Year-class Strengths and Recruitment in a Grayling Population - 1998 Sampling

A. T. Ibbotson BSc, PhD, MIFM, Grad IPM

Report to: Environment Agency, South West Region
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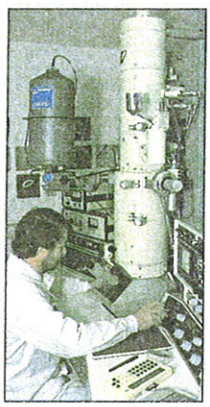

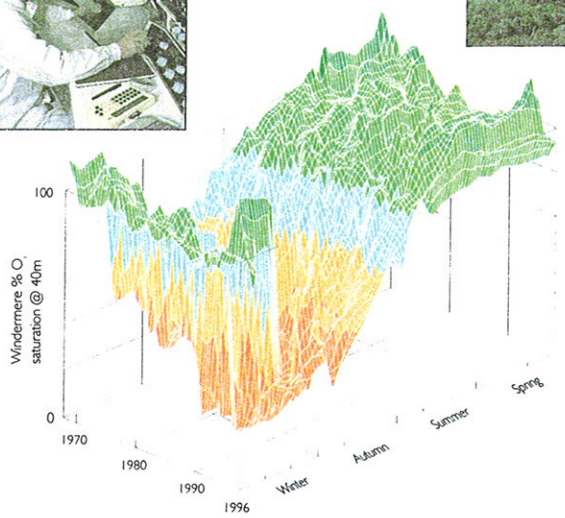

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1. Introduction

Methods for resolving water resource issues for fish have improved in recent years with the advent of a number of hydrological and habitat based models, such as PHabSim. However, these models are not designed to predict the impacts of variations in flow or other environmental factors on fish populations directly.

Most modelling of the man-made impacts on riverine fish populations in this country concerns trout *Salmo trutta* and salmon. *Salmo salar* However, grayling *Thymallus thymallus*, a comparatively understudied fish species, are numerically dominant in large areas of the middle reaches of chalk streams and other rivers. Indeed Huet's original zonation scheme of rivers, afforded a complete zone to grayling. These areas are often subject to the impacts of abstraction, impoundment and other forms of regulation, and grayling are thus a well suited species to study because they are abundant and in most cases less manipulated than trout.

In 1996 the Institute of Freshwater Ecology in collaboration with the Grayling Society Research Fund, Piscatorial Society and Environment Agency commenced a study of the grayling population at 12 sites on the River Wylye, with the following objectives.

2. Objectives

- To quantify fluctuations in recruitment and year-class strength in a grayling population.
- To develop predictive relationships between various environmental factors, including flow levels and the measured fluctuations in year-class strength.
- To model recruitment in a grayling population and to develop a conceptual model for other grayling populations.

This document reports the catches of fish from the third year sampling carried out on 5 and 6 October 1998. Summaries of the previous years catches are included in this report.

3. Methods

On 5 and 6 October 1998 the Piscatorial Society completed single pass electric fishing surveys on 12, 200m sections of the River Wylye between Heytesbury and Stockton (Fig. 1). All grayling were captured in nets, measured in length and a sample had scales removed for age analysis. All fish were returned to the river alive.

The following environmental measures have or are being collected:-

Local habitat features for each site including width, depth, habitat type and cover.

Measures of flow from the guaging weir at Stockton

Measures of air temperature.

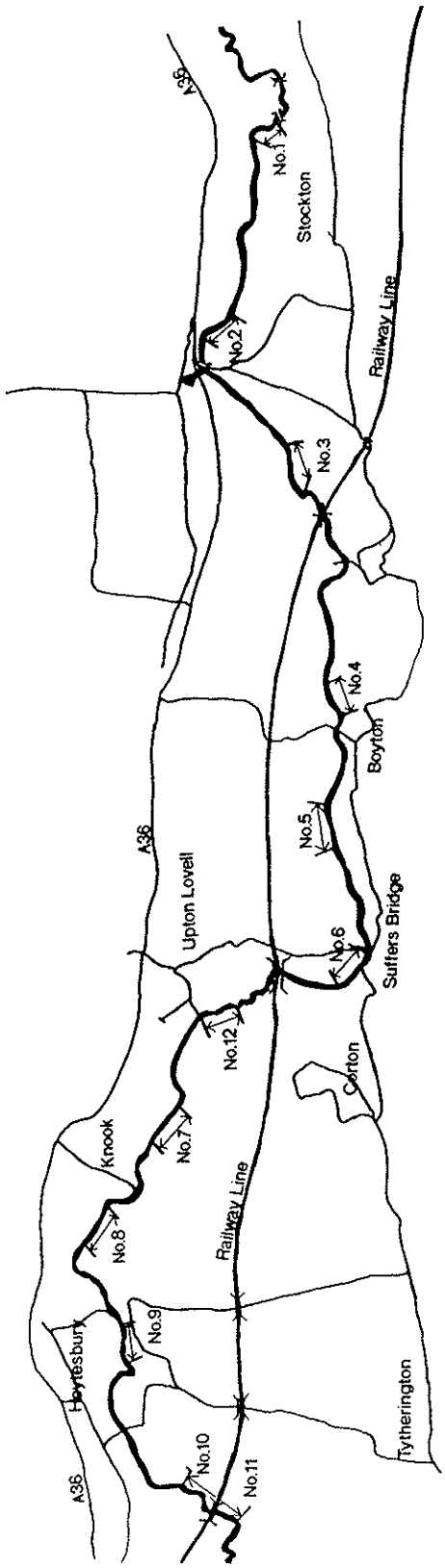

Figure 1. Map of the River Wylye identifying the 12 sites where the grayling population was sampled.

4. Results

In total 543 grayling were captured split between 6 year classes (Table 1). The numbers of fish in each year-class did not decline linearly with age and more fish were captured from the 1997 year-class than from the 1998 year-class.

Table 1. The numbers and mean sizes of grayling in each year-class captured from 12 sites on the River Wylye in October 1998.

Yearclass	Number of grayling captured	Mean length (mm) ± S.E.
1998	124	134 ± 0.91
1997	199	249 ± 1.03
1996	150	290 ± 1.47
1995	45	323 ± 3.61
1994	19	345 ± 6.65
1993	6	351 ± 16.2
Total	543	

The 1998 year-class could be separated by size from the other year-classes, but there was considerable overlapping of size amongst the other age groups (Fig. 2).

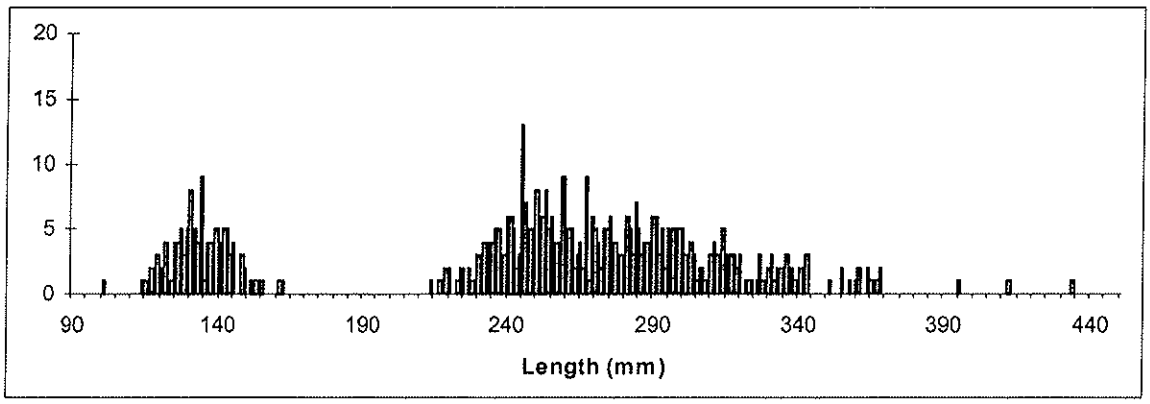

Figure 2. Length frequency histogram of grayling captured at 12 sites on the River Wylye in October 1998.

Over the three years of the study to date, there have been clear differences in the age structures of the population between years. For example, the 1994 and 1996 year-classes look to have been strong, whereas the 1998 year-class looks to be weak (Table 2).

Table 2. Summary of the numbers grayling captured on the River Wylye in October of the years 1996-1998.

	Number of fish captured in each sampling year		
Year-class	1996	1997	1998
1991	2	-	-
1992	2	2	-
1993	89	18	6
1994	206	100	19
1995	152	94	45
1996	282	287	150
1997		206	199
1998			124

Survival rates between the ages of 3, 4 and 5 years looks to be stable between year-classes (Table 3). Some apparent variation, appears to occur between the ages of 2 and 3.

Table 3. Survival rates for each year-class of grayling on the River Wylye.

	Age next birthday (years)		
Year-class	2-3	3-4	4-5
1993	-	-	0.20
1994	-	0.49	0.19
1995	0.62	0.48	-
1996	0.52	-	-

Growth rates between years are variable (Table 4), with the 1997 year-class being bigger than other years.

Table 4. Summary of the mean lengths (mm) of grayling captured on the River Wylye in October of the years 1996-1998.

	Mean length (mm) of fish captured in each sampling year		
Yearclass	1996	1997	1998
1991	370 ± 12.5	-	-
1992	340 ± 0.50	326 ± 8.6	-
1993	330 ± 2.38	319 ± 12.6	351 ± 16.2
1994	283 ± 1.60	313 ± 5.3	345 ± 6.7
1995	238 ± 1.28	282 ± 4.2	323 ± 3.61
1996	134 ± 0.79	227 ± 2.23	290 ± 1.47
1997		141 ± 1.95	249 ± 1.03
1998			134 ± 0.91

5. Discussion

Fewer fish were captured in 1998, than in the two previous sampling occasions. This could either result from a change in the population size or a change in the efficiency of capture. Although we cannot be certain which of these is the cause, it would seem unlikely to be a change in the efficiency of capture as the methodology is kept identical in every year. Analysis of the population structure and previous years survival rates would suggest that there were less 0+ fish in 1998 and that the mortality rate for 2+ fish had been higher than in previous years. These two factors explain all of the shortfall in the number of fish captured.

This suggests a weak year-class in 1998. The reasons for the higher mortality of the 2+ fish are unclear, but could be related to many factors including angling or density dependent mortality. It will become more clear next year as to whether this is a true reflection of the population structure.

This raises the question of whether to continue the study. The original objectives were dependent on the ability to quantify fluctuations in recruitment and year-class strengths and then to relate these to various environmental factors which include flow levels, temperature and local habitat. At the very beginning of the study this was recognised to be a long term undertaking and that it would not provide useful data for management purposes in the short term.

Now that three years has passed since the studies inception, it is worth reviewing whether these objectives can be achieved in the long-term. Specifically, this will apply to the quality of the data collected and whether this will enable a realistic estimate of year-class strength for each year-class.

Ideally, one would like to collect data on the absolute numbers of grayling. However, even if this were possible it would be highly labour intensive and expensive. Failing this some mechanism for estimating abundance such as the catch-depletion method would be the second choice. To complete such an exercise over all the sites looked at in this study would require many more days of field and laboratory work and also be considerably more expensive than the present study. In any case there is no possibility of this occurring because the mechanism for field data collection is not under our control.

Thus we have to ask whether the single shock method of collecting fish from 12 different sites spread over 12 km of the River Wylye gives data of sufficient quality to calculate year-class strength.

Year-class strength can be estimated by a variety of methods. If the data collected gives a good estimate of the true population size at any point in time, then that figure can be used to estimate year-class strength. For a single shock electric fishing field sampling method to provide data of sufficient quality to do this, the effort would have to be consistent every year and the efficiency not influenced by sampling conditions. In this case, sampling is consistent; using the same man power and equipment each time and sampling exactly the same sites. The sampling efficiency is difficult to quantify, however one might expect it to be stable as sampling is always completed during clear water conditions. Further evidence of this stability comes from the data collected to date. If efficiency were highly variable then apparent mortality rates between ages of the same year-class should also vary considerably. However, these do not, with the decline in abundance between 3 and 4 years old and 4 and 5 years old being very consistent between

year-classes (Table 3), although it should be recognised that there are only two measures of this. The variation in the survival rates between 2 and 3 years of age for the 1995 and 1996 year-classes may be a real variation. Thus if it can be accepted that effort and efficiency of capture are constant then year-class strength can be estimated from the number of fish captured in each age group. Using, the age of 1+ as the selected group, since this is the largest size that fish are captured before maturity, that would give relative YCS values of 0.72, 1.35 & 0.94 for the year-classes 1995, 1996 & 1997 respectively.

Other methods of estimating year-class strength, are based on comparisons of the % numbers of fish from a particular year's hatch summed over the years they appear in the catches divided by the mean % number for each age group summed for the life-span of the grayling. However, this may not give the best estimate for this population as it appears that survival rates between 2 and 3 years of age are variable.

Currently, year-class strength has not been estimated for enough years to make any assessment of what influences it. Data is still being collected on flows, temperatures, angling catches and local habitat features. However, as previously stated this was always intended to be a long-term study and it does appear from the data that year-class strength can be estimated satisfactorily. Further, the value for money aspect of this study is very high, since large amounts of data about this particular population are being collected for a very small amount of money. We recommend that the study is continued under the same financial arrangements for at least another three years before further review.

APPENDIX A.

Individual lengths (mm) of all grayling captured at 12 sites on the River Wylye in October 1988.

Site 1 Glebe Farm 5/10/98		
130		365
134		368
134		
138		
139		
148		
149		
242		
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249		
250		
250		
251		
255		
256		
258		
260		
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343		

Site 2 Stockton 5/10/98	
129	
136	
136	
137	
138	
142	
143	
145	
148	
219	
232	
245	
246	
254	
267	
272	
275	
277	
277	
282	
284	
287	
291	
300	
313	
364	
395	

Site 3 Lower Boyton 5/10/98		
139		
232		
238		
243		
253		
255		
258		
261		
264		
265		
265		
267		
267		
269		
270		
275		
281		
285		
287		
290		
291		
334		
338		
341		
361		
367		
368		

Site 4 Lower Boyton Bridge 5/10/98		
132		332
220		333
228		334
235		336
235		341
240		
245		
253		
253		
254		
254		
255		
256		
257		
263		
264		
269		
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306		
318		
320		
326		
330		

Site 5 Middle Boyton The Heronry 5/10/98			
114		312	
116		315	
118		320	
120		323	
121		327	
123		331	
126		343	
127		358	
129		412	
130			
130			
132			
133			
133			
135			
136			
144			
225			
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306			
310			
310			
311			

Site 6 Upper Boyton Suffers Bridge 5/10/98			
117		320	
122		331	
127		333	
127		339	
134		342	
139		351	
141		355	
143			
152			
153			
223			
233			
234			
235			
236			
246			
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318			

Site 7 Lower Knook 6/10/98		
125		
127		
129		
220		
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244		
245		
245		
250		
250		
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262		
264		
273		
284		
286		
298		
301		
308		
315		
319		
336		
360		

Site 8 Knook Car Park 5/10/98		
115		283
120		283
125		287
128		288
130		289
130		290
131		292
132		292
133		293
137		294
141		295
143		303
145		304
149		314
219		314
225		316
227		317
232		361
237		
237		
237		
240		
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255		
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283		

Site 9 Heytesbury Mill 6/10/98		
142		
249		
249		
254		
269		
273		
285		
290		
297		
297		
301		
302		
310		
311		
312		
317		
327		
328		
330		
331		
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338		
434		

Site 10 Parsonage below Viaduct 6/10/98			
118			
119			
124			
126			
127			
129			
134			
137			
142			
142			
148			
151			
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253			
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266			
269			
274			
280			
282			
285			
298			
299			
302			
314			
327			
336			

Site 11 Parsonage above Viaduct 6/10/98			
119		262	
122		265	
125		266	
126		270	
126		270	
128		279	
129		281	
130		281	
130		282	
131		286	
134		291	
134		291	
134		291	
134		297	
137		300	
138		305	
140		343	
141		355	
143		364	
144			
145			
162			
214			
229			
231			
232			
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245			
245			
245			
245			
248			
250			
251			
253			
257			
259			
259			
262			

Site 12 Upton Lovell 6/10/98		
101		246
117		248
119		250
122		250
122		252
125		253
128		253
130		258
131		259
131		261
132		262
132		263
133		265
134		267
136		267
138		273
139		274
139		274
140		274
140		275
141		277
142		285
143		288
144		290
145		293
155		297
161		299
217		300
224		304
224		307
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