AN APPRAISAL OF THE CONSERVATION CASE

ON THE PROPOSED BAN OF THE KILLING OF WILD SALMON

Proposal: Scottish Ministers are proposing that there should be no killing of wild Salmon by net or rod, except under licence, for *"conservation reasons"* and as *"conservation measures to help regulate exploitation".* The proposal also states that it has the aim of *"managing the pressure of exploitation through fishing"* which can only mean controlling the numbers of Salmon killed under each licence issued. This therefore raises the practical issues around the concept of each licenced fishery in Scotland being given an annual quota for killing if it wishes to do this.

Analysis:

1 Reduction of killing by anglers for conservation reasons

1.1 The rationale for controlling the killing of wild Salmon by anglers "*for conservation reasons*" is based on two assumptions: (1) that the number of Salmon killed by anglers is a significant proportion of the stocks and is having an impact on their conservation; and (2) that more Salmon are needed to escape to spawn.

1.2 However, anglers only catch a small proportion of the Salmon that enter Scottish rivers – the rule of thumb is a 10-12% catch rate. As such a small proportion is even caught, let alone killed, it is difficult to see how angling catches could be regarded as any sort of "*pressure of exploitation*" on the national stocks and evidence is required for this assumption.

1.3 That the actual numbers of Salmon that would be saved by any restriction on killing by anglers would be only a small fraction of the national stock is illustrated below from both the national catch data for 2013 and for recent catch data for the Tweed:

1.3.1 National catch data for 2013 (the latest published figures):

a) Total national rod catch of Salmon and Grilse after 31st May [*this is to exclude Spring Salmon which are all now protected by total catch and release*] = 55,009.

b) Taking this catch as being 20% of the total Summer and Autumn stock that came in to Scottish rivers, this can be estimated as having been c. 275,045.*

c) The total number of fish killed after the 31st May in 2013 was 12,294.

d) Therefore the percentage of the total national stock killed by anglers in 2013 was only **4.47%.**

e) In absolute terms, if half the 12,294 fish killed by anglers after the 31st May in 2013 had been females (6,150 approx.) and a licence system had reduced this by half, then there would have been just 3,075 more female Salmon spawning for the whole of Scotland. As it is, however, angling tradition is not to kill females in Autumn, so most of the 12,294 would, in fact, have been males, making the number of females that would have been "saved" by any licencing even smaller.

**This estimation depends very much on the catch rate. Here, 20% is used to give a conservative estimate, but this rate will be higher in smaller rivers and lower in larger. As the larger rivers produce most of the national catch, their lower catch rates are actually the more relevant. For comparison, the estimates made by ICES (ICES, 2013) of the numbers of Grilse and Salmon spawners in Scottish rivers over the period 2008-2012 average just over 506,000 per year (including Spring Salmon). This suggests*

that the average national catch rate is less than 20% and therefore that the percentage of the total national Summer and Autumn stock actually killed by anglers is even less.

1.3.2 Tweed data for recent years:

a) Average Salmon rod catch, July to November, for the last five normal years (excluding 2010 as abnormally high and 2014 as abnormally low*): 11,163 [*to exclude Spring Salmon from the estimation for Tweed, June catches have been omitted as well as February to May figures*].

b) For those five years, the average number released, July to November, is 6,146, and the average annual total killed is 5,017.

c) Taking the Summer & Autumn angling catch rate as 10% [*though tagging & recapture data shows this is nearer 5%, this is to give a conservative estimate*] the average run of Salmon in to the Tweed after the 30th June is around 111,000 fish.

d) The proportion of the total run of Summer and Autumn Salmon killed by anglers on the Tweed is therefore, at the very most, 4.5%. Again, males will be selected for killing.

e) Over this period, the fish counter on the Gala Water, a Summer and Autumn fish river, showed a consistent surplus over the number of Salmon required to fully spawn it and regular juvenile monitoring surveys have shown good numbers of Salmon fry throughout the catchment other than in areas upstream of known obstacles.

**It is worth noting that the very high numbers of fish in 2010 were the parent generation of the Grilse of 2014, a year of very low catches, a good illustration of the well-known lack of connection between numbers of spawning adults and the numbers of their progeny. This is not recognised in the Wild Fisheries Review, however, as shown by its Recommendation No. 37 (2), that there should be research on "*The feedback loop linking salmon licenses issued and resulting impacts on stocks*" which assumes just such a direct connection (the licences referred to are those proposed to allow the killing of salmon).*

1.4 There is also the practical point that any restriction on killing brought in under a licence system could only reduce the number killed in years when catches were high enough for any limitation on killing to take effect. In years with poor runs in which catches did not reach this level, killing would not be reduced. To have any effect in the latter situation, limitations on killing would have to be set at a very low level, appropriate for "worst case" situations.

2 Is reducing the killing of adults aimed at the right part of the Salmon life-cycle to have any effect? (*This refers to the fact that any management action, to be effective, must be applied to the right place in the life cycle. It is no use, for example, to target adults when it is some factor in the juvenile stages that is limiting production.*)

2.1 The proposal is for the killing of Salmon to be legal only under a licence issued by Scottish Ministers, which could then be used to limit the numbers killed to levels appropriate for the conservation of a stock. The biological aim of this would be to increase the number of adult Salmon spawning and therefore the number of eggs being deposited in a river.

2.2 The adult to egg stage is, however, the most resilient part of the whole Salmon life cycle, because of the very high fecundity of female Salmon which means that a few hundred spawners produce tens of millions of eggs – more detail on this can be found in the IFM Scotland's "*Code of Good Practice in Fisheries Management*", page 17, Section 5.4 "*Salmon Breeding*" : see

http://www.ifm.org.uk/sites/default/files/page/Fishery%20Management%20COGP_1.pdf

2.3 There is a huge difference between the freshwater and the marine phases of the Salmon life cycle in terms of numbers: Salmon out at sea are estimated to be in the hundreds of thousands for all the Salmon rivers of the North Atlantic put together while the number of eggs in even a small river will be in the millions, for example:-

Numbers in life-cycle stages in the North Esk

Female spawners (in 1978)	7,521	
Eggs deposited	29,000,000	
Smolts emigrated	144,000	*From 1980 (1yr old smolt) to 1984 (5 yrs old smolts)*

From Shearer, 1992

2.4 Since only small numbers of females are required to fully stock nursery areas, increasing the number of them spawning by limiting killing by anglers will not have any effect in increasing juvenile numbers. Only when adult numbers are very low indeed is there any connection between numbers of spawners and numbers of resulting juveniles.

2.5 It is well established that the limiting factor for numbers of juveniles (and so of number of smolts produced) is not the number of spawning females but the carrying capacity (the amount of food and space) of nursery areas.

2.6 It is therefore only where local evidence showed numbers of spawning females to be restricting the number of juveniles in the nursery areas that reduction in killing by anglers would be useful.

3 Practical considerations around the concept of annual quotas for rod fisheries

3.1 As shown above, no significant biological effect from this proposal could be expected, except on rivers where adult stocks were so low that their numbers actually did limit the number of juveniles.

3.2 Determining how many fish could be killed under licence between the end of one fishing season and the start of the next for all the rod fisheries in Scotland that wished to kill fish would be a massive administrative exercise.

3.3 Quotas would be set for whole rivers, so there would then be the problem of dividing it up between the different fisheries. For example, there are 167 registered (plus more unregistered) rod fisheries on the Tweed, providing many thousands angler-rod-days per year.

3.4 Catches also vary immensely from year to year as catches depend as much on river conditions as they do on stock levels – the table below shows the variation on some lower Tweed fisheries:

July to November catches 2000-14

Fishery	**Max**	**Min**
A	394	0
B	678	1
C	1069	52
D	202	16
E	969	140

3.5 It appears from the Wild Fisheries Review, that any annual quotas would be set on the basis of Conservation Limits (CLs) for adult spawners. Estimation of CLs is, however, a complicated procedure as outlined in Appendix A.

4 Summary

4.1 Restricting the numbers of adults killed by anglers under the proposed licence system could not have any conservation value as: (1) the proportion of the national stock killed by anglers is too small to be having any significant effect; (2) the adult to egg stage is actually the most resilient part of the Salmon life cycle, due to the high fecundity of female Salmon, so shortage of fry due to shortage of spawners is only an infrequent and local issue that does not require a national licencing system which would (3) be extremely difficult to implement in practical terms.

5 ALTERNATIVE PROPOSAL

5.1 What Ministers actually need is a simple, effective and streamlined system that would give them the assurance that exploited stocks were in good condition and so meet Scotland's international commitments relating to Salmon conservation, and the powers to require / take action if local indicators showed problems for a particular stock.

5.2 Such a system for Scotland would: (1) use "hard" data from actual measurements made in every catchment as its base; (2) act at parts of the life cycle where it could actually have an effect; (3) be appropriate for the different requirements not only of each individual catchment but for any different stocks within catchments, and (4) be cheap and simple to administer and based on work that is already being done or is already planned.

5.3 This would require good monitoring systems to be put in place in **all** Scottish Salmon rivers, to provide "hard" targets ("Alternative Reference Levels" or "Biological Reference Points") for Salmon stocks to meet. These should include, as a minimum;

5.3.1 Fish counters on a wide range of waters, on the main stems of smaller rivers or on some of the tributaries of larger, with estimates made of the number of spawning fish required upstream of them to fully stock nursery areas. MSS has, at present, a plan for a network of fish counters throughout Scotland which would be a base for this.

5.3.2 Regular juvenile surveys to show if nursery areas in general were being fully stocked. All the Fisheries Trusts in Scotland already undertake juvenile surveys. New genetic techniques can greatly increase the value of such survey data (see 5.12 below).

5.3.3 An indication as to the ease / success rate of downriver smolt migration and, where possible:

5.3.4 Monitoring of angling exploitation rates (by tagging fish low down on a river and seeing how many of these were then caught by anglers upstream).

5.4 Data from (5.3.1) would show if enough fish were escaping to spawn for a small catchment or for sample tributaries of a large one, while data from (5.3.2) would show if catchments generally were being fully stocked with juveniles.

5.5 Data from (5.3.3) would show if the downriver smolt migration, the most vulnerable part of the life-cycle in freshwater, was straightforward or had difficulties. Increasing evidence is that it is this part of the life-cycle that limits the number of smolts getting to the sea which the numbers of adults that spawn is known not to do, except in exceptional circumstances.

5.5.1 There is also increasing evidence of very high losses of smolts, sometimes over 50%, just after their transition to salt water. If added to high downriver losses, much of the freshwater production of a stock would be lost, even before the marine phase of the life cycle began.

5.5.2 Action at this part of the life cycle, the smolt migration, is much more likely to have a biological impact than the proposed action at the adult spawner stage.

5.6 With so many Salmon being caught and released now, angling exploitation is no longer of major concern to managers, but the sampling of adult fish coming in to a system, as suggested in (5.3.4) is a way of monitoring their health and level of damage by predators and their tagging to give angling catch rates provides data from which population estimates can be made.

5.7 Where such monitoring showed that stocks were in good condition this should be accepted as showing no additional restriction on killing was required. It should be noted here that angling culture has changed enormously over the last 20 years, with the release of fish now being more common than killing.

5.8 Warning signs that stocks were decreasing would come from fish counters; increasing rod exploitation rates and from the genetic analyses that can now accompany juvenile electro-fishing surveys and amplify their results (see 5.12 below).

5.9 Where such monitoring systems were not in place, precautionary intervention could be justified until such time as they were.

SUMMARY of ALTERNATIVE

5.10 A system based on the monitoring of juvenile stocks and adult counts has three major advantages:

(a) Every catchment can be electro-fished to provide local data.

(b) No data from the killing or accurate measurement of adult fish is required, which is now very limited with the reduction in netting and the prevalence of Catch & Release.

(c) Counts of adults are a direct measure of spawning stock. The assumption can be made that counted stocks will have the same trends in numbers as uncounted stocks of the same basic type (Spring, Summer, Autumn).

Basing monitoring on such data shifts the basis of management away from old, declining, data sources such as netting and fish killed by anglers onto modern and expanding data sources. It is also much less dependent on rod catch data, which is as much dependent on fishing conditions in any one year as it is on numbers of fish in the river.

5.11 Juvenile surveying is already widespread in Scotland and could easily be further developed in to a national monitoring system for Salmon stocks. The basic requirements for this would be:

(a) Better knowledge about the relationship between habitat capacity and juvenile numbers.

(b) Further standardisation of method and equipment (this will be made easier by the new generation of electro-fishing machines in which the amount of electricity used can be set, instead of using stop-watches for timing sampling effort).

(c) Determination of what levels of juveniles indicate fully spawned catchments. The Irish level of 17 per five minutes might be appropriate but it would need to be proven to be so. It is also quite possible that the regional differences in Scotland would mean different regional critical levels would be required. On the Tweed, a three-minute fry sampling protocol is used, and the Irish level of 17 per 5 minutes

transposes to the Tweed category "Low". The "Moderate" Tweed category would work out as 22 to 33 fry per 5 minutes. Most Tweed sites are "Moderate" or higher and have shown consistent results since Fry Index surveys started in 2006.

5.12 New genetic techniques are also now being developed that greatly increase the value of data from juvenile electro-fishing. One already available is a technique that gives the number of full siblings in a sample of fry, i.e. indicates how many fry are from the same pairing of spawning Salmon. The higher this number, the fewer matings there have been in the area and if such sampling was carried out as part of fry surveys, it would indicate the level of spawning activity. For example, if a sample of 50 fry had no full siblings in it, it would indicate a wide range of spawners, but if half the sample were full siblings it would show that even if fry numbers were at good levels, the spawning stock that produced them was limited in that particular part of the catchment.

5.13 Counts of adults give an accurate and "instant" assessment of a spawning stock. The numbers required to fully stock the area upstream of a counter can be worked out and used as Management Targets. If these were not met, action would be taken to restrict any killing downriver. It has to be said that some rivers are better formed for a network of counters than others – the Tweed, for example, not only has many tributaries of a size that are feasible for counting but also a "legacy" of instream structures that can be used to mount counters. At present, two tributaries are counted, and there are plans (by MSS) for a third, and other opportunities exist.

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REFERENCES

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APPENDIX A

A Conservation Limits for the number of returning adults as the basis for the licencing system

A.1 Conservation limits (CLs) for numbers of adult spawners are suggested as the basis for the quotas referred to in the Wild Fisheries Review (WFR) and for the proposed licencing system, but they would have to be set not only for each and every river in Scotland but also for the discrete stocks that exist within the larger rivers. It is questionable if their accuracy is sufficient to bear this weight. In England and Wales, CLs are used to give conservation thresholds for managers, not for determining the numbers that can be killed.

A.2 The methodologies for working out CLs for adult spawners are complex with many assumptions. They require the sort of data that is only available for a few rivers (National Index Rivers) so an extra dimension of uncertainty is created by the need to transpose the required data from Index Rivers to others, which will in many cases be very different. Such uncertainties can be of a level to make practical management use of CLs problematic.

A.3 In the case of Scotland, there is only one index river, the North Esk, and attempts to translocate the required data from this to other Scottish rivers have, so far, not given workable results (MacLean, 2007). These difficulties are further compounded by the need for local data on, for example, fecundity and accurate age/size that are not obtainable other than by killing fish. With the decline of net fisheries and the increasing prevalence of Catch & Release in rod fisheries, such data is becoming less and less available.

A.4 Though CLs for adult spawners are widely used, for practical management action they can only be of value (if accurate) if losses due to angling are significant at the stock level. Given that angling in Summer and Autumn only catches 10-20% of the fish that come in to a river and of those that are caught, most are already returned, this is now unlikely to be the case. Spring Salmon are now all protected by local, total, Catch & Release agreements.

A.5 A recognised alternative to estimated CLs for adult spawners is to have what are called "*Alternative Reference Levels*" (ICES, 2013) , "hard", targets for fisheries management, such as the numbers of fish passing through fish counters or the abundance and spread of juveniles in spawning areas.

A.6 An example of an Alternative Reference Level system in operation can be found in Ireland, where surveys of Salmon fry are used to monitor Salmon rivers where there are no fish counters or other sources of data on adults. The assessment made there is that rivers that have an average juvenile number of 17 fry per five minute sampling for their catchments are meeting their spawning targets. This information is then used to determine if a harvest can be taken from a particular river or whether it should be completely Catch & Release.