

The Present Status of Grass Carp (*Ctenopharyngodon idella*) for the Control of Aquatic Weeds in England and Wales

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Abstract

The use of the herbivorous fish, the Chinese grass carp (*Ctenopharyngodon idella*), for water weed control in the U.K. has been studied experimentally for nearly 20 yrs. Now that they are fairly well understood, many grass carp are being released under license into private lakes, fisheries and drainage channels where weed management is essential. Detailed trials are still going on, however, with many data being collected. This paper attempts to summarise these and to describe the procedure involved before releases are allowed into waters, all of which come under Water Authority jurisdiction.

Utilisation Actuelle des Carpes Herbivores (*Ctenopharyngodon idella*) dans la Lutte Contre les Plantes Nuisibles Aquatiques au Royaume-Uni

L'utilisation de la carpe herbivore chinoise dans la lutte contre les plantes nuisibles aquatiques au Royaume-Uni a fait l'objet d'études expérimentales depuis environ 1968. Maintenant que les effets de ces poissons sont relativement bien connus, on ensemence actuellement dans lacs et des zones de pêche privées, sous réserve d'un permis. Toutefois, des essais détaillés se poursuivent et de nombreuses données sont rassemblées comme c'est le cas à l'Université de Liverpool. Le présent rapport vise à résumer ces essais et d'autres travaux ainsi qu'à décrire les politiques des diverses autorités en matière d'eau au sujet de l'ensemencement des carpes herbivores dans les eaux qui relèvent de leur juridiction. De façon générale, on croit que l'introduction de carpes herbivores est avantageuse, particulièrement si on utilise en même temps d'autres méthodes de lutte contre les plantes nuisibles.

Introduction

The grass carp (*Ctenopharyngodon idella* Val.; Cyprinidae) is a fish native to northern China. It is almost completely herbivorous, being carnivorous for only the first few weeks of its life. Early publications (Hickling 1965; Pentelow and Stott 1965; Cross 1969) suggested that conditions in the U.K. might suit the use of this fish for controlling aquatic weeds. Very early experiments in England (Stott 1967; Stott *et al.* 1971; Stott and Robson 1970) showed that the fish could survive in our climate and that many of the more troublesome weeds were attractive to them.

Later, more detailed trials (Fowler and Robson 1978; Stott 1981; Buckley 1981; Fowler 1982, 1984; Moore and Spillett 1982; Mugridge *et al.* 1982) indicated no particularly adverse effects on indigenous or other introduced species of fish, or invertebrates, and confirmed that good weed control could be achieved. The danger, that once introduced, grass carp would breed naturally, was studied but the risk of their so doing is minimal as the fish need a simultaneous rapid rise in water flow and

temperature, conditions not found in the U.K. Moore (1983), confirmed that grass carp are unlikely to affect freshwater environments more seriously than mechanical or chemical methods which are at present routinely employed.

The fish, however, were not always entirely successful in clearing the desired amount of weed. Most failures in Britain can be attributed to low water temperatures. The fish consume large amounts of weed only when water temperature is well above 16°C. Usually this only occurs in June, July and August by which time weed growth is well established. Recently we have experienced warmer springs than usual and the fish were able to graze the early weed growth before it got too thick. Even so, many water bodies may be too cold even in summer, because they are too deep, too shaded, or rely on cold spring water supplies (Mugridge *et al.* 1982).

Predation is another bar to grass carp success. A trial in a canal in the southeast of England was thought to have failed because of the presence of a large pike population (Dr. B.R. Buckley and Mr. K. Wilson, Southern Water Authority, pers. comm.). Also the fishes' preference for some plants (e.g. *Elodea canadensis* Michx., Hydrocharitaceae, and *Potamogeton pectinatus* L., Potamogetonaceae) over others (e.g. *Myriophyllum spicatum* L., Haloragaceae, *Ceratophyllum demersum* L., Ceratophyllaceae, and some algae) is critical and it must be ensured that the weed problem present is one with which the fish can deal.

Fish of a reasonable size (at least 100 g) seem to survive cold winters where there is some ice cover, although it is becoming apparent that in mild winters, where the water temperature remains in the region of 10°C, the fish are still reasonably active, but do not eat. This may be detrimental to their survival. Their weakened condition in February and March leaves the way open for parasites (i.e. flukes, *Gyrodactylus* sp. and *Dactylogyrus* spp.; the flagellate, *Costia* sp. and the ciliates *Chilodinella* and *Trichodina* spp.) (Dr. B.R. Buckley, pers. comm.). I have also noticed *Argulus foliaceus* and small leeches on 12–15 cm fish in February which resulted in deaths.

In spite of these limitations, the greater understanding of the needs of the fish has encouraged water authorities to initiate larger trials. Recently, some individuals and public corporations have also been licensed to stock fish in small enclosed waters.

Most grass carp introductions are aimed at reducing, not eliminating, weeds. Some plant life is essential to permit maintenance of a balanced aquatic ecosystem. Over-grazing by grass carp can encourage the predominance of inedible plant species including some species of filamentous algae (Fowler and Robson 1978; Fowler 1984).

Only in areas of low-lying, valuable arable land such as the Fens in Eastern England, much of which is below mean sea level and where an efficient drainage system is essential, is water weed in any quantity difficult to accept (Cave 1981). Even here there is conflict of water use and drainage engineers now accept that some weed is tolerable, providing the risk of flooding especially in the summer is minimised (Honnor 1984). In July 1968 an 8-hr storm resulted in floods which destroyed 24,000 ha of crops in the Welland and Nene area of the Fens (Miles 1976). Heavily weedy drainage channels prevented the flood water reaching the pumping stations.

Present Research and Development

Much of the research work on aquatic weed control is, at present, aimed at reducing costs as these mount up year by year. Chemicals become more expensive and the buying, maintenance and running costs of machinery increase. Grass carp could help reduce these costs. In the 4th District Main Drain, near Spalding in Lincolnshire (which is 3.2 km long and 5 m wide) the cost of a twice-yearly cut is currently £945. In summer

1983, 504 grass carp, average weight 330 g, were introduced. By August, grazing was evident on the beds of *Callitriche* sp. (Callitrichaceae). Although emergent and bank-side growth had to be cut in October and some *Vaucheria dichotoma* Ag. (after Walz) which is not touched by the fish was removed, the cost of the summer cut was saved. The evidence seen in 1984 is that the control is improving (Mr. J. Honnor, Welland and Deeping Internal Drainage Board, pers. comm.). Although the initial cost of the fish (£10/kg) is high, their survival is good and their influence will increase with their biomass and should last many years.

Biologists in the Wessex Water Authority are very interested in grass carp for weed control. An initial trial in an isolated ox-bow lake of the River Axe, showed that the fish could bring about a highly significant reduction in weed growth. Consequently, other sites have been stocked and a major drain is to be stocked in 1984. It is hoped that this will provide a convincing demonstration of the potential of grass carp to the Authority's land drainage engineers.

Thames Water Authority has allowed licensed introductions of grass carp, including some to flooded gravel pits. Many of these pits are used now for fishing, water skiing and sailing and the predominant weed is nearly always Canadian pond weed (*E. canadensis*). This is an introduced plant, first recorded in the British Isles in 1836 (Perring and Walters 1962) and usually infests newly made lakes. It is appropriate that by introducing another exotic species, the grass carp, we can perhaps control the problem.

Currently the most ambitious and detailed trial was started in 1982 by the University of Liverpool in part of the Lancaster Canal in northwest England (Dr. J. Eaton and colleagues, Liverpool University, pers. comm.). Fish-proof barriers were installed to enclose 0.2 ha areas, and two stocking densities of 200 and 100 kg/ha together with controls were replicated. Frequent assessments of weed growth, water quality and invertebrate fauna are being made and fish survival and growth are monitored.

As well as numerous submerged plant species, the canal supports a large amount of floating plants (mostly *Lemna minor* L.; Lemnaceae). The 100 kg/ha stocking density has reduced the submerged weed, but has had little impact on the floating weed. The higher stocking density significantly reduced both floating and submerged species, effecting about a 60% reduction in the peak summer crop of total weed in the first year, and about 75% reduction in the second year.

As part of this project, fish behaviour studies have been carried out using a radio-telemetric system. Five fish were tagged and released into a 1.2 km section of the canal already containing 70 or 80 grass carp. Preliminary findings suggest that the fish feed in loosely attached shoals, grazing for some time in one patch before individuals move off at speed, for no apparent reason, to another patch, where they resume eating. Only three distinct feeding areas appeared and although this type of grazing will not reduce the weed growth evenly there are certain advantages of an ecological nature. Patchy clearance increases the diversity of the channel environment by creating areas of open water within which free-swimming invertebrates proliferate. The open areas also experience more stable oxygenation than do thickly vegetated areas where plant photosynthesis and respiration commonly result in violent day/night cyclic variations in dissolved oxygen concentrations. Clear areas will obviously please fishermen.

The Yorkshire, Severn-Trent and Welsh Water Authorities all have small ponds and lakes stocked with grass carp and are taking great interest in the results. The 10 Water Authority areas and the approximate positions of all introductions are shown on Fig. 1.

Legislation

If a person or organisation wishes to put grass carp into their water, the local Water Authority must be satisfied that the proposed site is suitable and that grass carp would be successful. Under section 30 of the Salmon and Freshwater Fisheries Act (1975) fish cannot be released without Water Authority permission. This also applies to the movement of fish from one place to another. The Authority, if permission is given, also insists on some degree of reporting on the progress of the fish.

In order to further protect our environment the Wildlife and Countryside Act (1981) states that 'it is an offence to release *into the wild* any animal, including fish and shellfish, which is not normally resident in, or a regular visitor to Great Britain *in the wild*'. The exact interpretation of what is meant by '*in the wild*' is open to debate, but there must certainly be no possibility of the fish escaping into a river system.



Fig. 1. Map of England and Wales showing Water Authority boundaries and sites of grass carp introductions up to 1984.

The Grass Carp Field Trials Steering Committee (consisting of representatives from Water Authorities, Internal Drainage Boards, Universities, the Ministry of Agriculture, Fisheries and Food, the Nature Conservancy Council, The Weed Research Organization and the British Waterways Board) has been meeting annually to discuss experiments and policy. The committee has also produced a simple guide to would-be users, which gives essential information about the fish, their likely effects, the conditions and plants suitable and the procedure to be followed before applying for a license.

If all these bodies are satisfied then the Ministry of Agriculture will issue a license (for a fee of £20). In spite of all these somewhat daunting impediments a number of

licenses have been issued to individuals, to fishing clubs and public bodies to stock private lakes, fisheries or park lakes (Table 1).

Availability

Grass carp are still not widely available and there is at present only one commercial source in Britain. Imported supplies are limited because of the inability of most foreign producers to meet our disease requirements. The Ministry of Agriculture, Fisheries and Food has bred grass carp successfully (Stott and Durbin 1980) and also some of the Water Authorities have their own breeding programmes, and have stockable-sized fish available. Southern Water Authority has been able to supply fry and fingerlings to sister organisations.

Table 1. Field trials and other grass carp introductions in the UK.

Date	No. of introductions	Organizations responsible ¹
Pre - 1971	4	MAFF and WRO
1977	4	WRO and WA
1979	5	WRO and WA
1980	2	WA
1981	12	WA
1982	7	WA
1983/4	29	WA, IDB and Private

¹MAFF = Ministry of Agriculture Fisheries and Food.

WRO = Weed Research Organization.

WA = Water Authority.

IDB = Internal Drainage Board.

The actual production of eggs and fry is well understood, but the growing on of grass carp in large numbers to an appreciable size requires major facilities with warm water for all of the first year. Small numbers of fish are no problem, although rearing is time-consuming as the very young fish need live food before gradually progressing to vegetable feeds at about 6-8 wks old. Bringing on fry in outside ponds is being done, but the process is longer and more hazardous. Reading University together with Thames Water Authority has initiated trials on the best way of bringing fish up to a stockable size. They are employing glasshouses and polyethylene 'tunnels' erected over tanks and excavated ponds to provide the warmth necessary for fish growth (Domaniewski 1983). Wessex Water Authority is also artificially raising fry in warm water re-circulation systems, and has some experiments in lagoons under polyethylene 'tunnels'. Fry are also being grown on to stockable size (300-700 g) by a commercial cyprinid fish farm and some small lakes (0.5-1 ha) have been stocked experimentally with young fish (Mr. A. Frake, Wessex Water Authority, pers. comm.).

It could still be some years before reliable sources of disease-free appropriately sized grass carp are extensively available in the U.K.

There is now confidence about the future of grass carp in the U.K. It is accepted that they are not the answer to all weed problems, but they can complement other more established methods and, sometimes may be the only alternative to no weed control at all! There is a constant flow of enquiries from interested people but the scarcity of fish, the licensing procedure and the knowledge and experience of water authority

scientists, who make the decisions on whether to allow grass carp to be introduced, should ensure that unnecessary releases do not occur.

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