

Performance of stocked triploid and diploid brown trout and their effects on wild brown trout in UK rivers

Summary report – 1st Draft

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Note. This report summarises the key findings of a series of field studies undertaken by The Game Conservancy Trust, in partnership with the Environment Agency (EA), between 2005 and 2007. The work investigated a number of issues with relevance to EA policy on brown trout stocking, and specifically the use of all-female triploid brown trout, which feature in the EA National Trout and Grayling Fisheries Strategy (2003). More detailed information on these studies will be published in the main report, which will be obtainable from the EA shortly.

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1. Introduction and background

The stocking of farmed brown trout into rivers has been practiced for at least 200 years (Elliott, 1994) and it is estimated that approximately 344 tonnes of brown trout are stocked annually in England and Wales (Gandhi, 1996, cited in Summers *et al*, 1996). The majority of these are adult brown trout around a pound in weight which are released into rivers. Therefore, around 750,000 takeable farmed brown trout may be produced and stocked each year. These fish are stocked to support an important part of the angling industry with an estimated 430,000 anglers fishing for trout in either still waters or rivers in England and Wales (Spurgeon *et al*, 2001). Without stocking many of these fisheries would not be viable because stocks of wild brown trout are often insufficient to satisfy current angler demand for size and quantity.

In recent years, there has been increasing concern that introducing domesticated farmed trout into rivers could in some circumstances damage wild stocks. Potential areas of concern include stocked trout:

- competing with or predated on wild trout
- stimulating an influx of predators
- stimulating fishing effort and hence excessive exploitation of wild stocks
- introducing disease
- changing the genetic composition and fitness of wild stocks through interbreeding

These concerns were highlighted in the National Trout and Grayling Fisheries Strategy (NTGFS) published in July 2003 by the Environment Agency (EA) (Environment Agency, 2003). The EA is the leading public body responsible for maintaining, improving and developing fisheries in England and Wales.

Recent developments in aquaculture now make it possible to stock with two types of trout; diploid and triploid. Diploid trout are fertile and generally mixed-sex. However, triploid trout are infertile and generally all-female. Triploids are produced by subjecting newly fertilised eggs to either heat treatment (Crozier & Moffett, 1989) or, as is apparently more successful, pressure treatment (Lincoln, 1996). This affects cell division within the developing embryo producing three (triploid) sets of chromosomes instead of the normal two (diploid).

Essentially, the two types of trout look the same but there are some differences. The cells in triploid trout are larger because they contain 50% more DNA which might in theory cause problems such as reduced oxygen carrying capacity (Benfey 1999) due to the surface area to volume ratio of their red blood cells being lower than those of diploids. This might reduce their fighting ability and provide poorer sport for anglers. However, in culture, annual triploid growth rates are better than diploids because they do not lose condition over the spawning period (Sheehan *et al*, 1999).

Given that triploid trout are infertile, the EA are in favour of using these fish for stocking to reduce the risk of interbreeding which may reduce the fitness of native trout. This is particularly important in rivers which are classified as “native” (Environment Agency, 2003) which have been subject to some degree of historical stocking. However, there is little information on triploid performance in a fishery or

their impacts on wild trout. For example, triploid brown trout might be harder to catch or they could predate more heavily on wild fish than their diploid counterparts.

Solomon (2001) reviewed the scientific literature and anecdotal evidence of producers and river keepers. Areas of concern were highlighted. Female triploid trout could over winter better and as a result have a wider window for competition with wild fish. Triploid trout could reduce wild trout recruitment due to their locking up resources without contributing to the population and they could predate on the eggs of wild trout.

Also, there are only a small number of fish farms in England and Wales that produce triploid brown trout for restocking. The majority of brown trout stocked are mixed-sex diploid trout. Further measures to encourage the use of triploid brown trout for restocking could therefore require a major shift in the production practices of the brown trout restocking industry.

Prior to making decisions on whether to further encourage the use of triploids for restocking through their NTGFS, the EA commissioned a series of studies to address these areas of concern. These studies aimed to: -

- investigate the production and performance of triploid brown trout and their interaction with wild fish
- investigate the performance of farmed diploid brown trout and their interaction with wild fish
- improve the assessment of the risks to wild trout via genetic changes resulting from stocking fertile trout of farmed strains

2. Results and observations from field studies

A series of field studies were undertaken by The Game Conservancy Trust, in partnership with the EA, to address some of the issues and concerns raised in the NTGFS. This work aimed to compare the performance of the two types of trout when stocked into upland rivers and lowland chalk streams, into fisheries and in particular their impacts on wild trout.

Studies were specifically designed to measure and compare the impact of stocked fish on the growth and abundance of wild trout. Also, competition for food, levels of fish eating and their interactions with wild trout during the spawning season were investigated.

The aims, results and implications of the results to the management of wild brown trout conservation and fisheries from each study are summarised below.

2.1 Relative performance of farmed mixed-sex diploid and all-female triploid brown trout and their effects on wild brown trout

The aims of this study were to compare the “in-fishery” performance of both types of stocked fish and highlight impacts on wild trout. The study involved a large scale mixed-sex diploid and all-female triploid stocking programme and post-stocking electric fishing surveys in 2005 and 2006. In total, approximately 2000 fish were stocked in April and May of each year into the upland rivers (Honddu in mid Wales and Arrow in Herefordshire) and the lowland chalk streams (the Allen, Frome, Piddle and Avon in the south of England).

The central 200 m of 33 x 500 m stocked and control sites were sampled by quantitative electric fishing between July and September of 2005 and 2006.

Numbers of fish to be stocked were determined on the basis of the density of adult wild trout present as recorded in 2004 during previous work by The Game Conservancy Trust. In reality the stocking densities equated to the higher levels observed in management. The average size of the fish stocked was approximately three quarters of a pound, again typical of most fisheries. Prior to stocking, all fish were weighed, measured and marked with a visible implant and visible implant elastomer tag. This enabled the identification of individual fish and batches of fish on recapture so that pre- and post- stocking growth, abundance and movements could be compared.

During the summer electric fishing surveys, all fish caught were weighed, measured and counted. All larger trout were checked for tags and any recaptured stocked fish were noted.

The results of this work demonstrated a generally low persistence and probably poor survival of both types of stocked fish, particularly in the upland rivers. Approximately three months after stocking, the average persistence of triploid and diploid trout in upland rivers was only 2 and 4 per cent respectively in 2005 and 8 and 1 per cent respectively in 2006. More stocked fish persisted in lowland chalk streams with the average persistence of triploid and diploid trout being 15 and 8 per cent respectively

in 2005 and 30 and 20 per cent respectively in 2006. The data show that, generally, in both upland and lowland rivers, a higher percentage of triploids were recaptured in their stocking sites. Although not always statistically significant, this indicates a higher persistence of triploid trout. The overwinter persistence of stocked fish between the 2005 stocking and the 2006 electric fishing surveys was negligible. Only two trout were recaptured in their original stocked site 15 months after release. These were from the triploid group and were recaptured in the Avon.

Generally, during their time in the river, both types of stocked fish lost weight and condition.

Despite two consecutive years of stocking both types of fish at a high level, there was no evidence to suggest that either had adversely affected the density, growth or biomass of wild brown trout of any of the age/size groups examined nor was the condition or displacement of adult wild brown trout affected.

2.2 Comparisons between the diets of wild and farmed mixed-sex diploid and all-female triploid brown trout

Another potential area for competition between stocked fish and wild trout is for food. Trout feed primarily on aquatic and terrestrial invertebrates, and either on the surface, river bed or drifting in the current. In any water body there is a limited availability of food and increased competition for it may affect the growth and survival of wild trout. There is also the risk of stocked fish preying on smaller wild trout, young salmon and other fish. No previous studies have been undertaken to simultaneously compare diets and levels of fish eating between the three groups of trout.

During the electric fishing surveys of 2005, described in the previous study (2.1), stomach content samples were obtained from the three groups of fish by stomach flushing. This is a technique where water is pumped into the fishes' stomach via the mouth and flushes any items from the stomach. Samples were collected from both types of recaptured stocked fish and similar sized wild trout in both stocked and control sites.

The samples were analysed by the EA to family level. In particular, the presence and type of fish in samples was noted. Due to the specific concern highlighted in the NTGFS that stocked trout may eat fish at higher levels than wild trout, further samples were collected during the repeat electric fishing surveys in 2006.

Statistical analysis of the data produced no evidence to suggest that either type of stocked fish had impacted on the diets of wild trout. There was also no evidence to suggest that either type of stocked fish predate heavily on wild fish. In upland sites fish constituted less than one per cent of samples by number and volume. At lowland sites fish made up a larger proportion of the samples and approximately half of the fish recorded in the samples were bullheads but these were mainly found in wild fish. There were, however, some subtle differences in the composition of the diets.

2.3 Movements and interactions of wild, farmed all-female diploid and all-female triploid brown trout during the spawning period

Previous genetic studies of wild brown trout populations have indicated that interbreeding between wild trout and farmed diploid brown trout takes place. The potential impacts of these interactions are being assessed by an expert geneticist for the EA. However, little is known of what direct impacts triploid brown trout may have on wild fish during spawning. Obviously, sterile triploid trout will not interbreed with wild fish. However, anecdotal evidence suggests that the overwinter survival of farmed triploid brown trout is higher when compared with farmed diploid trout. This may expose wild fish to more potentially detrimental interactions with triploids. For example, concerns over interferences with wild trout or egg eating by triploid trout during spawning are highlighted in the NTGFS.

To shed light on these concerns, two radio tracking studies were undertaken to compare the movements and interactions of all-female triploid, all-female diploid and female wild brown trout. No male fish were used during these studies because this would add an additional variable into the analysis and hence sample sizes would have to increase which was beyond the scope of this study. Also, given that all-female triploids are most commonly used, it was most appropriate to compare their behaviour with female diploid and female wild trout.

One study was run on the River Arrow in Herefordshire, a typical moderate gradient rain-fed river. Another was carried out on the River Allen, a small lowland chalk stream in Dorset. The Arrow study was undertaken between September 2005 and February 2006. However, the Allen study was run over two spawning periods between September 2005 and March 2006 and October 2006 to March 2007. In both studies, and each year, radio tags were surgically implanted into the body cavity of 20 female wild brown trout, 20 all-female triploid brown trout and 20 all-female diploid brown trout. Wild trout were captured by electric fishing prior to surgery.

Following the implanting of tags under home office licence, the fish were released and tracked on foot with a hand-held antenna, and by fixed listening stations. A minimum of twice weekly fixes was made for each fish and more detailed and prolonged observations were undertaken during peak spawning times.

During the upland study on the R. Arrow heavy losses of stocked fish were noted soon after release. This was caused by predation and wash out during spates. It is difficult to determine what caused all the predation, but a small number of partially eaten dead stocked fish were found which was consistent with otter damage. Otter spraint, heron and mink were also recorded in the study area. During a large spate a group of stocked fish were washed several kilometres down stream in a short period. Given the poor survival of stocked fish no interactions with wild trout during spawning were noted.

On the lowland chalk stream, the R. Allen, the survival of stocked fish was higher even though marked predation was recorded. Otters were again active in this study area. Spawning by radio-tagged wild trout and farmed diploid trout was observed. However, the movement of the all-female triploid trout onto spawning areas during the spawning window was very limited. In both years there were no observations of the triploid group interacting with the wild trout during spawning. Heavy losses of stocked diploid and wild trout were observed during spawning. This probably

accounts for the lower survival in both years of these two groups compared to the triploid group.

This finding support the anecdotal evidence presented by Solomon (2001) which suggested a higher overwinter survival of all-female triploid trout. Although not explored in detail during the study, the spatial difference between triploids and the other trout groups during spawning make it unlikely that triploids predate significantly on wild trout eggs. No evidence of this was observed during spawning observations.

2.4 Recapture rates and anglers' perception of the fighting ability and visual condition of all-female triploid and mixed-sex diploid brown trout

The aims of this study were to compare the recapture rates of farmed all-female triploid and mixed-sex diploid brown trout in the fishery environment. It also was designed to measure the anglers' perception of these fish.

A field trial was run on a fishery of the River Avon near Salisbury in Wiltshire during the whole 2005 season. Equal numbers of farmed all-female triploid and mixed-sex diploid trout were stocked simultaneously into the fishery. Prior to stocking all farmed fish were marked with a clear visible implant elastomer mark to denote diploid or triploid. Anglers were unaware of which mark identified which fish type.

During the angling season, anglers were asked to record details of captured fish on a recording card. These cards included simple scoring questions on the fighting ability and visual condition of the fish.

By the end of the season, only 17 and 11 per cent of stocked triploid and diploid trout were recaptured by anglers respectively. Results showed that slightly more triploids than diploids were captured. There was no significant difference between the two groups for visual condition or fighting ability.

In the context of the NTGFS, these results suggest that all-female triploid brown trout are an equal quarry and possibly provide a higher return to rods compared to mixed-sex diploid brown trout.

3. Conclusions

This work aimed to address some of the issues which had been raised regarding the use of farmed diploid and triploid trout in riverine fisheries in the UK and their interactions with wild brown trout.

The conclusions of each study highlight the overall poor performance of both types of stocked fish, particularly, in the harsher upland rain-fed river environment. This may be why, despite high levels of stocking, no evidence of impacts on the growth, abundance and diet of wild brown trout were recorded. There was also no evidence to suggest that heavy predation on wild fish by either type of stocked fish takes place during the summer in the rivers studied.

The lowland chalk stream radio tracking study demonstrated that all-female triploid brown trout do not participate in spawning activity and hence a higher proportion may survive compared to all-female diploid brown trout. Triploid brown trout also performed as well if not better than diploids during the angler study.

The evidence from these studies suggests that there is no reason why farmed all-female triploid brown trout should not be used as a fishery management tool with regards to the conservation of wild brown trout.

From a fisheries perspective, farmed all-female triploid brown trout may perform better in a fishery than farmed diploids, including remaining in their release site for a longer period.

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