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ENVIRONMENT AGENCY

Analysis of growth and survival of sea trout from the Welsh Dee:

Interim Report, 2nd April 00

Atlantic Salmon Trust: Project Ref 99/7

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1. Introduction

The purpose of this interim report is to provide the Atlantic Salmon Trust with a brief summary of the main findings of the project to date – examining progress against the first three (main) objectives. Any comments by the Trust on the report would be welcome.

Its format it is not meant to reflect that of the Final project report - which will adopt a more formal structure common to scientific studies of this type.

Data analysis for the Final report is still being undertaken and it is anticipated that a draft will be available to the Trust by the end of April 00.

This represents a delay of 1 month on the expected reporting date and is partly due to staff changes during the second half of the project when Jenny McIlroy (employed specifically to assist with the project) left to take up a post elsewhere in the Agency. Jenny has since been replaced by another MSc graduate – Matthew Hazlewood – who has a background in freshwater and marine biology.

2. Aims and Methods

The main aim of the project is to examine processes of growth and survival in sea trout from the Welsh Dee - utilising an 8-year (1991-98) time-series of data collected from returning adult fish captured at Chester Weir fish trap.

These data include:

i. **Estimates of annual run size for .0+SW and >.0+SW fish** - these were derived from tagging and recapture (12 months later) at Chester Weir (see, for example, Table 1).

ii. **Freshwater and marine age** – taken from scale readings from around 10,000 fish.

iii. **Measured length and weight** – recorded for a similar sample size to the above.

In order to explore freshwater (juvenile) as well as marine (adult) growth processes, measurements from a sub-sample of maiden .0+ and .1+ adult scales were used to back-calculate pre- and post-smolt lengths (the Dee has no facility for sampling sea trout smolts). This was a major component of the project and provided a significant amount of additional data with measurements taken from over 2,000 scales.

3. Provisional findings

3.1 Objective I: To examine individual smolt age/size and first summer marine growth among maturing and non-maturing .0+ maiden sea trout recaptured on the Welsh Dee, 1992-98

Tagging studies show that of the .0+ sea trout captured at Chester Weir, a proportion will go on to spawn in the year of their first return to freshwater while some will remain maiden fish. This is confirmed by the recapture of fish, a year later, as .0+SM+ fish (ie. previous spawners) or .1+ maidens, respectively.

This objective sets out to explore whether these two groups of recaptured fish show differences in freshwater or marine growth which might provide an indicator of their subsequent maturation history.

To answer this question, analysis to date has focussed on any size differences which exist, *on their first return*, between adult (.0+) fish recaptured as .0+SM+ fish or 1+ maidens.

Figs 1a and b show the length distributions of .1+ and .0+SM+ recaptures on their first return. The comparison is restricted to fish tagged from 1994 onwards because, prior to 1994, the grid spacings on the upstream grill of the trap were wide enough to allow escape of fish (principally .0+ fish) less than around 350mm long.

To improve trap efficiency, temporary screens with smaller spacings were deployed during the peak of the .0+ run in July-August 1994 and in each year subsequently. This resulted in capture of a more representative sample of the .0+ run - indicated by Fig 1c and d, where the (geometric) mean length of .0+ fish in 1991-93 (343mm) was significantly greater ($P<0.01$) than that in later years (313mm).

For 0+ fish recaptured as 0+SM+ and 1+ fish (Fig 1a and b), the mean length of the former (316mm) was significantly greater than the latter (300mm) ($P<0.01$). This suggests (as perhaps might be expected) that larger fish within the .0+ run are more likely to mature and spawn in the year of their first return than smaller individuals.

Further analysis is to be carried out on these data, in particular to examine smolt age and freshwater growth history of maturing and non-maturing .0+ fish and to look for other differences in these two groups (eg. timing of first return). An additional question of interest is whether all fish returning as .1+ maidens also return a year earlier as .0+ fish or whether a component of this group remains at sea in the first year. If the latter were the case than different growth patterns might be expected among individuals within this age group.

3.2 Objective II: To compare smolt age/size and first summer marine growth patterns among all sampled fish with those of recaptured fish (above) in order to investigate any tagging effect on the growth of surviving fish and/or confirm any growth indicators of subsequent maturation history

A major concern with any fish tagging study such as that on the Dee is that handling and tagging may have an adverse effect on subsequent behaviour and survival. If such effects were present they might be expected to be more severe in smaller members of the tagged population than larger and, as a result, surviving (recaptured) fish would tend to be larger *at first return* than the population as a whole.

To test this hypothesis, the size composition of surviving .0+ tagged fish (ie .0+SM+ and .1+ recaptures) was compared with that of the remaining tagged population (whose fate was unknown). For the years 1994-98 combined, there was no significant difference ($P>0.05$) between the mean length of all recaptured fish in the year of their first return (311mm) and that of the remaining .0+ population (314mm). The same was also true of fish tagged in 1991-93.

The only difference to emerge from these comparisons (for the 1994-98 data set) was that .1+ recaptures were significantly smaller (300mm) at first return than the remaining .0+ population (314mm) ($P<0.01$). This is the opposite of what might be expected from any adverse tagging effect and provides additional evidence of a link between .0+ size and maturation.

To explore this further, back-calculated lengths at 1 and 2 river years were derived from scales of .0+ and .1+ fish and compared within and between year classes (Fig 2). For this comparison, only data from fish which emmigrated as 2 year old smolt were examined (more than 80% of adult sea trout returning to the Dee have a smolt age of 2 years).

For most year classes shown in Fig 2, and within any one river age category, there were significant differences ($P<0.05$) between back-calculated lengths derived from .0+ or .1+ adult scales. However, at 1 river year these differences were far less marked than at 2 years, when back-calculated lengths derived from .0+ fish were always greater than those from .1+ fish.

While maturation fate at first return is unknown for the .0+ fish used in this comparison it may indicate that faster growth in the second river year in particular, and the size attained at smoltification, could be important to early maturation.

One problem with using back-calculated lengths is that there is uncertainty as to whether the back-calculation procedure itself is introducing bias to the result, particularly if this bias is affected by adult size. For example, back-calculation from larger (1+) adults may systematically underestimate pre-smolt size.

To investigate this possible bias, back-calculated lengths derived from the same fish on two different occasions can be compared. From the tagging programme on the Dee in the last 8 years, 66 .0+ fish have been recaptured as .1+ maidens, but , to date, only 9 of these fish have been found with scales in a condition which allows annuli measurements at both adult stages (many scales have eroded river centres and normally only 3 or 4 scales are taken from each fish.). For the 9 fish with repeat measurements, there was no significant difference ($P<0.05$) between the back-calculated lengths at ages 1 or 2, suggesting that any size related bias may be minimal. Further scale samples of this type will be sought .

3.3 Objective III: To explore annual variation (1991-97) in survival and growth of maiden and previous spawning sea trout and inter-relationships between these parameters and temperature (both freshwater and marine)

To date, limited analysis has been carried out to address this objective. One area of particular interest is whether post-smolt growth (ie. growth over the first summer at sea) can be linked to survival at sea or some index of survival (eg. associations of this type have been found in salmon) and to explore the influence of marine temperature on these processes.

Part of this analysis is described in Figs 3-5 where post-smolt growth over the first summer is expressed as an absolute (Fig 4) or proportional (Fig 5) increase in length from smoltification. Both these measures show similar trends, and in the early years at least, some evidence of synchrony for values derived from 0+ and 1+ adults. [It should be noted that these measures require a mixture of back-calculated and observed lengths which vary according to the origin of the data (ie. whether from .0+ or .1+ adults) and so, strictly speaking describe growth over slightly different time periods.]

The next phase of this analysis will estimate survival for different groups of maiden fish and previous spawners; the run estimates required for this process have already been derived (Table 2).

Sea temperature data around the Dee estuary and Liverpool Bay have been obtained and similar data from the freshwater Dee are currently being collated.

Ian Davidson and Matthew Hazlewood
02.04.00

Table 1 Tagging, recapture and run estimates details for sea trout at Chester Weir, 1991-97

	Year: 1991	1992	1993	1994	1995	1996	1997
Trap catch	594	911	1293	3183	3354	2468	2427
Number tagged	422	651	889	1726	1755	1748	1622
% Tagged	71.0	71.5	68.8	54.2	52.3	70.8	66.8
Trap recaptures	19	53	54	131	87	120	129
Run estimate:							
0SW fish	5202	2537	9693	3897	6673	4645	5509
(+/- 95% CL)	(2301-10252)	(1359-4931)	(4572-18646)	(2901-5226)	(4814-9222)	(3408-6317)	(4164-7277)
>0SW fish	2776	1767	1708	1838	2653	1450	1731
(+/- 95% CL)	(1725-4407)	(1328-2347)	(1238-2350)	(1428-2365)	(1938-3621)	(1139-1844)	(1353-2214)
Total	7978	4304	11401	5735	9326	6095	7240

Table 2 Estimated numbers of sea trout in each sea age group by year of return, 1991-97

	1991	1992	1993	1994	1995	1996	
0+	5202	2537	9693	3897	6673	4645	
0+SM+	528	425	406	450	520	574	
0+2SM+	88	116	90	105	80	58	
0+3SM+	7	45	32	15	25	13	
0+4SM+		13	17	10	15	7	
0+5SM+	7					2	
0+6SM+							
0+7SM+			3				
1+	1656	782	820	956	1409	589	
1+SM+	183	177	152	90	260	107	
1+2SM+	44	23	41	12	24	21	
1+3SM+	29		12	10		6	
1+4SM+		6	3		9	2	
1+5SM+				2	3		
2+	198	119	85	169	287	54	
2+SM+	22	29	26	5	18	13	
2+2SM+	7	26	6	7		2	
2+3SM+	7	3	12	5	3		
2+4SM+		3		2			
2+5SM+			3			2	
Total >0SW	2776	1767	1708	1838	2653	1450	

Fig 1a Size distribution of .0+ sea trout recaptured as .1+ maidens; River Dee, 1994-97

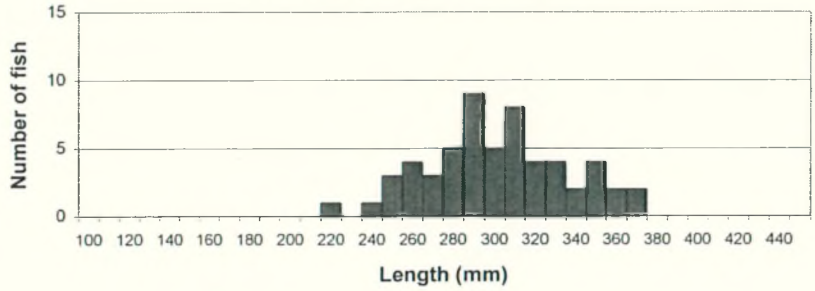

Fig 1b Size distribution of .0+ sea trout recaptured as .0+SM+ previous spawners; River Dee, 1994-97

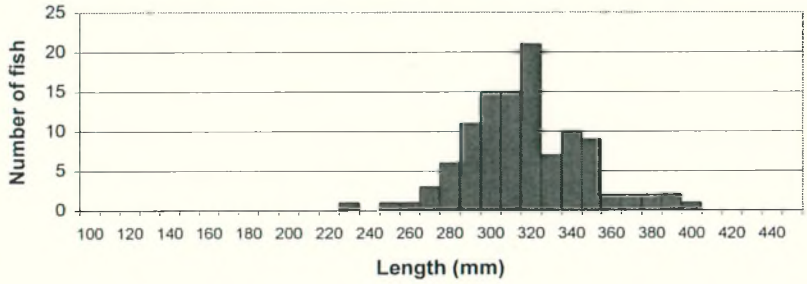

Fig 1c Size distribution of all .0+ sea trout; River Dee, 1994-97

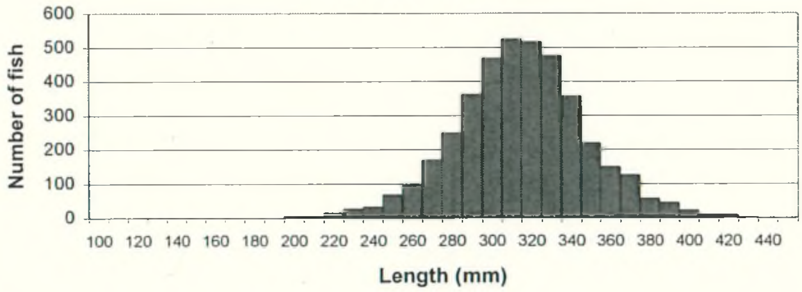

Fig 1d Size distribution of all .0+ sea trout; River Dee, 1991-93

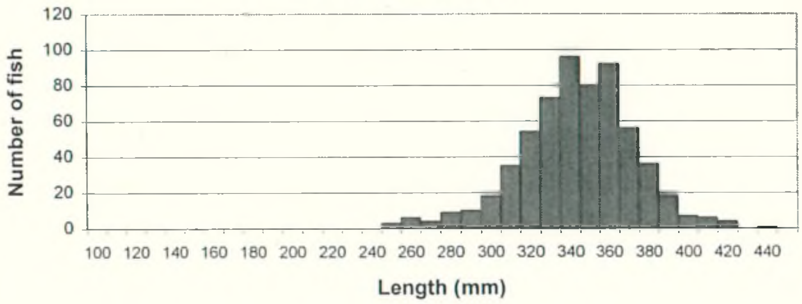

Fig 2 Mean back-calculated lengths (+/-95% CL) at river ages (RA) 1 and 2 - derived from adult .0+ and .1+ scale measurements (all fish emmigrating as 2-year old smolts).

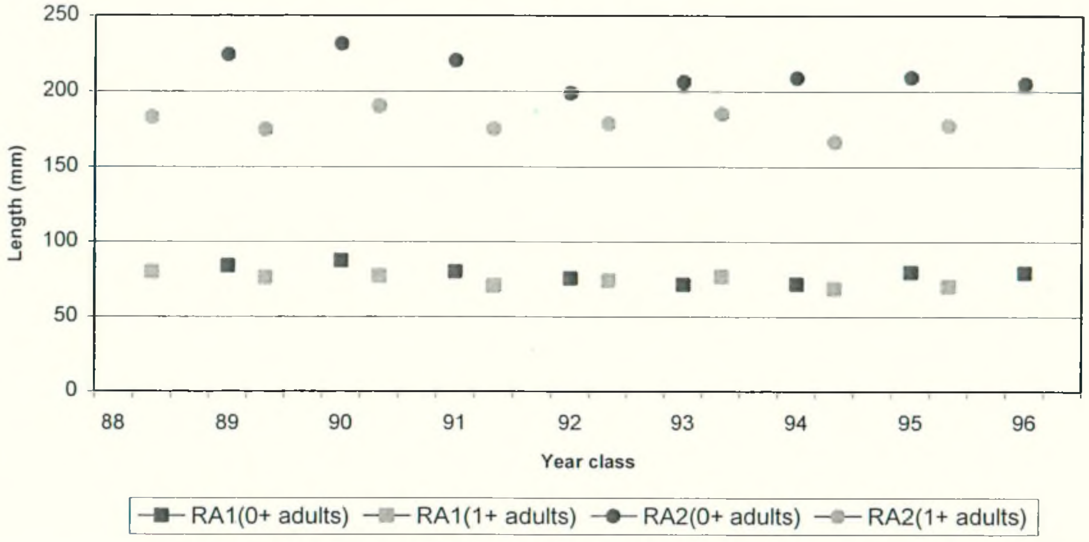

Fig 3 Mean back-calculated and measured lengths (+/- 95%CL) approximate to size at smoltification and size after one summer at sea (lengths derived from .0+ and .1+ adults)

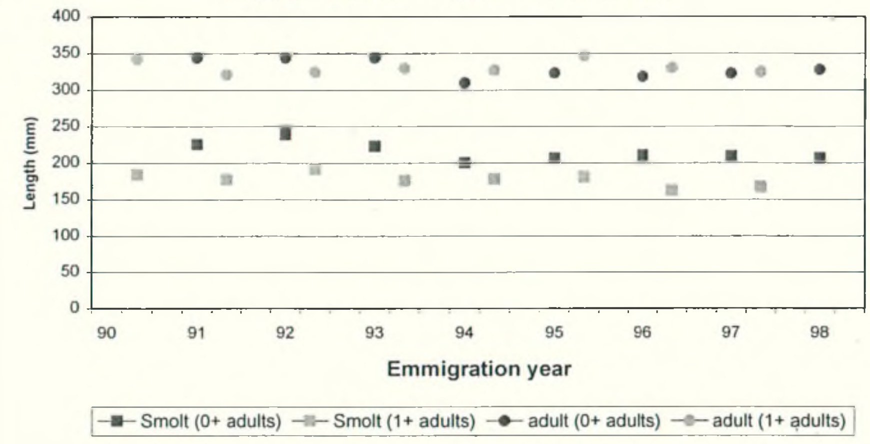

Fig 4. Increase in mean length (+/- 95%CL) from approximate size at smoltification to size after first summer at sea

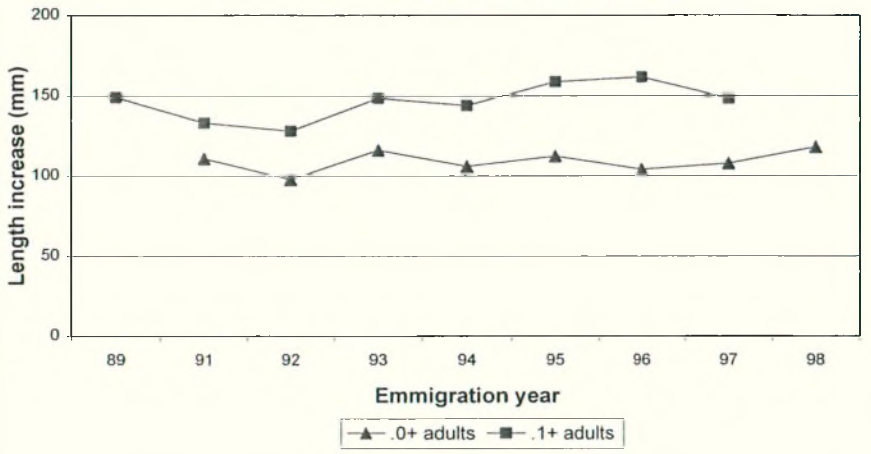

Fig 5. Proportional increase in mean length (+/- 95%CL) from approximate size at smoltification to size after first summer at sea