



Catch and Recapture Rates of Tweed Salmon and the Effect of Recaptures on the Catch Statistics

A. CATCH RATES – What proportion of the salmon running the Tweed actually get caught by anglers?

- The most comprehensive study of catch rates of Salmon in a river like the Tweed (large, with different runs of Salmon at different times of year) was made in the 1990's on the Welsh Dee, where there is a fish trap at Chester that allowed a substantial sample of Salmon to be caught and tagged. The rates of capture of tagged fish by anglers upstream of the trap were:

	MA	A	M	J	J	A	S	O
% later	39	3	2	1	2	1	1	5

Data from Davidson, Cove & Milner, 1997

from which it can be seen that early running fish had much higher rates of capture by anglers than later.

- Early season fish are generally believed to be behaviourally more likely to be caught than later fish. This could well be related to more recent experience of feeding, as shown by a study of the stomach contents of net and rod-caught fish from the Tweed published in the 13th & 14th Annual Reports of the Fishery Board for Scotland, 1894 & 1895. This clearly shows that while many early season fish had been feeding right up to their entry into the river, few August or September fish had been.

1894 & 1895	No. of fish	% with food in stomachs
Feb & Mar	63	33.33
Apr	133	24.06
May	215	16.74
Jun	236	9.75
Jul	383	1.31
Aug	310	2.58
Sep	106	1.89
Oct	96	0.00
Nov	152	0.00
TOTAL	1694	

The very odd thing about Salmon fishing which makes it so different from any other kind of fishing is, of course, that it is for fish that are not feeding. As their stomach lining physically disintegrates in fresh water, adult Salmon should not be interested in artificial lures that look like food, but for some reason they can be caught with them. Whether or not recent experience of feeding is related to readiness to be caught is unknown, but the percentages found with food given in this table have the same sort of downward trend through the year as the percentage catch rates shown in Para 1.

- Each year, since 1997, a netting station on the Tweed has been hired by The Tweed Foundation for 3 to 5 days in the week after the end of the netting season on the 14th September and all the Salmon and Sea-trout caught tagged. In all, exactly 500 Salmon have been tagged at this time of year in 12 years (2008 was flooded out) and of these 5.11% have later been caught by anglers. Yearly catch rates have varied from 0% in 1999 to 15.00% in 2003, which was a very dry autumn when fish were stuck at the bottom of the river. An overall catch rate of around 5% matches the autumn rates found on the Welsh Dee.



4. The possible errors for all studies using tagged fish are: (1) Non-reporting of capture of tagged fish; (2) fish losing their tags; (3) Tagged fish dying in the river or (4) leaving it, and so being unavailable to anglers (this is a factor as fish are tagged at the bottom of the river and may not always be Tweed fish: e.g. one Salmon radio-tagged in the Tweed estuary was later caught by an angler 12 miles up the Coquet). The 1st and 2nd of these possible errors reduce the estimate of catch rate, the 3rd and 4th increase it (as the reported catches would be from a smaller number of fish in the river than there actually were). To check on these errors, some tagged fish will also be acoustically tagged in 2010 so that individual fish can be tracked after their tagging and it can be seen if any leave the river.
5. It should be noted that this catch rate is for the beginning of the autumn run, for the third week of September – the catch rate for fish entering the river later than this may well be different. A fish entering in the first week of November has only four weeks in which to be caught and one entering in the last days of the season is very unlikely to be caught at all. Some netting and tagging in the later autumn season is planned to try and work out what the catch rates might be at that time.
6. No similar data is yet available for summer Salmon, though The Tweed Foundation is working on the catch (“Exploitation”) rate of these as part of the Fisheries Management Plan for the river. The dates on which fish are being netted and tagged through the summer are advertised each year on the Tweed News site (<http://www.rivertweed.org.uk>) for anyone interested who would like to see this in progress. The 2009 attempt to collect this data was almost completely washed out by flooding, with none of the fish that were tagged on the two days on which netting was possible later being caught in the high water levels and poor fishing conditions. While it might be expected that catch rates for summer Salmon would be intermediate between a high rate for spring fish and the low rate for autumn fish, it is also possible that the generally erratic fishing conditions on the Tweed in summer (flood or drought) could be the controlling factor.
7. As the netting stations no longer operate in spring, this sort of netting and tagging is not possible for this run of fish. However, an estimate can be worked out from the radio-tracking work carried out by The Tweed Foundation in the 1990’s. Although the numbers of fish netted and radio-tagged before the 1st of June in each of the three years was small, the capture rates by anglers were 29%, 33% and 31%, which shows consistency. The overall catch rate was 31.6%, which has to be regarded as indicative, rather than accurate, as some of the radio-tags did not work properly, so it is not entirely certain how many of the spring fish tagged actually ran the river.
8. However, a catch rate for Tweed Spring Salmon of around 30% is consistent with the results from the Welsh Dee. There is also, however, some evidence that catch rates increase if numbers of fish are low and if angling effort remains at its usual level and so is concentrated on fewer fish. The pattern of catches on the Tweed in spring since the 1970’s has been for considerable variation in spring catch totals (except for the years 2001-08 when it was very constant) so it is possible that in years with lower numbers of Spring Salmon in the river, catch rates could be higher than 30%.
9. Other data for the Tweed is provided by the catch rate of fish upstream of the fish counter on the Ettrick, which was installed in 1998. Although most of the fish running up the Ettrick enter the Tweed in the spring and summer, most do not make their final spawning migration till the autumn rains come. Most fishing effort upstream of the counter is concentrated in the autumn as well, and the release rate averages 83%. Overall, only 3.27% of the fish counted going through the fish ladder from 1998 to 2008 were later caught by anglers upstream, the annual rates varying from 1.12% to 7.14%. There is little fishing effort on the Ettrick in spring, but the overall catch rate of fish that had gone through the counter from February to June 1998-2008 was 3.4%, with annual rates varying from 0.53% to 12.1%.
10. The variation in catch rate from run to run shows that an overall, average, catch rate of Salmon in a river has to be calculated with care. If a river’s Salmon are 10% spring, 20% summer and 70% autumn, with catch rates of 40%, 20% and 10% respectively, then an overall average catch rate has to take 70% of its value from the autumn run’s catch rate, 20% of its value from the summer run’s catch rate and only 10% from the spring run’s high catch rate.

B. RECAPTURE DATA: What proportion of the fish caught and released by anglers on the Tweed get caught a second time?



1. Recapture Rates have a different background to Catch Rates: recapture rates are for fish that have run upriver before being caught by anglers and are then tagged and released, so when recaptured, they are being caught for a second time by rod. The catch rates in part A of this paper are for fish that were tagged after being netted or trapped, or counted through a fish counter, and so are being caught for the first time by anglers when taken. Recapture rates will be affected by the time taken for fish to recover from their experience of capture and, possibly, by their learning to avoid recapture by the same method (see Note 1 in Section D below).
2. When Catch and Release for Spring Salmon was introduced on the Tweed in 1998, released fish were tagged through the adipose fin with a new design of tag that any angler could use, so that recapture rates could be assessed.

SEASON	Total fish tagged & released	Number of recaptures	Percent Recapture Rate	Av. days from tagging to recapture	Max days from tagging to recapture
2000	631	11	2.5%	56	*142
2001	997	33	3.6%	40	152
2002	792	20	2.5%	50	135
Total	2420	64	2.64%		

*One fish tagged at Rutherford on the 24th May 2000, was found dead as a kelt in the Yarrow Water on the 28th October. The minimum number of days from tagging to recapture in each year was 1 day

3. The recapture rate of these angler-caught and tagged fish is a lot less than the 30% or so Catch Rate indicated for Spring Salmon tagged fresh in the estuary. Various studies have shown that Atlantic Salmon have two periods in which they are more likely to be caught by anglers: (1) when they are fresh in from the sea and (2) when they are nearing spawning. Salmon tagged in spring on the Tweed will also enter a summer period of low flows and poorer fishing conditions, with those tagged late in spring reaching this after a shorter period in the river than those tagged earlier. Fish tagged fresh in the estuary early in spring are therefore likely to have a higher catch rate than fish tagged upriver and later on. There is also the possibility that the behaviour of the fish is changed by the experience of being caught, making it less likely for them to be caught by the same method for a second time (see Note 1 in Section D below).
4. On the Aberdeenshire Dee, standard Floy tags were used to mark fish released by anglers and of over 400 tagged between 1996 and 1998, only 5% were later caught for a second time. (The River Dee Stock Component Review, 2006.)
5. On the Spey, 786 rod-caught Salmon were tagged and released from 2000 to 2002 using standard Floy tags. Thirty-eight of these were later recaptured by anglers (4.8%) before the end of the season. Of 504 Multi-Sea-Winter fish (Salmon) released before the end of June, 26 were recaptured within 61 days (5.2%) but there was a great deal of variation within this: 25% of the fish tagged and released in early March were recaptured, but only 2% of those caught and released in early June. Of the 267 fish tagged and released after July, however, only 1 was recaptured by an angler before the end of the season (0.37%) (Thorley et al, 2007). Given that these are recaptures, fish caught for a second time by rod, the rate of first time capture for February and March fish must be higher than 25% showing a high catch rate for the small numbers of early Spring Salmon of the Spey.
6. On the River Eden, in the English Lake District, of 203 Salmon caught by anglers and then radio-tagged in 1990, 2000 & 2002, only 1 was later recaptured by rod (0.49%), though angling pressure on the upper Eden was believed to be low (A. Gowans, Environment Agency North-west.)
7. The low recapture rates of angler caught and tagged Tweed Spring Salmon are similar to those of the Dee, Eden and the later Spey fish, even though a new design of tag was used. It can be taken



from all these examples therefore that recaptures of angler caught and released Spring Salmon are generally low, other than for very early running fish on the Spey.

8. There are some other rivers from which capture and/or re-capture data is available, but care has to be taken to compare "like-with-like". Small rivers, where no water is out of the reach of any angler, regardless of their skill level and where fish are never far from the sea; or rivers where there are major man-made or natural barriers that hold fish back and concentrate them for anglers are different situations.
9. The effect of recaptures on annual catch totals has also to be calculated with care. If a river is 100% "Catch and Release", then every fish caught has a chance of recapture, with a corresponding effect on the annual catch total. However, if a river is not full "Catch and Release", then it is only those fish that are released that can be caught again: the others having been killed. For example, in a river that catches a 1,000 fish in a year, 400 of which are released, the only recaptures possible are of those 400, the other 600 having been killed. This limits the possible effects of recaptures on the annual total.

C. THE EFFECT OF RECAPTURES OF RELEASED FISH ON THE SALMON CATCH STATISTICS OF THE TWEED

1. Since autumn fish on the Tweed have a low first-time catch rate, around 5% (+ and – errors), their recapture rate will not be higher. Even if, however, the recapture rate was as high as the catch rate, then for every 1,000 autumn fish caught and released, only around 50 (5%) would be caught for a second time. The average number of fish released on the Tweed in autumn over the years 2004-2008 was 5,797 – if 5% of these were then recaptured, then an extra 289 fish on average would have been recorded in the statistics. As the average annual Tweed rod catch for the years 2004-08 was 14,505, 289 double-counted autumn fish could have made up 2% of this. However, this would be a maximum possible impact as their recapture rate will actually be lower than the 5% first capture rate.
2. On average, 69% of the Tweed's catches are taken in autumn, so this low recapture effect covers the bulk of the annual catch total.
3. With an estimated first time catch rate of around 30%, recapture rates for Spring Salmon could be much higher than for autumn fish, but the tagging results for the Tweed actually indicate that these are as low as they generally are in other comparable rivers. If the recapture rate of Spring Salmon was, for example, 10%, then for every 1,000 Spring Salmon released, 100 would be recaptured and added to the statistics. As the average number of Spring Salmon released on the Tweed over the years 2004-2008 was 1,464 per year, even such a 10% recapture rate would only add around 146 fish, which would then make up 1% of the annual catch total. However, the evidence is that spring recapture rates are much lower than 10%, only around 3% in fact, so any effect would only be about a third of 1%, around 0.3%.
4. As Spring Salmon make up only 15% of the annual catch, their recapture rate, however high or low, would only have a very small impact on the annual catch totals.
5. It also has to be accepted that the catch recording system is not perfect and that there is some under-reporting of catches which has to be set against any double-counting through recaptures.

D. NOTES

1. "LEARNED AVOIDANCE": There does not appear to be any information on this for Atlantic Salmon, but a study of trout in two New Zealand rivers, one in a National Park that was fished rarely and where the trout had little or no experience of angling (the Ugly River) and another, heavily fished river (the Owen River) found major differences in the behaviour of the two fish populations: "The most marked behavioral response to angling pressure was in the Ugly River, where trout that had been caught and released or merely disturbed by anglers were rarely seen over the following days. No such hiding response was observed in the Owen River. A learning response was also evident, as



trout that had been fished previously were more likely to be scared by anglers or required smaller, low-profile flies before being caught than naive trout. Faced with increasing angling pressure, anglers can perhaps cope with the observed learning response by improving their techniques to outsmart trout." Young, R.G. & J.W. Hayes, 2004: Angling pressure and trout catchability: Behavioral observations of brown trout in two New Zealand backcountry rivers. *North American J. Fisheries Management*, 24 (4). Obviously, Salmon fresh in from the sea have never met an angler before and so will be "naïve" – but one that has been caught and released may well have learnt a lesson.

2. In general, for what are called "mark – recapture" experiments, it is regarded as best practice for different methods to be used for the initial catching for marking and for the second catching, the recapture, to avoid any possibility of "learned avoidance".

REFERENCES:

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Thorley, J.L., Youngson, A.F. & Laughton, R. (2007). Seasonal variation in rod recapture rates indicates differential exploitation of Atlantic salmon, *Salmo salar*, stock components. *Fisheries Management and Ecology*, 14, 191–198