

# TAY DISTRICT SALMON FISHERIES BOARD

## FREQUENTLY ASKED QUESTIONS

No. 2. (June 2011)

### Could smolt stocking achieve similar results for the Tay as in Iceland?

The stocking of salmon smolts has transformed catches from the River Ranga in Iceland. We are often asked whether this could happen on the Tay.

There are a number of issues which would have to be considered before deciding to embark on a large smolt stocking programme (e.g. what broodstock to use, where to release them, what effects returning fish would have on the existing population) but the most basic is, would there be a sufficient return to make it worthwhile?

This note reviews the available evidence on return rates from existing and past smolt stocking programmes in order to assess the return that might be expected. Evidence from Iceland is considered before evidence from the British Isles.

#### Icelandic experience

On the Ranga, in most years, the proportion of released smolts that have been subsequently recaptured by anglers has varied from between about 0.4% to 2% and exceptionally as high as 3% (Figure 1). This means a rod caught salmon might be produced for as little as £15 in a very good year and £100 at worst. Recaptures were particularly high from smolts released in 2007 and 2008. Thus, the main cause of exceptional grilse catches in 2008 and 2009 was a good recapture rate rather than increased numbers of smolts released.

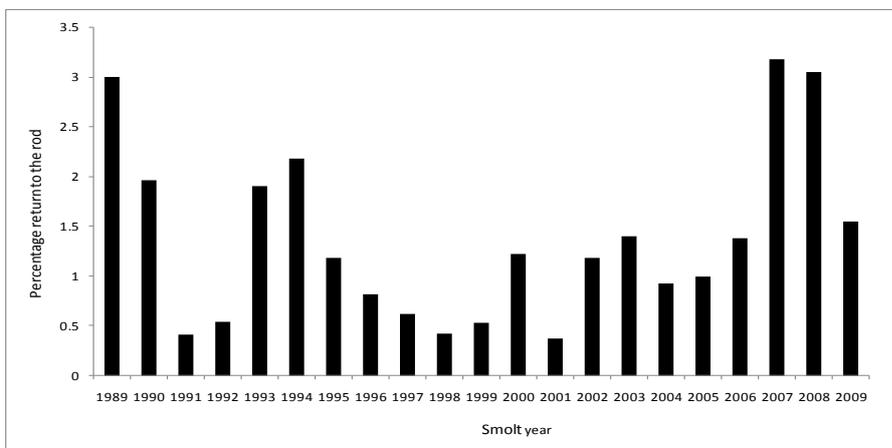


Figure 1. Percentage of smolts released in the River Ranga which were subsequently recaptured as adults by anglers, 1989 – 2009 smolt years<sup>i</sup>.

Could such results be expected in Scotland? To help answer that question we now consider results from monitored examples of smolt stocking in the British Isles.

### River Tay

The Freshwater Fisheries Laboratory (FFL) released 25,000 microtagged<sup>ii</sup> smolts into the River Braan near Dunkeld between 1989 and 1998<sup>iii</sup>. In the years prior to the removal of the Tay estuary nets (i.e. before 1997), releases of one year old smolts produced an average recapture rate to the rod of 0.024% (i.e. 2 adults caught from 8,500 smolts released) and 0.153% (13 adults out of 8,500 smolts) to the Tay estuary nets. Two year old smolts<sup>iv</sup> gave an average rod recapture rate of 0.042% (3 adults out of 7,220 smolts) and an average estuary net recapture rate of 0.208% (15 adults out of 7,220 smolts). However, for one year old smolts released in years after the nets were removed, the average rod recapture rate increased to 0.064% (2 adults out of 3,115 smolts) (although the recapture rate varied from 0% and 0.167% between years) and, for two year old smolts, to 0.08% (5 adults out of 6,253 smolts). These rates are much lower than the recapture rates of smolts released in the Ranga, even in its poorest years.

When smolts which had been reared in the wild in the River Braan were microtagged the recapture rate in Tay estuary nets was 5.14% compared to the 0.153% for hatchery smolts. None were recaptured by rods, but the numbers tagged were small. It is typically the case that wild smolts have a much greater survival than hatchery smolts.

### River Carron

In the last few years there has been a well publicised hatchery scheme on the River Carron (Wester Ross) of which smolt releasing has been a part.

Over the period 2002 to 2004, microtagged smolts were released and these yielded angling recapture rates between 0.125% and 0.35%, which are again much lower than the general Ranga experience, but a bit higher than the Tay releases described above. Some of the smolts were treated with SLICE (an anti sea-lice chemical) but that did not apparently make any difference<sup>v</sup>.

### River Lochy

Releases of hatchery reared smolts by the FFL in the River Lochy (Fort William) in the 1980s yielded recapture rates as adults of only 0.04% in one year and 0.08% in another<sup>vi</sup>.

Another programme of smolt release has been developed more recently. In 2009 some 35,000 smolts reared on a commercial fish farm (cages in a loch as opposed to tank reared) were apparently released. It is understood these fish were fin clipped. From numbers which were reported on a River Lochy fishing website,<sup>vii</sup> it appears that something like a dozen or so recaptures were made as grilse in the River Lochy in 2010 and only one 2SW fish was caught by 6 June 2011. That would imply a recapture rate of the order of 0.04%. It is also understood that over 2000 smolts were tagged with PIT tags<sup>viii</sup> in 2009 and that a very small number (less than ten) were detected in 2010 by a PIT tag detector sited in a fish pass on the river.

The relatively poor survival of the 2009 Lochy smolt release may partly be a result of extra mortality which emigrating smolts from that river appear to face as a result of fish farming. It is understood that smolts released in 2010 were fed before release with the anti-sea lice chemical SLICE and it is hoped this might improve return rates in 2011.

### Kielder Hatchery

Most of the fish from the Kielder Hatchery on the River Tyne are stocked as parr in the autumn. However, some of its production has been stocked out in the spring some weeks before smolting. These “pre-smolts” might not perform exactly the same as fish reared right to the smolt stage, but some of these have been tagged from time to time and have yielded recapture results which are interesting nonetheless.

- From 1980 to 2002 micro-tagged pre-smolts were introduced into the River Tyne on an annual basis. The overall average recapture rate by rod and line in the Tyne over this period was estimated by the Environment Agency to be within the range of 0.035% to 0.1%<sup>ix</sup>. This figure might not be strictly comparable with the present day because more fish were recaptured by the drift net fishery at that time than were recaptured on rod and line and the drift net fishery has since been considerably reduced.
- In two years in the late 1980s some Tweed fish were reared at the Kielder hatchery and introduced into the Tweed after having been microtagged. The subsequent recapture rate by rod and line in the Tweed was 0% and 0.01% of the number stocked. More recaptures were made in net fisheries (0.025% and 0.08%)<sup>x</sup>.
- Between 1988 and 1994 over 76,000 pre-smolts reared at Kielder were microtagged and released into the Yorkshire Esk. Wild salmon smolts caught in a trap were also micro tagged in 1994. On average, 0.26% of the hatchery fish were recaptured by the North East drift net fisheries and 0.04% by anglers in the Esk. However, the wild smolts produced a recapture rate of 3.32% from the drift nets and 0.47% from the rods<sup>xi</sup>.

These results suggest that, even if the effect of the drift net fishery is factored in, the recapture rates of stocked pre-smolts are still a fraction of those reported for Ranga smolts. Kielder bred smolts also perform much less well than wild smolts.

### Delphi Fishery

One place where smolt releasing has been more successful is the Delphi fishery in Co. Mayo, Ireland. The smolts are microtagged before release<sup>xii</sup> and this has provided excellent data<sup>xii</sup>.

Since 1991, recaptures of adult fish by anglers at the Delphi fishery have generally been somewhere between 0.25% and 1% of the smolts released (Figure 2), although several years were over 1%. This is much higher than that generally found in the British Isles. However, the rod recapture rate for grilse from the 2008 release, at 0.01%, was the poorest by far.

For most of the period, the majority of recaptures from Delphi smolts were not from the rod fishery but from coastal net fisheries and that was generally in the range of 1% to 3% (Figure 2), which is high relative to recapture rates of Kielder pre-smolts in the English drift net fishery. The fall in recapture rates from nets after the 2002 smolt year may partly reflect restrictions on netting, culminating in the cessation of drift netting after 2006. The later arrival of grilse in recent years may also have contributed to reduced exploitation in the years immediately before 2007. The rod recapture rate might be expected to increase now that the drift net fishery has closed, although that did not happen with the 2008 smolts.

It is also the case that, before the closure of the drift net fishery, with the exception of the 2005 smolt year (i.e. 1991 – 2004 smolt years), there is a significant positive correlation between the coastal netting recapture rate and the angling recapture rate. That is, with the exception of the 2005 smolt release (which may have been affected by the fact the net fishery was restricted), in years when there was a high rod recapture rate at Delphi the netting recapture rate was also high. That suggests interception by nets may not have been of a sufficient scale to have been the main cause of variation in rod recapture rates. Rather, it would imply that variations in the survival of released smolts were more likely to have driven variations in recapture rates in both fisheries. Indeed, recapture rates from Delphi smolts in the net fishery have been found to be positively correlated with the estimated pre-fishery abundance (PFA) of all wild Irish grilse, implying that the survival of released smolts parallels that of wild smolts. However, no correlation was found between Delphi rod recaptures and the PFA of wild grilse, although it was the case that the year with the lowest recapture rate (2008 smolts → 2009 grilse) also had the lowest PFA of wild Irish grilse since 1991.

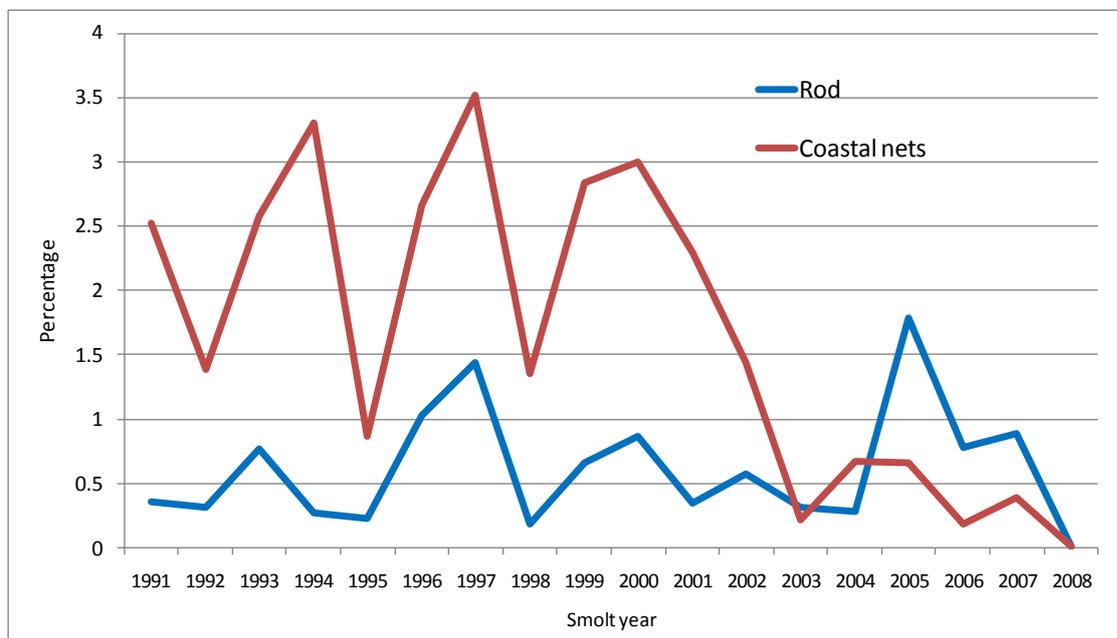


Figure 2. Recapture rate by rods and coastal nets as adults of smolts released at Delphi, 1991 – 2008 smolt years. Please note: 2008 data only consists of grilse returns.

If no net fisheries had ever operated between 1991 and 2007, more fish would have been available to have been caught by anglers at Delphi. If it is assumed that 15% of the fish that were caught by coastal net fisheries had instead been caught by anglers, then the expected angling recapture rates can be seen in Figure 3. The recapture rates for the River Ranga, where there is no netting, are also shown for comparison.

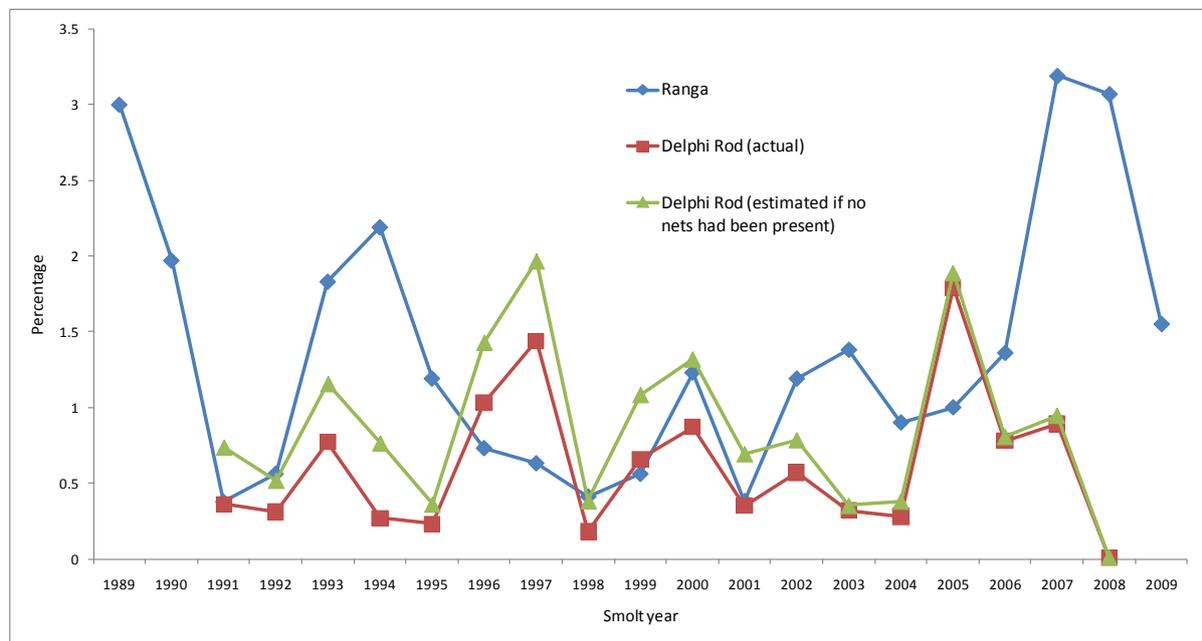


Figure 3. Actual recapture rates of released smolts as adult fish by rods at the Delphi and Ranga fisheries plus estimated recapture rates at Delphi had coastal net fisheries never operated (assuming an angling exploitation rate at Delphi of 15% in summer).

This suggests that, under a level playing field in terms of netting, return rates to the rod at Delphi would have been as good as the Ranga in some years, sometimes even better. However, the best years on the Ranga would have been much better than the best years at Delphi. Ironically, one of the best years for the Ranga (2008 smolts → 2009 grilse) was by far the poorest for Delphi, and indeed for wild grilse in Ireland and Scotland.

That rod recapture rates at Delphi have generally been higher than the Scottish or Kielder experience, may be due to the fact that Delphi smolts have mainly been derived from line-bred strains of ranched smolts which appear to give better survival than smolts derived from eggs obtained from adult fish taken from the wild. This is explained more fully below.

### Burrishoole

Like Delphi, the Burrishoole Fishery in Co. Mayo depends to a large extent on smolt releasing. This programme was set up several decades ago by what was then the Salmon Research Trust of Ireland. The facility is now run by the Marine Institute.

In the early years, smolts were produced from ova obtained from wild fish, but on their return to freshwater surviving adults were captured and ova were stripped from them to produce the next generation of hatchery smolts. It was found that by continuing this process

for a number of generations the survival at sea increased and the hatchery reared smolts achieved survival rates more like those of wild smolts than first generation hatchery smolts.

Figure 4 shows estimated “pre-fishery” (i.e. prior to the drift net fishery) return rates for Burrishoole grilse to the Irish coast from 1980 onwards. There has been a long-term decline since the 1980s but, over much of the period, the return rate was between 5% and 15%. However, the return of the 2008 smolts was the lowest of all, only 1.8%, a finding echoed at Delphi. So poor was the return of grilse in 2009 (despite there being no drift nets) that the Marine Institute was concerned that they might not be able to maintain the ranching strain.

When Delphi started releasing smolts it was initially based on broodstock obtained from Burrishoole and wild Delphi fish. The smolts derived from wild Delphi fish survived less well than those from the Burrishoole stock. However, over time, the returns from “Delphi” stock have improved now that a number of generations of a ranched Delphi strain has developed.

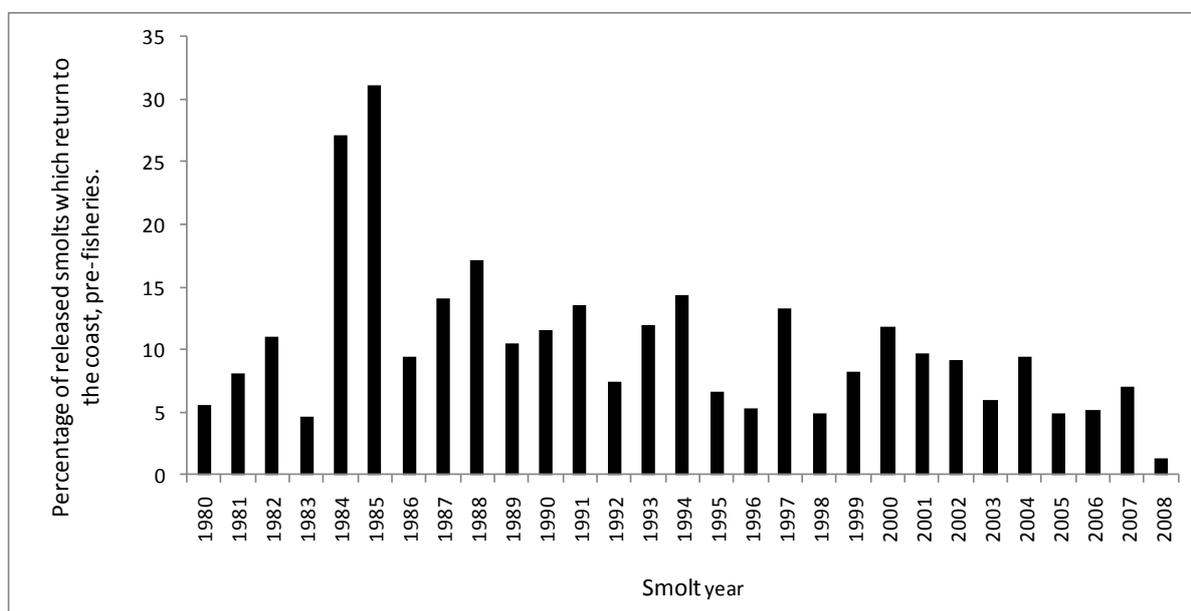


Figure 4. Return rates to the coast of ranched strain smolts released from the Burrishoole Fishery, Co. Mayo, Ireland<sup>xiii</sup>.

### Unreported smolt releases

In addition to the examples described, we are aware that there have in the past been other attempts at smolt releasing in other rivers for which less information has been obtained. For example we are aware of such attempts on rivers as far apart as the Dionard and North Uist in the north and the River Test in Hampshire. However, such trials must not have not achieved their objectives presumably.

## Discussion

It is clear that, in most years, Ranga smolts have much higher recapture rates than those which have been reported in the British Isles.

There appear to be several main causes of this difference.

- In some recent years, marine survival rates of all salmon in western Iceland have been much higher than in the British Isles. For example, the survival of wild salmon from the 2007 and 2008 smolt runs on the River Elliðaár, a small river at Reykjavík which is monitored by Icelandic government scientists, was of a level not seen in Scotland since the 1970s (Figure 5).<sup>xiv</sup> Although reared Ranga smolts do not experience as high survival rates as wild smolts, they obviously also benefited from more favourable marine conditions in 2007 and 2008.

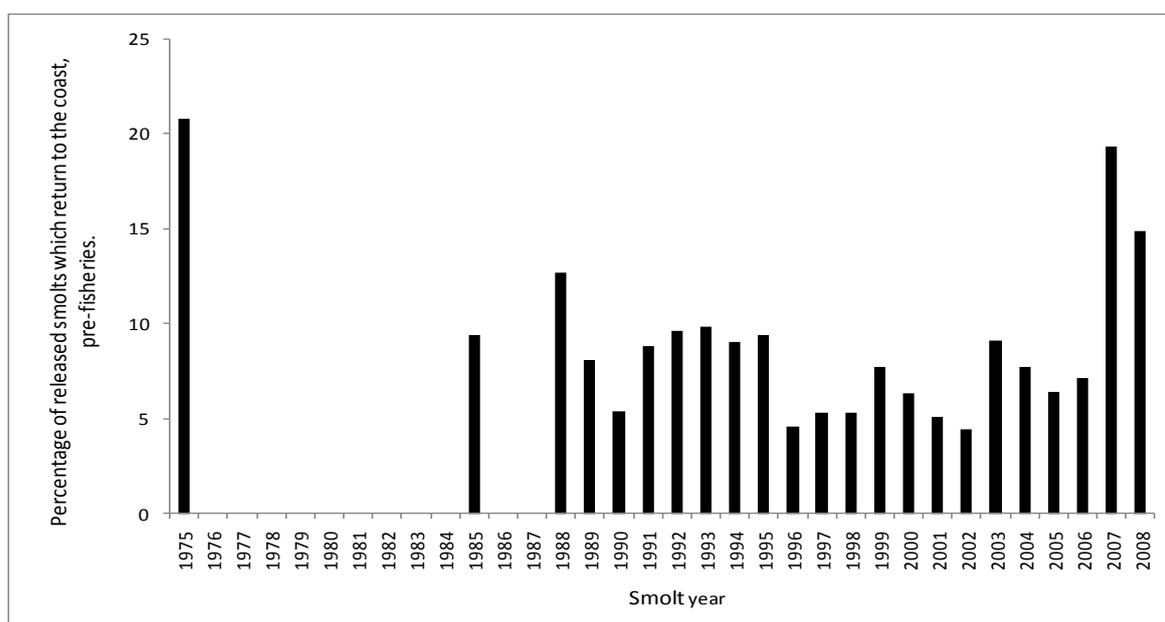


Figure 5. Marine survival of wild fish between smolt and return as grilse, River Elliðaár, Iceland, according to smolt year<sup>xv</sup>. Note: blanks represent years for which data are missing.

- Another factor is that, in Iceland and other high latitude countries, salmon appear to be more easily caught than in Scotland. Icelandic scientists estimate that 50% of grilse and 70% of salmon entering Icelandic rivers normally get caught on rod and line. Here it is nearer 10%<sup>xvi</sup>. Perhaps Icelandic fish have a less suppressed appetite when they return to freshwater because of their closer proximity to the feeding grounds. But whatever the reason, it means that for a given number of released smolts two or three times the number of adults will subsequently be caught.
- On the Ranga, smolts are held in off stream ponds for a period prior to release. This apparently improves return rates, or at least homing precision, and is sometimes cited as a factor in the Ranga's success. In contrast, the smolts released into the River Braan (Tay) referred to earlier were released straight into the river. Maybe that

did contribute, in part, to the generally very low recapture rates of those fish. However, Carron smolts are also released via a pond system and their recapture rates were not much higher than those in the Braan.

On the basis of these studies, it would appear likely that if smolts were released in the Tay at the present time, even via release ponds, recapture rates would only be a small fraction of 1% and this would depend on where in the catchment the smolts were introduced. If, for example, the recapture rate was 0.25%, which is higher than that obtained from any of the batches of smolts released into the River Braan by FFL but making allowance for under-reporting, 400 smolts would need to be released to produce one rod caught fish at a cost of perhaps £200. Even to increase the Tay rod catch by only 10% (1000 fish) would require a very large rearing facility (40 tanks of 5 metre diameter) with running costs which might average about £200,000 per annum. If, in the event that a recapture rate of 0.25% was over-optimistic, the costs would be even higher.

Smolt releasing would produce its best returns in years when natural marine mortality is low which, in the Tay, would mean catches of wild fish would be good anyway. However, it may produce particularly poor returns in years when marine mortality is high and wild returns are also poor – precisely the type of year when we would most wish smolt releasing to be successful. A bad year will remain a bad year irrespective of what is stocked. A good example of that would have been 2009, the year when enquiries about Ranga style smolt releasing were most common. While the Ranga did have record catches, the Tay would most likely have had disastrous returns.

To conclude, could smolt releasing produce the same results for the Tay as Iceland? The answer, at the present time, does appear to be no, unless an extremely large financial outlay is made every year.

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<sup>i</sup> Data provided by Gudni Gudbergsson, Institute of Freshwater Fisheries, Reykjavik.

<sup>ii</sup> A microtag is a tiny piece of stainless wire with a code etched into it which is inserted into the cartilage of a salmon's nose. Tagged fish are identifiable by removing the adipose fin.

<sup>iii</sup> Data kindly supplied by D. Stewart, Marine Scotland Science, Freshwater Lab, Pitlochry.

<sup>iv</sup> The age of the smolts is significant because a 2 year old hatchery smolt, being bigger, may survive better than a 1 year old smolt, but in a real hatchery situation fish are unlikely to be kept to 2 years old because of the extra costs of doing so.

<sup>v</sup> Based on a talk given by R. Kindness at the FFL on 4/2/2010

<sup>vi</sup> Salmon and sea trout: to stock or not? *Scottish Fisheries Information Pamphlet* No. 22. Fisheries Research Services 2003. <http://www.scotland.gov.uk/Uploads/Documents/Stocking.pdf>

<sup>vii</sup> [www.riverlochy.co.uk](http://www.riverlochy.co.uk)

<sup>viii</sup> A PIT tag is a tiny electronic "chip" with an individual identifiable number which is inserted into the body cavity of a fish. When the fish swims past an appropriately located detector the chip emits a radio signal and the fish is detected. This method of tagging has the advantage in that fish do not have to be caught and then reported by fishermen for fish to be identified.

<sup>ix</sup> Data obtained from Milner, N.J. Russell, I.C., Aprahamian, M., Inverarity, R., Shelley, J., and Rippon, P. (2004) *The role of stocking in recovery of the River Tyne salmon fisheries*. Fisheries Technical Report No. 2004/1, Environment Agency, 68pp.

<sup>x</sup> Data obtained from [http://www.tweedfoundation.org.uk/FAQs/Tweed\\_stocking\\_results.pdf](http://www.tweedfoundation.org.uk/FAQs/Tweed_stocking_results.pdf)

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<sup>xi</sup> River Esk Salmon Action Plan Consultation Document. Environment Agency 1998.

<sup>xii</sup> Presented in *Delphi Fishery News* 2010 (<http://www.delphi-salmon.com/newsletter/Delphi%2025th%20Anniversary%20News%20-%20single%20pages.pdf>).

<sup>xiii</sup> Data obtained from reports of ICES Working Group on North Atlantic Salmon.

<sup>xiv</sup> 5% - 10% would appear to be the recent norm for Scotland.

<sup>xv</sup> Data obtained from reports of ICES Working Group on North Atlantic Salmon.

<sup>xvi</sup> Note: One of the findings of work done on the River Carron is that adult fish which have been caught and released have a higher second time recapture rate than has generally been found in other studies in Scotland. If this is the case it may be that the first time catch rate of Carron fish is also relatively high. If this is so it will add to the apparent recapture rates from smolt releases on that river.