Monitoring of sea trout post-smolts, 2008

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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 supported by Regional Development Officers (RDO's), Argyll, Lochaber & Skye, Wester Ross & West Sutherland and the Outer Hebrides, and each RDO has produced a report covering the lice monitoring within their area. The data within this project for May, June and July has therefore been analysed together with that for Wester Ross (McLellan 2008). All RDO reports are available from the TWG website, www.tripartiteworkinggroup.com.

Materials & Methods

Two estuaries, Laxford Bay and the Polla estuary, were sampled monthly where possible from March to October, at low tide. The Kyle of Durness was sampled monthly from May to August, also 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 = $(((\ln(\text{final wt}) - \ln(\text{initial wt}))*100)/\text{time})$, where weight is in grams and time in days.

Results and Discussion

The largest catch within a single sweep was 174 fish in the Laxford estuary during May (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.

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	[+]4	4	[*]64	57	-	-
May	[**]55	47	[*+]13	10	[++]55	47
June	23	21	[+*]30	25	3	3
July	28	28	-	-	7	6
August	10	9	13	7	6	6
September	11	7	-	-	-	-
October					-	-

([+]1 lost from basket; [*]32 returned; [*+]plus 1 salmon smolt; [**]171 trout in total, plus 3 salmon smolts; [++]plus 2 salmon smolts; [+*]3 lost from basket)

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 few adults (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. The length of fish in each estuary was similar although there was a greater proportion of larger fish in the Polla (Fig. 2), while post-smolts dominated the Kyle of Durness samples.

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 smolts appear to have started migrating in April this year.

Table 2 The percentage of smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
March	-	-	-
April	50	5.6	-
May	61.5	80	98
June	87	79	100
July	89	-	100
August	44	82	83
September	90	-	-
October			-

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 tagged fish recaptured during 2008 were taken in the same location as originally tagged.

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, although it can be seen that the Laxford post-smolts have a lower condition index than the other sites. This would suggest that feeding within the Laxford was poorer during 2008 than in the other estuaries.

Length appears to vary with time in a different manner in each estuary. No pattern is discernible within the Laxford (Table 3a), while post-smolts decline in length with time in the Polla. This is likely to reflect the movement of larger post-smolts out of the river mouth to find feeding. Sea trout post-smolts within the Kyle of Durness, in contrast, do not show any difference with time. Again, this is likely to reflect the movement of fish within the estuary for feeding.

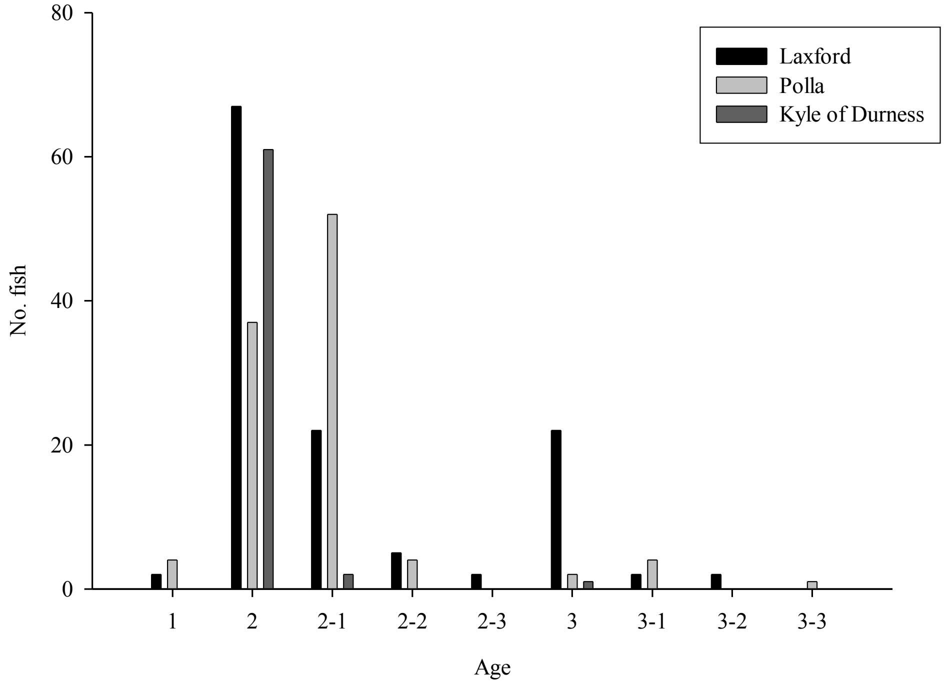

Fig. 1 The number of fish of each age taken in the estuaries

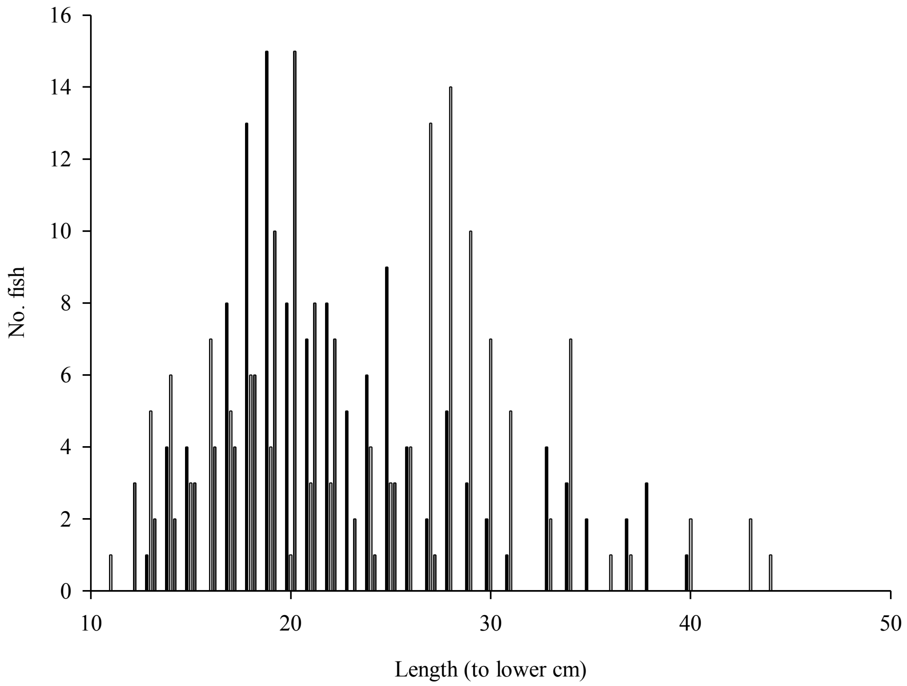

Fig. 2 The number of fish of each length taken in the estuaries

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	177.5 ± 16.26	58 ± 9.90	1.04 ± 0.11
May	200.25 ± 29.76	85.19 ± 34.92	1.01 ± 0.08
June	187.2 ± 26.10	66.3 ± 27.67	0.96 ± 0.04
July	187.04 ± 29.70	-	-
August	308 ± 53.98	337.4 ± 166.95	1.06 ± 0.09
September	223.67 ± 35.63	95.11 ± 32.71	0.86 ± 0.24
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	203 ± 15.62	97.67 ± 23.12	1.15 ± 0.04
May	187.5 ± 23.42	70.88 ± 29.38	1.02 ± 0.08
June	168.89 ± 24.65	53 ± 23.60	1.06 ± 0.12
July	-	-	-
August	160.78 ± 45.11	52 ± 47.58	1.03 ± 0.12
September	-	-	-
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	194.26 ± 30.87	80.2 ± 34.57	1.03 ± 0.11
June	183 ± 21.38	62.67 ± 11.85	1.03 ± 0.17
July	197.57 ± 36.66	-	-
August	191 ± 20.15	68.4 ± 16.88	0.97 ± 0.08
September	-	-	-
October	-	-	-

Recaptures

There were 12 recaptures during 2008, most within the estuary netting but one was captured by rod and line in the River Polla. The growth of recaptured trout is shown in Table 4a, for the Polla estuary, and Table 4b, for Laxford Bay. No recaptures were reported in the Kyle of Durness. While the majority of the recaptures were tagged in 2008, 2 were originally tagged in 2006 and 1 in 2007. This gives yet more information on sustained growth rates and demonstrates the potential effectiveness of the tagging programme. All recaptured fish were taken in the same estuary as they were tagged demonstrating that most sea trout remain within a small area.

The average growth, per month, is 6.23 mm, and 8.35 g within the Laxford, which is similar to growth in 2007 Within the Polla average growth rates were 18.35 mm and 10.56 g, which shows a reduction in length growth but an increase in weight compared to 2007. This demonstrates a difference between the 2 populations, with Polla fish on this occasion showing a greater growth than those in the Laxford, similar to that observed in 2007 (WSFT 2008). While based on a small sample size, this indicates that a greater variability in growth rates exists within a system, and suggests that growth may not be the only factor influencing the variations reported in catches.

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

Tag number		Tagged	Recaptured	Differences
P02	Date	25.7.06	22.4.08	21 mths
	Length (mm)	209	449	240
	Weight (g)	101	988	887
M36	Date	22.4.08	5.5.08	2 weeks
	Length (mm)	280	286	6
	Weight (g)	228	235	7
M61	Date	22.4.08	5.5.08	2 weeks
	Length (mm)	247	258	11
	Weight (g)	168	185	17
M51	Date	22.4.08	3.6.08	1.5 mths
	Length (mm)	270	304	34
	Weight (g)	230	340	110
*M46	Date	22.4.08	18.7.08	3 mths
	Length (mm)	318	-	-
	Weight (g)	314	450	136
M62	Date	22.4.08	31.7.08	3 mths
	Length (mm)	270	341	71
	Weight (g)	200	390	190

*Caught by rod and line

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

Tag number		Tagged	Recaptured	Differences
N93	Date	17.7.07	6.5.08	10 mths
	Length (mm)	220	260	40
	Weight (g)	80	172	92
P33	Date	25.8.06	6.5.08	21 mths
	Length (mm)	279	382	103
	Weight (g)	248	575	327
M98	Date	6.5.08	2.6.08	1 mth
	Length (mm)	256	261	5
	Weight (g)	178	192	14
M93	Date	6.5.08	4.8.08	3 mths
	Length (mm)	252	288	36
	Weight (g)	152	254	102
N41	Date	2.7.08	2.9.08	2 mths
	Length (mm)	173	190	17
	Weight (g)	-	56	-
N72	Date	4.8.08	2.9.08	1 mth
	Length (mm)	245	248	3
	Weight (g)	153	122	-31

Figure 3 shows that while the growth rate in the Laxford continued to fall since 2006 the Polla growth rate has increased to a level greater than that observed since 2001. In both estuaries there is a general trend of a high growth rate following a year with a low growth rate, a situation that is particularly obvious in the Laxford. The years with lower growth rates in the Laxford tend to be the years with a higher growth rates in the Polla and *visa versa*. This demonstrates the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature.

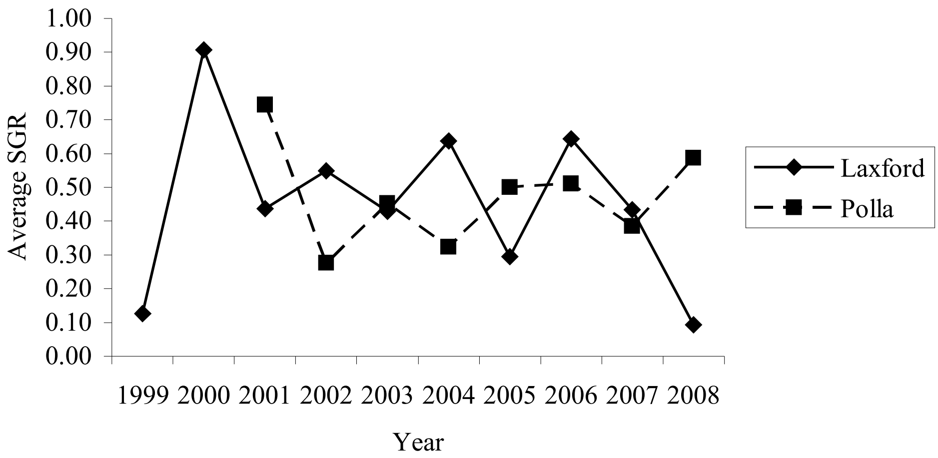

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

Sea Lice Infestations

Sea lice were present to a variable degree throughout the year in all estuaries, although more prevalent within the Laxford (Table 5). Lice were found during each sampling occasion. Chalimus stages dominated the samples (Fig. 4) every month, with gravid females only appearing in small numbers. Lice numbers were generally high in both the Laxford and Polla, peaking in both estuaries in June. Numbers increased with time in the Kyle of Durness but remained relatively low.

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	75	44	-
May	15	8	2
June	96	70	67
July	79	-	71
August	60	46	100
September	27	-	-
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

The pattern of lice abundance within the Laxford samples (Table 6) is similar to that in previous years, rising through the year until June, before dropping again (Marshall 2003; WSFT 2008). The low abundance in May is likely to reflect a high number of fresh run smolts in the sample. Higher median values in April and June would indicate that there were a larger number of more heavily infested fish within those samples compared to previous years. Lice numbers on neighbouring cages were low and no correlation can be seen between them and those found on wild fish. A few gravid lice were observed in July and August, but the catches remained dominated by Chalimus and mobile staged (Fig. 4a).

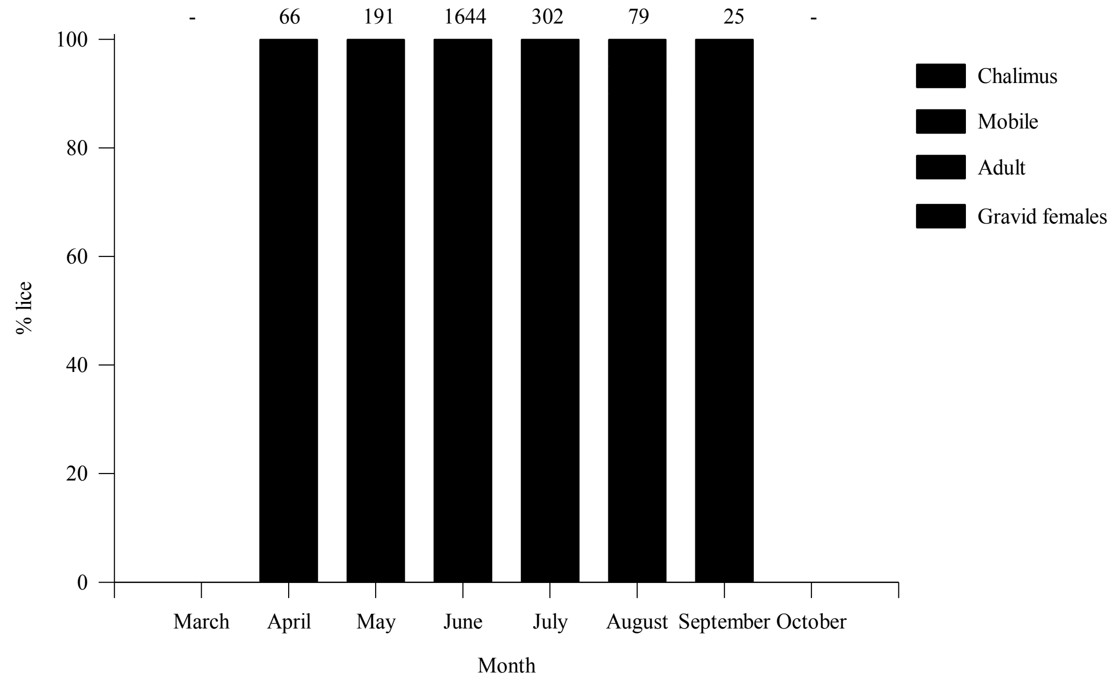

Fig. 4a Showing the proportion of each stage of lice within the Laxford samples, by month. The total number of lice is given at the top.

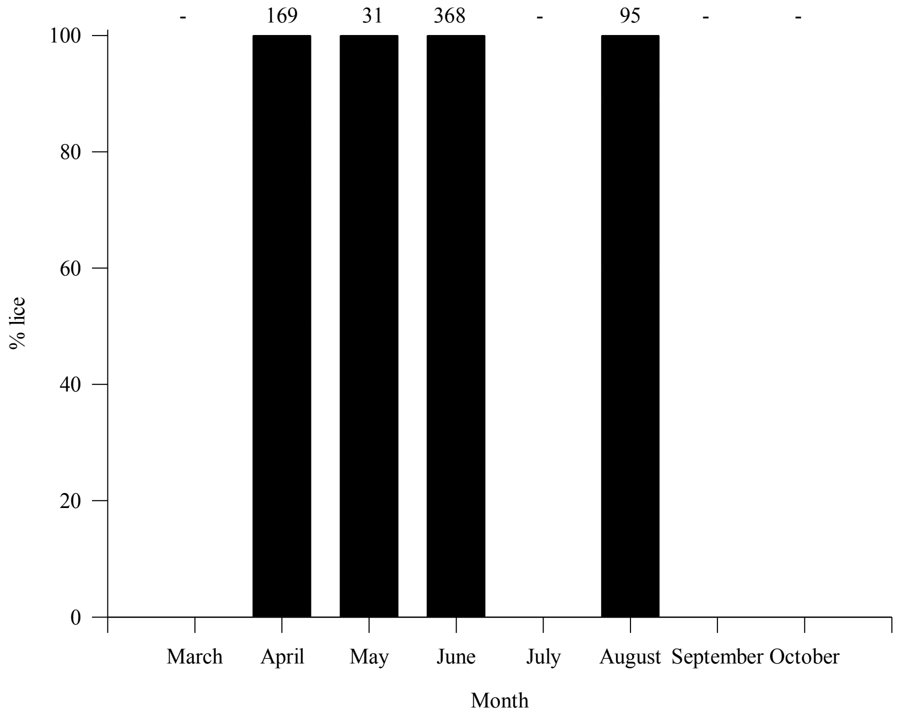

Fig. 4b Showing the proportion of each stage of lice within the Polla samples, by month. The total number of lice is given at the top.

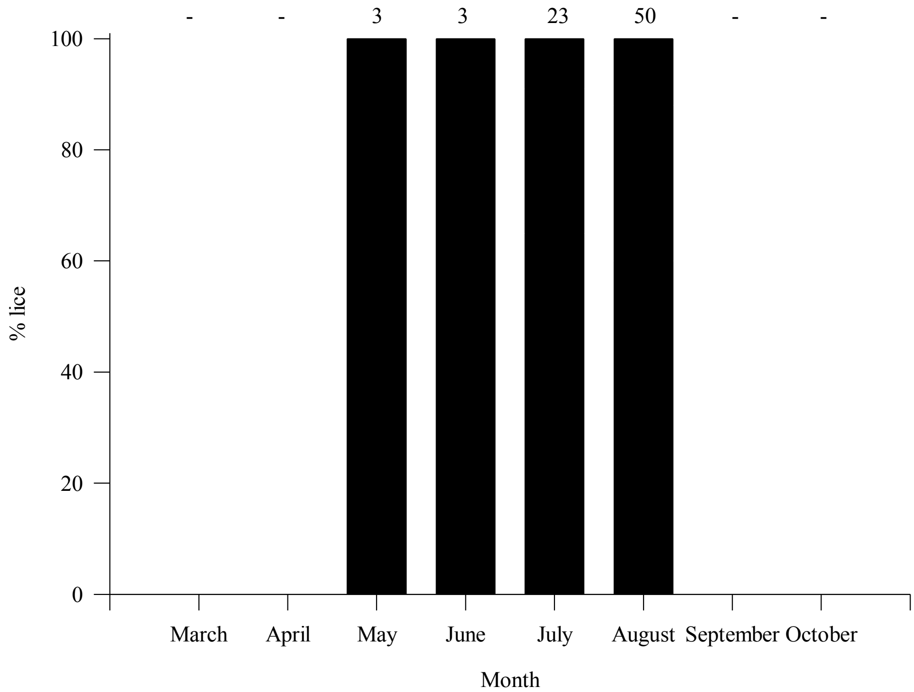

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

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	16.5	0 - 35	22	2 - 35	15.5
May	3.47	0 - 71	23.88	1 - 71	0
June	71.48	0 - 196	74.73	2 - 196	83
July	10.79	0 - 42	13.73	1 - 42	6
August	7.9	0 - 72	13.17	1 - 72	1
September	2.27	0 - 19	8.33	1 - 19	0
October	-	-	-	-	-

Polla

The abundance of lice shown in Table 7 is similar to that observed in the Laxford, with an increasing lice population until June before it starts to decline again. However, the values were significantly lower than those observed within the Laxford. There were a greater proportion of adult and gravid lice within the Polla catch compared to the Laxford (Fig. 4b), with gravids observed each month. This indicates a mature lice population and is frequently observed within the Polla suggesting that there is a lice population being maintained within the wild fish population in Loch Eriboll. Lice numbers on neighbouring cages were very 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	2.64	0 - 34	6.04	1 - 34	0
May	2.38	0 - 31	31	31	0
June	12.27	0 - 91	17.52	1 - 91	2.5
July	-	-	-	-	-
August	7.31	0 - 29	15.83	2 - 29	0
September	-	-	-	-	-
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. The pattern of lice abundance observed within the Kyle of Durness was unique to the area as it continued to increase with time (Table 8). In addition, the maturation of lice was observed from mobile to gravids, with no Chalimus seen during this sampling period (Fig. 4c). These facts, coupled with the increasing numbers of larger fish observed moving in the Kyle over the monitoring period, would suggest that the lice population on sea trout post-smolts are the result of lice breeding on the adult, wild salmonid population.

The exceptionally dry summer, and therefore low river flows, and high temperatures have created ideal conditions for lice development. A lack of freshwater gives maximum survival for the different lice stages, while the inability of returning adults to ascend into the rivers has maintained the population of adult and gravid lice. While returning salmonids routinely have high densities of adult sea lice, these die on migration of the salmonid into the rivers and are lost to the breeding population. This did not happen during 2008, when salmon were held in the estuaries for long periods of time, a situation noted in various places including the Aberdeenshire Dee (M. Bilsby, *pers. comm*.).

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
May	0.05	0 - 3	3	3	0
June	1	0 - 2	1.5	1 - 2	1
July	3.29	0 - 7	4.6	3 - 7	3
August	8.33	1 - 14	8.33	1 - 14	10.5

The Laxford and Polla, both estuaries containing salmon cages in their second year of production, showed similar patterns of lice abundance, although the Laxford trout were significantly more heavily infested. This contrasted to the pattern observed in the control site and indicates that the presence of cages influences lice distribution. However additional monitoring of the Kyle will be required to confirm, particularly given the unique weather conditions observed during 2008.

In addition, a study of the louse response to Slice within the Laxford population undertaken by Loch Duart Ltd suggested that the lice on the wild sea trout are not derived from the cages within Loch Laxford. Analyses carried out by the Fish Vet Group confirmed that the wild population of lice are naive to Slice, while those obtained from the cages have some 'knowledge' of the treatment. This creates an anomaly that will require additional analysis to assess.

Recommendations for further research

1. It is recommended that the current programme be continued.
2. It is recommended that the Kyle of Durness is retained as a site and monitoring extended to cover March – October inclusive.
3. 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.

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