Rotary Screw Trap Data from the River Truim 2011

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SUMMARY

A 4ft rotary screw trap was installed on the lower River Truim, an upper tributary of the Spey during Spring 2011. Data on the run time and age structure was determined along with the effects of environmental parameters such as water flow. Comparison with data from 2010 is made along with estimates of salmon and trout run size are also 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. To continue 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 data on size, age and run time salmon and sea trout smolt runs,
4. Compare data with previous years smolt data.

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.

A 4ft rotary screw trap was installed and operated successfully in the lower Truim during 2010 (Laughton 2010a) and this reports details the results from the second year of installation.

3. MATERIALS AND METHODS

Figure 1a: Rotary screw trap (4ft) installed in the lower River Truim 2010 and 2011.

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

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 24th March 2011.

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 during 2010 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.

4. RESULTS

4.1 Installation and operation 2011

The trap was installed in the lower river Truim at Glentruim Bridge (268900, 795000) on 24th March 2011 and operated until 24th May 2011 (Figure 1a). This site had been trialled successfully in 2010 and operated well across a range of flows (Laughton, 2010)

The trap was in operation for 61 days and of those it was actively fishing for 59 days. The remaining 2 days were lost due to high water levels on the 5th and 6th June 2011.

4.2 Fish Data

Table 1: Number, age, and mean length of salmon and trout captured in the lower River Truim RST during 2011.

Salmon				**Trout**		
Smolt	1762			Silvery	84	
Parr	43			Brown	142	
Scale Samples Collected						
Salmon Smolts				**Trout**		
Age	**Number**	**%**	**Mean Length (mm)**	**Number**	**%**	**Mean Length (mm)**
1	1	0.6	116	0	0.0	
2	66	36.5	120	3	7.3	129
3	101	55.8	127	11	26.8	182
4	1	0.6	117	6	14.63	233
5				6	14.63	305
6				8	19.51	348
7				1	2.44	392
No Age Resolved	12	6.6		6	14.6	
Un Read	0	0.0		0	0.0	
Total	181	100		41	100	

Table 1 provides a summary of the salmon and trout captured descending the Truim from 24th March to 24th May 2011. Salmon were by far the most dominant fish type with 1805 captured, of these 1762 (97.6%) were smolts and 43 (2.4%) were salmon parr. 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 226 trout were captured and of these 84 (37.2%) were considered to be showing signs of smoltification the remaining 142 (62.8%) were classed as brown trout.

Scales were collected from 141 salmon smolts and scale readings indicated that 2 and 3 year olds dominated, 36.5% and 55.8% respectively. One 1 year old and one 4 year old smolt were also found. Table 1 also indicate that older smolt age classes had a greater mean length although the four year old smolt was smaller than the mean lengths of the two and the three year old smolts.

Scales were collected from 41 trout and 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 26.8%. 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 2011.

Species	Total
Minnow	0
Eel	1
Brook Lamprey (Transformers)	1
Stickleback (3 Spine)	1
Pike	3

Table 2 indicates that four other species of fish were captured in the lower Truim RST, including eel, brook lamprey, three-spined stickleback and pike. The brook lamprey that was caught was a transformer.

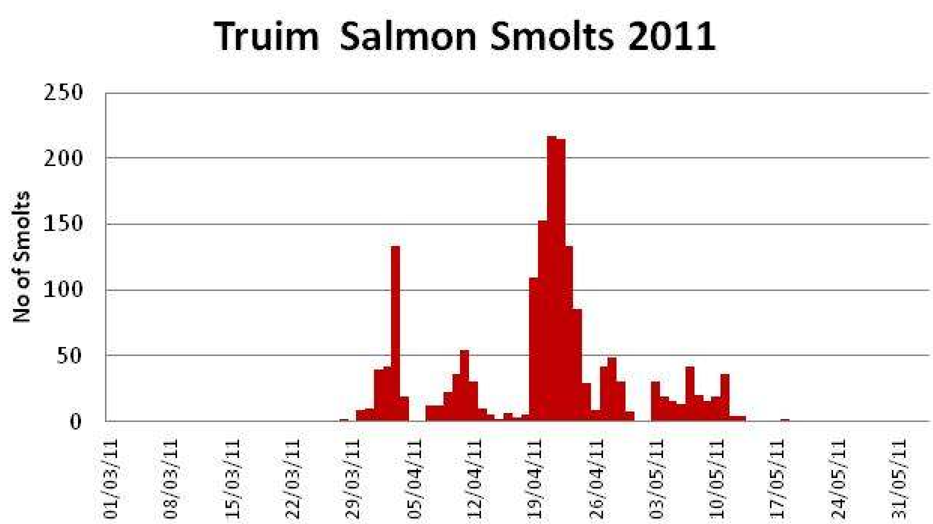

Figure 2: Daily salmon smolt capture in the River Truim RST, 24th March to 24th May 2011 Note the trap was not operated on the 5th and 6th of April 2011.

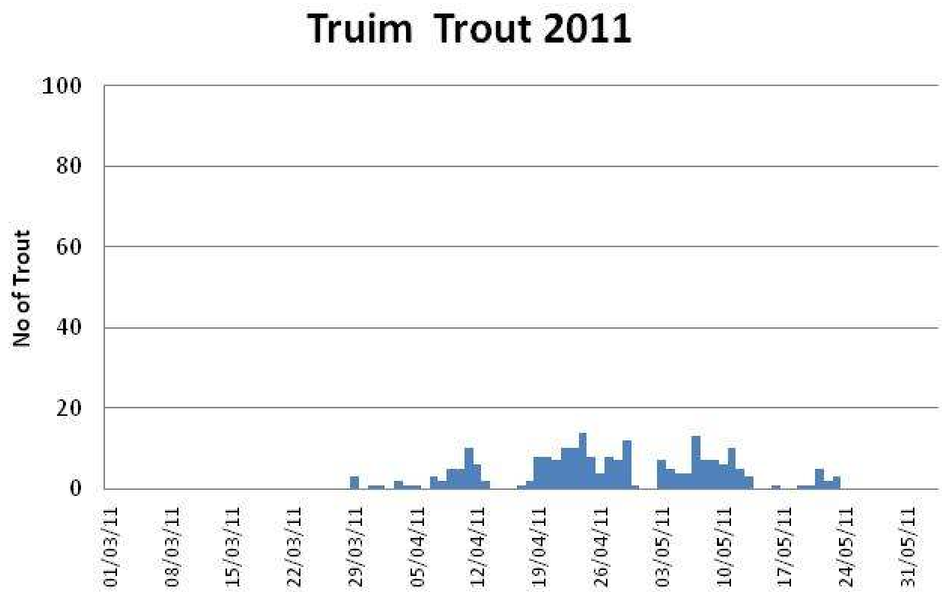

Figure 3: Daily trout capture in the River Truim RST, 24th March to 24th May 2011 Note trap was not operated on the 5th and 6th of April 2011.

Figures 2 and 3 indicate the daily catches of salmon smolts and trout respectively. Only two days were lost due to high water, the 5th – 6th April 2011) and thereafter the trap was operated continuously. Salmon smolts were captured on most days with the highest catch of 217 on the 21st April 2011. Trout catches were patchy with 14 trout being the highest daily catch on the 24th April 2011.

4.3 Salmon and Trout Capture and Environmental Parameters

Smolt Capture and River Temperature

Temperature data for the Truim was recorded hourly using a VEMCO minilogger and the mean daily temperatures for the period of smolt trap operation is plotted with the daily catches of salmon smolts and trout in Figures 4 and 5 respectively. Mean daily temperatures during March to May indicated a steady rise after a sudden drop in early March. This reflects the fairly mild and stable weather conditions throughout Spring 2011. The relationship between salmon smolt capture and river temperature is not clear although as temperatures approach 10^{O}C salmon smolt catches increased. Catches of trout were much lower (Figure 5) and no clear relationship is evident.

Smolt Capture and River Flow

River 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. Flow levels during the spring 2011 were characterised by spate in early April (4th-6th) followed by a steady decline in flows throughout April and May. One or two small increases in flow were recorded during April and a small rise was evident in early May but in general the sampling period was dry and mild. A further large spate marked the end of the trapping season at the end of May. Figure 6 indicated that smaller increases in flow were recorded throughout April did lead 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.

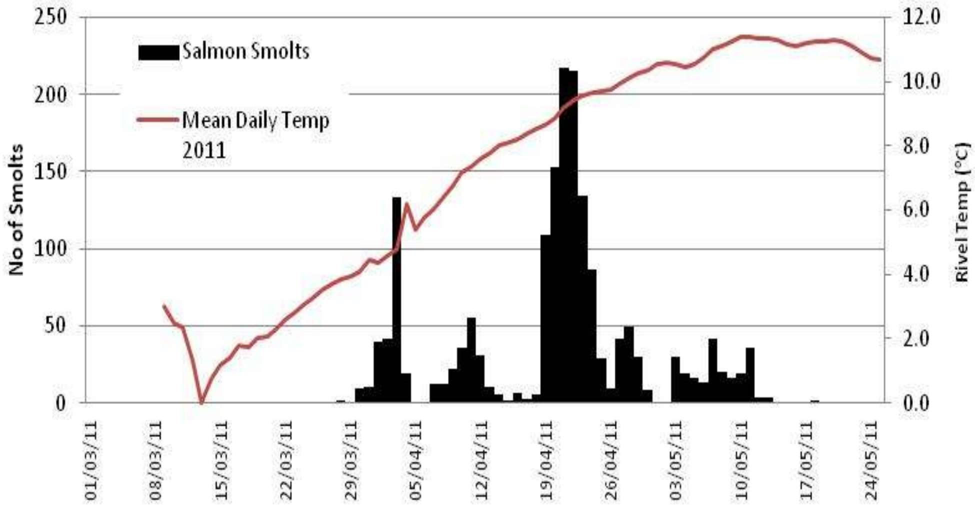

Figure 4: Salmon smolt capture and river temperature (°C) during March to June 2011 on the River Truim.

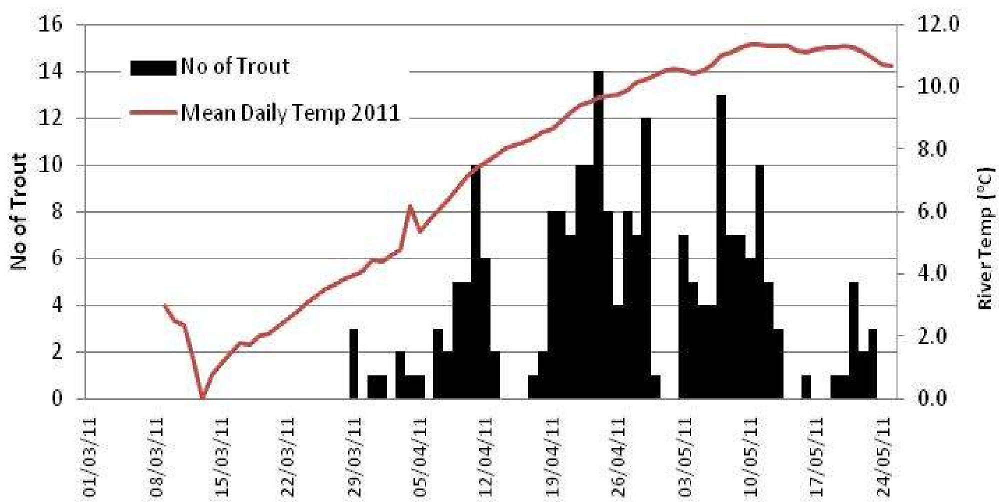

Figure 5: Trout smolt capture and river temperature (°C) during March to June 2011 on the River Truim.

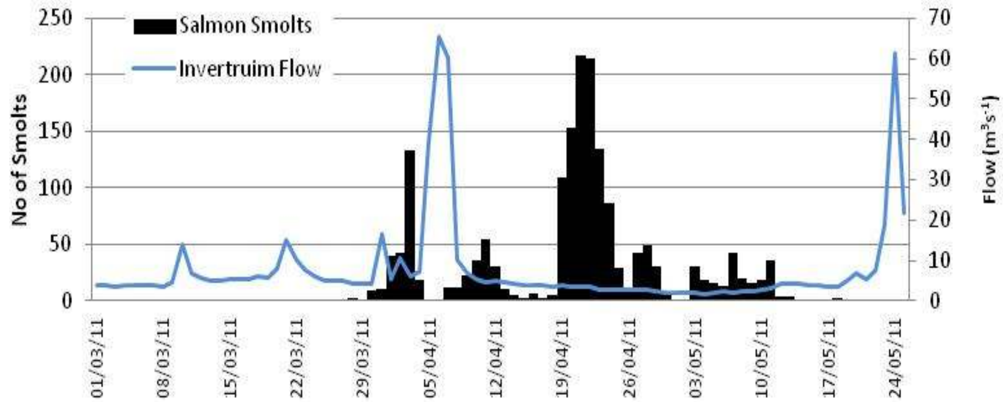

Figure 6: Salmon smolt capture and river flow (m^3s^{-1}) during March to June 2011 on the River Truim. River flow data supplied by SEPA.

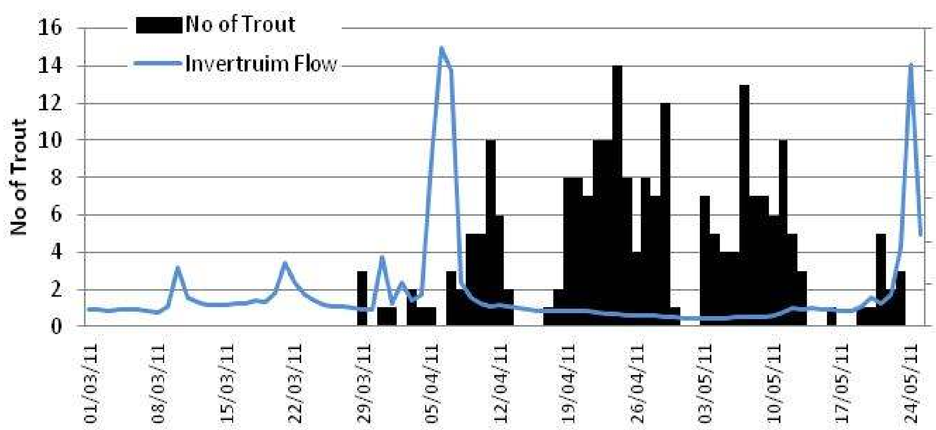

Figure 7: Trout capture and river flow (m^3s^{-1}) during March to June 2011 on the River Truim. River flow data supplied by SEPA.

4.4 Cumulative Salmon Smolt Catch

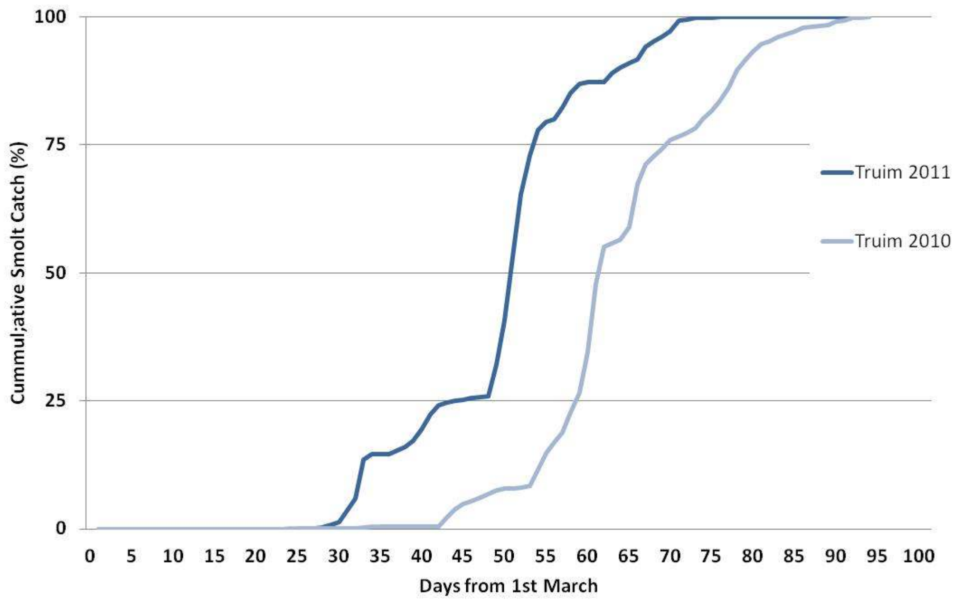

Figure 8: Cumulative salmon smolt catch (%) and time from 24th March 2010 on the River Truim.

Figure 8 shows the cumulative smolt catch with the time for 2010 and 2011. and it is evident that there was quite a difference in the timing of the run in each year. In 2010, 50% of the catch was reached by the 2nd May 2010 while in 2011 it was a week earlier, 21st April 2011. The smolt run was largely complete by the end of May in both years.

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- 2011 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
2011	1762	1668	467	6293	28.0

Table 5: Trout run estimates for the River Truim 2010 - 2011 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
2011	226	194	17	2579	8.8

5. DISCUSSION

This report provides data for the second year of operating a 4ft rotary trap on the River Truim, an upper tributary of the Spey. Similar to 2010 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 the trap was lifted during the 5th and 6th April during high water levels sand heavy debris loads so some smolts would have been lost.

Six species of fish were captured by the trap, including salmon, trout, pike, eel, stickleback and Brook lamprey. Salmon smolts were the most abundant followed by trout. The vast majority of the salmon were smolts and four age classes were recorded this season. Two year and three year old smolts were the dominant age classes, 36.5% and 55.8%, respectively, and a one year old and a four year old smolt were also caught. The mean length of salmon smolts increased with increasing age although the four year old smolt was smaller than its younger contemporaries. This is similar to data from the nearby Tromie (Laughton 2010a) and other Highland Scottish tributaries such as the Water of Mark on the North Esk (McKay and Smith, 2007).

Similar to 2010 only a small number of trout were captured, much lower than a similar recent study on the neighbouring River Tromie (Laughton 2010b). 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.

Approximately on third (37%) of 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 7, 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. River flow data was supplied by SEPA from their Invertruim gauging station. This station is located on the mainstem Spey a short distance downstream from the Truim confluence so flow levels will include both the Truim and the upper Spey. However, the trends in flow should be indicative of the Truim and suitable for comparing with smolt data.

There was some evidence of increased smolt capture after spate events in March. However, during the April, when the majority of smolts were captured, weather conditions were very dry leading to low, stable flow conditions. Studies such as Allen (1944); Hvidsen, Jensen, Vivas, Bakke and Heggberget, (1995) and previous trapping on the Truim in 2010 (Laughton 2010a) have generally indicated higher numbers of smolts captured after spate events. However, in 2011 with little or no change in flow rates other environmental factors are also affecting the smolt emigration.

Temperature is also an important factor in the development of smolts (Kennedy and Crozier, 2010), for example, Jonsson and Ruud-Hansen (1985) suggest that the start of the yearly smolt run was not triggered by a specific water temperature or a specific number of degree-days, but was controlled by a combination of temperature increase and temperature level in the river during spring. Zydlewski, Haro and McCormick, (2005) also suggest that temperature experience over time is more relevant to initiation and termination of downstream movement than a particular temperature threshold. Gurney, Bacon, Tyldesley and Youngson, (2008) also indicate that temperature is an important part of development but other factors such as density dependant mortality at earlier life stages also play an important part. To examining the relationships between smolt output from the Truim and environmental factors, better long term data is required. There is a water gauging station operated by SEPA nearby on the Spey and a Vemco minilogger has also been installed at the trap site to record year round data.

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 The EF data provides an estimate towards the upper end of this predicted range (EF = 9700 smolts : 0.049 smolts per m^2) while this years smolt trap estimate sits more towards the middle (RST = 6293 smolts : 0.032 smolts per m^2). The estimate from the RST in 2010 was higher at 8268 smolts so 2011 indicates a slight decline but still encouraging given the Truim is affected by significant water abstraction for hydro-electric purposes. 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 2007) and other trapping on the Tromie (2011: 0.048smolts per m^2), (Laughton. 2011).

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 are within the predicted range. 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 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 2011. 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

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