Monitoring of sea trout post-smolts, 2010

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Introduction

Started in 1997, this project has enabled the establishment of a good database of the population dynamics of sea trout within the area. Additional information about lice burdens on the trout within the estuaries has also provided an analysis of the relationship between fish farms and sea trout, with particular regard to sea lice (Marshall 2003).

The monitoring of post-smolts was originally designed to give an indication of the migrations and growth of sea trout within the area. The individual tagging of fish, combined with the measurements taken at capture, gave a baseline from which to assess these parameters following re-capture by nets or rod and line. In addition to these data, the numbers of sea lice were also assessed. This has now progressed, such that sea lice counts are the main part of the project, with the tagging of fish giving additional information.

This programme is funded by the Tripartite Working Group (TWG) as part of a west coast monitoring programme. There are 4 areas within the TWG process, Argyll, Skye, Wester Ross & West Sutherland and the Outer Hebrides, and each area has produced a report covering their lice monitoring. The data within this project for May, June and July has therefore been analysed together with that for Wester Ross (Hunter 2010).

Materials & Methods

Three estuaries, Laxford Bay, Kyle of Durness and the Polla estuary, were sampled monthly where possible from March to October, at low tide. Sampling was performed using a 50 m sweep net with a stretched mesh size of 15 mm hand pulled in a large circle to give one sweep of the area. Differences between the number examined and tagged (Table 1) reflect the presence of re-captures, the small size of trout involved or difficulties in loading the injector. Where trout <15 cm are involved, injection of the tags can prove difficult with only a thin membrane available to hold the tag and is therefore not undertaken.

All sea trout were removed and anaesthetised with 2-Phenoxyethanol. The length (± 1 mm) and weight (± 1 g) were recorded, scales removed and a visible impact (VI) tag implanted behind the eye. The fish were examined for the presence of sea lice, which were counted and roughly staged, i.e. Chalimus, mobile, adult and gravid female.

The condition index for the trout was calculated from the length and weight such that:

Condition Index = $100W/L^3$, where weight is in grams and length in cm.

Throughout this document, post-smolts are defined as fish that went to sea in this year. Adults refer to fish that have had one year or more at sea.

The Specific Growth Rate (SGR) was calculated for the recaptured fish to give annual variations, such that:

SGR = (((ln(final wt) – ln(initial wt))*100)/time), where weight is in grams and time in days.

Results and Discussion

The largest catch within a single sweep was 969 fish in the Laxford estuary during May (Table 1). A comparison of the catches with time in all estuaries demonstrates the variability in the abundance of fish within the sample sites and the difficulties in using these results to demonstrate population size. The by-catch from the netting in both estuaries was as expected from previous years, with few species and low numbers observed. The exception to this was the catch of 13 mackerel and one large herring taken in the Polla in September. The presence of a reasonable number of marine fish in the tidal pool is extremely unusual. There were also large numbers of salmon captured in 2010 compared to previous years.

Table 1 The number of fish examined and tagged, by estuary and month

	Laxford Bay		Polla estuary		Kyle of Durness	
Month	No. examined	No. tagged	No. examined	No. tagged	No. examined	No. tagged
March	-	-	-	-	-	-
April	[+]66	54	22	17	1	1
May	[*]60	50	-	-	0	0
June	56	49	11	3	24	17
July	[b]32	31	[a]9	1	3	3
August	-	-	-	-	7	5
September	[c]69	55	[d]34	27	0	0
October	3	3	-	-	-	-

([+]plus 45 released; [*]plus 909 released; [a]plus 2 salmon; [b]plus 1 salmon; [c]plus 136 sea trout released, 1 salmon and 2 sea bass; [d]plus 1 lost)

Age, Length, Weight and Condition of Fish Captured

The fish caught were of varied age (Fig. 1) and length (Fig. 2), reflecting a mixed population structure. The age structure in the three estuaries was similar, with the Kyle of Durness returning the oldest adult (Fig. 1). From Fig. 1 the predominant smolt age in all rivers is 2 years (S2), although there was a number of S3's also present. S1's were also observed in small numbers in all of the estuaries. The length distribution of fish in each estuary was similar (Fig. 2).

A proportion of the fish examined were from previous smolt runs (Fig. 1; Table 2). There does not appear to be a pattern in the proportion of post-smolts within the samples, but they dominated the catches in all estuaries after May. While a May smolt run is normally found in West Sutherland (WSFT 2010), this appears to have been delayed in 2010, possibly as a result of water flow.

Table 2 The percentage of smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
March	-	-	-
April	14	29	0
May	58	-	0
June	98	86	95
July	66	86	67
August	-	-	100
September	65	80	0
October	100	-	-

The presence of post-smolts at all sites throughout the year indicates a heavy usage of estuaries by this group, presumably for feeding and shelter. That the sea trout populations are relatively static can be inferred from the information on recaptures, where all bar one of the tagged fish recaptured during 2010 were taken in the same location as originally tagged. The exception in this case was a sea trout tagged in the Laxford and recaptured in the Polla (I87).

The mean length, weight and condition index, ± s.d., of post smolts per month are given in Table 3a, for Laxford Bay, Table 3b for the Polla estuary and Table 3c for the Kyle of Durness. There does not appear to be a pattern to the condition index in any of the estuaries. However, it is apparent that the condition index in the Laxford is lower than that in the other areas for much of the time. The high condition indices observed, however, is in contrast to the observations during netting, where the sea trout appeared thin and retained a 'crease' at the body cavity. Analysis of a small sample of fish from the Laxford and Polla by Marine Scotland revealed empty stomachs and intestines. Disease testing indicated that there was no obvious underlying reason for the observations but that muscle degeneration of the intestine could reflect part of the process of a failing smolt. These observations were made not only within west Sutherland but also in a river flowing into the Kyle of Lochalsh, which was surveyed on behalf of the RDO and included fish of all sizes in areas containing significant

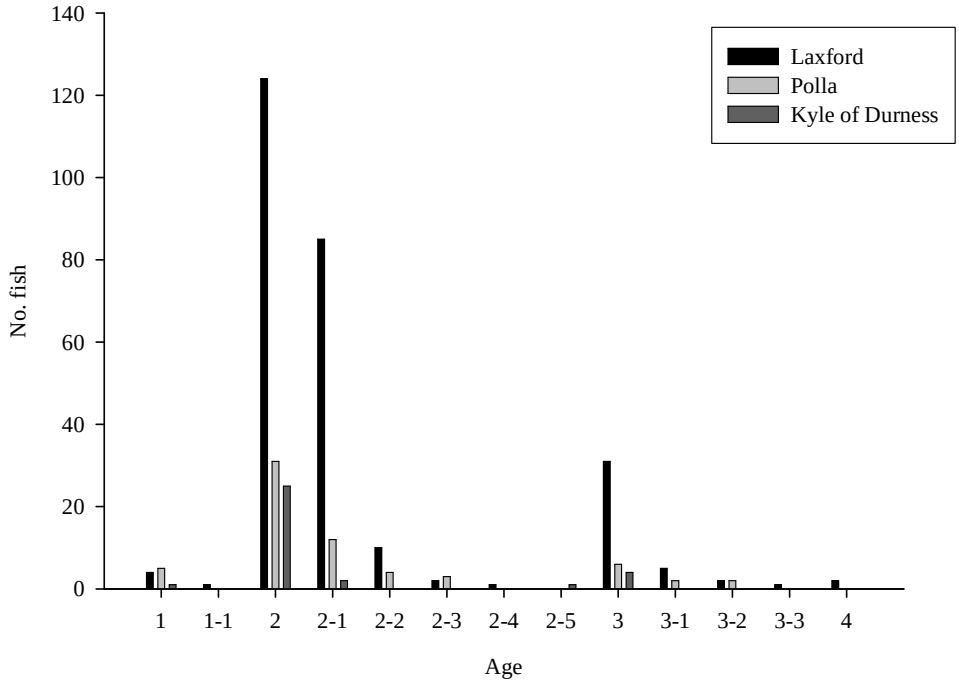

Fig. 1 The number of fish of each age taken in the estuaries

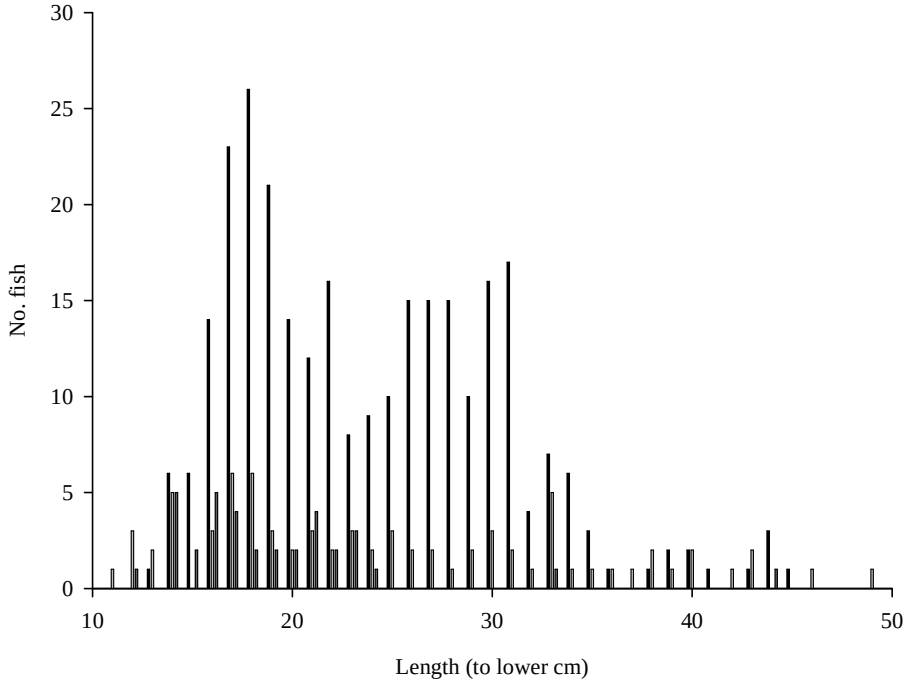

Fig. 2 The number of fish of each length taken in the estuaries

numbers of prey items. It is thus probable that, while some fish had undergone a failure in smoltification, there was an as yet unidentified reason for this condition.

Length appears to vary with time, decreasing over the sampling period before increasing towards the end. The exception to this is the Kyle of Durness, where length continues to increase over the sampling period (Table 3). This reflects the movement of post-smolts within the estuaries for feeding and shelter.

Table 3a The mean length, weight, and condition index of the post-smolts captured in Laxford Bay, per month

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
March	-	-	-
April	249.75 ± 22.64	144.25 ± 39.88	0.92 ± 0.07
May	195.65 ± 26.28	76.21 ± 33.99	1.00 ± 0.09
June	174.18 ± 20.67	56.62 ± 19.74	1.04 ± 0.09
July	200.81 ± 19.65	83.24 ± 34.19	0.99 ± 0.21
August	-	-	-
September	220.78 ± 26.09	116.05 ± 39.27	1.05 ± 0.08
October	179.33 ± 12.42	61.00 ± 13.00	1.04 ± 0.02

Table 3b The mean length, weight, and condition index of the post-smolts captured in the Polla estuary, per month

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
March	-	-	-
April	190.17 ± 27.36	76.17 ± 32.57	1.06 ± 0.08
May	-	-	-
June	174.50 ± 50.57	67.50 ± 52.12	1.08 ± 0.08
July	154.67 ± 52.56	54.67 ± 57.76	1.23 ± 0.18
August	-	-	-
September	201.92 ± 34.29	97.67 ± 53.79	1.10 ± 0.10
October	-	-	-

Table 3c The mean length, weight, and condition index of the post-smolts captured in the Kyle of Durness, per month

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
March	-	-	-
April	-	-	-
May	-	-	-
June	173.43 ± 28.57	59.14 ± 28.72	1.07 ± 0.10
July	186.00 ± 33.94	73.00 ± 32.53	1.11 ± 0.10
August	209.57 ± 16.11	90.43 ± 17.68	0.97 ± 0.07
September	-	-	-
October	-	-	-

Recaptures

There were 38 recaptures during 2010, all bar 1 within the estuary netting. The exception was taken during by rod and line in the Polla. The growth of recaptured trout is shown in Table 4a, for the Polla estuary and Table 4b, for Laxford Bay, there were no recaptures within the Kyle of Durness. Of the recaptured trout, 2 were originally tagged in 2005 and 2 in 2008. This gives yet more information on sustained growth rates and demonstrates the potential effectiveness of the tagging programme. All bar one of the recaptured fish were taken in the same system as they were tagged demonstrating that most sea trout remain within a small area.

The average growth, per month, is 7.45 mm, and 10.17 g within the Laxford, which is a lower length increase but greater weight increase than that found in 2009. Within the Polla average growth rates were 5.23 mm and 15.58 g, which show a significant reduction in both length and weight growth compared to 2009. This does

not appear to support the poor body condition observed in many of the fish, or the health study carried out which demonstrated the presence of 'anorexic'fish, but is encouraging.

Table 4a The lengths and weights of recaptured trout within the Polla estuary

Tag number		Tagged	Recaptured	Differences	Recaptured (2)	Differences (2)	Recaptured (3)	Differences (3)
I20	Date	21.7.09	15.4.10	9 mths	14.6.10	2 mths	14.7.10	1 mth
	Length (mm)	372	396	24	406	10	407	1
	Weight (g)	359	597	238	663	66	600	-63
I70	Date	18.9.09	15.4.10	7 mths				
	Length (mm)	316	374	58				
	Weight (g)	373	571	198				
*I87	Date	21.9.09	15.4.10	7 mths				
	Length (mm)	221	294	73				
	Weight (g)	107	247	140				
J01	Date	28.3.05	14.6.10	63 mths				
	Length (mm)	266	460	194				
	Weight (g)	188	980	792				
M54	Date	15.4.10	14.6.10	2 mths				
	Length (mm)	212	242	30				
	Weight (g)	96	144	48				
M62	Date	15.4.10	14.6.10	2 mths	14.7.10	1 mth		
	Length (mm)	282	305	23	313	8		
	Weight (g)	215	285	70	321	36		
M61	Date	15.4.10	14.7.10	3 mths	10.9.10	2 mths		
	Length (mm)	215	259	44	273	14		
	Weight (g)	100	171	71	210	39		
+K56 (red)	Date	19.8.05	4.8.10	60 mths				
	Length (mm)	267						
	Weight (g)	236	ap. 4.75	4.25 lb ish				
I82	Date	18.9.09	10.9.10	12 mths				
	Length (mm)	253	331	78				
	Weight (g)	193	385	192				

* Tagged in the Laxford; + Caught on rod and line

Table 4b The lengths and weights of recaptured trout within Laxford Bay

Tag number		Tagged	Recaptured	Differences	Recaptured (2)	Differences (2)
A15	Date	25.5.09	14.4.10	11 mths	12.5.10	1 mth
	Length (mm)	159	316	157	332	16
	Weight (g)	39	299	260	326	27
A77	Date	22.6.09	14.4.10	10 mths	9.9.10	5 mths
	Length (mm)	149	231	82	257	26
	Weight (g)	26	115	89	183	68
H45	Date	27.4.09	14.4.10	12 mths		
	Length	154	253	99		

	(mm)					
	Weight (g)	39	155	116		
	Date	25.5.09	14.4.10	11 mths		
H57	Length (mm)	176	266	90		
	Weight (g)	42	170	128		
	Date	25.5.09	14.4.10	11 mths		
H62	Length (mm)	188	260	72		
	Weight (g)	60	149	89		
	Date	25.5.09	14.4.10	11 mths		
H68	Length (mm)	187	305	118		
	Weight (g)	57	270	213		
	Date	25.5.09	14.4.10	11 mths		
H86	Length (mm)	166	297	131		
	Weight (g)	42	227	185		
	Date	25.5.09	14.4.10	11 mths		
H98	Length (mm)	204	288	84		
	Weight (g)	77	222	145		
	Date	23.7.09	14.4.10	9 mths	12.5.10	1 mth
I40	Length (mm)	205	279	74	281	2
	Weight (g)	91	242	151	234	-8
	Date	21.9.09	12.5.10	8 mths		
I85	Length (mm)	287	304	17		
	Weight (g)	251	251	0		
	Date	14.4.10	12.5.10	1 mth		
M26	Length (mm)	272	273	1		
	Weight (g)	193	193	0		
	Date	14.4.10	12.5.10	1 mth		
M42	Length (mm)	263	264	1		
	Weight (g)	180	180	0		
	Date	2.7.08	12.5.10	22 mths		
N27	Length (mm)	190	338	148		
	Weight (g)	-	364	-		
	Date	11.6.10	13.7.10	1 mth		
K80	Length (mm)	175	190	15		
	Weight (g)	60	80	20		
	Date	13.7.10	9.9.10	2 mths		
D68	Length (mm)	186	212	26		
	Weight (g)	60	110	50		
	Date	11.6.10	9.9.10	3 mths		
D00	Length (mm)	217	234	17		
	Weight (g)	106	123	17		
	Date	22.6.09	9.9.10	15 mths		
A82	Length (mm)	196	311	115		
	Weight (g)	80	303	223		

K80	Date	11.6.10	9.9.10	3 mths		
	Length (mm)	175	207	32		
	Weight (g)	60	93	33		
D04	Date	11.6.10	9.9.10	3 mths		
	Length (mm)	183	211	28		
	Weight (g)	70	114	44		
D24	Date	11.6.10	9.9.10	3 mths		
	Length (mm)	193	224	31		
	Weight (g)	65	107	42		
N24	Date	2.7.08	9.9.10	26 mths		
	Length (mm)	242	295	53		
	Weight (g)		228	-		
D53	Date	13.7.10	9.9.10	2 mths		
	Length (mm)	208	224	16		
	Weight (g)	99	112	13		
M06	Date	14.4.10	9.9.10	5 mths		
	Length (mm)	313	344	31		
	Weight (g)	282	400	118		

Figure 3 shows that the specific growth rates in the Laxford and Polla have both declined from the previous year, breaking the trends seen over the past 12 years of the study. The growth rate within both estuaries is low, being at the lowest recorded within the Polla. This demonstrates the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature.

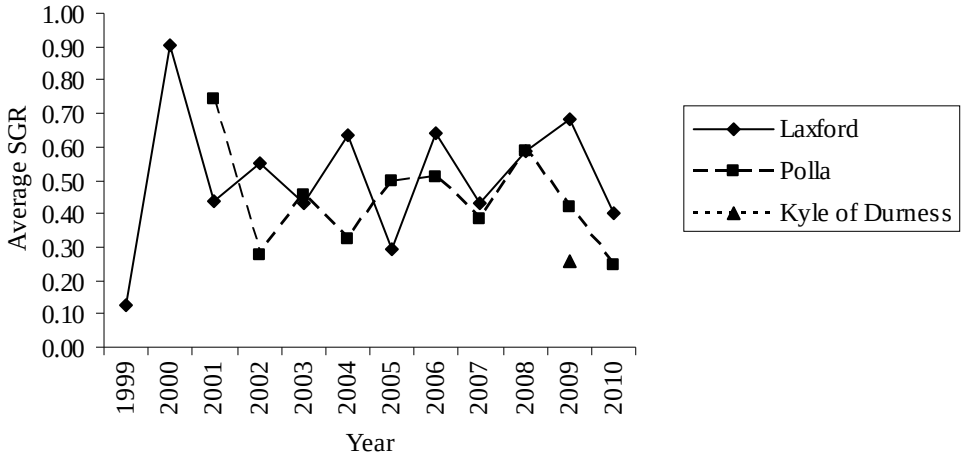

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, and Kyle of Durness, by year

Sea Lice Infestations

Sea lice were present to a varying degree throughout the year in all estuaries (Table 5). Lice were found during most sampling occasions, the exceptions being the Kyle of Durness in April and the Laxford in April and May. A mixture of lice stages were noted in all samples, with the exception of the Laxford in October, when only Chalimus were present (Fig. 4). With this exception, gravid females were present on all occasions from July and in the Polla every month. Lice numbers were variable within the sampling, being high in April and September in the Polla, but high in July and September in the Laxford. Numbers declined with time in the Kyle of Durness, despite the increase in prevalence.

Table 5 The percentage of sea trout with the salmon louse, by estuary and month

Month	Laxford Bay	Polla estuary	Kyle of Durness
March	-	-	-
April	0	55	0
May	0	-	-
June	9	36	21
July	84	33	100
August	-	-	100
September	36	41	-
October	67	-	-

In order to determine the potential impacts of sea lice on fish it is important to know the number of lice present per fish as well as their occurrence (Table 6 (Laxford), 7 (Polla) & 8 (Kyle of Durness)). The use of intensity will give a more accurate impression of the degree of infestations, being the number of lice on the infected fish, but abundance gives a better impression of the lice within the population. In addition, abundance is used in several studies, including Butler (2002), and is the preferred method of recording within the neighbouring farms and is therefore given here. The use of the median value, being the middle value if they are ranked numerically, also gives an indication of the degree of infestation within the population, while removing the bias created from a single heavily infected individual.

Laxford

Lice abundance within the Laxford samples remained variable throughout the year (Table 6). The neighbouring cages were stocked with smolts in April 2010. All samples were dominated by juvenile lice, although a maturation of lice was observed, with increasing numbers of adults observed with time, until

October when only Chalimus were seen (Fig. 4a). This does not follow the picture observed within the neighbouring farm, where lice numbers remained low and adults were not observed until August.

Table 6 The abundance, intensity and median value of the salmon louse on wild sea trout in Laxford Bay, where abundance is the mean number of lice per fish and intensity is the mean number of lice per infected fish.

	Abundance		Intensity		
Month	mean	range	mean	range	Median
March	-	-	-	-	-
April	0	0	0	0	0
May	0	0	0	0	0
June	0.61	0 - 24	6.8	1 - 24	0
July	9.53	0 - 33	11.30	1 - 33	6.5
August	-	-	-	-	-
September	1.61	0 - 21	4.44	1 - 21	0
October	4	0 - 8	6	4 - 8	4

Polla

As with the Laxford, the abundance of lice shown in Table 7 is variable throughout the year. Adults dominated the population with the exception of the September population, with Chalimus appearing in July. Gravid females were recorded each month (Fig. 4b). This indicates a mature lice population, a situation frequently observed within the Polla, suggesting that the lice population is being maintained within the wild fish population in Loch Eriboll. Lice numbers on neighbouring cages were low and comprised predominantly of juvenile stages. There was no correlation observed between them and those found on wild fish.

Table 7 The abundance, intensity and median value of the salmon louse on wild sea trout in Polla estuary, where abundance is the mean number of lice per fish and intensity is the mean number of lice per infected fish.

	Abundance		Intensity		
Month	mean	range	mean	range	Median
March	-	-	-	-	-
April	3.82	0 - 15	7	1 - 15	1
May	-	-	-	-	-
June	5.36	0 - 38	14.75	2 - 38	0
July	2.89	0 - 12	8.67	6 - 12	0
August	-	-	-	-	-
September	6.24	0 - 65	15.14	1 - 65	0
October	-	-	-	-	-

Kyle of Durness

The Kyle of Durness is the furthest sea loch from fish farm cages within the west Sutherland area and as such provides an example of ‘natural’ levels. As with the other estuaries within this programme, lice levels within the Kyle of Durness were variable throughout the year (Table 8). Sampling was limited within the Kyle, but a level of maturation was observed within the population (Fig. 4c), suggesting a relatively immobile host population.

Table 8 The abundance, intensity and median value of the salmon louse on wild sea trout in the Kyle of Durness, where abundance is the mean number of lice per fish and intensity is the mean number of lice per infected fish.

	Abundance		Intensity		
Month	mean	range	mean	range	Median
March	-	-	-	-	-
April	0	0	0	0	0
May	-	-	-	-	-
June	2.38	0 - 53	11.4	1 - 53	0
July	8.33	2 - 19	8.33	2 - 19	4
August	3.57	1 - 7	3.57	1 - 7	3

September	-	-	-	-	-
October	-	-	-	-	-

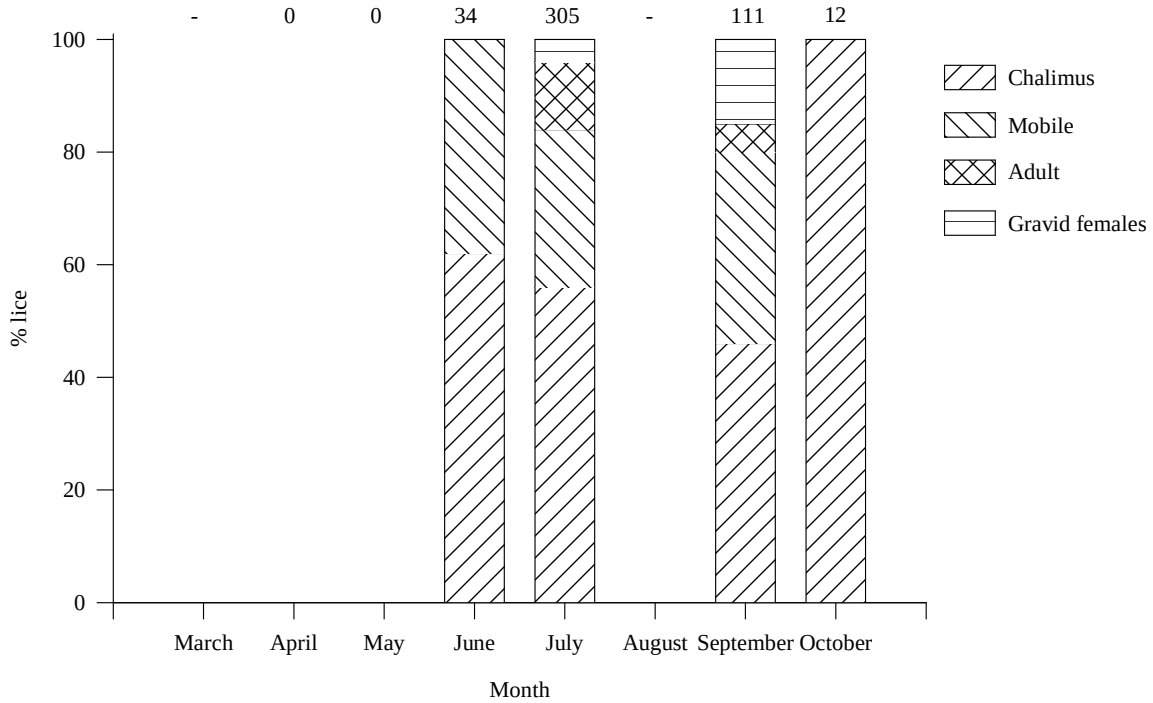

Fig. 4a Showing the proportion of each stage of lice within the Laxford samples, by month. The total number of lice is given at the top.

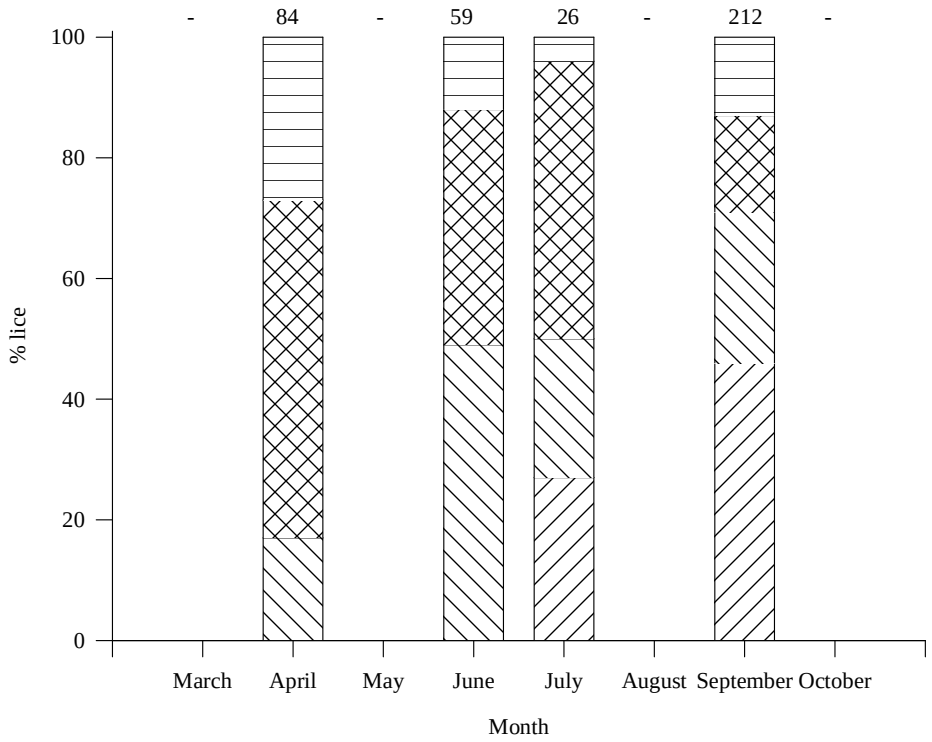

Fig. 4b Showing the proportion of each stage of lice within the Polla samples, by month. The total number of lice is given at the top.

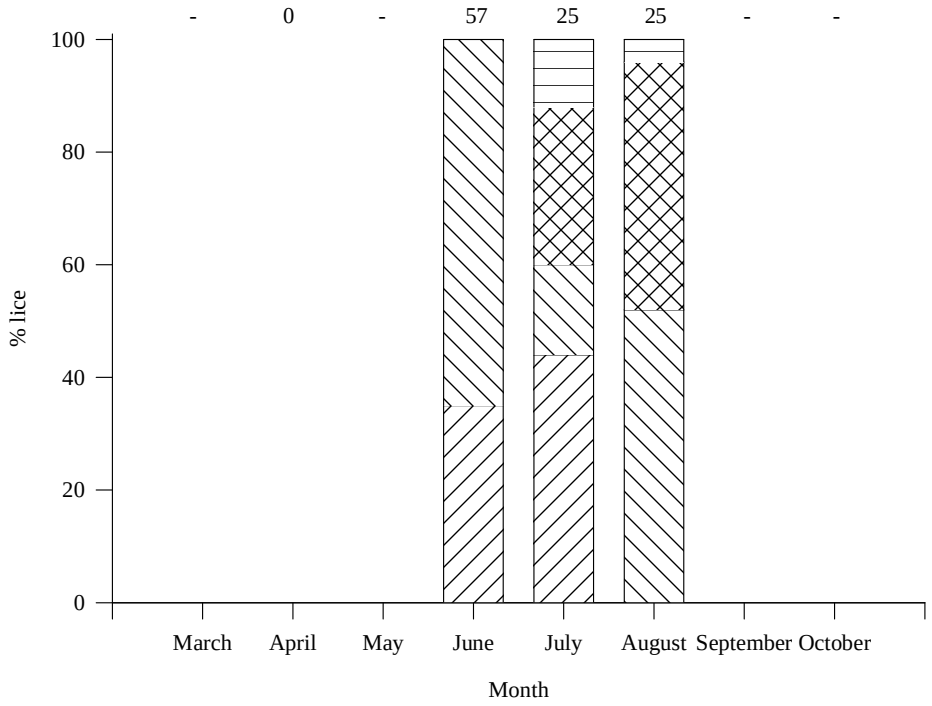

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

Recommendations for further research

1. It is recommended that the current programme be continued in order to maintain the existing dataset.
2. It is recommended that the TWG programme is utilised and that analysis of data from a greater number of sites be undertaken in order to assess the anomalies noted during this programme. This analysis is currently being undertaken by marine Scotland.
3. It is recommended that the sea trout population of West Sutherland be examined in order to determine the degree of mixing of the population across catchments.
4. It is recommended that the current programme be expanded to examine other features of sea trout biology in marine areas.

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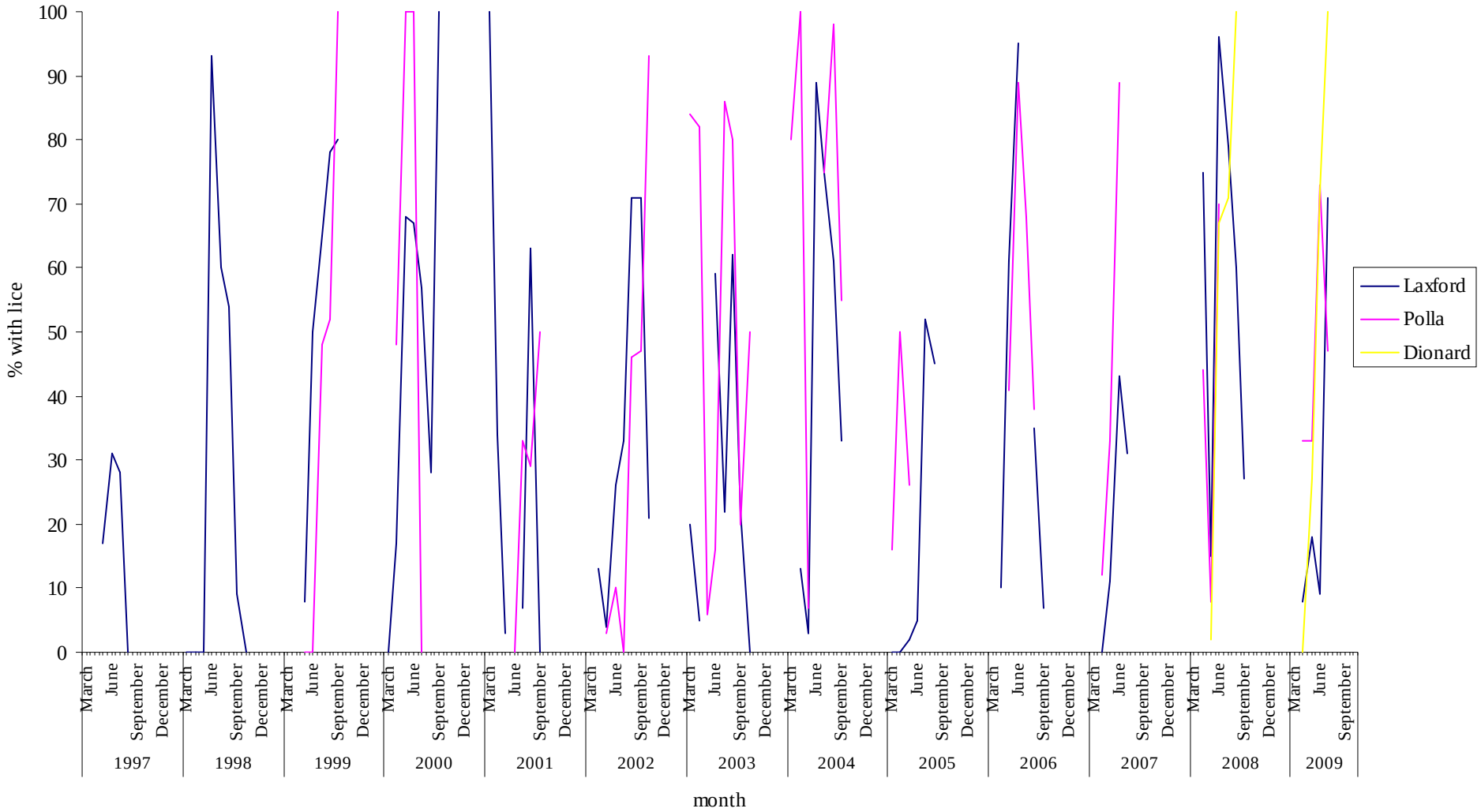

Fig. 5 Showing the changes in prevalence of lice with time for the different estuaries

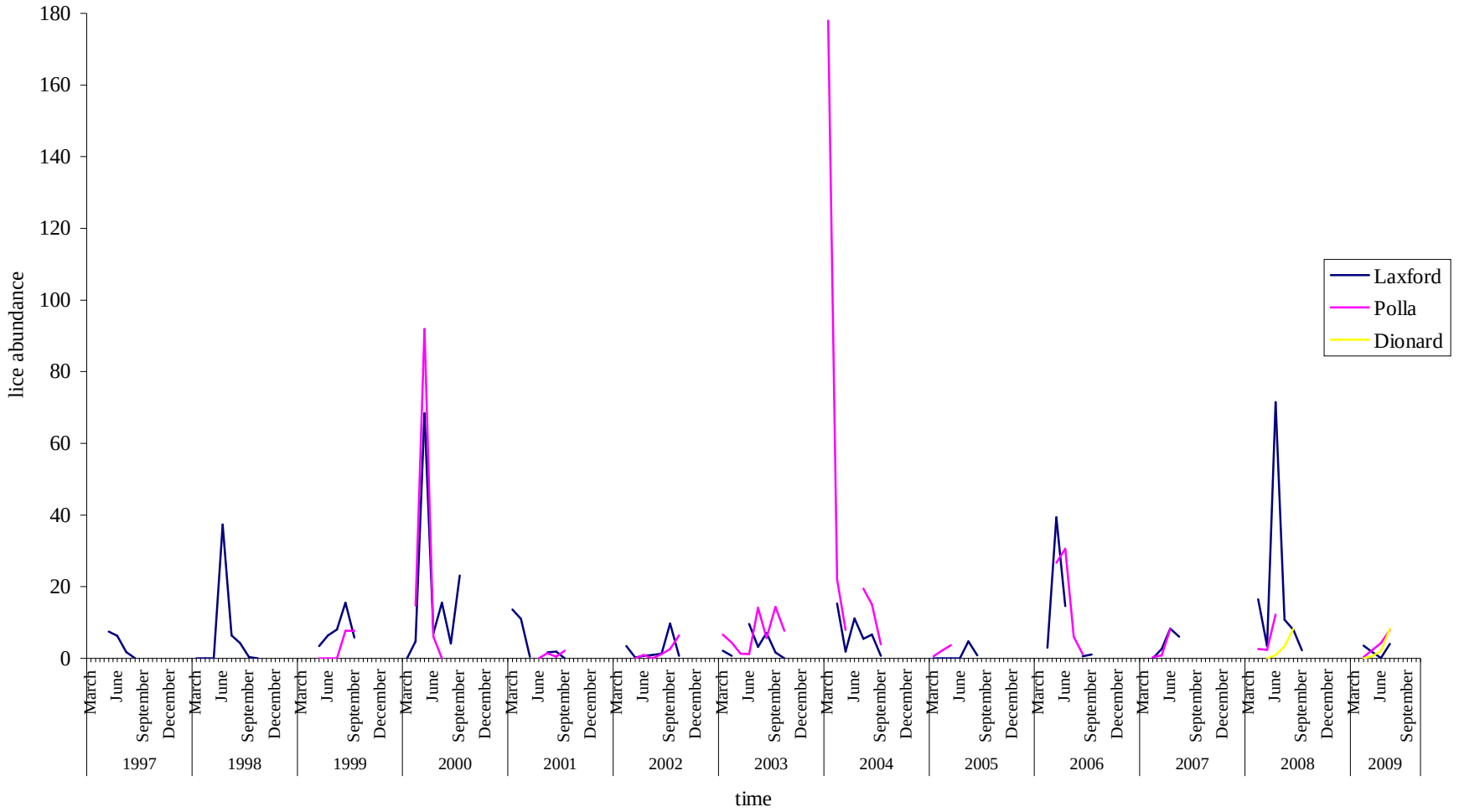

Fig. 6 Showing the changes in abundance of lice with time in each estuary