Rotary Screw Trap Data from the River Truim 2010

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Spey Foundation Report 04/10

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September 2010

CONTENTS

SUMMARY

A 4ft rotary screw trap was installed on the lower River Truim, an upper tributary of the Spey during Spring 2010. Data on the run time and age structure was determined along with the effects of environmental parameters such as water flow. Initial estimates of salmon and trout run size are also estimated through a mark and recapture approach and application of the Petersen method. Comparisons with smolt estimation produced through electrofishing data and desk based studies are also compared. Data on other fish species was also collected.

1. OBJECTIVES

The aim of this study was to:

1. Examine the feasibility of operating a rotary screw trap in the River Truim,
2. Provide estimates of salmon and sea trout smolt production for the River Truim,
3. Collect baseline data on size, age and run time salmon and sea trout smolt runs,
4. Collect additional data on other species that may be obtained as a by-catch.

2. INTRODUCTION

The River Spey is a Special Area of Conservation (SAC) for four species: Atlantic salmon (*Salmo salar)*, otter (*Lutra lutra*), sea lamprey (*Petromyzon marinus*) and the freshwater pearl mussel (M*argaritifera margaritifera*). The Spey salmon population supports long-term average catches of around 9000 fish per annum and the sport fishery brings considerable economic benefits to the local and national economy (ref). It is essential that every effort is made to protect and where possible enhance the numbers of juvenile salmon produced by the Spey and its tributaries. To facilitate this high quality data is required to monitor the status of the salmon stocks.

Smolt data is considered to be the best measure of the health of salmon stocks in the river, but is hard to come by and usually requires the construction of an instream trap. Although this has proved successful in many areas it often requires a considerable amount of costly river engineering and has high staffing costs. However the recent development of rotary screw traps (Figures 1a and 1b) offer a more cost-effective approach.

Traps of this kind have been used extensively in Canada and the USA and are now being utilised in a variety of rivers across Scotland and the UK. They offer several advantages; the trap requires little engineering other that a suitable anchor point, it is relatively moveable from site to site and will operate across a range of flows.

This reports details the results from the first year of installation of a 4ft trap in the River Truim an upper tributary of the Spey.

3. MATERIALS AND METHODS

Figure 1a: Rotary screw trap (4ft) installed in the lower River Truim 2010.

Figure 1b: Inspecting the rotary screw trap (4ft) for smolts, River Truim 2010.

3.1 Trap Installation

A 4ft rotary screw trap (RST) (Key Mill Construction Ltd, Ladysmith, BC, Canada) was installed in the lower River Truim, downstream from Glentruim Bridge (268900, 795000) on 25th March 2010.

The trap is constructed with two large floats supporting a rotating drum in the centre. The drum faces upstream and is turned by the river flow. An internal screw allows any smolts entering the drum to pass freely into a holding box at the rear of the trap without being removed from the water. The trap was anchored to the river bank by chain and rope attached to the bridge parapet and bankside trees.

The trap was inspected daily, generally in the morning, and captured fish were removed for analysis. The trap was also cleaned daily using brushes. During periods of high spates which carry high debris loads the drum of the trap would be lifted to protect the device and avoid it being washed away. During these periods accessing the trap also was unsafe and some sampling time was lost until safe operation conditions returned.

Captured fish were removed from the holding box by dip net. Fish were anaesthetised (benzocaine) and species identified. Fish length was measured for all fish captured and a small sample of scales for age determination was collected from every tenth salmon and trout captured. All salmon and trout were assessed visually for their condition and classed as smolt, parr, brown trout, silvery trout, etc.

A proportion of salmon and trout smolts were marked on their underside using a spot of Alcian Blue dye for mark re-capture estimates. These fish were then transported approximately 0.5 - 1km upstream before release back into the Truim. Subsequent smolt catches were then examined for recaptures of marked fish so that the efficiency of the RST could be calculated and thus, the size of the overall smolt run to be estimated.

3.2 Environmental Data

A stage post was installed close to the rotary screw trap on 14th May and water levels were then recorded daily. Additional data on river flows was provided by SEPA for their gauging station at Invertruim (268761, 796425) which monitors flows in the upper Spey immediately downstream from the Truim confluence.. A Vemco Minilogger was also installed to collect hourly temperatures. However, this was lost during a spate so a river temperature measurement was taken daily, generally between 08:00 and 11:00hrs each day.

4. RESULTS

4.1 Site Selection

The trap was installed in the lower river Truim at Glentruim Bridge (268900, 795000) on 25th March 2010 and operated until 3rd June 2010. The site was immediately downstream from Glentruim Bridge (Figure 1a) and had a number of positive features for trap operation. Initial inspections of the site indicated that the water flow during low and medium flows was channelled through a narrow rock feature under the right hand bridge arch (Figure 1b). Tests indicated that there was sufficient velocity in the water flow to turn a 4ft drum and that with careful positioning the trap would cover a reasonable proportion of the flow. It was also felt that the smolts would be concentrated into this narrow channel increasing the chance of good capture rates. The bridge parapits and nearby trees provided excellent anchor points and access for staff to and from the trap was also relatively straightforward.

During higher flows water begins to flow through the left hand arch of the bridge which helps to reduce pressure on the trap and there is also an area of sheltered water towards the right hand bank where the trap can be manoeuvred for some protection during spates. A series of high flow events in late March/early April hampered operation and the drum was lifted to avoid damage and the trap moved into the shelter water. However from early April onwards flows remained generally low and no further operational problems were encountered.

The trap was in operation for 70 days and of those it was actively fishing for 56 days. The remaining 14 days were lost due to spates between 28th March and 14th April 2010.

4.2 Fish Data

Table 1: Number, age, and mean length of salmon and trout captured in the lower River Truim RST during 2010.

Salmon		Trout	
Smolt	2845	Silvery	67
Parr	41	Brown	71

Scale Samples Collected						
Salmon Smolts				**Trout**		
Age	**Number**	**%**	**Mean Length (mm)**	**Number**	**%**	**Mean Length (mm)**
1	0	0.0		0	0.0	
2	134	46.5	116	4	12.1	138
3	130	45.1	124	11	33.3	171
4	1	0.4	135	5	0.2	206
5				4	0.12	304
6				3	0.09	404
7				0	0.00	
No Age Resolved	23	8.0		6	18.2	
Un Read	0	0.0		0	0.0	
Total	288			33		

Table 1 provides a summary of the salmon and trout captured descending the Truim from 25th March to 3rd June 2010. Salmon smolts were by far the most dominant fish type with 2845 captured (98.6%). A small quantity of salmon parr were also recorded (1.4%). Trout were also caught and these were visually assessed for silvery appearance indicating the fish may be smolting and therefore likely to become a sea trout. Table 1 indicates that 138 trout were captured and of these 71 (51.4%) were considered to be showing signs of smoltification.

Scales were collected from 288 salmon smolts and scale readings indicated that 2 and 3 year olds dominated, 46.5% and 45.1% respectively. One 4 year old smolt was also found. Table 1 also indicate that older smolt age classes had a greater mean length.

Table 1 indicates that trout showed a much wider range of ages from 2 through to 6 year olds, with 3 year olds giving the greatest percentage at 33.3%. The majority of silvery trout were 2 and 3 year olds. Similar to salmon the mean lengths of trout increased with increasing age.

Table 2: Other fish species captured in the lower River Truim RST during 2010.

Species	Total
Minnow	4
Eel	2
Brook Lamprey (Transformers)	5
Stickleback (3 Spine)	1

Table 2 indicates that four other species of fish were captured in the lower Truim RST, including minnow, eel, brook lamprey and three-spined stickleback. All five brook lamprey that were caught were transformers.

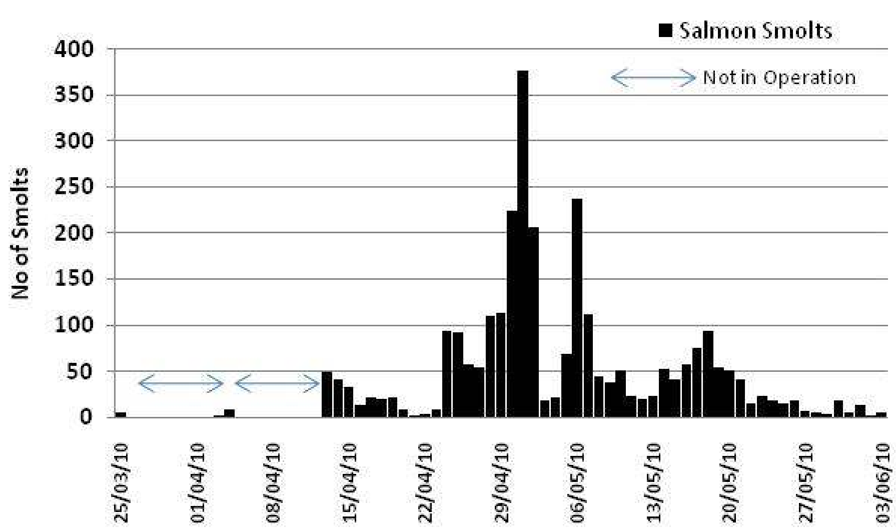

Figure 2: Daily salmon smolt capture in the River Truim RST, 25th March to 3rd June 2010.

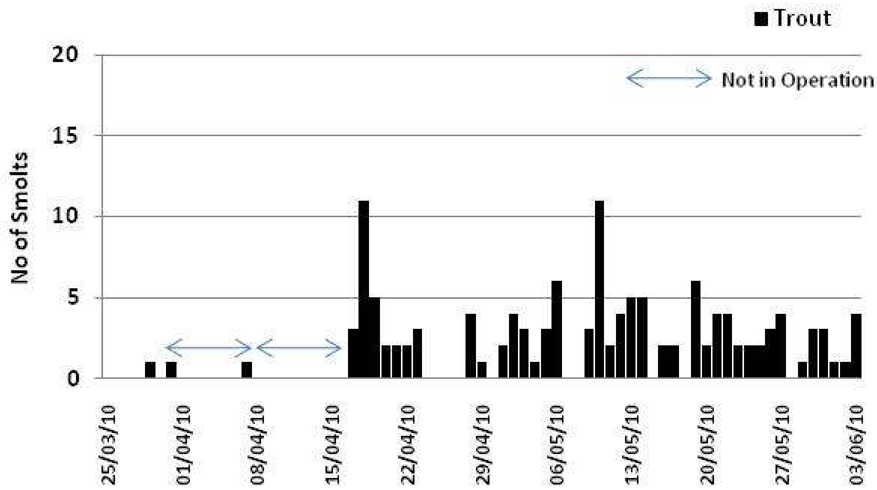

Figure 3: Daily trout capture in the River Truim RST, 25th March to 3rd June 2010.

Figures 2 and 3 indicate the daily catches of salmon smolts and trout respectively. The trap was only operated for one day between 28th March and 14th April 2010 due to spate conditions but thereafter was operated continuously. Salmon smolts were captured on most days with the highest catch of 377 on the 1st May. Trout catches were patchy with 11 trout being the highest daily catch on the 18th April and 10th May 2010.

4.3 Salmon and Trout Capture and Environmental Parameters

Smolt Capture and River Temperature

Temperature data for the Truim was recorded daily between 08:00 and 11:00 and is plotted with the daily catches of salmon smolts and trout in Figures 4 and 5 respectively. It is evident from Figure 4 that temperature may influence the salmon smolt catch. During April and May temperatures were generally below 10^{o}C but when water temperatures did show a rise smolt catches were generally higher. Catches of trout were much lower (Figure 5) and no clear relationship is evident.

Smolt Capture and River Flow

Flow data from the SEPA Invertruim gauging station was obtained and is plotted with the salmon smolt catch data in Figures 6 and the trout catch data in Figure 7. It is evident from Figure 6 that river flow influences the salmon smolt catch. During the initial weeks of operation a particularly large spate (6th April 2010: 60.66m^3s^{-1}) disrupted trap operation and no smolt data is available for that period. This spate produced a flow which compares with the mean annual flow of the lower mainstem River Spey at Boat O' Brigg (64m^3s^{-1}). However Figure 6 indicated that smaller increases in flow were recorded throughout April and May and these often led to increased salmon smolt numbers for the following few days. Catches of trout were much lower (Figure 7) and although there is some evidence of increased catch after spates the relationship is not as clear.

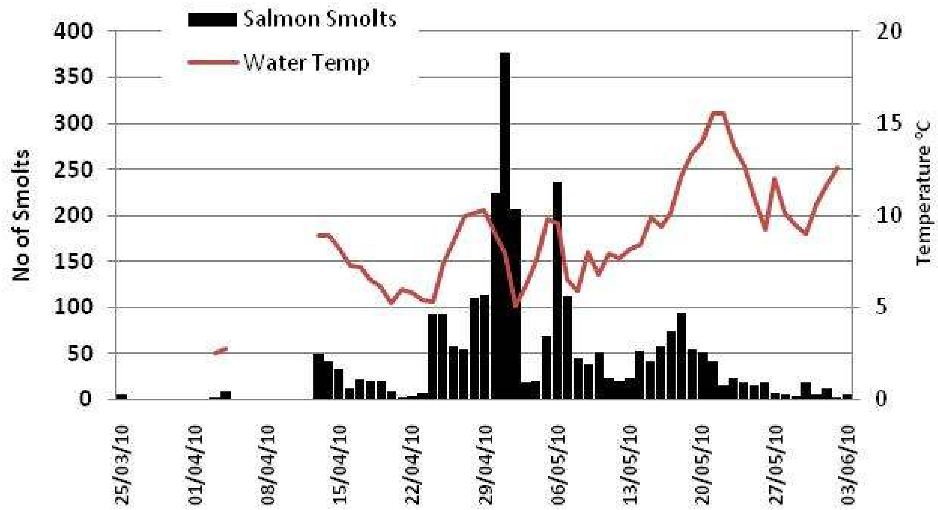

Figure 4: Salmon smolt capture and river temperature (°C) during March to June 2010 on the River Truim.

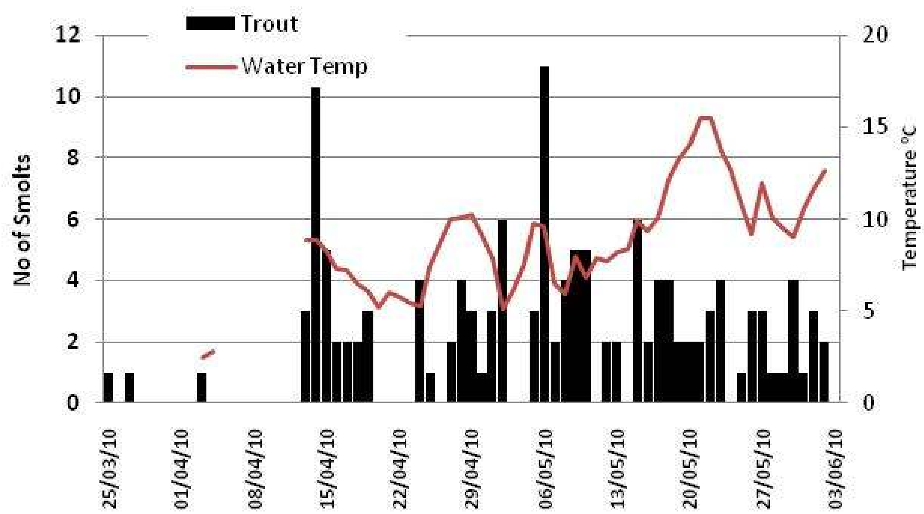

Figure 5: Trout smolt capture and river temperature (°C) during March to June 2010 on the River Truim.

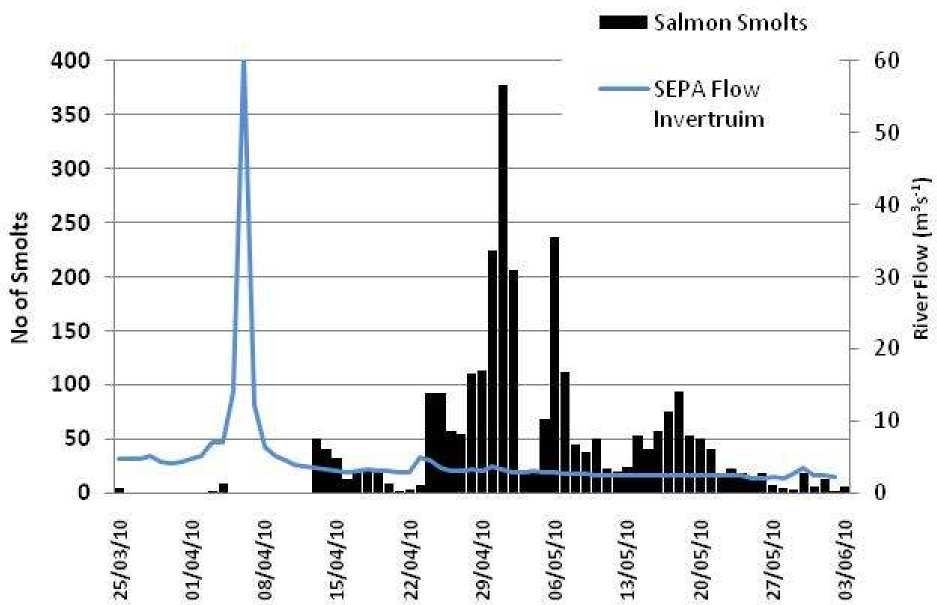

Figure 6: Salmon smolt capture and river flow (m^3s^{-1}) during March to June 2010 on the River Truim.

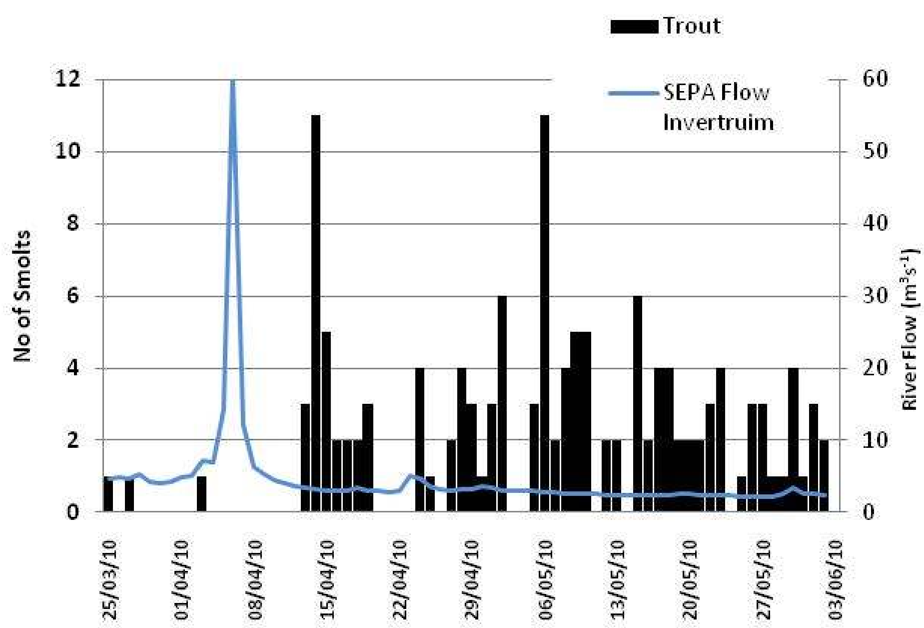

Figure 7: Trout capture and river flow (m^3s^{-1}) during March to June 2010 on the River Truim.

4.4 Cumulative Salmon Smolt Catch

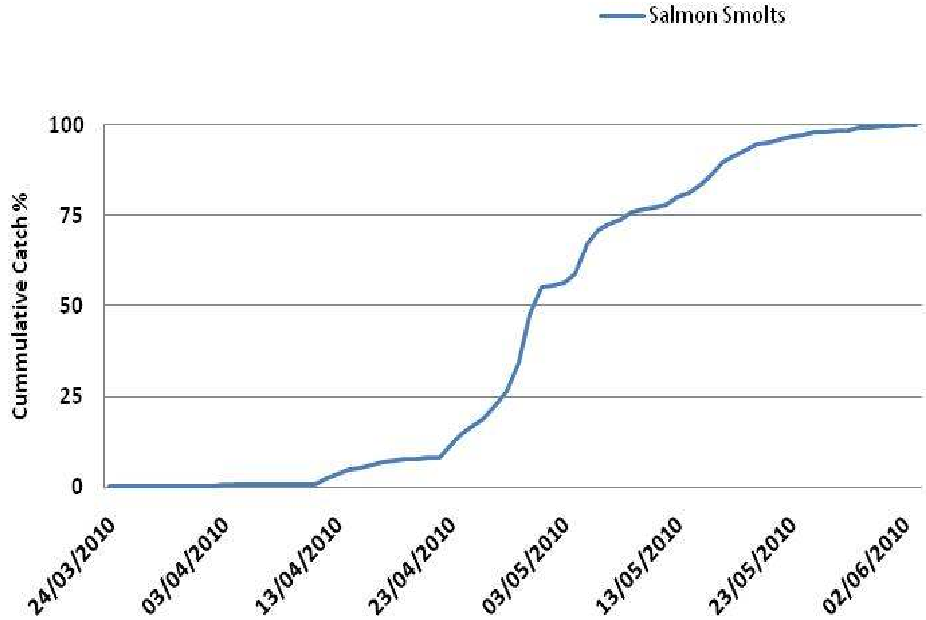

Figure 8: Cumulative salmon smolt catch (%) and time from 24th March 2010 on the River Truim.

Figure 8 shows the cumulative smolt catch with the time from 24th March 2010 and it is evident that 50% of the catch was reached by 2nd May 2010. The smolt run was largely complete by 1st June 2010. This type of analysis will become more useful in future to compare run timings each year.

4.5 Estimating the Smolt Run for the Truim

4.5.1 Using Electrofishing Data

One of the aims of this study was to estimate the numbers of salmon smolts originating from the Truim. Using historical results from traps in the Spey catchment at Spey Dam, the Cally Burn and River Fiddich (Spey Fishery Board, 2005) it has been estimated that the maximum smolt output ranges between 2 and 5 smolts per 100m^2 of riverine habitat. Similar figures have been found by Marine Scotland on the Girnock Burn, Diver Dee, and by the Conon Fishery Board on the River Brahan (*Mckelvie, S. pers com.*).

The length of the Truim utilised by salmon is approximately 19.5km while the mean wetted width is 10.1m (determined from electrofishing sites). So the area available for smolts is 196,950m^2. Using the smolt output range of 2 and 5 smolts per 100m^2 we would predict the Truim to produce between 3939 to 9848 smolts. This can be checked by using electrofishing survey data and the new data from the rotary screw trap.

Table 3: Smolt estimation for the River Truim using electrofishing data from 1990 to 2008.

Truim Smolt Estimation from EF Data 1990-2008		
River Dimensions	Mean Width (m)	River Length (m)
	10.1	19500
Area (m^2)	**196950**	
Long term Mean Densities (m^{-2})	Salmon 1+	Salmon 2+
	0.09	0.04
Adjustment >90mm	Salmon 1+	Salmon 2+
	65%	100%
Adjusted Density (m^{-2})	**0.0585**	**0.04**
Production	Salmon 1+	Salmon 2+
	11522	7878
Total	**19400**	
Over winter survival	50%	
Estimated Smolt Output	**9700**	

Table 3 illustrates how long term electrofishing data can be used to estimate salmon smolt output. The mean densities of salmon 1+ in the Truim from 1990 to 2008 is $0.09m^{-2}$ while the mean density for salmon 2+ is lower at $0.04m^{-2}$. By examining length data from the electrofishing data, approximately 65% of the 1+ salmon are 90mm or above and so are likely to smolt the following spring. All the 2+ parr have reached 90mm and will potentially smolt. These figures are then multiplied by the tributary area to provide an estimate of production. Over winter mortality is also estimated at 50% and so using the electrofishing data we achieve an estimate of 9700 smolts (0.049 smolts per m^2) from the Truim.

4.5.2 Using RST Smolt Data

To estimate the Truim's salmon smolt run using the RST a mark-recapture scheme was initiated. Throughout the spring sampling periods a proportion of both salmon and trout smolts were marked using a simple Alcian Blue dye mark, transported approximately 1km upstream and released. The numbers of marked smolts recaptured were then recorded. Initially a simple Petersen mark-recapture equation (Volkhardt, *et al,* 2007) was used to estimate the overall population as follows,

$$N_i = n_i (M_i/m_i)$$

Where:

N_i = Estimated number of downstream migrants during period i

n_i = Number of fish capture during period i

m_i = Number of marked fish captured during period i

M_i = Number of fish marked and released during period i

This equation also provides a measure of trap efficiency e_i as follows,

$$e_i = (m_i/M_i)$$

Data from the 2010 sampling season was used with the Petersen method to estimate the salmon smolt output for the Truim (Table 4). Table 4 indicates that the percentage recapture rates (34.4%) were good for marked salmon smolts. Using the Petersen method this provided an estimated run of 8268 salmon smolts (0.042smolts per m^2) from the Truim in 2010. Table 5 applies the same approach for trout and it is evident that recaptures of trout were lower with the trap efficiency calculated as 11.2%. The run size for trout was estimated at 1231 fish.

Table 4: Salmon smolt run estimates for the River Truim for 2010 using Petersen mark-recapture method (from Volkardt, *et al* 2007).

Simple Petersen Recapture Model					
Year	Total Salmon Smolts Captured (n_i)	Marked Smolts (M_i)	Marked Smolts Recaptured (m_i)	Estimate of Population Size (N_i)	Trap Efficiency (e_i)
2010	2845	2662	916	8268	34.4

Table 5: Trout run estimates for the River Truim 2010 using Petersen mark-recapture method (from Volkhardt, *et al* 2007).

Simple Petersen Recapture Model					
Year	Total Trout Captured (n_i)	Marked Smolts (M_i)	Marked Smolts Recaptured (m_i)	Estimate of Population Size (N_i)	Trap Efficiency (e_i)
2010	138	116	13	1231	11.2

5. DISCUSSION

The use of rotary traps to estimate smolt outputs has increased considerably in the last few decades. The approach was initially developed in the USA and Canada (Volkhardt, *et al* 2007) and adopted in the UK during the 1990s. This report provides data for the first trial of a 4ft rotary trap on the River Truim, an upper tributary of the Spey.

The site selected for the trap was immediately downstream from Glentruim Bridge and this proved to be a successful choice of location. During low and medium flow levels the water flow passes through a bedrock channel under the right hand bridge arch and this helps to guide smolts to the trap. Plenty of anchor points were also available and access for staff to and from the trap was also fairly straightforward during most water levels.

Spates are always problematic to any trapping system and the RST is no different. During larger spates the drum was raised to prevent damage and some additional protection was also available in the sheltered backwater to the right hand bank. However, although the drum was lowered back into position as soon as possible some smolts would have been missed. Indeed Figure 6 indicates that when the trap was restarted on the 12th April the catch of salmon smolts was quite high for the next few days perhaps indicating that a sizeable number of smolts had emigrated from the Truim after the spate on the 6th April.

One initial concern was that the site was easily accessible to the public and in a similar previous study on the Fiddich this led to vandalism problems. However, no such problems occurred this season.

Six species of fish were captured by the trap, including salmon, trout, minnow, eel, stickleback and Brook lamprey. Salmon smolts were the most abundant followed by trout. The vast majority of the salmon were smolts (98.6%) and three age classes were recorded. Two year and three year old smolts were present in similar proportions, 46.4% and 45.1%, respectively, and a solitary four year old smolt was also caught. The mean length of salmon smolts increased with increasing age. This is similar to data from other Highland Scottish tributaries such as the Water of Mark on the North Esk (McKay and Smith, 2007).

Only a small number of trout were captured during the study which was a surprise since a similar recent study on the neighbouring River Tromie has indicated much higher migrations of trout. The mark-recapture approach was used for trout as well as salmon and indicated that recaptures ie, trap efficiency, was much less for trout than salmon smolts. This may result from differences in behaviour between the species; the salmon are on a definite seaward migration so after re-release above the trap they will be highly likely to migrate downstream again. Trout may not be as committed to downstream migration and so could move upstream from the trap instead. In addition salmon smolts tend to migrate higher in the water column (Moore, Potter, Milner and Bamber, 1995) so may be more susceptible to capture. The large trout may also be strong enough swimmers to avoid the sampling drum.

Just over half (51.4%) the trout captured were silvery in appearance and may well develop into a sea trout smolt. The majority of these trout smolts were 2 and 3 year olds but older trout, up to age 6, were also captured. Elliot (1994) indicated that sea trout smolts range from 140mm to 250mm for the British Isles and the size range observed for the Truim is within this. Although the trout captured were silvery in appearance it is not clear whether they would have developed into sea trout smolts.

Most trout populations will produce a proportion of sea trout and there are reports of occasional sea trout as far upstream as the Truim. Brown trout also undergo migrations within the river and tagging studies have shown trout will travel from the upper tributaries downstream to the lower mainstem. For example, a brown trout (W1923) tagged on the Feshie in October 2005 was caught in June 2010 at Ballindalloch, over 50km downstream.

Smolt capture was during the night and on the occasions when the trap was inspected through the day no smolts were recorded. A number of studies have indicated that salmon smolts largely migrate during the night (Thorpe, Ross, Struthers and Watts, 1981; Moore, Ives, Mead and Talks, 1998) and the pattern of capture here supports this.

Environmental parameters also influenced the catches, in particular river flow. In general higher catches of salmon smolts were evident after a rise in water flow than in periods of more stable flows. This is similar to other studies such as Allen (1944); Hvidsen, Jensen, Vivas, Bakke and Heggberget, (1995). The loss of the temperature logger left only daily spot records of temperature for analysis. There is a slight suggestion that capture rates were greater when river temperatures were higher but better data is needed to explore this relationship further.

The output of salmon smolts from a tributary can be predicted by estimating the stream area and applying smolt estimates from other rivers. This was used to predict a range of smolt outputs for the Truim of 3939 to 9848 smolts. This can then be tested using electro-fishing data and RST data and both approaches provided estimates which were towards the upper end of this predicted range (EF = 9700 smolts (0.049 smolts per m^2) and RST = 8268 smolts (0.042 smolts per m^2)). This was encouraging given the Truim is affected by significant water abstraction for hydro-electric purposes. However, a number of problems are evident within this approach. This is similar to other highland tributaries such as the Water of Mark in the upper North Esk which produced 0.04smolts per m^2 in 2009 (G. Smith and F. Mackay, Marine Scotland Science, *pers com*).

The simple Petersen mark-recapture model used here for smolt estimates depends on a number of assumptions including: the population is closed ie, there is no significant movement in or out of the population; all fish have the same probability of re-capture; all fish have an equal probability of capture in the first sample and similarly in the second sample; marking does not affect the catchability; fish don't lose their marks; and all recovered marked fish are reported. Not all these criteria are adequately met. It is debateable if a migratory smolt population can be considered as a closed population. In general we assume that catchability remains the same between each sample and we are confident that the dye marks used will remain on the fish for the short time period required. Trap operators were experienced in marking techniques and although some may have been missed, losses due to lack of observation is not thought to be significant. However other approaches to estimating smolt population such as installing paired traps and batch marking groups of fish are worth exploring this would allow more sophisticated analysis models to be applied (see Bjorkstedt, 2000). However, to achieve this more resources and manpower would be required.

Trap efficiency will also vary throughout the sampling period (Schwarz and Dempson, 1994; Thedinga, Murphy, Johnson, Lorenz, and Koski, 1994) and can be related to environmental conditions such as water flow (Volkhardt, *et al* 2007). This provides a relationship which allows the prediction of catches to be developed and this can then be utilised when the trap is not operational due to debris jams etc. Inclusion of these estimates would further improve the overall population estimate. However, further data across a wider range of flow rates is required before a robust relationship of this kind can be fully developed for the Truim.

The smolt prediction from electrofishing surveys was based on a long term dataset (1990-2008) and includes a range of survey sites across the length of the Truim which are visited yearly. A whole range of factors affect electrofishing data such as habitat, flow rates, adult spawning success, operator efficiency, number of survey sites visited, etc, and further work to refine the smolt output prediction to account for some of the factors is required. Comparing the smolt output with the density of relevant age classes from the preceding year may also be more helpful than simply using averages. For example the smolts produced in 2010 should be compared with salmon parr densities from 2009. Nonetheless it is encouraging to report that both approaches are providing smolt estimates that are similar. As more data is collected from the RST this approach can be further developed and potentially a relationship between smolt output and elecrofishing densities developed for the Truim. Collecting information on adult numbers and spawning in the Truim would also be beneficial.

6. RECOMMENDATIONS

1. Continue sampling Truim smolt runs using rotary screw trap (RST) placed below Glentruim Bridge in 2011 and 2012,
2. Further examine the effects of environmental parameters on the smolt run from the Truim,
3. Explore and implement better population estimate techniques for the RST on the River Truim,
4. Continue to develop area based estimates of smolt production from the Truim using electrofishing data and compare with smolt trap estimates.

7. CONCLUSIONS

The rotary screw trap was successfully operated in the River Truim, an upper tributary of the Spey, during 2010. Valuable data on the run time and age structure of salmon smolts was gathered along with the effects of environmental parameters such as water flow and temperature. Application of a simple mark and recapture approach allowed population estimates to be created and comparisons with predicted smolt outputs using desk-based estimates and electro-fishing data to be explored. The RSTs provided excellent data for salmon smolts and although trout were regularly caught the traps did not appear to be as good at trapping them. A small amount of data on minnows, eels, lamprey and sticklebacks was also collected.

The Truim is a known spawning area for the vulnerable spring run adult salmon and the river is also subjected to water abstraction for hydro-generating purposes. Thus the smolt data will prove very valuable for the future management of the Spey SAC salmon stocks.

8. ACKNOWLEDGEMENTS

This study was generously financially supported by The Hon Michael Samuel, Phones Estate, Newtonmore and Scottish and Southern Energy.

Thanks must go to the following personnel: Steve Burns (Spey Foundation), Jim Reid (Spey Foundation) and Jason Hysert (Spey Fishery Board) who operated the trap for the season; Richard Whyte, Duncan Ferguson and Lindsay Grant, all from Spey Fishery Board, who very ably assisted with the installation and removal of the traps. Thanks also go to Michael Glass, Phones Estate, for his interest and support throughout the study, to Marcus McBain, Baldow Smithy, who provided much needed repairs to the traps after spate damage and to the staff at Invernavon Caravan Park for providing parking.

I am grateful to Gordon Smith (MSS Montrose), Ross Gardiner (MSS Pitlochry) and Rodger Knight (SFB) for their useful comments on earlier drafts of this report.

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