Monitoring of sea trout post-smolts, 2009

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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, Lochaber & 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 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 117 fish in the Polla estuary during September (Table 1). A comparison of the catches with time in both 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. There were large numbers of salmon smolts and adults captured in 2009 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	+71	56	6	6	*4	4
May	85	67	21	15	51	40
June	11	9	411	8	**29	29
July	7	6	15	10	**9	8
August	-	-	-	-	-	-
September	11	9	++46	39	-	-
October	-	-	-	-	-	-

(+plus 14 salmon smolts; *plus 2 salmon smolts; 4plus 1 grilse; **1 lost from basket; ++plus 2 grilse and 71 sea trout released)

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, although the Kyle of Durness returned only one 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 the Laxford and Polla. The length of fish in each estuary was similar although post-smolts dominated the Kyle of Durness samples (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 2008), the Laxford and Kyle smolts appear to have started migrating in April, a pattern also observed in the Laxford in 2008.

Table 2 The percentage of smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
March	-	-	-
April	79	33	100
May	95	91	100
June	100	36	100
July	100	93	89
August	-	-	-
September	67	*79	-
October	-	-	-

(*included an autumn smolt run)

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 2009 were taken in the same location as originally tagged. The exception in this case was a sea trout tagged in the Kyle of Durness and recaptured in the Polla.

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 Polla is lower than that in the other areas for much of the time, indicating poor feeding at those times.

Length appears to vary with time in a different manner in each estuary. There is little pattern discernible in any of the estuaries with the exception of the Polla where length slowly increases with time over the

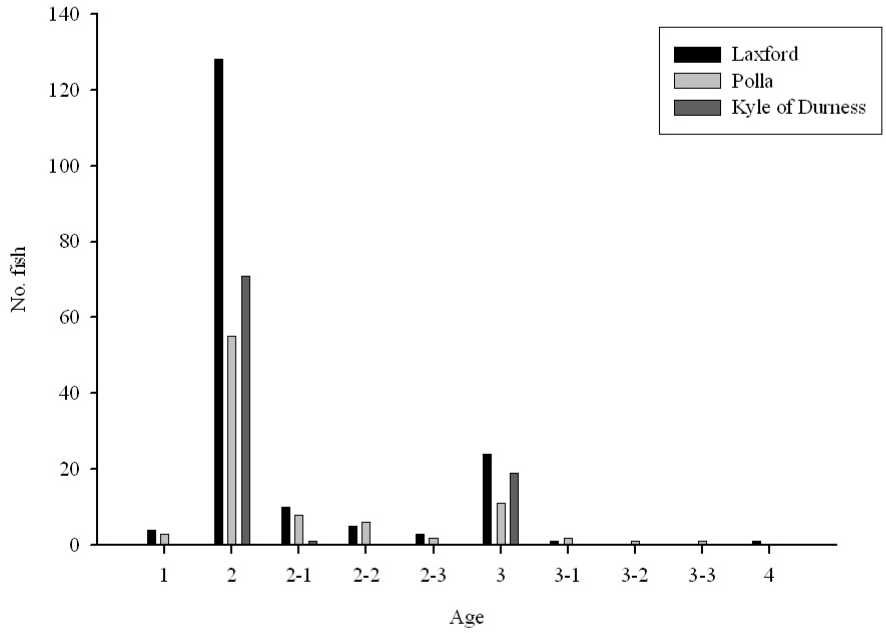

Fig. 1 The number of fish of each age taken in the estuaries

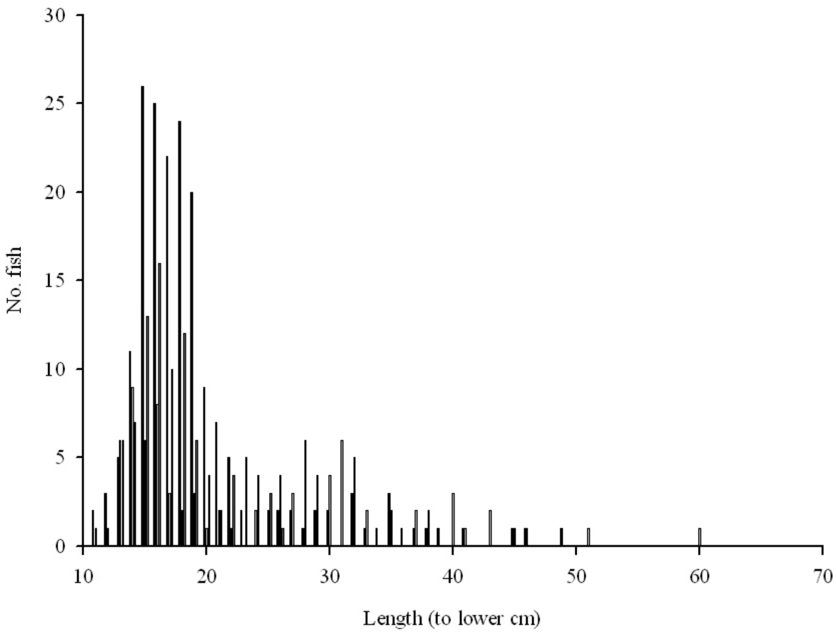

Fig. 2 The number of fish of each length taken in the estuaries

middle period of the study (Table 3b). 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	174.08 ± 26.82	54.15 ± 24.10	0.97 ± 0.08
May	172.99 ± 22.46	48.39 ± 17.64	0.91 ± 0.13
June	166.75 ± 19.28	44.58 ± 19.00	0.91 ± 0.14
July	222.29 ± 71.56	122.00 ± 129.80	0.94 ± 0.10
August	-	-	-
September	176.50 ± 26.31	59.17 ± 26.74	1.03 ± 0.05
October	-	-	-

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	207.00 ± 53.74	64.50 ± 41.72	0.68 ± 0.06
May	154.21 ± 18.92	39.95 ± 17.07	1.03 ± 0.19
June	156.50 ± 19.67	37.75 ± 15.20	0.96 ± 0.16
July	157.43 ± 33.54	29.79 ± 17.98	0.71 ± 0.19
August	-	-	-
September	276.87 ± 44.64	271.73 ± 115.13	1.18 ± 0.08
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	214.25 ± 21.41	82.75 ± 29.73	0.81 ± 0.06
May	176.04 ± 33.21	59.08 ± 36.03	0.99 ± 0.12
June	188.07 ± 35.03	-	-
July	175.25 ± 12.02	49.38 ± 9.23	0.91 ± 0.12
August	-	-	-
September	-	-	-
October	-	-	-

Recaptures

There were 7 recaptures during 2009, all bar within the estuary netting. The exception was taken during broodstock netting in the Laxford. The growth of recaptured trout is shown in Table 4a, for the Polla estuary, Table 4b, for Laxford Bay and Table 4c for the Kyle of Durness. Of the recaptured, 2 were originally tagged in 2007 and 3 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 9.4 mm, and 8.9 g within the Laxford, which is a lower length increase but similar weight increase to that found in 2008. Within the Polla average growth rates were 11.3 mm and 33.9 g, which shows a reduction in length growth but an increase in weight compared to 2008. The Kyle of Durness gave a growth of 7.3 mm and 7.2 g per month respectively. However it should be noted that growth rates in the Polla and Kyle of Durness are based on one recapture only.

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

Tag number		Tagged	Recaptured	Differences
*O21	Date	7.5.08	18.9.09	16 mths
	Length (mm)	203	384	181
	Weight (g)	77	620	543

*tagged in the Kyle of Durness

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

Tag number		Tagged	Recaptured	Differences
Red N79	Date	14.6.07	27.4.09	22 mths
	Length (mm)	436	497	61
	Weight (g)	837	1125	288
Orange N38	Date	2.7.08	27.4.09	9.5 mths
	Length (mm)	159	213	54
	Weight (g)	-	85	-
H12	Date	27.4.09	25.5.09	1 mth
	Length (mm)	453	462	9
	Weight (g)	1010	920	-90
A11	Date	25.5.09	22.6.09	1 mth
	Length (mm)	148	171	23
	Weight (g)	35	50	15
Red +N26	Date	17.5.07	27.11.09	29 mths
	Length (mm)	150	343	193
	Weight (g)	38	-	-

+caught during broodstock netting

Table 4c The lengths and weights of recaptured trout within the Kyle of Durness

Tag number		Tagged	Recaptured	Differences
N14	Date	4.6.08	22.7.09	13 mths
	Length (mm)	159	254	95
	Weight (g)	49	143	94

Figure 3 shows that the growth rates in the Laxford and Polla continue to show opposite patterns, with a rise in the Laxford mirrored by a fall in the Polla. This follows the trends seen over the 11 years of the study. The growth rate within the Laxford remains low, while that in the Polla is about average for the estuary. This demonstrates the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature. The Kyle of Durness has a similar growth rate to that of the Laxford.

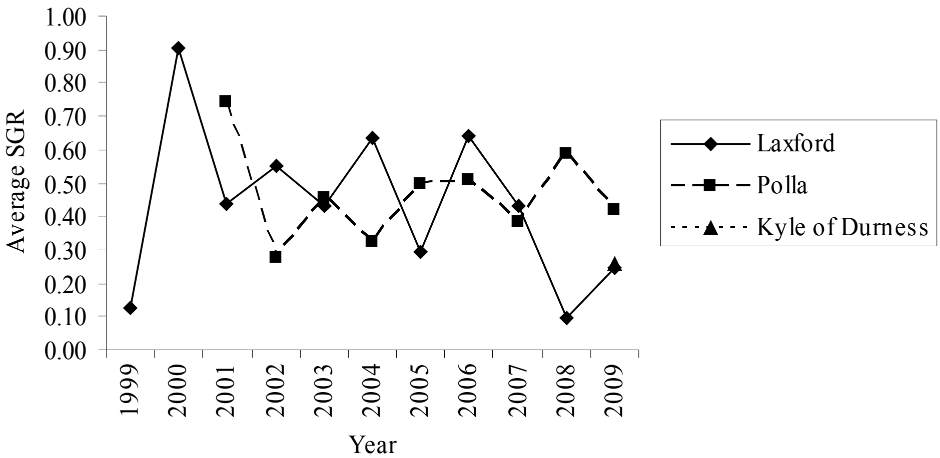

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, and Kyle of Durness, by year

Sea Lice Infestations

Sea lice were present to a variable degree throughout the year in all estuaries, although more prevalent within the Polla (Table 5). Lice were found during each sampling occasion, with the exception of the Kyle of Durness in April. Chalimus stages only dominated the catches in the Laxford in April, with mobile stages being more common (Fig. 4). Gravid females were present on all occasions from July on, and in the Polla every month. Lice numbers were generally high in all estuaries, although the Laxford densities were low from June onwards. Numbers increased with time in both the Kyle of Durness and the Polla.

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	8	33	0
May	18	33	27
June	9	73	72
July	71	47	100
August	-	-	-
September	9	93	-
October	-	-	-

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 on the fish (Tables 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 farm 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 declines through the year, with the exception of a peak in July (Table 6). The neighbouring cages were fallowed in May 2009 with the removal of the broodstock fish. No fish were on site over the sampling period. All samples were dominated by juvenile lice, until September when only adults were observed (Fig. 4a). An ageing of lice from Chalimus to gravid could be observed throughout the Laxford samples.

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	3.56	0 - 93	42.17	7 - 93	0
May	1.75	0 - 37	9.93	1 - 37	0
June	0.17	0 – 2	2.00	2	0
July	4.00	0 - 8	5.60	4 - 8	4
August	-	-	-	-	-
September	0.45	0 - 5	5.00	5	0
October	-	-	-	-	-

Polla

The abundance of lice shown in Table 7 shows an increasing lice population which drops slightly at the end of the year. Median values indicate that, with the exception of June and September, however this is likely to have been caused by a few more heavily infested individuals. Chalimus stages were rare within the samples, with gravid females recorded each month (Fig. 4b). This indicates a mature lice population and is frequently observed within the Polla suggesting that there is a lice population being maintained

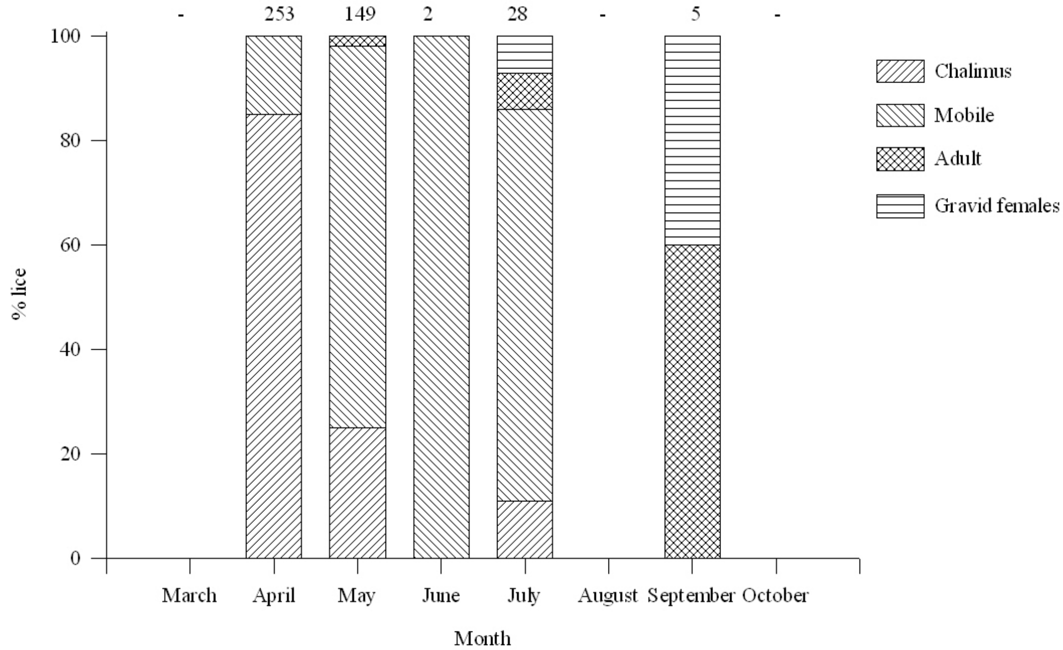

Fig. 4a Showing the proportion of each stage of lice within the Laxford samples, by month. The total number of lice is given at the top.

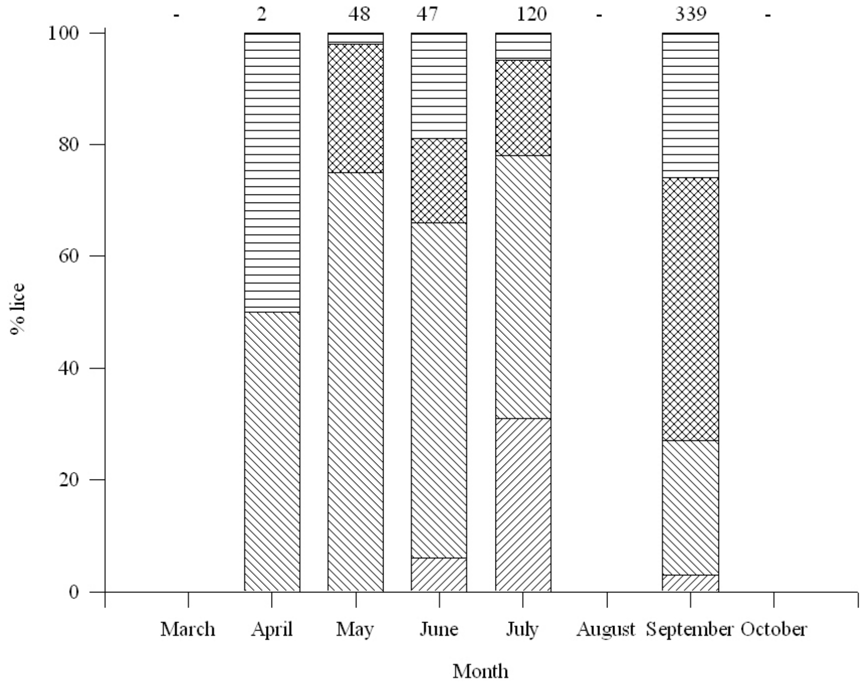

Fig. 4b Showing the proportion of each stage of lice within the Polla samples, by month. The total number of lice is given at the top.

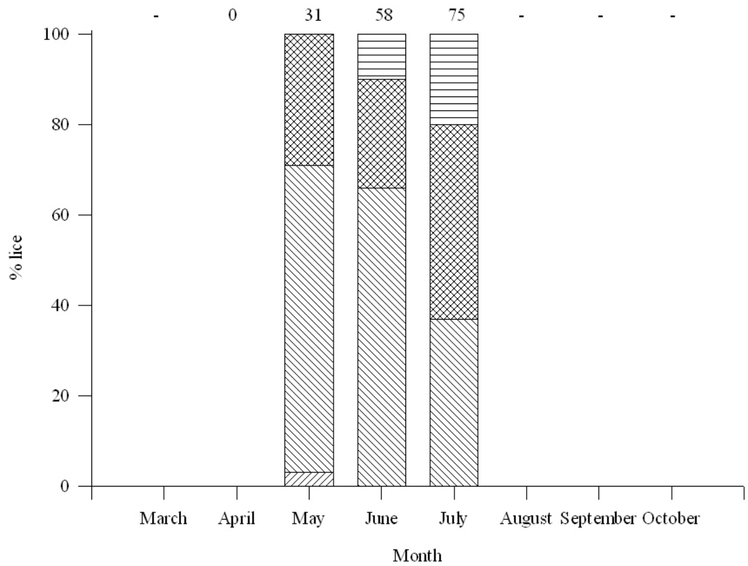

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

within the wild fish population in Loch Eriboll. Lice numbers on neighbouring cages were low and no correlation can be seen 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	0.33	0 - 1	1	1	0
May	2.29	0 - 37	6.86	1 - 37	0
June	4.27	0 - 13	5.88	1 - 13	3
July	8.00	0 - 47	17.14	1 - 47	0
August	-	-	-	-	-
September	7.37	0 - 20	7.88	1 - 20	6.5
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 is a suitable control site for this monitoring programme. As with the Polla, lice levels within the Kyle of Durness continued to increase over the sampling period (Table 8). In addition, the maturation of lice was observed from Chalimus, through mobile to gravid females (Fig. 4c), suggesting an 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	0.61	0 - 6	2.21	1 - 6	0
June	2.00	0 - 6	2.76	1 - 6	2
July	8.33	4 - 16	8.33	4 - 16	8
August	-	-	-	-	-
September	-	-	-	-	-
October	-	-	-	-	-

2009 was a year of extremes, with exceptionally warm, dry conditions in June and July, followed by wet conditions in subsequent months. This will have created ideal conditions for lice development at the time of the smolt run. In addition, the sea trout run appeared to have been delayed throughout the area. Anecdotal evidence suggesting that, for the Polla, this delay was approximately 2 months in length. Thus fish were being retained within the estuary, creating an additional host population for the lice. Similarly, salmon catches within the area were mixed, indicating that mature salmon may also be sitting in the coastal areas.

Laxford and Polla lice data, historical analysis

The counting of sea lice on wild sea trout caught within the Laxford started in 1997, while Polla counts began in 1999. By showing the differences in prevalence (Fig. 5) and abundance (Fig. 6) with time, trends in the data can be assessed. In addition, there is evidence from many areas that the abundance of lice on wild fish is related to the year of production on the farm, being higher in the second than the first year. This pattern is also widely accepted within the farms themselves.

From Fig. 5, it would appear that the prevalence of lice on fish is affected by the month, with each year showing a similar pattern. In general the percentage of trout with sea lice starts low, increasing to June before decreasing again. There is no relationship between the prevalence of lice and the stage of production within the neighbouring farm in either the Laxford or the Polla.

Abundance of lice on the wild fish (Fig. 6) appears to have a more recognisable pattern, with higher abundance apparent in the 2nd year of production within both the Laxford and Polla samples. However analysis of the data over the period of the study shows that this relationship, while statistically significant in the Polla is not significant in the Laxford.

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.
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.

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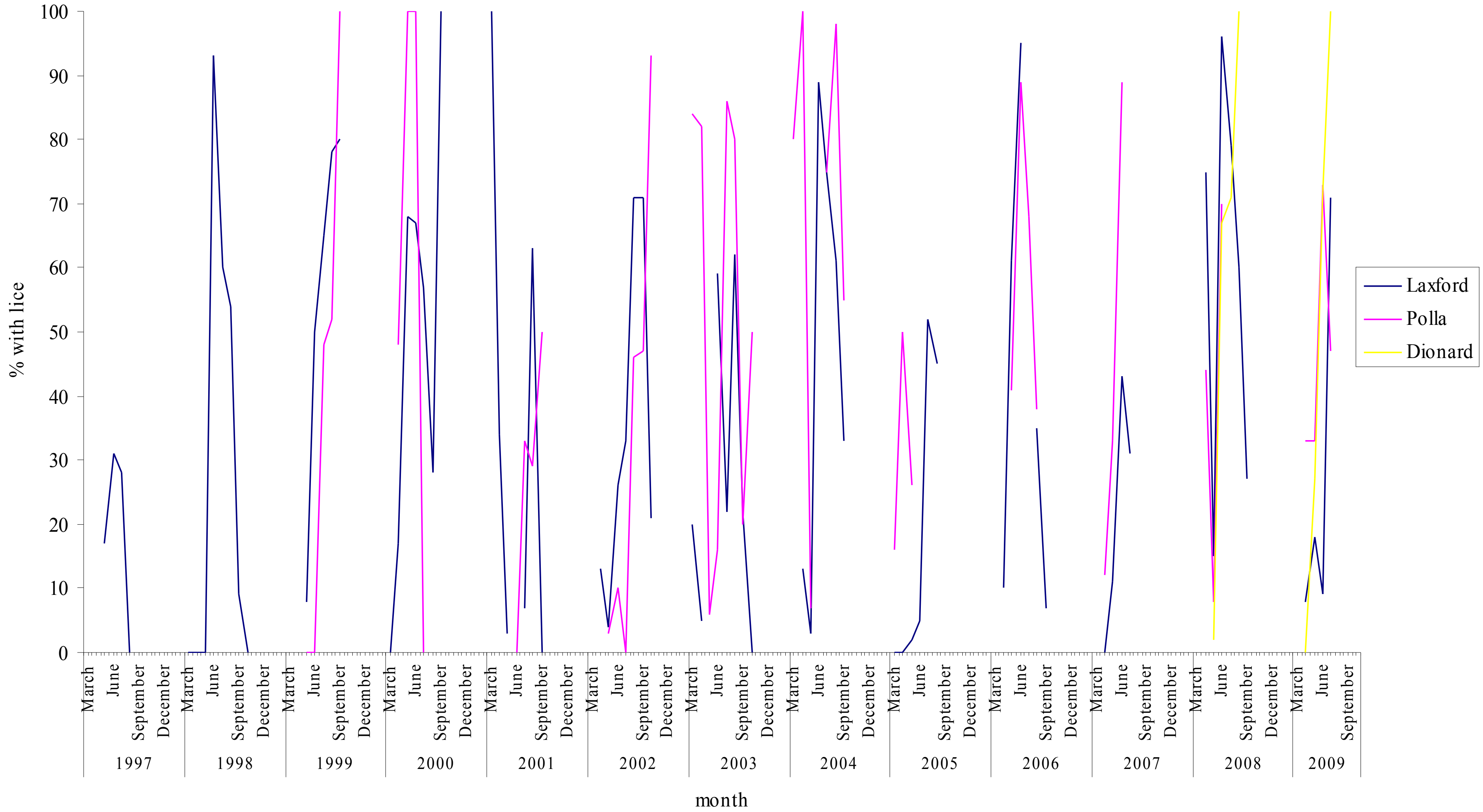

Fig. 5 Showing the changes in prevalence of lice with time for the different estuaries

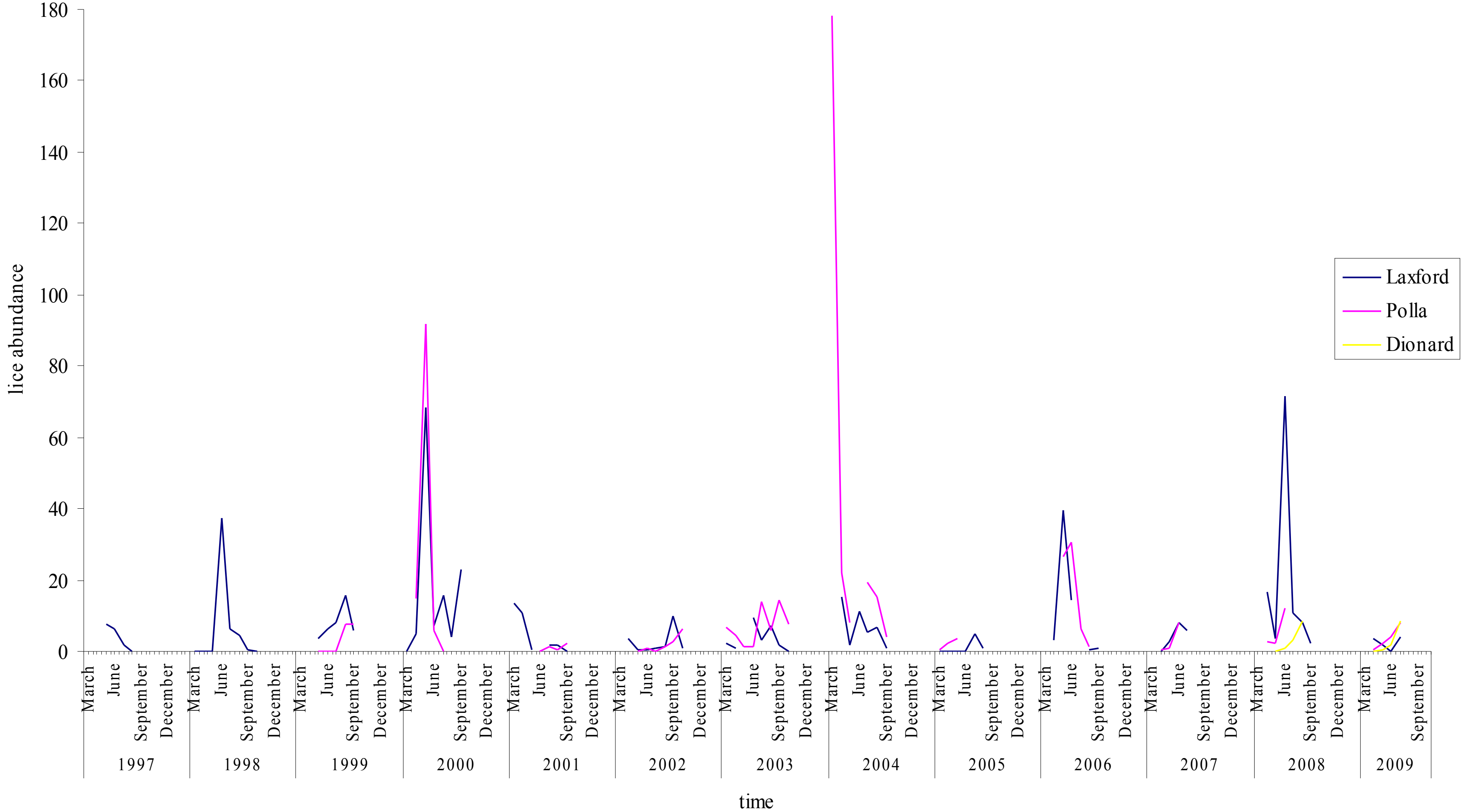

Fig. 6 Showing the changes in abundance of lice with time in each estuary