly of tench, pike and perch, in order to promote macrophyte growth in soft-bottomed waters. Larger stocks, of the above species, along with roach, rudd and crucian carp, can be acceptable in harder bottomed lowland waters. In acid or neutral upland waters a maximum of 100 kg/ha is suggested[13]. ***Standing crops of more than 400 kg/ha, especially when these include carp and bream, are likely to be prejudicial to conservation interests.***

Estimation of fish stock levels in still water is notoriously difficult, even following intensive surveying. As a consequence, it is recommended that Trust staff make use of indirect methods of fish stock assessment. These include the clarity of the water, the presence of aquatic plants and the status of invertebrate populations; clear water, luxuriant growths of soft, submerged plant species and a diverse invertebrate population are indicative of 'well-balanced', usually low, fish stocks. A useful table of biological indicators of still water health and fish stock levels is provided in the Environment Agency Guide to Freshwater Fisheries and Wildlife Conservation[13] which is reproduced below.

Biological indicators of stillwater fishery health and stock levels		
Well–balanced fishery	**Over-stocked fishery**	**Notes**

Water quality Water is often relatively clear, especially on low-nutrient stillwaters.	Water is often clouded by algal blooms and by silt and clay particles stirred up by feeding fish.	Cloudy water limits the light penetrating to the lake bed and tends to shade out valuable beds of soft-leaved weeds.
Soft-bedded lakes and naturally productive waters will suffer most from increased turbidity.	Over-stocking will tend to change naturally unproductive (upland or peaty) waters markedly, causing damage to some species.	Good water quality is precious and everything should be done to preserve it. Use chemical herbicides with extreme care.
Aquatic Plants Stoneworts (*Chara* species) may be present, especially in 'marl' lakes.	Tend to disappear when lakes become naturally or artificially enriched.	Occur in clear-watered, lime rich lakes and gravel pits.
Water Milfoil (*Myriophyllum* species), Canadian Pondweed (*Elodea*), Fennel-leaved Pondweed (*Potomogeton)* and other soft-leaved pondweeds.	These delicate species tend to disappear when lake beds are disturbed by dense shoals of feeding fish.	The loss of these plants is very common in over-stocked waters and removes tench spawning habitat and invertebrate habitats.
Water lilies (*Nuphar, Nymphaea, Nymphoides)* and tough-leaved pondweeds (*Potomogeton* species)	These often tolerate the disturbance created by adult carp and bream shoals, especially in hard-bedded lakes.	These plants tend to have relatively few aquatic invertebrates living on them and are poor spawning substrates.
Aquatic invertebrates Well-balanced fisheries support diverse dragonfly, damselfly, caddisfly, mayfly, midge, mollusc and crustacean faunas.	Over-stocked waters tend to have low numbers of a few hardy species of midge larvae, worms, leeches and snails.	Poor invertebrate communities tend to be associated with over-stocking, poor weed growth and reduced water quality.
Rarities such as native crayfish need good (hard) water quality and refuges from fish predation.	Stocking exotic crayfish such as North American signal crayfish will wipe out native crayfish stocks and is illegal.	Do not introduce exotic plants or invertebrates as these may well have unforeseen damaging effects on your fishery.
Rare fairy shrimps thrive in a few fish-free stillwaters.	Predation by introduced fish wipes out these rare animals.	Do not forget that some small pools are best left fish-free.
Fish Good size-range of key species with specimen fish produced regularly to skilled anglers.	Poor body condition of fish with many 'stunted' individuals. Diseases and parasites common. Poor species range.	High quality specimen fish grow in well-weeded, food-rich waters with a sensible stock level.
Amphibians and reptiles Frogs, toads and newts thrive best in well-weeded waters. Grass snakes breed in piles of rotting bankside vegetation	Heavy fish predation can eradicate amphibians.	A well-balanced fishery allows the support of vulnerable wildlife.
Aquatic birds and mammals Waterfowl and small mammals (water voles, water shrews and otters) need both bankside and submerged vegetation for breeding and feeding habitats.	On heavily-stocked and intensively-fished waters little bankside cover is afforded to shy wildlife attempting to breed. Ducklings need large quantities of aquatic insects.	The whole aquatic ecosystem that waterside birds and mammals depend upon is only maintained where angling pressure is kept within reasonable limits. Attractive fisheries are also successful fisheries.

Reproduced from Freshwater Fisheries and Wildlife Conservation: a good practice guide[13]
Fish can be removed by a combination of seine netting, electrofishing and trapping. These techniques require both the written consent of the Environment Agency and a range of specialist equipment. A number of commercial fishery operations will undertake fish removal on behalf of owners, paying between £3-7/kg for fish removed, depending on the species and size of the fish. Money raised from fish removal can be ploughed back into the fishery, helping to fund a range of positive initiatives. It should be realised that fish removal is not usually a 'one-off' exercise; it may

need to be carried out on a regular basis, perhaps every 3-5 years, in order to maintain a desired biomass and age-class structure.

2.3.3 'Appropriate' fish communities

Fish communities should be appropriate to the water body in question. Native species are favoured although it is recognised that introduced species may well be present. To ascertain what is appropriate, a fishery evaluation will be needed.

Coarse fisheries:
A survey by the Environment Agency[44] has shown that natural coarse fisheries (ie not managed for at least 25 yrs) are rare, and that they usually consist of 6 species: common / mirror carp, crucian carp, roach, bream, perch and pike.

Some species of coarse fish are more likely than others to cause significant ecological damage to stillwater fisheries. The damaging impacts of high densities of common/mirror carp and bream feeding in soft bottomed lakes is detailed in Section **2.3.1.** Small numbers of carp can live in soft bottomed lakes without causing serious ecological damage. However, the development of a mixed community of pike, perch, rudd, roach, crucian carp and tench offers the best chance of maintaining optimum water quality and habitat in such waterbodies. Indeed, crucian carp and rudd are becoming increasingly considered as 'rare' fish species in some regions of the UK, following the decline in crucian carp numbers due to interbreeding with introduced carp species, and the impact of poor water quality and habitat changes on both species.

Even in firmer-bedded lakes, where larger populations of carp and bream can be supported without prejudicing the ecological value of the water, periodic removal of excess stock may still be necessary.

In an historic context, the value of so-called 'wild carp' should not be underestimated. These relatively slow-growing fish are generally recognised as descendants of the earliest fish introduced by monks for food. In contrast to the fast growing, modern continental strains of carp that can reach more than 25kg in weight, wild carp rarely grow larger than 6-7kg and thus do not generally reach such damaging biomasses in still water systems. Moderate numbers of wild carp that occur in many estate lakes can be an acceptable addition to the fish fauna.

Game fisheries
The 'appropriate' species for game fisheries are the native, natural stocks. Both rainbow trout and farmed brown trout are recreational species, not appropriate for a natural water body being managed for Trust purposes. However, reared trout are allowed in some Trust fisheries at densities up to 80 kg/ha if there are good reasons to allow them, eg. there is an existing tenancy; condition of acquisition. The fishery should be returned to a more natural species composition as soon as practicable. The recent Environment Agency Trout and Grayling Strategy[41] contains details of appropriate stocking levels and strategies.

2.3.4 Sites with no fishing

Open Countryside states that fishing is welcomed at sites where it already takes place. Where fishing does not already take place, it should only be permitted after an ecological evaluation of the water body, an assessment of the likely impacts of fishing and the preparation of a Fishery Management Plan. In some circumstances, the existing ecological value of the waterbody may, on balance, mean that the development of a fishery is undesirable. At other locations, it may be feasible to develop a sustainable fishery without prejudicing the ecological value of the site.

Sites where it may be inappropriate to allow fishing could include small water bodies, sites with rare fish, sites of nature conservation value eg. for amphibians or invertebrates, sites with fish numbers at very low levels in which recovery is desired, or sites in a degraded condition undergoing restoration or biomanipulation.

It may be appropriate to designate part of a site or property as a no-fishing zone, eg one bank of a river, or designated lakes or ponds, in order to have 'sanctuary' sites with very low levels of public access

3.0 STRATEGIC PLANNING FOR FISHERIES

Essential steps in the effective management of fisheries within the Trust are the production of national and regional guidance, and Fishery Management Plans for properties. Without these documents, it is difficult to promote appropriate development of fisheries and associated nature conservation interests.

3.1 National and regional guidance

National guidance relating to recreational fishing is currently set by the guiding principles published in *Open Countryside*[39]. It was re-issued in 2000 and made reference to the principles in the first edition of this report with respect to fisheries management issues. This report provides national guidance on all fisheries.

With some exceptions, there is little regional guidance and co-ordination with reference to fisheries. Benefits of co-ordination could include pooling resources between properties with respect to assessing the worth of fisheries, input into Environment Agency Plans (Catchment Abstraction Management Plans, and forthcoming River Basin Management Plans) and other catchment-wide initiatives, and the development of regional fishing guides, as seen in the Lake District. The establishment of a small regional fisheries group, with the interest or expertise to advise, could be helpful.

3.2 Site Evaluation

Evaluation of the significance of the water body is a necessary prerequisite to formulating objectives and the production of a Fisheries Management Plan. The value of the water body should be explained, whether it is ecological, recreational, commercial, landscape, historical or a combination of these.

Unfortunately there are as yet few evaluations of National Trust fisheries.

Input and information can be provided by Nature Conservation staff, the Statutory Agencies, including the Fisheries and Ecology sections of the Environment Agency, the local fisheries consultative (information from the Environment Agency) and catch data from people already fishing the site. It is often necessary to commission studies in order to obtain the necessary information.

The ecological 'desired state' of the water body should be considered as well as its present state, if it is not in good condition.

Ideally the following data should be available for all waters prior to identifying the significance of the fishery, and hence the objectives of ownership:

- a description of the water body and its main physical and biological characteristics;
- a River Corridor Survey or, in the case of a still water, a survey of macrophytes and habitat types in and around the water. The Environment Agency may be able to provide the necessary information;
- a fish survey, detailing in a quantitative/semi-quantitative manner the fish stock of the water. The Environment Agency can advise on suitable techniques and may be able to undertake the survey themselves. Alternatively, they will be able to provide a list of suitably qualified contractors (see Appendix B);

- X a preliminary macro-invertebrate survey, more detailed if the Biological Survey team indicate that communities or species of special interest may be present. A damselfly / dragonfly survey may also be appropriate;
- X a mammal survey, looking especially for signs of otters (*Lutra lutra*) and water voles (*Arvicola terrestris*), and an ornithological survey of the water and its environs;
- X an assessment of the historic and landscape value of the water;
- X other recreational interests and the impact of fishing on these.

These data and the comments from the suggested organisations, in conjunction with the information given in this report, should enable the site manager to make an informed decision as to the current value of the water and its future management needs.

SITE EVALUATION

- X A Site Evaluation is a necessary prerequisite to the production of a Fishery Management Plan.
- X This should establish the importance of the site's ecological, landscape and historic value, as well as its importance as a fishery.
- X Consultation with statutory and non-statutory organisations should be undertaken as part of the Site Evaluation process.
- X Ecological data should be gathered in an effort to protect and promote valuable wildlife and associated habitats. This may necessitate the commissioning of additional surveys.

3.3 Fishery Management Plans and related plans

Based on the Evaluation, objectives for the water body can be formulated. Objectives should be consistent with the management principles in Section **2.2,** and in the case of a recreational fishery those in *Open Countryside*[39]. The plan should complement the Property Management Plan.

Objectives should also support and reinforce the aims of the Environment Agency's plans (see 3.1 above). ***The Trust should contribute issues of concern to the Environment Agency during the plan preparation or updating process.***

Where large areas of Trust farmland are involved in the catchment, Whole Farm Plans will also be relevant, and should provide a mechanism for addressing land-uses of relevance to the fishery.

3.3.1 Format

Written Fishery Management Plans have been prepared for some Trust properties, including the River Dove, River Test at Mottisfont, Dudmaston Hall Lakes and the lakes at Stowe Park.

Like other management plans, following the evaluation and objectives the plans for Trust fisheries need to include:

- A programme of management work for a 5-year period;
- the necessary statutory consents required;
- responsibilities for the work;

- costings for the projects.

Adequate survey and monitoring should be costed and included.

4.0 FISHERIES MANAGEMENT: GUIDELINES FOR PRACTICAL SITE MANAGEMENT

This section covers common fishery management practices and land-use practices which have impacts on freshwater wildlife conservation. Further details can be found in publications cited in the reference list (Appendix D), particularly, as regarding game fisheries, in *Nature Conservation and Game Fisheries Management*[40].

Many issues apply not just to the fishery but to the wider catchment. The National Trust has a Soil Protection Policy[45]. The Trust undertakes to conserve soils with the same degree of care as that devoted to its other prime resources. This includes managing soils so that they can provide essential functions such as protecting water resources, and keeping agricultural soils *in situ*. Implementation of this policy will do much to protect and enhance the quality of National Trust fisheries.

4.1 Water quality

4.1.1 Recognition and control of pollution

'Water quality' is defined by various parameters, with standards varying according to the use to which the water is put. Water quality reflects the composition of the runoff entering the water body. For instance lake and river systems can be severely affected by poor quality discharges from sewage treatment works (STWs) and from agricultural premises. Other sources of potentially damaging inputs to an aquatic system include diffuse runoff from arable land or heavily stock-grazed areas, effluent from poorly maintained septic tank/cess pit systems, runoff from roads, tracks and footpaths, and from farmland and coniferous forestry drainage.

Some effluents from these sources have a high organic loading, with the potential to lead to deoxygenation of the water. Such effluents may also have high nutrient concentrations, particularly of phosphate and nitrate, with all that this implies for the process of eutrophication or excessive nutrient enrichment of the water. They may also contain large volumes of suspended solids.

High levels of suspended solids can cause a range of problems from siltation of salmonid spawning gravels to the reduction in the effective life of a lake (see Section **4.2**).

Fish themselves can affect water quality, as described in Section **2.3.**

In order to maintain or improve the water quality of the fishery, it is essential that water quality is investigated, and that polluting inputs are recognised and controlled. The plant and invertebrate species present, water colour and clarity (and in extreme cases smell), whether or not there are regular algal blooms, and the amount of 'mud' on nearby roads and in ditches, will provide indications of water quality.

Where the cause of water quality problems is known to emanate from Trust property, remedial action should be undertaken immediately. In other cases beyond the Trust's boundaries concerns should be raised with the Environment Agency.

Details of all consented discharges (e.g. STWs, effluent from industrial premises etc) are held on a public register by the EA. The compliance of these discharges against legally agreed standards are regularly monitored by the EA, with the results also available on a public register. Trust staff should ensure that discharges into their waters are maintained at a level commensurate with their consent standards; the EA has a legal duty to take enforcement action where appropriate.

The impacts of diffuse source pollution, which can be harder to detect, should be addressed at source during the planning process (see also Section **4.2.1**).

In the event of an emergency, the EA have a 24 hour Freephone number: 0800 807060.

Water levels: low levels and inadequate water quantity can exacerbate water quality problems and are a matter of concern on several Trust fisheries. Causes should be identified, with the help of the Environment Agency if necessary. If low levels are linked with abstraction in the catchment the issues can be addressed through the EA's Catchment Abstraction Management Plans. Land-use issues linked with poor water quality may well be relevant to water quantity too, eg agricultural drainage, overgrazing and rapid run-off, etc.

4.1.2 Fertilisation of water

Artificial fertilisation to increase nutrient status is undertaken in still water fisheries in order to increase recruitment and subsequent growth of coarse fish. This practice can significantly, and adversely, alter the ecology of the water. The effects of nutrient enrichment are very hard to reverse, involving considerable expenditure and substantial physical disruption to the water body[1,2,3]. ***Therefore in Trust waters artificial fertilisation should not be allowed.***

The justification for most fertilisation programmes is dissatisfaction with the productivity of the fish stocks, so instead it is preferable to match the angler's expectations with the water under the Trust's management (see Section **2.2.2**).

4.1.3 Application of lime

The liming of water courses by the application of lime or powdered chalk is an old-established procedure intended to boost productivity and aid the breakdown of accumulated organic sediments. Liming has also been used on a catchment scale to ameliorate acidification. Acidification can be detrimental to a wide range of aquatic species, including macroinvertebrates, salmonid fish, dippers (*Cinclus cinclus*) and otters. Impacts are greatest in areas dominated by granitic and siliceous bedrock, where the buffering capacity of the soil is low.

The benefits of liming in river catchments are mixed. Some success has been achieved in the River Tywi catchment, with pH rising from 5.1 to neutral, with associated recovery of previously impoverished juvenile salmonid stocks. However, there are questionable aspects to this technique. Water chemistry is not restored to pre-acidification conditions; rather, pH and calcium concentrations are often much higher than previously, with some aquatic organisms such as mosses and liverworts being negatively affected. Additionally, responses by invertebrate communities have been slow and partial, with limed streams gaining only a fraction of the communities found in streams that are naturally circumneutral.

Overall, there is a presumption against liming of National Trust fisheries. With respect to any requests to apply lime or chalk to water, it is recommended that detailed advice be sought from the Environment Agency or Trust's advisers. Clear assessment of potential benefits and disbenefits should be made prior to undertaking any liming of catchments[40]. Again, ideally the impacts of acidification need to be dealt with at source.

4.1.4 Fish densities

High densities of certain species of fish can have a detrimental effect on water quality, and fish may therefore have to be removed - see Section **2.3**.

WATER QUALITY

- Inputs of nutrients may have a number of significant impacts on flora and fauna, including a decrease in macrophyte diversity, an increase in the growth of algae, changes to the macroinvertebrate community and other changes, generally detrimental ecologically.
- These changes are extremely difficult and costly to reverse.
- Point source inputs of poor quality water should be addressed urgently, seeking advice from the EA if necessary.
- Diffuse source pollution should be addressed through land use change, as part of the Whole Farm Plan mechanism if Trust land is involved, and via partnerships with others and the statutory agencies beyond Trust boundaries.
- Artificial fertilisation should not be allowed.
- Application of chalk to rivers and still waters is an old-established practice. Data on impacts is limited.
- Catchment scale applications of lime to ameliorate surface water acidification may benefit certain groups of plants and animals. However, there are potentially serious disbenefits on other species assemblages. Careful assessment is needed before liming is considered.
- Numbers of certain fish species may require control.

4.2 Sediment management

Sediment input to and transport through aquatic systems is a natural phenomenon[4]. Entering from a variety of sources, it may be temporarily deposited to form valuable features of the geomorphology of streams such as point bars and sidebars[4].

However, anthropogenic processes have increased sediment loadings in water bodies, often to the detriment of the indigenous flora and fauna. Changes in agricultural practice (winter planting of crops, ploughing to the very top of river banks, overgrazing by stock), coniferous forestry (increased drainage, construction of forestry roads) and increases in the areas of 'hard' landscape (property developments, roads) have contributed to an increase in the sediment inputs into aquatic systems. Recent studies on the River Exe have indicated that as much as 60 tonnes of sediment per km may enter the river annually.

Impacts of increased sediments are manifold. In all systems, they have the potential to smother benthic invertebrates, reducing their number and diversity. They may cause significant changes in macrophyte flora, favouring silt tolerant species such starwort (*Callitriche spp.*) at the expense of species such as water crowfoot (*Ranunculus spp.*). With respect to fish, siltation of river gravels has the potential to reduce the spawning success of salmonid species such as brown trout and salmon.

The creation of on-line ponds, often a feature of landscape parks, effectively forms large silt traps which highlight the impacts of increased sedimentation rates. Sediments (and nutrients) accumulate in these still waters, reducing their effective lives as open bodies of water.

'Sediment' is soil. Under the National Trust's Soil Protection Policy[45], soils which are in agricultural use should be maintained *in situ*, both so that they can continue to support farming, and so that they don't cause damaging off-site pollution.

4.2.1 Control at source

Control of excessive sediment input is often a major component of fisheries management. Of primary importance is the control of sediments at source. Often, this involves not only reducing inputs of sediment to the river, but also controlling associated increases in nutrients and the intensity of surface water discharges. Mechanisms of source control of sediments are varied, but some of the most successful include:

a) Changes in agricultural and forestry practice

Significant benefits in reducing run-off of sediment-laden surface water can accrue through changes to forestry and agricultural practices including:

- allowing permanent and undisturbed vegetation cover;
- where possible, removing or impounding drainage systems to hold back runoff;
- controlling runoff from farm and forest tracks and other roads;
- cessation of ploughing and machinery use across contours;
- changing from winter sowing to spring sowing of crops, reducing the amount of bare ground liable to erode in winter rains;
- reducing stocking rates.

Further details are given in the Trust's document *National Trust Soils – management and conservation in agricultural landscapes*[46].

In many cases, these changes will be beyond the immediate influence of fisheries managers. However, at Trust properties, necessary changes should be identified in property and farm planning processes. Beyond Trust boundaries, managers should seek to modify damaging land use practices through the mechanism of catchment wide initiatives such as ESAs and River Basin Management Plans.

b) Fencing of riverbanks

Modern stocking densities are generally high, for both cattle and sheep. A consequence of this is an increase in the extent of bank erosion and poaching attributable to stock. Examples of significant bank erosion due to high duck and goose numbers and trampling by walkers have also been recorded. Whearas natural bank erosion has various values, the amount of sediment generated by current levels of stock erosion is very substantial and is damaging to water quality.

To prevent these impacts, fencing is often erected to exclude stock. This is set far enough from the riverbank to facilitate angler access and casting. The benefits of these riparian buffer strips are widely recognised[5] and include:

- improvement to the quality of surface water runoff;
- the establishment of valuable linear wildlife corridors;

- X the creation of instream habitat, of particular value for juvenile salmonids to whom overhanging, fringing cover is vital;
- X narrowing of the channel cross-sectional area, which aids sorting of substrates, increases average channel depth and decreases water temperature. These changes are valuable for salmonid fish species, and many invertebrate and macrophyte species;
- X opportunities for other forms of access.

It should be noted that a number of specialised invertebrate and plant species, including rarities, require areas of poached, wet margins. Their requirements should be taken into account, for example by allowing some grazing of defined areas of bank[40].

c) Swales, detention ponds, constructed reed beds and silt traps

Modern catchment management recognises the value of a suite of mechanisms to control silt and other pollutants in surface water runoff. Detailed discussion of the design of these systems is beyond the scope of this publication, but fishery managers should be aware of the range of options available to them[7,8]. Amongst others, these include the following:

- X <u>Swales</u>. These are engineered, grassed depressions that lead surface water overland from the drained surface to a storage or discharge system. The swale is normally dry but water slowly moves through the grassed area during periods of runoff.
- X <u>Detention ponds</u>. These are wet or dry ponds designed to temporarily detain surface water runoff and therefore allow the settlement of suspended solids. They can also act to attenuate peak flood flows, helping to reduce the flashiness of rivers.
- X <u>Constructed reed bed systems</u>. These are engineered systems that utilise the rhizome systems of a number of emergent aquatic species, including common reed (*Phragmites australis)* and reed mace (*Typha latifolia)* to trap sediment (and remove nutrients).

4.2.2 Local control measures

If control at source is not an option to fishery managers, local mitigation may be deemed necessary. Measures available include:

a) De-silting in rivers

De-silting is a routine task on many rivers, involving the removal of accumulated soft sediments. It may be undertaken in a number of ways:

- X 'Mudding' is a traditional annual task undertaken by river keepers on chalk streams. Sheep hurdles or 'mud engines' are temporarily placed in rivers at strategic locations in order to increase local flow velocity and wash silt deposits downstream. In addition to mudding, keepers on chalk streams regularly 'pull back' silt and associated marginal vegetation in an effort to prevent its encroachment into the river channel.
- X Using hydraulic excavators. Localised areas of silt build-up are removed from the river by machine and deposited on the bank at convenient locations or are utilised in river narrowing operations on other sections of the fishery.

The main potential effects on macrophytes from de-silting are changes in community structure resulting from alterations in habitat and possible extinction of rare species. The latter is unlikely, so long as the whereabouts of rare species is known and documented. National Trust Biological Surveys or River Corridor Surveys (RCS) should highlight the location of those species of particular note. Changes in community structure are less predictable. Most aquatic vegetation in rivers is resilient to de-silting, recovering quickly and maintaining its species composition in the long term.

Invertebrate species may also be affected by desilting, both by direct impacts and by damage to their habitat. Direct impacts include removal of part of the invertebrate population from the watercourse and disturbance leading to increased drift of invertebrates. Indirect effects may include reduction of cover, loss of emergence sites, removal of food plants, increased instability of the river bed and increased suspended solids load. However, studies have shown that the impact of these changes tends to be short term, with full recovery of invertebrate populations normally complete within a year.

Timing, location and extent of de-silting operations are important:

- X areas of silt naturally accumulating along river margins, especially on the inside of bends (‘point bars’) should be left;
- X silt shoals are important areas for many invertebrates and for active growth of *Phalaris* and *Glyceria*, amongst other emergents;
- X if localised silt removal is carried out in combination with river narrowing (see Appendix E), areas of gravel may be exposed that are beneficial to spawning salmonids and a range of macrophytes and invertebrates;
- X extensive silt removal over long lengths of river has the potential to increase environmental disturbance;
- X de-silting should be timed to avoid key life stages of important species assemblages. For instance, it would be counter-productive to de-silt areas of chalk stream during November and December, when brown trout spawning activity will be at its peak.

The above comments relate purely to de-silting (i.e. removal of accumulated soft sediments). ***Removal of hard bed sediments such as gravel and associated reforming of the profile of the river channel, has the potential to cause extensive and often irreparable damage to stream ecology. Such operations should never be considered as part of routine fisheries management.*** In the event of a proposal to carry out such works, detailed advice should be sought from the Trust’s nature conservation staff or the Environment Agency.

b) De-silting in lakes and ponds

In still waters, silt removal is generally undertaken with a view to restoring open water areas in a heavily silted lake. ‘On-line’ lakes , i.e. those with a stream running through them, are predisposed to the accumulation of sediment. Without remedial de-silting, they will inevitably succeed to woodland, via reed swamp, carr and other habitat types. These can in fact be of more nature conservation value than the open water. ***Lakes should preferably not be dredged. If it is decided that maintenance of an open water area is of prime importance, then de-silting may be thought necessary. If so, it should not be carried out before the causes of siltation have been investigated and addressed. A detailed impact assessment is needed.*** For more information see *Sediment Management and Dredging in Lakes*[42].

Almost without exception, desilting is undertaken by mechanical means. Excavated sediment is usually either spread on land surrounding the lake or is carted by lorry to a registered waste disposal site.

Provision for the welfare of particular groups of animals (e.g. fish, birds and amphibians) and plants should be made during the planning process. Advice on the protection of fish during such operations can be obtained from the specialist advisers listed in Appendix B or from the Environment Agency.

Suction dredging of nutrient-rich sediments can have a rôle in lake restoration, as described in the literature[34].

SEDIMENT MANAGEMENT

- X Sediment should where possible, be controlled at source. Changes in land use practice may be necessary.
- X Techniques such as fencing river banks, and the provision of swales, reed-beds and silt detention ponds may prove of benefit.
- X Local techniques of river de-silting such as mudding and mechanical removal of soft sediments may be acceptable if undertaken at appropriate locations and at a suitable time.
- X Mechanical de-silting of lakes and ponds is very damaging. If it is deemed essential to preserve areas of open water and to halt succession, careful planning and an impact assessment are required.

4.3 Algae and vegetation management

4.3.1 Control of algae

Unicellular and filamentous algae are important components of aquatic ecosysytems. However, excessive growth is often an indicator of over-enrichment, particularly of phosphate. Intense algal 'blooms' can result in a reduction in abundance and diversity of macrophytes, and in extreme cases, large scale fish mortality due to diurnal dissolved oxygen fluctuations. Blue-green algae, that have a competitive advantage in periods when available nitrate has been exhausted, may produce toxins that are dangerous to both fish and mammals.

It is thus necessary in some cases to control algal growth. There are two main techniques that can be usefully employed:

a) Reduction in fish stock
Reducing fish density can decrease predation pressure of zooplankton, allowing these species to increase and control phytoplankton numbers. This technique is of particular benefit when fish stock levels are high (>400kg/ha. See **2.3.1**).

b) Introduction of barley straw
Barley straw has long been used to control algae in stillwaters. As introduced barley rots in a water body, it produces a number of chemicals (including fulvic and humic acids, generically known as Dissolved Organic Carbon or DOC) which, in the presence of sunlight and oxygen, form hydrogen peroxide. Concentrations of hydrogen peroxide of >2 ppm peroxide have been demonstrated to inhibit the growth of algae.

Currently barley straw products have been prohibited by the Health and Safety Executive, although bales can be used.

For practical application, barley straw should be introduced into the waterbody in early spring at a rate of 500kg/ha. The straw should be replaced in early summer at a rate of 250 kg/ha, with subsequent replacement later in the season at a rate of 100kg/ha likely to be adequate to continue the suppression of the algae. Further details on barley straw and other materials can be found in the IACR-Centre for Aquatic Plant Management Information Sheet 3[29].

4.3.2 Management of aquatic vegetation

Removal of aquatic vegetation is routinely undertaken in order to create open areas of water for fishing, facilitate angler access to the water and to improve habitat conditions for a range of fish species. ***Aquatic vegetation plays a very important role in water quality and the functioning of the aquatic ecosystem, as outlined in Section 2.3. With the exception of a few very aggressive, introduced water plants, any removal has the potential to seriously impact on the whole freshwater environment.***

Excessive abundance of one 'weed' species may be due to poor water quality, which should be addressed at source.

Other impacts of removing aquatic vegetation can include alterations to dissolved gas and pH regimes from decaying vegetation, increase in detritus, toxin and nutrient release from decaying vegetation, habitat alteration for non-target species and rapid growths of opportunistic plants species (algae or rapid-growing macrophytes) to fill the niches vacated by the loss of target macrophytes.

These factors should be taken into account when considering vegetation control proposals, and there will often be a presumption against this activity.

However, the recent rapid increase in a few aggressive introduced plant species (such as Swamp Stonecrop *Crassula helmsii*, Parrot's Feather *Myriophyllum aquaticum* and Floating Pennywort *Hydrocotyl ranunculoides*)[47] which are threatening the ecology of freshwaters is an urgent concern, and control, if not eradication, is likely to be an objective for these.

Three main methods are adopted for the control of aquatic vegetation. Detail is found in the references[40].

a) Cutting - in river channels and still waters

Historically, cutting aquatic vegetation in rivers for fisheries purposes was carried out by hand to a 'side and bar' pattern, in order to concentrate flows between the bars, whilst holding up water slightly behind them. This served to scour the bed of silt, conserve pools during low flows and create a variety of microhabitats for fish and invertebrates.

Mechanical methods of instream vegetation control are now becoming more prevalent, both in rivers and still waters. Cutting in still waters is almost exclusively undertaken by mechanical means. Weed cutting boats can cut huge amounts of weed in a day at a relatively low cost. Used in conjunction with weed booms or pits, which are then cleared using mechanical grabs, the whole operation can be carried out efficiently with minimum labour requirements. The precision with which the cutting can be carried out is markedly poorer than with hand cutting.

Following cutting, vegetation must be removed from the water to prevent deoxygenation occurring as a result of decomposition and as a legal requirement of the Water Resources Act 1991[10].

The impacts of in-channel vegetation cutting on wider nature conservation interests are complex[40]. Given the general presumption against it wherever possible, guidance is as follows:

- timing, extent of cut and species targeted are critical. For instance, cutting during the spawning period for fish such as roach (R*utilus rutilus*) and perch may result in the loss of a whole year class of fish;
- recommendations for the cutting of vegetation in rivers, chiefly *Ranunculus*, are given in the literature[40];
- ***mechanical weedcutters have the potential to cause significant environmental disruption. There should be a presumption against their use in Trust waters.***

b) Application of herbicides

There are various herbicides approved by government for the control of aquatic macrophytes, and DEFRA / Environment Agency guidelines for their use[12, 28]. All National Trust staff must consult the National Trust's COSHH Endorsed Substances List which is updated regularly.

Herbicides provide the only realistic option for the control of some introduced plant species, including Japanese Knotweed *Polygonum cuspidatum a*nd Giant Hogweed *Heracleum mantegazzianum*, and may help to control Swamp Stonecrop *Crassula helmsii*[11, 43].

However, killing aquatic vegetation has serious impacts, as already described. Herbicides may allow killing of large stands, which may include many species. ***There should therefore be a presumption against the use of herbicides.***

If herbicides are used, safeguards should be observed prior to and during any treatment. These include the correct identification of target plants, checking for the presence of any rare plant species and ensuring operators are fully trained. Statutory consents are required for the use of herbicides on or near water from the Environment Agency under the Water Resources Act, 1991[12] in all cases, and from the statutory conservation agencies if the site is a SSSI.

Guidelines[28] provide a list of rare plant species that may be adversely affected by aquatic or bankside herbicides. For more information relating to the use of aquatic herbicides, contact the Centre for Aquatic Plant Management (details in Appendix C).

c) Control using fish

Submerged plants can be controlled in still waters by stocking with Chinese grass carp (*Ctenopharyngoden idella*). As their common name suggests, ***this is an alien species and cannot be introduced into the wild without a licence issued by DEFRA*** under the Wildlife and Countryside Act, 1981 and a consent from the Environment Agency under the Salmon and Freshwater Fisheries Act, 1975. Licences will only normally be granted if DEFRA and the Environment Agency are satisfied that no grass carp can escape from the water body. Key points to be considered include:

- Grass carp control a range of plants (eg. Canadian pondweed *Elodea spp.* and starwort), preferring softer vegetation to more fibrous species;
- they do not feed actively until the water temperature has reached 16^0C;
- initial stocking densities should be in the region of 100-200 kg/ha. (Cost at 1998 prices = £1400 - £2800 per ha.)
- Grass carp do not breed in this country but do grow at a considerable rate. Consequently, some removal of fish may be required from time to time to prevent overstocking.

The wide range of plant species consumed by grass carp makes them unsuitable for stocking into sites with particular macrophyte interest. Their use will not generally be appropriate in National Trust sites.

In addition to grass carp, high densities of common carp (*Cyprinus carpio*) have been used to control submerged weed growth in still waters. This too is to be avoided for reasons given in Section **2.3**.

4.3.3 Management of bankside and marginal vegetation (excluding trees)

Provision of access to the water for anglers is an essential element of game fisheries management, especially on the more managed lowland rivers. Paths (3 - 10 m wide) and vegetation at the river edge are regularly cut. Typically, the emergent vegetation is cut both horizontally and vertically on chalk streams, leaving a fringe approximately 0.5-1 m wide and 1-1.5 m high. This provides cover to the anglers when stalking trout and also retains the bank stabilising root system. On upland streams, vegetation management is less intensive, with limited path cutting and fringe trimming undertaken. In fact establishing bankside vegetation rather than controlling it is often the issue.

Impacts of riparian vegetation management on wildlife interests can be minimised by observing the following principles[9]:

- X Cutting should only take place on a single bank of a watercourse;
- X marginal vegetation is of great importance in narrowing river channels, which aids the sorting of bed material and helps increase habitat diversity for a range of species;
- X cut material should be gathered and stored in heaps in non-sensitive areas[10];
- X a vegetation strip must be retained at the toe of the bank;
- X timing of cutting should be considered with respect to the desired conservation objectives;
- X patch cutting on a rotational basis, rather that regular cutting, improves plant species and habitat diversity;
- X fishing areas or ‘swims’ may be cut in the natural vegetation and rotated on an annual basis to allow re-growth of the vegetation.

4.3.4 Tree management

Bankside trees

Trees on the edges of water bodies have a number of beneficial functions. Shaded water is cooler and holds more dissolved oxygen; roots stabilise river banks; roots provide spawning sites for species such as roach; overhead tree cover provides protection from predation for species such as chub; the invertebrate fauna associated with trees provides a significant food resource for trout and juvenile salmon, and waterside trees and tree roots provide important habitat for many species. Tree shade can suppress growth of aquatic and bankside plants which can be regarded as a benefit in the recreational fishery. Harper[16] provides a useful table summarising the importance of riparian habitats.

However, too dense a tree cover is undesirable. Too much shading results in a suppression of the overhanging fringing vegetation that is of vital importance to juvenile trout and salmon, leading directly to increased erosion of the banks and over-widening of streams. This fringing vegetation also acts to narrow streams, thus increasing their velocity, scouring them deeper and aiding the sorting of bed substrate. All of these processes help to increase the geomorphological diversity of streams. The converse side of this equation is that excessive removal of streamside trees can result in the loss of bank stability.

A compromise management policy on most water bodies is to instigate a programme of rotational coppicing/pollarding. By selectively coppicing riparian trees over a 6-15 year period, the benefits of more open water areas can be gained without compromising the structural benefits of the tree's root systems. Recommendations for the ratio of open canopy vary but generally a figure of around 40-60% tree shade is suggested[14,15]. This type of coppicing is valuable on all streams, but assumes particular importance when the stream width is less than 5m. Typically, streams of this sort are used extensively as nursery areas for salmonids. Crack willows *(Salix fragilis)* are regularly pollarded in order to preserve their lifespan and value to the fishery.

It is good management practice, if both sides of a water course are owned, to allow sections of bank to remain unmanaged, whilst coppicing or pollarding on the opposite bank, alternating the sections[40].

Woody debris

Large woody debris (fallen trees and branches) in rivers and lakes constitutes valuable habitat and has many other benefits. These include:

- provision of cover for a number of fish species, notably chub (*Leuciscus cephalus*);
- the creation of roughness in river channels, which contributes to microhabitat diversity by scouring pools, with associated slackwater areas and eddies;
- the stabilisation of sinuous streams, by trapping both inorganic sediments and organic material mobilised during high discharge events;
- the collection of fine sands and silts prevents their deposition on gravels, preserving their value for spawning salmonids and as invertebrate habitat;
- the retention of organic material by trash dams, providing a major food resource, particularly in heavily wooded streams;
- chemicals produced by the rotting wood have algicidal properties which can help to control algal blooms in small lakes;
- provision of habitat for invertebrates, including scarce species, and amphibians.
- provision of egg laying sites for some fish species, including perch *Perca fluviatilis*.

Woody debris should therefore generally be retained *in situ*. However, there are situations where its build-up can seriously disbenefit salmonid populations. If trash dams develop immediately below known spawning areas, the associated increase in upstream depth and fine substrate can combine to reduce hatching success and subsequent recruitment to the fishery. In severe cases, large trash dams may prevent migration of fish. If debris has to be removed from the stream, it can be utilised to create potential otter habitat by the creation of log pile holts[17].

Reviews of the literature relating to coarse woody debris can be found in a number of publications[15,16].

Legal constraints

There are legal constraints in relation to tree management. Riparian owners have the responsibility for tree maintenance and removal of fallen trees from rivers. If deemed to be a flood risk or otherwise necessary, the Environment Agency will carry out work of this nature using permissive powers under the Land Drainage Act, 1991. Consent is needed under this Act and associated byelaws, for the planting of trees within 8 m of a watercourse.

If conflicts of interests arise, these should be raised with the EA.

VEGETATION MANAGEMENT

- X Vegetation plays an important role in the aquatic ecosystem.
- X Its removal can have significant impacts on water quality, and plant and animal communities, including many detrimental ones.
- X Excessive abundance of one species of aquatic vegetation (including algae) may be the result of poor water quality that should be addressed at source.
- X Manual cutting in rivers to a 'side and bar' pattern is an acceptable form of control for fishery management.
- X The use of mechanical cutting should generally be resisted.
- X Herbicide use should generally be avoided. There can be undesirable impacts on non-target species, as well as on the ecology of the water body.
- X Bankside trees have many values, but large areas of dense shade can be a disadvantage. Rotational coppicing or pollarding can serve all interests.
- X Where possible, only one bank of the river should be actively managed. Staggering and alternating the lengths of managed and unmanaged banks optimises ecological benefit whilst maintaining access for fishing.
- X Large woody debris and associated leaf litter is a valuable component of lake and stream ecology. Its removal should be resisted.

4.4 Habitat restoration and enhancement

Many freshwaters have been badly damaged in recent decades. Causes are mainly water pollution, and modifications to rivers and floodplains for flood control purposes. This is well recognised by the Statutory Agencies and many restoration programmes are now under way, on Trust property and elsewhere. These vary in scale from whole lakes and river/floodplain systems, to very small-scale projects.

Common problems which degrade the quality of fisheries are:

- excessive bank erosion;
- low summer flows in river channels which are too wide and/or too deep;
- uniform river channels in terms of both profiles and velocities;
- reduction in the quantity or quality of gravels;
- siltation of gravels;
- channels regulated with large numbers of weirs etc.;
- polluted and sediment-laden inflows.

Whatever the scale of the restoration, it is important that the causes of the problems are fully investigated. If possible, these should be remedied at source. For example, if a river channel is restored to more natural profiles and function, it will not be necessary to install weirs and current deflectors. However, having investigated the causes, if restoration at source or on a large scale is not possible, local projects can be valuable as an interim measure. Furthermore they can help pump-prime more wholescale schemes, and forge useful partnerships for putting forward further proposals.

As noted, The National Trust is already actively involved in many restoration schemes. ***Restoration of rivers and lakes to more natural profiles, governed by natural processes, with nutrient and sediment input controlled at source will benefit sustainable fisheries and should continue.***

For details of methods see Appendix E.

4.5 Signal crayfish

Signal crayfish *Pacifastacus leniusculus,* were introduced into Britain during the 1970's. Originating in North America, the species has caused significant damage to stocks of the indigenous white-clawed crayfish *Austropotamobius pallipes*, via the transmission of the fungal crayfish plague *Aphanomyces astaci* and by direct competition. Crayfish plague is transferred from one waterbody to another via stocked fish and fishing gear etc. As a result, white-clawed crayfish are now rare throughout the UK, a fact recognised by their protection under the Wildlife and Countryside Act, 1980. In addition to their impact on native crayfish, signal crayfish are known to reduce both the number and diversity of a range of aquatic macroinvertebrates. They have also been implicated in the loss of submerged macrophytes and predation on benthic fish.

As a result of these damaging interactions with native species, ***the control of signal crayfish has become a priority***. The Environment Agency and other interested parties are currently researching a range of possible control measures including the use of toxic substances and the release of tetraploid crayfish in order to create sterile triploid individuals through interbreeding with normal diploid crayfish. However, to date no effective solution to this issue has been found. The only practical option presently available is to intensively trap signal crayfish and remove them from the waterbody. Suitable traps are commercially available but can only be used with the written consent of the Environment Agency. Care should be taken in areas known to be inhabited with water voles *Arvicola terrestris* as these may enter crayfish traps and drown. There is a small but lucrative market for the sale of signal crayfish for culinary purposes that may provide a modest income to Trust properties.

The Environment Agency's Crayfish Code should be promoted at fisheries so that anglers observe good practice such as drying and disinfecting fishing equipment.

4.6 Cormorants

The possible impact of cormorants *(Phalacrocorax carbo)* on fisheries is of growing concern throughout Britain, with many fisheries reporting significant losses of stock through cormorant predation. Research carried out has ascertained that:

- The population of cormorants has increased in recent years (3% per annum, 5-10% per annum for wintering populations), with inland breeding populations now established (1500 breeding birds and 10,000 wintering in 2003)
- Damage to fish stocks is more likely during winter, when numbers are highest
- Average daily consumption of cormorants is approximately 750g, with fish of between 10cm and 30cm in length preferred
- Cormorants have impacted on fish stocks in some locations
- A range of scaring methods (e.g. thunderflashes, kites, scarecrows etc) has proved to have variable success rates
- Providing increased submerged cover has been shown to have some positive benefits for the protection of fish stocks from cormorants. More cover can be provided using brush wood

bundles, submerged gabion cages, or other material providing void spaces for fish to hide in.

The legal position regarding cormorants is clear. The species is fully protected under the European Union (EU) Birds Directive (EEC/79/409) and through the Wildlife and Countryside Act, 1981. In order to gain a licence to use shooting as an adjunct to other deterrent measures, fishery owners must apply to the Department of Food and Rural Affairs (DEFRA) and prove 'serious damage' to their fishery or to their livelihood.

The Trust regards cormorants to have biodiversity value, and does not manage fisheries primarily as commercial enterprises. Given this position, and the present state of knowledge of this issue, it is recommended ***that there should be a presumption against shooting, and at Trust waters where cormorant predation is believed to have detrimentally affected fish stock levels, efforts should be focused on the increased provision of submerged cover.*** Licensed shooting should only be considered as a last resort. Further detailed advice on this issue can be obtained from DEFRA, Wildlife Management Team, Administration Unit, Burghill Road, Westbury-on-Trym, Bristol, BS10 6NJ (Tel. 0845 4523).

5.0 FISH STOCK MANIPULATION

5.1 Fish introduction

Introductions of alien fish into England and Wales have taken place over a long period. Monks were almost certainly responsible for the introduction of common carp (*Cyprinus carpio*) for farming as food, probably around the 11th century. Anglers have been moving fish between waters and rearing them for the purpose of restocking for recreational fishing for at least 150 years. Several other introductions including rainbow trout (*Oncorhynchus mykiss*) have become naturalised in a number of waters, and play a major role in recreational angling. More recently, a plethora of non-indigenous fish species have been imported, many of them illegally. These include amongst others, Wels catfish (*Siluris glanis*) and zander (*Stizostedion lucioperca*). Waters that have not been stocked are the exception rather than the rule.

Introductions of fish into all inland waters requires the written consent of the Environment Agency under the Salmon and Freshwater Fisheries Act, 1975. In addition, the introduction of alien species requires the written consent of DEFRA under the Wildlife and Countryside Act 1981.

Fish introductions may impact on Trust fisheries in two key areas, namely

X direct impacts on existing fish populations, and
X their impact on freshwater habitat and water quality (See Section **2.3**).

In many still waters, inappropriate species and numbers of fish are stocked, especially carp and tench, with detrimental effects on the fishery and the water body. In addition, the introduction of species previously not present in a waterbody, including species which are native and otherwise could be said to be 'appropriate', can have unplanned consequences for its ecology.

As indicated in Section 2.2 the Trust should encourage the development of self-sustaining fish stocks, without stocking. However, where trout are concerned, some stocking may need to be undertaken in the short term if recreational angling is to continue. The stocking policy, if any, should be included in the Fishery Management Plan, and should have regard to the potential areas of impact as detailed below.

5.2 Impacts on existing fish populations

Genetic and disease considerations

Introductions of hatchery reared or translocated fish have the potential to produce genetic contamination of indigenous stocks by interbreeding with them. This is of particular importance with respect to populations of trout in unstocked water bodies and to salmon stocks throughout the UK. A diverse literature is available in relation to the complex topic of genetic management of fish stocks[36,37].

In waters that have been heavily stocked for a long period (i.e. most recreational trout waters in lowland areas and many in upland areas), any genetic 'purity' is likely to have been already compromised. However, ***in any water that has never been or has only occasionally been stocked, the precautionary principle should apply and no future stocking should normally be permitted. Where it is clear that valuable stocks of genetically isolated fish do exist, it is important that***

Trust managers obtain expert advice from the Environment Agency or other appropriate organisation (see Appendix B).

In certain circumstances, the use of triploid rainbow trout or brown trout can be a useful management tool. These fish are rendered sterile during the egg stage in the hatchery and thus are unable to breed successfully, eliminating the risk of genetic contamination.

Fish introductions also carry with them the risk of introducing diseases to established fish stocks. Recent serious outbreaks of Spring Viraemia of Carp (SVC) have been caused by the introduction of infected carp, whilst fungal spores of crayfish plague are thought to have been introduced into river systems through water introduced with stocked fish. ***Prior to any stockings, a sample of the fish should be health screened by a reputable fish pathologist. In the case of waters known to hold native crayfish, appropriate precautions should be taken to avoid possible introduction of crayfish plague.*** The EA can provide lists of suitable individuals and companies who undertake fish health screening. It should be noted that this is not a foolproof system; checks are not routinely carried out for viral infections. English Nature has produced a guidance paper on the prevention of transfer of crayfish plague.

Behavioural interactions

There is evidence that hatchery reared trout interact significantly with wild trout. Much of this interaction is related to increased and inappropriate territorial aggression by the stocked fish. This aggressive behaviour affects the condition of the wild trout and reduces overwintering success of the stocked fish. Overwintering success in rivers is usually poor for most species of stocked fish, with passive downstream displacement, often over very long distances, a common phenomenon. This may be a result of density-dependent factors, such as competition for food and refuge areas.
There is also a concern that stocked rainbow trout could spawn successfully in the wild, establishing a self-sustaining population of alien fish. This phenomenon has actually occurred on a number of rivers in England. In order to eliminate this risk, it is recommended that only triploid rainbow trout be stocked into rivers.

Risk to rare species

There is a number of fish species that are afforded special protection under statutory legislation (Wildlife and Countryside Act 1981, EC Habitat and Species Directive). These include Atlantic salmon, bullhead, lampreys, twaite shad (*Alosa fallax*), allis shad (*Alosa alosa)*, and the coregonids, vendace (*Coregonus albula*) and gwyniad (*Coregonus lavaretus*). Introductions of fish have the potential to seriously impact on the status of these species. For instance the (illegal) introduction of roach and ruffe as livebaits into Derwentwater and the adjacent Bassenthwaite in Cumbria has had a deleterious effect on coregonids stocks in Bassenthwaite. ***Stocking should not be permitted where populations of rare, statutorily designated fish exist.*** Detailed advice on the risk associated with stocking in these circumstances should be sought from the statutory conservation agencies and the Environment Agency[38].

5.3 Fish removal from rivers and lakes

Removal of coarse fish, including grayling, from riverine trout and salmon fisheries is an historic management practice that is still carried out, usually by electrofishing. It is asserted that coarse fish compete with salmonids for food, eat their eggs and generally cause a lowering of the numbers of them present in the river. The relatively small amount of research undertaken does not support these claims. Coarse fish and salmonids occupy subtly differing habitat types and have not been shown to compete for food. Also, they spawn at different times.

Studies of long term fish removal operations have generally failed to show any linked improvements to salmonid numbers. It should also be noted that many trout fisheries have been developed in rivers naturally containing a mixture of coarse and game fish. Large-scale removals of coarse fish and grayling may lead to an increase in predation on trout and salmon by pike and piscivorous birds.

Removal of pike is also carried out from riverine game fisheries, usually by recreational angling and electrofishing. Fisheries professionals still hotly dispute the case for and against pike removal. There is a general feeling that removal of large pike is a bad management practice, as it reduces cannibalistic control of smaller pike numbers. Both electrofishing and recreational angling are size-selective removal methods, with larger fish selected for. Removal of larger pike may increase both the numbers of small pike and predation on juvenile salmonids. This is undesirable where attempts are being made to establish self-sustaining fish populations.

Eels are sometimes removed from fisheries on the assumption that they are competing for food, or eating large quantities of salmonid eggs and fry, although scientific evidence suggests that this is unfounded. Eel numbers are declining in Europe for various reasons, and eels should be conserved.

In conclusion, there should be a presumption against the removal of coarse fish, eels, grayling and pike from Trust river fisheries.

The same will usually apply to lakes, although pike may occasionally be removed.

FISH STOCK MANIPULATION

- X Stocking of fish for recreational angling is a longstanding practice.
- X The Trust should seek to develop self-sustaining fish stocks in all its waters. However, it is inevitable that some stocking of trout will be necessary in the interim at many sites in order to support the recreational fishery.
- X Stocking carries the risk of genetic contamination, adverse ecological and behavioural interactions and the introduction of disease. There should be a presumption against stocking into any waters not previously stocked or known to contain populations of rare fish.
- X High stock densities in still waters can adversely impact on water quality, habitat and existing flora and fauna (See Section **2.3**).
- X Biomanipulation by removal of fish from still waters may partially reverse these changes[34].
- X Removal of coarse fish, grayling and pike from riverine game fisheries has not been shown to have any beneficial impacts on populations of brown trout or salmon. There should be a presumption against this practice in all Trust fisheries.

6.0 RECREATIONAL ANGLING

The control of exploitation of the ecological fishery by recreational angling forms a key part of the Trust's fishery policy.

6.1 Regulation of recreational fishing and fishery rules

Recreational fishing in Trust waters should be controlled through a set of site-specific rules implementing the objectives of the Fishery Management Plan. Basic controls include the need for a current Environment Agency rod licence; the need to adhere to Environment Agency angling byelaws and the need to observe the provisions of good angling practice as laid out in published good practice guides[13,31,32,33] . A copy of one of these guides should be provided with each permit sold for the fishery. Relevant safety and health information should also be provided, including the hazards of Weil's disease and overhead cables, for example.

Other key areas of angling practice that may warrant particular reference in the fishery rules are listed below.

Staff training
Staff with a responsibility for managing Trust fisheries should receive basic training in the principles and application of fisheries law. The Environment Agency often runs suitable courses for their own staff and may be willing to include Trust staff on these.

6.1.1 Exploitation or 'cropping'

In salmonid waters, the control of exploitation by anglers is an important conservation measure. For salmon, professional advice should be sought from the Environment Agency regarding acceptable levels of removal. For trout, good recruitment and many small fish but few larger ones may indicate over-exploitation. ***Fishery rules should actively seek to prevent excessive exploitation. This is of particular importance in relation to stocks of salmon and wild brown trout.***

In order to provide basic information on exploitation rates, catch returns should be produced by all anglers annually, detailing numbers of species caught and time spent fishing over the season. From these data, simple 'catch per unit effort' data can be calculated that forms a valuable relative assessment of changes in fish stock levels over time.

Mechanisms that can be used to control exploitation include the regulation of numbers of anglers fishing, prohibition of certain methods such as bait fishing, bag limits, so-called slot limits, where anglers are encouraged to take fish only within a particular length range and the promotion of 'no-kill' or 'catch and release' fisheries. Specialist advice should be sought regarding the appropriateness of each of these measures, although there should be a presumption for a 'catch and release' policy on conservation grounds at all fisheries where stocks of salmon, brown/sea trout and grayling are believed to be under threat. The EA has introduced a raft of new measures aimed at reducing angler exploitation of salmon throughout England and Wales, including compulsory 'catch and release' before 16th June and restrictions on legal methods in some catchments.

6.1.2 Numbers of anglers

It will often be necessary to control the number of anglers, not only to control the numbers of fish taken but also to control associated impacts such as trampling.

6.1.3 Location of angling areas

Game anglers are generally mobile, moving regularly in order to locate salmon or trout. However, coarse anglers often occupy one area of bank (known as a ‘swim’ or ‘peg’) for several hours or even days. This can cause considerable erosion to these swims. Fishing platforms can reduce erosion and facilitate access for disabled people.

Consideration should be given to formally controlling access to the banks of heavily fished waters through designation of ‘no-fishing’ areas.

6.1.4 Close seasons for coarse fisheries

There is a minimum statutory close season for coarse fish on rivers, streams and drains of 15 March to 15 June inclusive. This is based on the need to protect spawning fish. Because there is as yet no data to support removing this close season, and because of the complexity of multiple ownership, the statutory rule is continuing to apply. On most other waters (most canals, lakes, ponds and reservoirs) there is no statutory close season as there is no scientific reason to observe a one, and individual owners can impose their own. It is recommended that the Trust do observe close seasons. ***All fisheries should have a close season*** to allow a period without disturbance to fish, birds, vegetation and other wildlife. The minimum is 15 March to 15 June; in most cases it should be longer than this. For details on close seasons applying in local areas Environment Agency offices should be consulted.

6.1.5 Keepnets

Recent scientific studies have not found any increased mortality of fish as a result of the use of keepnets. However, it would be good practice to ***consider banning their use during particularly hot periods of weather***. This will minimise any potential stress to fish following capture.

6.1.6 Barbless hooks

Most modern fishing hooks have so-called ‘micro-barbs’ and thus pose no more risk of injury to fish than barbless hooks. Recent scientific work examined the impact of barbless vs. barbed hooks on mortality of rod caught trout in a number of studies and could find no statistical difference. The use of barbless hooks is therefore not thought to be of significant benefit to fish welfare. One exception is in the use of treble hooks for pike fishing. ***The use of barbless hooks for pike fishing does appear to benefit fish survival, and so should be specified in the fishery rules***.

6.1.7 Bait and Livebait

The excessive use of groundbait and other baits thrown into the water has the potential to cause water quality problems on small, intensively fished waters. In addition, it may increase the food supply to the water, allowing an artificially high fish stock density with all that this implies (see Section **2.3**). It is difficult to lay down hard and fast rules regarding what constitutes ‘excessive’ use of bait, but fishery managers should be aware of potential problems from this source and seek specialist advice if necessary. Some restrictions on bait usage already exist at some Trust properties.

Livebaiting

Leaving aside animal welfare issues, the use of fish livebaits on Trust fisheries poses a potential risk to fish stocks. Of particular concern is the illegal importation of fish livebaits from another water. This poses the dual risks of disease introduction and the introduction of a fish species not already in the water. This potential has already been realised on the Derwentwater/Bassenthwaite system in Cumbria, where ruffe and roach used by pike anglers as livebaits have escaped and are threatening the survival of stocks of the rare vendace. As a consequence, the Environment Agency has created a byelaw banning the use of live fish bait in these systems.

Due to the potential risks associated with the illegal transfer of fish for livebaiting and the difficulties of policing this issue, no fish livebaits should be allowed at National Trust fisheries.

6.1.8 Control of litter

This should be strictly enforced. Anglers rubbish, especially discarded line, poses a threat to wildlife and is aesthetically unacceptable. Anglers should be responsible for litter at their own swim, whether or not they discarded it. An angling ban should be imposed on persistent offenders.

6.1.9 Night Fishing

Whether or not to allow night fishing should be decided on the property. Camping on NT property must be authorised (except for 'wild camping' above 450m) – see Trust policy in Open Countryside[39]. Considerations such as mansion security, car parking and availability of toilet facilities will have to be taken into account. Currently some Trust properties welcome night fishing; others do not allow it.

6.2 Access to Trust fisheries

Despite its support for recreational angling, the Trust has faced criticism regarding lack of access to fisheries under its management. This criticism has focused on both the comparatively small number of waters under Trust ownership that are open for angling and the public availability of angling permits for those waters in which the Trust does allow fishing. These complaints have some validity. In order to address them, it is recommended that nationally and regionally, the Trust undertake the following action:

- ***In any letting arrangements for a specific fishery, provisions should be made for the purchase of day tickets.*** The number of tickets should be strictly controlled and should have regard to the prescriptions of the Fishery Management Plan. By this mechanism, access will be made available to Trust fisheries for the casual or visiting angler. In some circumstances, access to fisheries for day ticket anglers may still not be possible, for instance due to the conditions of acquisition.. ***However, the reasons for the lack of public access should be clearly stated.***

The Trust has produced a booklet 'Enjoy Fishing with the National Trust'. In this publication, which is regularly updated, fisheries are listed by Trust region, with brief details of fishery types and ticketing arrangements provided. Copies of the guide are available from the National Trust Membership Department, PO Box 39, Warrington. WA5 7WD. Tel. 0870 458 4000. email enquiries@nationaltrust.org.uk.
It is also available on the Trust's website www.nationaltrust.org.uk.

7.0. LETTING ARRANGEMENTS AND FINANCIAL ASPECTS OF TRUST FISHERIES

There is a range of options available to the Trust with respect to letting of its fisheries. These include:

- Leasing or licensing the fishery to an individual or syndicate.
- Leasing or licensing the fishery to angling club.
- Leasing or licensing the fishery to an individual in association with another Trust asset, for instance a farm or hotel.
- In-house control of the fishery through the issuing of day tickets or season tickets.

These options have attractive features and disadvantages. Leasing or licensing relieves the Trust of much of the day to day administration, but at the cost of some control. Long term leases give tenants security of tenure to undertake enhancements to the fishery, in conjunction with the Trust. They also allow tenants to seek additional sources of finance for enhancements from funding streams such as the National Lottery, Heritage Fund and Landfill Tax. ***In no circumstances should the Trust relinquish control of a fishery without an agreed Fishery Management Plan.***

Any leases should contain appropriate break clauses and reviews, so that the Trust can ensure that the Fishery Management Plan is being implemented.

Corporate leases and sub-letting for commercial purposes, where the primary objective is commercial gain, are not compatible with the Trust's objectives for its fisheries, and there should be a presumption against these.

All leases and licences should contain details of an agreed Fishery Management Plan for the fishery (see 3.3). As a minimum, this plan should specify objectives for the management of fish stocks, prescriptions for physical management of the fishery, agreed angling regulations, controls and codes, and a requirement for reporting of fish catches to the Trust.

Direct management through day and season tickets may optimise the financial return at 'honey pot' sites. The fishery asset can also be used to improve the potential earning capacity of other Trust properties; for instance, a section of trout fishing available through a tenant farmer's bed and breakfast business.

All letting arrangements for Trust fisheries should in future contain a provision for public access via a limited number of day tickets (see Section **6.2**).

The associated legal agreement should be seen not just as a way of gathering money, but also as a way of managing the fishery. At its simplest, this means that rules associated with the sale of a day ticket can be used to control angling practice at the fishery (see Section **6.0**.) On other fisheries, the Trust should see leases as an integral part of their long-term development, with detailed prescriptions identified in the Fishery Management Plan included with them.

The Trust should acknowledge that it in some circumstances, it might prove difficult to significantly increase revenue derived from recreational fishing. For instance, it may be unacceptable to attempt to raise the price of salmon fishing against a background of declining catches. As outlined in Section **2.2**, it is also important to accept that ***fisheries and water bodies may require expenditure, as do other habitats and communities; any presumption that recreational fishing should be the sole funder of work to water bodies should be challenged.***

If the National Trust owns the land but not the fishing rights, these should be acquired if possible so that the Trust can implement its management.

APPENDIX A: THE BRITISH FRESHWATER FISH FAUNA

SPECIES	COMMON NAME	STATUS	DESIGNATION
Petromyson marinus	Sea lamprey	Native	EC, BAP
Lampetra fluviatilus	River lamprey	Native	EC, BAP
Lampetra planeri	Brook lamprey	Native	EC, BAP
Acipenser sturio	Sturgeon	Introduced	
Alosa alosa	Allis shad	Native	EC, BAP, WCA
Alosa fallax	Twaite shad	Native	EC, BAP, WCA
Anguilla anguilla	European eel	Native	
Esox lucius	Pike	Native	
Coregonus oxyrinchus	Houting	Native	EC, BAP,
Coregonus albula	Vendace	Native	EC*, BAP, WCA
Coregonus lavaretus	Powan/schelly Gwyniadd	Native	EC*, BAP, WCA
Thymallus thymallus	Grayling	Native	EC*, BAP
Salmo salar	Atlantic salmon	Native	EC, BAP
Salmo trutta	Brown/sea trout	Native	
Salvinus alpinus	Arctic charr	Native	BAP
Abramis brama	Common bream	Native	
Alburnus alburnus	Bleak	Native	
Barbus barbu	Barbel	Native	EC*
Blicca bjoerkna	Silver bream	Native	
Gobio gobio	Gudgeon	Native	
Leuciscus cephalus	Chub	Native	
Leuciscus leuciscus	Dace	Native	
Phoxinus phoxinus	Minnow	Native	
Rutilus rutilus	Roach	Native	
Scardinius erythrophthalmus	Rudd	Native	
Tinca tinca	Tench	Native	
Cobitis taenia	Spined loach	Native	EC, BAP
Noemacheilus barbulatus	Stone loach	Native	
Lota lota	Burbot	Native	WCA, BAP
Gasterosteus aculeatus	3-Spined stickleback	Native	
Pungitus pungitus	10-spined stickleback	Native	
Cottus gobio	Bullhead	Native	EC, BAP
Perca fluviatilus	Perch	Native	
Gymnocephalus cernuus	Ruffe or pope	Native	
Cyprinus carpio	Common/mirror carp	Introduced	
Carassius carassius	Crucian carp	Introduced	
Siluris glanis	Wels catfish	Introduced	
Stizostedion lucioperca	Zander	Introduced	

Oncorhynchus mykiss	Rainbow trout	Introduced
Micropterus salmoides	Large-mouthed bass	Introduced
Ambloplites rupestris	Rock bass	Introduced
Rhodeus rupestris	Bitterling	Introduced
Lepomis gibbosus	Pumpkinseed	Introduced

All species in England and Wales are protected under the Salmon and Freshwater Fisheries Act, 1975.

In addition, the following special designations apply to some species:

EC Species specially protected under the EC Habitats and Species Directive
EC* Restrictions on exploitation of this species under Annex 5 of the Habitats and Species Directive
WCA Species specially protected under the Wildlife and Countryside Act, 1981.
BAP Species identified under the UK Biodiversity Action Plan, 1995.

The native fish fauna of Ireland is more restricted than that of the mainland UK. Consequently, some 'native' species are in fact introduced to the Ireland (e.g. roach)

The list of introduced species shown is not comprehensive - further new species continue to be imported to the UK, often illegally.

APPENDIX B: SPECIALIST ADVISORS FOR FISHERIES MANAGEMENT

APEM Ltd Enterprise House, Manchester Science Park, Lloyd Street North, Manchester M15 6SE

Dr.B.Broughton 27 Rushworth Avenue, Ruddington, Nottingham NG11 6GD (Tel. 01602 841703)

Environment Agency Rio House, Waterside Drive, Aztec Way, Almondsbury, Bristol BS1 24UD (Tel 01454 624400) www.environment-agency.gov.uk

Game ConservancyTrust Fordingbridge, Hampshire SP6 1EF (Tel. 01425 652381)

Dr. N. Giles and Associates 50 Lake Road, Verwood, Dorset BH31 6BX (Tel. 01202 824245)

Mr. V. Lewis, Windrush AEC Ltd
The Cottage, Fordwells, Witney, Oxon OX29 9PP (Tel. 0199378573)

Prof. P. Maitland Fish Conservation Centre, Gladshot, Haddington EH41 4NR (Tel. 01620-823691)

Moore and Moore Carp, Parkview, Swallowfield Road, Swallowfield, Reading, Berks (Tel. 01189 882844)

Dr. K. O'Grady 10 Hampden Hill, Beaconsfield, Bucks HP9 1BP (Tel. 01494 674085)

Dr. M. Perrow, ECON University of East Anglia, Norwich, Norfolk NR4 7TJ (Tel. 01603 - 592189)

Dr. D. Solomon Foundry Farm, Kiln Lane, Redlynch, Salisbury, Wilts SP5 2MT

The Wildfowl and Wetlands Trust, Slimbridge, Glos. GL2 7BX

The Wild Trout Trust 92-104 Carnwath Rd, London SW6 3HW

APPENDIX C: USEFUL CONTACTS AND ADDRESSES

Anglers' Conservation Association (ACA), Eastwood House, 6 Rainbow Street, Leominster, Herefordshire, HR6 8DQ

Angling Foundation Federation House, National Agriculture Centre, Stoneleigh Park, Warwickshire CV8 2RF

Association of Stillwater Game Fisheries Managers (ASGFM) Packington Fishery, Packington Hall, Meriden, Coventry CV7 7HR

Atlantic Salmon Trust (AST) The Moulin, Pitlochry, Perthshire PH16 5JQ

Centre for Aquatic Plant Management (CAPM) Broadmoor Lane, Sonning-on-Thames, Reading, Berks. RG4 6TH Tel.0118 969 0072. www.capm.org.uk

Commercial Coarse Fisheries Association Wyland Farm, Powdermill Lane, Catsfield, East Sussex TN33 OSU

English Nature (Environmental Impacts Team) Northminster House, Peterborough PE1 1UA (Tel. 01733 455200)

Haycock Associates (Dr. N. Haycock), Redroof, Wick Road, Little Comberton, Pershore, Worcs. WR10 3EG http://www.haycock-associates.co.uk

Institute of Fisheries Management (IFM) Balmaha, Coldwells Road, Hereford HR1 1LH

Institute of Freshwater Ecology The River Laboratory, East Stoke, Wareham BH20 6BB (Tel. 01929 462314)

National Association of Fisheries and Angling Consultatives (NAFAC) 30 Ainsdale Way, Goldsworth Park, Woking, Surrey GU21 3PP

National Association of Specimen Anglers 89 Windsor Rd, Carlton in Lindrick, Worksop S81 9D

National Federation of Anglers Halliday House, Eggington Junction, Derbyshire DE65 6GU

Pond Action School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane, Headington Oxford OX3 OBP (Tel. 01865 483249)

River Restoration Centre Silsoe Campus, Silsoe, Beds MK45 4DT (Tel. 01525 863341)

Salmon and Trout Association Fishmonger? s House, London Bridge, London EC4R 9EL

Specialist Anglers Alliance (SAA) 3 Great Cob, Springfield, Chelmsford, Essex. CM1 6LA

Welsh Salmon and Trout Angling Association Swynteifi, Pontrhydfendigaid, Ystrad Meurig, Cardigan

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APPENDIX E: METHODS OF HABITAT RESTORATION AND ENHANCEMENT

Before starting any scheme to restore or enhance a fishery, it is important to identify the critical factors affecting the fish stocks. Initial ideas should be discussed with the Environment Agency, and then in many cases further professional advice will be necessary.

A RIVERS

1. Bank revetment, river narrowing and raising bed levels

a) Bank revetment

Rates of erosion have been exacerbated in recent decades by land-use practices which create more 'flashy' river catchments, such as land drainage and the removal of traditional flood meadows. As a result, peak flood discharges have increased in intensity, resulting in higher energy impacts on riverbanks and increased erosion.

There are various detrimental impacts of increased erosion, such as damage and destabilisation of the river bed and profile, blocking access for salmonids into small tributary spawning streams, silting of backwaters and other impacts noted in Section **4.2** above.

The Environment Agency have produced a valuable guide to riverbank erosion[18]. This details the causes of erosion, both on a catchment wide basis and in a local context. It examines the role of trees, stock density and other land management regimes in the erosion process. The document highlights the need to understand the dynamics of erosion in a catchment context. In many cases, attempts to control localised erosion problems fail due to overriding catchment scale processes.

If a need for localised control is established, a number of techniques can be applied. Generally, the use of hard, man-made revetments should be avoided. 'Softer', more ecologically acceptable materials and techniques should be utilised where possible. These include:

- Fencing to prevent stock damage to riparian vegetation (See Section **4.2.1**). Excessive trampling by people using popular riverside paths can also be the source of considerable erosion.
- Coppicing/pollarding to increase the growth of valuable fringing vegetation (See Section **4.3.2)**.
- Planting willow whips/stakes to promote the establishment of silt-trapping willow beds.
- Spiling - this involves the creation of a woven, living willow 'fence' along the toe of the eroding bank, thus helping to both prevent further erosion and also to entrap sediment.
- Stone pitching - natural stone is used to create a protective cover to vulnerable bankside areas.
- Faggot bundles, created from coppice brashings can be pinned in place at the toe of the bank, helping to protect it from erosion. These bundles also provide an excellent habitat for a number of invertebrate species such as freshwater shrimps (*Gammurus pulex*) and help to trap sediments in the marginal areas.

- X Commercially produced coir fibre products including rolls, revetment cloth and planting pallets - these products are created from waste coconut husks and degrade naturally over a period of years, increasing their environmental acceptability. The fibre rolls can be obtained pre-planted with a range of emergent aquatic plants which adds to their erosion-protecting capability.
- X Deflectors or groynes used to divert river currents away from the site of local erosion - these are often placed in the line of prevailing currents and consequently are not particularly successful.

Further details can be found in The New Rivers and Wildlife Handbook[9].

b) River channel narrowing

Many rivers, especially in lowland areas, occupy channels that are substantially over-wide for their mean summer flows. The causes of this apparent mismatch include, amongst others, past dredging work, over-abstraction and poaching by livestock. In some cases, time does heal; marginal vegetation colonises the river, trapping silt around its root systems, gradually narrowing the river until a balance between summer flows and bed width is achieved. Increasing flow velocities then scour the substrate exposing gravel shoals, creating the pool-riffle sequence so important to salmonid fish.

If this is not the case, and the cause cannot be addressed, channels can be narrowed, decreasing their cross sectional area, and increasing flow velocity. This results in increased scour, deepening of the channel, sorting of bed substrate and a general increase in microhabitat diversity. Generally, the narrowing is carried out by the creation of a low-level berm at or just above mean summer water level. A revetment is created along the agreed line of the new channel and backfill material is then placed behind the revetment. This effectively creates a low flow channel within the existing, over wide channel. An alternative approach is to create mid-channel islands and use these to reduce the channel width.

Plans should be drawn up with professional guidance, including geomorphological guidance which is available from a variety of sources[19]. Materials used to create low flow channels and islands include faggot bundles; hazel hurdles; coir fibre rolls; natural blockstone; spiling and chalk. In addition, the sourcing of backfill material provides opportunities for further habitat creation. Shallow backwaters and isolated species rich ponds can be created as a result of excavation of backfill material.

c) Raising bed levels

Over-deepening of watercourses may be addressed by the introduction of imported stone, with the aim of raising the bed level, hence reducing the cross-sectional area of the channel. Again, professional advice should be sought. The keys to success with works of this nature are correct sizing and placement of the stone in order to increase flow velocity, without increasing the risk of flooding. The construction of these shallow areas or 'riffles' needs to take account of the geomorphological conditions pertaining in the catchment. Generally, riffles occur at an interval of approximately 5-7 channel widths, on straight sections of channel leading into a bend in the river.

A series of constructed riffle sections can be utilised to bypass high impoundments (e.g. mill heads). This approach to providing passage around impounding structures is of considerable benefit to fish migration and also provides other benefits (see below). It could be considered by Trust staff at sites where old impoundments exist.

Several studies have examined the impacts of re-introduction of stone and gravel to rivers. These found that:

- X Brown trout, salmon, chub, barbel, minnow, stone loach, bullhead and other gravel spawning species all utilise areas of introduced gravel, and so can extend the availability of this resource.
- X Macrophyte species such as water crowfoot, water moss (*Fontinalis antipyretica*) and Z*annechellia* spp., flourish on areas of introduced gravels.
- X Newly introduced gravels have a greater number and diversity of invertebrate species than adjacent untreated areas. These include rare species such as white-clawed crayfish (*Austropotomobius pallipes*).
- X Other species to utilise the introduced gravel included dippers (*Cinclus cinclus*).
- X Water quality improvements including increased levels of aeration and oxidation of nitrogenous compounds occur at the site of constructed riffle areas.

2. Low level weirs, current deflectors and boulders

Weirs and current deflectors are generally constructed to increase the heterogeneity of the flow regime in a section of river with a uniform, slow velocity, thus providing a range of habitat types for fish. They are often used to erode downstream pools by concentrating river flows. There are several key points to note with respect to their siting and construction:

- X The use of such structures should be unnecessary in a natural river channel.
- X Restoration of natural river processes represents the most acceptable means of remediating degraded or over-engineered watercourses.
- X Weirs, current deflectors, etc. should be regarded as interim measures prior to the restoration of natural river processes.
- X The geomorphology of the river should be considered. Installation of structures in inappropriate locations can be an expensive error, with a range of detrimental impacts occurring without achieving the original aims of the scheme.
- X Weirs and current deflectors should be constructed to concentrate flow, not impound it.
- X Considerable damage to upstream habitat can occur as a result of siltation resulting from backwater impacts of weirs. For this reason, current deflectors are normally preferable to weirs.
- X Staggered current deflectors on opposite banks can be used to introduce meanders into a degraded river channel.
- X Much of the flow diversity that is a key aim of weirs and current deflectors can be achieved in lowland streams by fencing and subsequent management of marginal and in stream vegetation.
- X Naturally occurring materials should be used. Wire mesh, corrugated iron or similar materials have no place in habitat enhancement work.
- X Except in exceptional circumstances (e.g. in hard unyielding clay substrates left after former dredging works) pools should not be dug in the river bed. Weirs and current deflectors should create their own depth variations by scouring. If they do not, then they have been wrongly sited.

X Benefits from the construction of current deflectors include increased sorting of gravels, creation of additional cover for adult fish and an increase in benthic macroinvertebrate numbers and diversity.

The placement of individual large boulders in a stream has often been carried out in order to both provide additional lies for adult fish, especially salmon and trout, and also to reduce the ease with which poachers can net pools for salmon. Their use is unlikely to produce any environmental disbenefits provided that their size, number and positioning is in keeping with the stream. Care should be taken to ensure that they do not increase the risk of localised flooding.

3. Gravel cleaning

It has long been recognised that gravel with a high permeability is required for the successful spawning of salmonids. More recently, the factors already mentioned elsewhere have led to increasing siltation of gravels.

Traditionally, this problem was addressed by using heavy horses to pull harrows across spawning gravel areas, breaking up concreted areas and releasing silt trapped in the gravel interstices. More recently, high-pressure water jets, high volume water pumps and tractor mounted rotovators have been used for the same purpose. Working downstream to minimise the impact of silt on treated sections, short lengths of suitable spawning gravel are cleaned.

Monitoring of the impacts of this process has shown that significant improvements in salmonid egg hatching rate have been achieved[24]. Impacts on other flora and fauna have been assessed. In essence, these studies showed that although the short term disruption to macrophyte and macroinvertebrate communities was extensive, recovery was good, with similar species assemblages generally present within 6 months of the treatment. One source of concern is that destabilisation of gravels may occur following their cleaning. In high-energy streams, this may result in mobilisation of the substrate and associated washout and loss of key spawning areas. The main points to consider with respect to gravel cleaning are.

X Select areas to be cleaned carefully. Only clean short sections (20-30m) at a time to minimise the impact on associated plants and animals.

X Avoid destabilising gravel riffles in high-energy streams as this may lead to their loss due to wash out.

HABITAT RESTORATION AND ENHANCEMENT - RIVERS

The most acceptable way of restoring degraded and over-engineered river channels is by the restoration of natural river processes.

X Careful planning of all schemes should be undertaken, considering catchment-wide issues, geomorphological processes, risk of flooding, etc. Most habitat enhancements will require, as a minimum, the consent of the EA. The potential complexity of many enhancements makes professional advice essential.

X Revetment and narrowing of rivers have the potential to cause significant changes to habitat conditions. The potential impacts on a range of species should be considered.

- X Replacement of stony substrate lost as a result of past dredging operations is beneficial. It creates a wide range of new habitat opportunities for a range of species, provides remove habitat bottlenecks for some fish species, increases geomorphological diversity and offers a range of water quality benefits.
- X Detailed information on a range of habitat enhancements is available in a number of publications[9,15,18,20,21,22,23].
- X The construction of low-level weirs and current deflectors may increase the available habitat for adult fish. However, the impounding resulting from poorly designed weirs may result in significant detrimental changes to upstream habitat. For this reason, the use of current deflectors is preferable.
- X The choice of techniques and materials is a prime consideration. Maximum use should be made of natural 'soft' materials for all enhancement works undertaken.
- X Gravel cleaning can significantly improve the hatch rate of salmonid eggs. Care should be taken with respect to selection of areas for treatment and the need to avoid de-stabilisation of bed material.

B STILL WATERS

The potentially most beneficial restoration techniques for still waters, both for fish and their general ecology involves the minimising of nutrient and sediment inputs, ideally by changes to existing land use practices.

1. Stream diversion

In many artificial lakes created by the impounding of natural watercourses, the biggest source of nutrient and sediment is from the inflowing stream itself. By removing this source, significant improvements to water quality will occur, whilst the natural life of the still water as an open water body will be prolonged.

Traditionally, silt traps were used to control sediment entering from the inflowing stream. However, these are generally inefficient in removing nutrients and require regular de-silting to remain efficient. It is far more beneficial and probably most cost effective in the longer term, to divert the inflowing stream around the lake. This can be effected by creating a new free-running channel alongside the lake. If properly designed, this will in itself have intrinsic wildlife value. A simple sluice arrangement at the upstream end of the new stream will allow the lake to be topped up as necessary. If such work is practicable it can provide an opportunity to significantly improve water quality and habitat, especially in conjunction with Biomanipulation[34].

2. Bank features, islands and artificial reefs

Other potentially beneficial enhancements in still waters include the creation of marginal shelf areas, spits and, in large lakes only, islands. These features add to habitat diversity on still waters and provide valuable areas for feeding and cover for many fish species[25]. The former two features can easily be constructed by reprofiling the existing banks using tracked excavators.

Islands in large lakes may be created by pumping gravel onto submerged reefs, building them up until they are above mean water level. This technique has been successfully used on a number of still water SSSIs. However, creation of islands and attraction of wildfowl to small lakes and ponds can have a detrimental effect on water quality.

In lakes with a perceived lack of submerged cover for fish, the creation of artificial reefs has been promoted as a beneficial management technique. Reefs can help protect fish from predation, an important consideration as cormorant numbers increase inland. In addition, if constructed from natural materials they have the potential to provide valuable feeding for a number of fish species and spawning areas for species such as perch. Unfortunately, many of the schemes have involved the use of unsuitable materials such as used tyres joined by chains to form a structure[30.] Similar structures can be created by utilising naturally occurring materials such as reed and faggot bundles and weighted logs. By locating reefs away from prime angling areas, they may be used to provide refuge areas in heavily fished waters. Artificial reefs should always be clearly marked to assist in future management operations, such as netting.