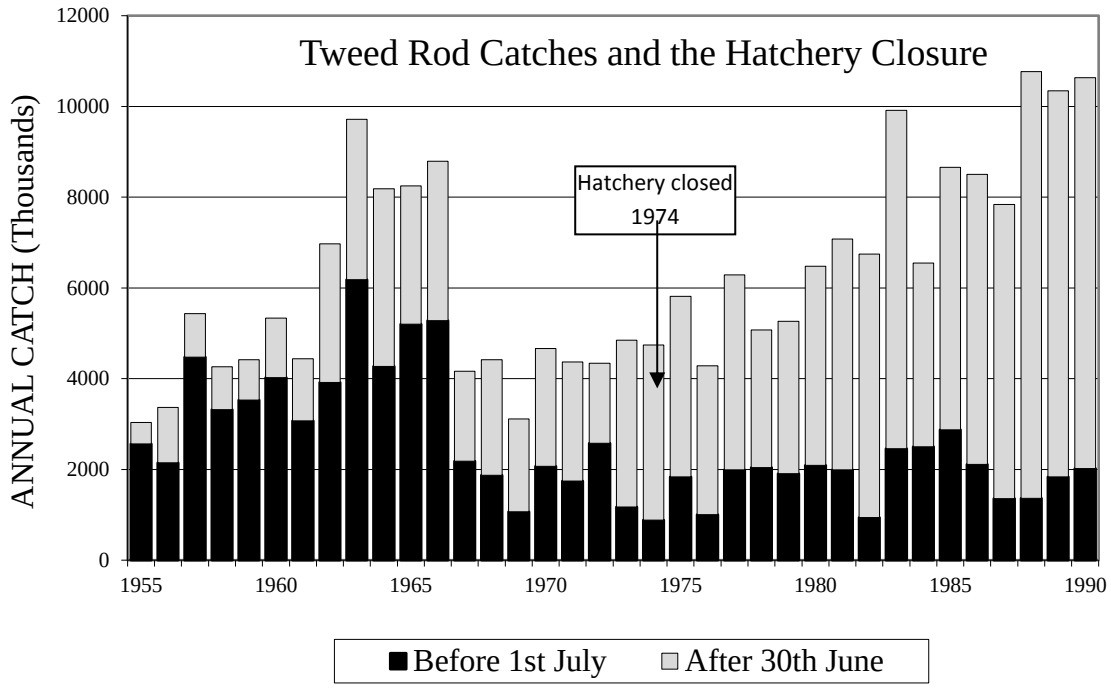
FREQUENTLY ASKED QUESTIONS ABOUT THE TWEED

1: Hatcheries and Salmon Management on the River Tweed

1 The Salmon hatchery on the Tweed was closed in 1974, at the end of the UDN outbreak that had reduced catches during the years after 1966. The graph below shows how Salmon catches on the river recovered after the disease faded out and how the timing of the catches changed from being mainly in the first half of the season (before the 1st July) to being in the second half of the season. This change was a return to the situation before WWI when catches had also been mainly in the Autumn. The closure of the hatchery made no difference to this process or to the recovery.

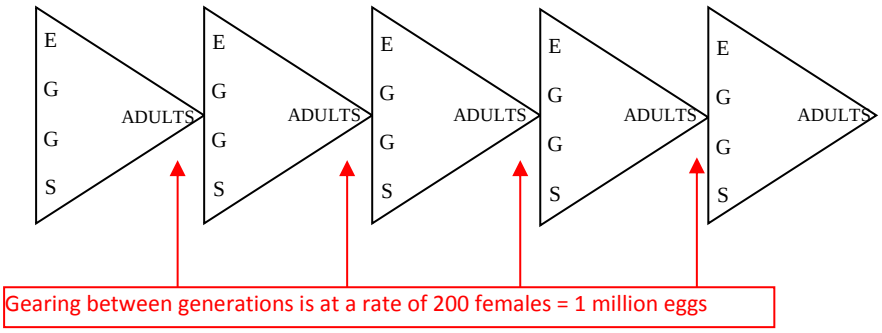


2 There has been no hatchery on the river since, because:

A Wild production is far greater than anything that could be produced in hatcheries. Estimates are that more than 200 million Salmon eggs are deposited naturally each year in the Tweed system, over its wetted area of 17.1 million square metres (6.6 square miles). This is around 15% of all the water open to Salmon in Scotland. On the main river, spawning stretches almost 90 miles, from Coldstream up to the Cor Water and is spread through all the tributaries, down to burns only a couple of metres wide, a huge and varied amount of nursery area. For artificial stocking to have any possible effect, it would have to be on a scale that would be significant in relation to natural stocking, which, in a catchment the size of the Tweed's, is simply not practicable – especially when the return rate of hatchery-reared smolts is typically only around one tenth that of wild smolts. The situation could be different though,

with a small enough river and a big enough hatchery – it would then be a question of economics (and a higher proportion of the stock is caught in small rivers than in large, for obvious reasons).

B The reproductive strategy of Salmon is to produce very large numbers of eggs: a 70cms/8lb female spawns around 5,000 eggs so the Tweed's record annual rod catch of Salmon of 23,000 in 2010 could have been produced by just five average-sized females! Unlike birds and mammals, a lot of Salmon "parents" are not needed to produce a lot of Salmon young. A shortage of eggs or fry (since hatching success is very high, around 80-90%), is therefore the least likely problem to affect Salmon. Each Salmon generation is a "pyramid", with a broad base of eggs and a small peak of adults:-



This means that even when rod catches of adults are low, there are still going to be huge numbers of eggs spawned, especially when it is considered that anglers catch less than 20% overall of the fish that come in to a river (catch rate varies seasonally, from up to 40% of Spring Salmon to less than 10% of late Autumn Salmon).

C Hatcheries could therefore only make a noticeable contribution if wild production became very low indeed, which as shown in B above, is very unlikely. Even if this did happen it is well known that wild production can recover very quickly without artificial stocking (see the case history of the Whiteadder in Point 3 below) so there is little need for hatcheries even in such situations - unless wild recovery is prevented by long-term problems such as Acid Rain or Salmon farming, in which case artificial rearing can be significant in scale to natural rearing.

3 Experience with the natural recolonisation of tributaries when re-opened to Salmon has shown that empty space in nursery areas is rapidly filled. The Whiteadder was fully opened up only in the 1990's, so the recolonisation could be tracked through electric-fishing surveys:-

1988	7 sites, average Salmon Parr density of	0.7 per 100 m^2	(at 1 site out of 7)
1996 same	7 sites, average Salmon Parr density of	16.1 per 100 m^2	(at 6 sites out of 7)
2000 same	7 sites, average Salmon Parr density of	21.3 per 100 m^2	(at 6 sites out of 7)
2002 same	7 sites, average Salmon Parr density of	20.1 per 100 m^2	(at 7 sites out of 7)
2005 same	7 sites, average Salmon Parr density of	21.6 per 100 m^2	(at 7 sites out of 7)

(*Note: in 1988, Fry were found at five out of the seven Whiteadder sites, though in single figures at three of these, the highest Fry density being at Ellemford*).

This recovery has been entirely natural, produced by the removal/easing of obstacles, there was no artificial stocking at all.

4 There is no evidence that economically affordable levels of smolt stocking can produce enough extra fish to make a noticeable increase in the catches of a large river. This was first pointed out as long ago as 1904, by Sir Herbert Maxwell, in his book "British Freshwater Fish" when he wrote "*River proprietors are spending more and more upon artificial Salmon hatcheries, in the belief that therein exist the means of replenishing exhausted rivers; but it is obvious to those who have watched most closely the operations of Nature that, in order to have any effect, artificial hatching must be carried out on a very considerable scale. Until one has watched the smolts descending to the sea in any ordinarily prolific river, no conception can be had of the profusion of Nature's provision for the maintenance of the species*".

The same consideration applies now:

- To increase catches by 1,000 Salmon, would need 10,000 extra Salmon to return to a river (a 10% catch rate is appropriate for Summer/Autumn fish);

- At a 1% return rate for hatchery smolts this would need 1,000,000 smolts to be put in the river each year. (Wild smolts typically have a return rate of around 8%, but hatchery smolts, being domesticated animals, do not do so well in the wild and have typical return rates of around 1% - see the note below. Return rates in Iceland are somewhat better, as the fish do not have the long migration north that ours do);

- At 80p per smolt (which is cheap), this would cost £800,000 per year. Even if hatchery smolts had the same return rate as wild, it would still cost £100,000 every year.

Note: Unless Salmon hatcheries are using eggs bought in from elsewhere, they are maintained by taking eggs *out* of the river. The assumption is that by being kept safe in hatcheries, more young are produced from the same number of eggs. However, this is based on the assumption that traditional hatchery rearing produces fish of the same quality and ability as natural rearing, which is now known not to be the case. The longer fish are kept safe in a hatchery, the less suited they are for life in the wild, not only in terms of physical shape and condition but also in their behaviour. The apparent increase in survival from eggs reared in traditional hatcheries is not therefore what it seems, as the survival of hatchery-reared fish in the wild is so much poorer than that of wild reared fish. This is why modern hatchery practice aims to keep fish in captivity for as short a period as possible before stocking them out to minimise these adverse effects of hatchery rearing on them.

5 While all the points above about the efficiency of hatchery stocking have been known for many years, there is now information from new, genetic, techniques that both confirm and quantify them. A very large scale study on the River Spey genetically characterised the broodstock used in the hatchery there from 2004 to 2010 and then looked for offspring of these (1) amongst the Salmon caught by anglers on the river from 2007 to 2012 and (2) amongst fish sampled below Spey Dam – as natural reproduction is low above the dam, this was an area that was heavily stocked. The results showed that the annual rod catches of Salmon of hatchery origin varied from 0% to 1.8% of the total, with the best rate being 3.1% (in 2009). Of the fish trapped below the Spey Dam, none were of hatchery origin.

The full report on this work can be found at:

http://www.speyfisheryboard.com/wp-content/uploads/downloads/2013/12/Spey-hatchery-final-report.pdf

6 This new genetic data confirms what had been worked out with less direct techniques – that hatchery stocking is not an effective way of increasing catches in a river that has significant wild production.

7 The whole question of hatchery stocking has recently been considered for the River Dee, the conclusion being that there was no case for it under current conditions. This report can be found at:-

http://www.riverdee.org.uk/news/2016/river-dee-hatchery-appraisal-report-published

8 Hatcheries and stocking have a long history in Scotland and elsewhere, and there is now a great deal of experience in their use (and mis-use). The best summary of this is probably given in the foreword to the Fisheries Research Services *Scottish Fisheries Information Pamphlet No. 22,* 2003, where it says: *"Advice on stocking is contradictory. Proponents raise expectations of large additional catches if stocked fish survive. Critics emphasise the heavy costs set against the modest, if any, gains shown from past stocking initiatives, as well as potential threats to health and genetic integrity of existing fish. What is clear is that stocking should only be considered as one of a number of courses of possible action:* Document available at:-

http://www.gov.scot/Uploads/Documents/Stocking.pdf

9 A case history showing the lack of effectiveness of even large scale stocking is available from the Northumberland River Tyne. Contrary to the popular perception, there is no evidence that the stocking programme had any significant effect in the recovery of Salmon there. Indeed, as the Sea-trout of the Tyne recovered as quickly and as well as the Salmon without any significant stocking, it is, in fact, a good case history of the lack of effect of stocking: this is available at:-

http://www.wyeuskfoundation.org/problems/downloads/Tyne20Hatchery20Report.pdf

10 A more general study comparing the angler catches over 15 years in 42 English rivers that were stocked with those in 20 rivers that were not, failed to find any significant effect of the stocking. Indeed, other factors being equal, the 42 stocked rivers had lower average catches than the un-stocked, with the results being poorer the older the age at which the fish were stocked. While catches in some stocked rivers did appear to improve, these still produced fewer fish than would be expected, suggesting that the stocking was damaging the wild production. The reference to this paper is:- Young, K. A. 2013, *'The balancing act of captive breeding programmes: Salmon stocking and angler catch statistics*' Journal of Fisheries Management and Ecology, vol 20 , no. 5 , pp. 434-444.

11 A general review and policy document on stocking was produced by RAFTS (Rivers and Fisheries Trusts Scotland) in 2014 and is available at:-

http://www.rafts.org.uk/wp-content/uploads/2014/03/RAFTS-Stocking-Policy-Technical-paper-2014.pdf

This paper, amongst other analyses, outlines the ways in which artificial stocking can damage natural reproduction and lead to the under-performance of stocked rivers mentioned in the paper above. A very broad summary of these effects would be that hatchery rearing keeps alive types of fish that would otherwise be weeded out of the population as less fit by natural selection. When these then breed with other hatchery fish or with wild fish, their offspring are also less fit and so survive less well.

12 The juvenile Salmon populations of the Tweed and their habitat have been extensively surveyed for nearly 20 years now and are well known. Nothing has been found to suggest that stocking would be a useful part of management here – and the circumstances in which stocking can be of use are now well defined in the scientific literature in a number of guides such as the one quoted in Point 9.

Additional Note, 2016

There is now clear evidence, both from the Tweed and from other rivers, that one of the cyclical changes in run timing/Grilse:Salmon proportion is taking place at present. These occur about every 50-70 years e.g. around 1915 the main run changed from Autumn to Spring and around 1965 it changed back, from Spring to Autumn and from Salmon to Grilse. An account of this is given in the Tweed Foundation's Annual Report for 2015.

These changes, when they occur, are both far-reaching and rapid, as shown in the graphs below for the catches of the Sandstell netting station *circa* 1915 and 1965. However, this is the first such change that has taken place since electric-fishing surveys of juveniles became possible so it is not known how such a change is reflected in juvenile numbers though it is known that Spring and Autumn Salmon do spawn in different parts of the catchment. It may be that one type of fish has to "colonise" the areas of the other to make the change happen.