Monitoring of sea trout post-smolts, 2016

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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; WSFT 2016).

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. No fish were tagged from the Kyle of Durness, although all other information was collected.

Materials & Methods

Three estuaries, Laxford Bay, the Polla estuary and the Kyle of Durness 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 recaptures, 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 implant (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 82 fish in the Laxford estuary during June (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, with the exception of October in the Laxford, when a good collection of reasonable sized codling, saithe and pollack were captured, and the Polla in the same month where the net was full of juvenile sprat.

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
March	26	4	-	-	-
April	51	30	-	-	-
May	72	56	8	3	0
June	*55	40	42	15	13
July	7	2	-	-	47
August	-	-	-	-	-
September	0	0	-	-	2
October	2	1	+1	1	-

(*plus 27; +1 lost from net)

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 Laxford returning a greater number of mature fish (Fig. 1). This is similar to the findings of 2015, although different from that in previous years when the Polla had the greater number of mature fish. From Fig. 1 the predominant smolt age in the rivers is 2 years (S2), although there were 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 within the estuaries was also similar (Fig. 2), with post-smolts dominating each estuary. Few larger fish were seen in 2016, possibly reflecting the reduced number of nettings in the Polla.

The majority of the fish examined were from the 2016 smolt run (Fig. 1; Table 2). While a May smolt run is normal for the Sutherland area (WSFT 2016), there were a number of smolts taken in the March and April samples from the Laxford indicating that some smolts may have run earlier.

Table 2 The percentage of smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
March	58	-	-
April	86	-	-
May	98	100	-
June	98	92	77
July	100	-	95
August	-	-	-
September	-	-	50
October	100	0	-

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 of the tagged fish recaptured during 2016 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. Problems with the weigh scales, occasioned by strong winds interfering with the reading, meant that the Polla weights may not be accurate and this will also have affected the condition index. Condition index in both the Laxford and Kyle of Durness were good throughout the year.

The average length of the post-smolts appears to reduce with time reflecting the movement of fish within the estuaries for feeding and shelter. During 2016 there was evidence of good feeding at sea, both from the condition index and from the presence of small fish within the sweeps. Indeed, the October sweep in the Polla was comprised primarily of large numbers of sprat.

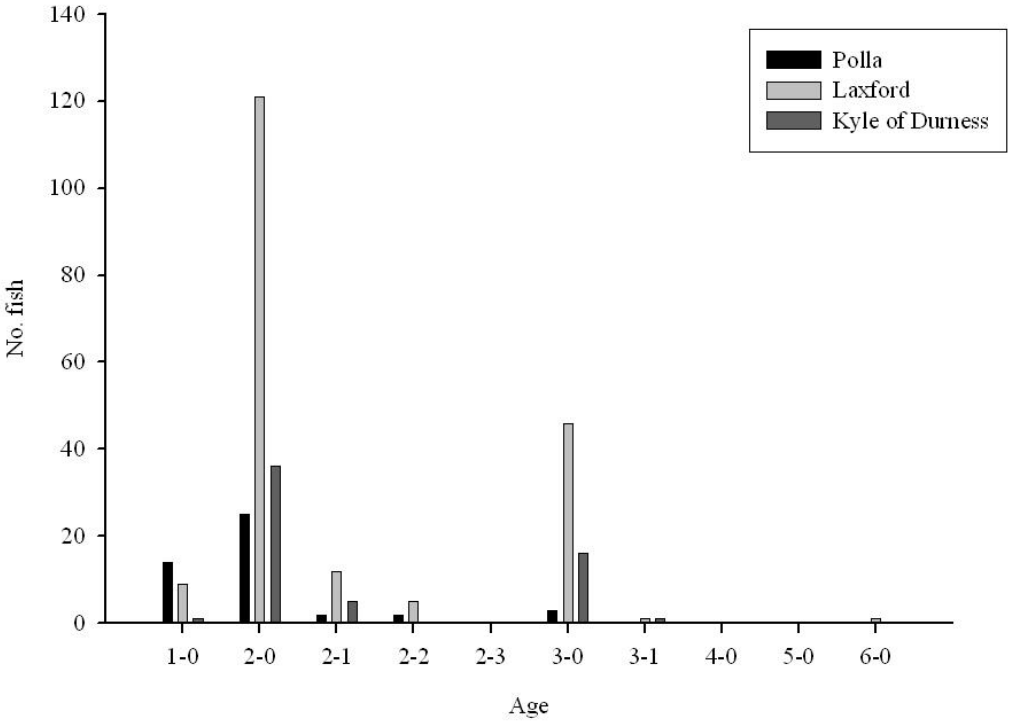

Fig. 1 The number of fish of each age taken in the estuaries

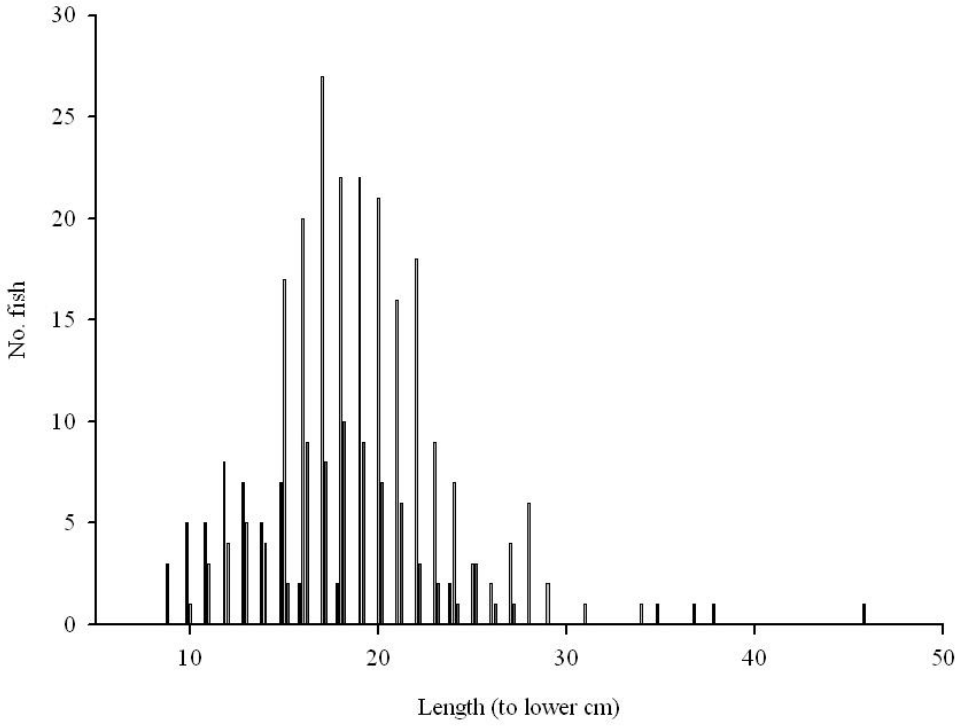

Fig. 2 The number of fish of each length taken in the estuaries

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

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
March	217.29 ± 19.82	102.86 ± 24.69	0.99 ± 0.09
April	215.84 ± 26.41	104.46 ± 37.59	1.01 ± 0.10
May	180.15 ± 22.68	63.94 ± 22.95	1.06 ± 0.14
June	173.10 ± 26.96	48.18 ± 24.30	0.87 ± 0.17
July	161.50 ± 51.31	-	-
August	-	-	-
September	-	-	-
October	179.5 ± 20.51	77.50 ± 20.51	1.33 ± 0.10

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

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
March	-	-	-
April	-	-	-
May	145.75 ± 43.42	34.00 ± 35.51	0.90 ± 0.13
June	136.29 ± 29.25	22.21 ± 20.11	0.74 ± 0.26
July	-	-	-
August	-	-	-
September	-	-	-
October	-	-	-

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

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
March	-	-	-
April	-	-	-
May	-	-	-
June	195.80 ± 27.33	81.70 ± 35.64	1.04 ± 0.12
July	189.93 ± 20.80	70.12 ± 20.96	1.00 ± 0
August	-	-	-
September	202	109	1.32
October	-	-	-

Recaptures

There were 6 recaptures during 2016, all within the Laxford estuary netting. The growth of recaptured trout is shown in Table 4. Of the recaptured trout, 1 was originally tagged in 2015, with the rest in 2016. All fish were taken in the area of original tagging. This pattern is common to the sampling programme over the past 19 years and demonstrates that the majority of sea trout do not stray far from their home rivers. One fish was reported as tagged by an angler in the River Laxford. Unfortunately no tag details were recorded.

Average growth rates within the Laxford were 12.85 mm, and 17.98 g per month. This is higher than that seen in 2015.

Figure 3 shows that the specific growth rates (SGR) in the Laxford, while lower than that observed in 2015, is still within the upper range observed during the past 20 years. The good condition was evident from the appearance of the fish in the net. The results from this analysis demonstrate the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature.

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

Tag number		Tagged	Recaptured	Difference
O07	Date	16.6.15	6.4.16	10 mths
	Length (mm)	186	202	16
	Weight (g)	63	77	14
O98	Date	10.3.16	6.4.16	1 mth
	Length (mm)	288	291	3
	Weight (g)	205	214	9
P05	Date	6.4.16	6.6.16	2 mths
	Length (mm)	198	241	43
	Weight (g)	72	155	83
*P42	Date	21.5.16	6.6.16	2 wks
	Length (mm)	195	205	10
	Weight (g)	65	85	20
*P43	Date	21.5.16	6.6.16	2 wks
	Length (mm)	178	184	6
	Weight (g)	45	44	-1
N53	Date	6.6.16	6.7.16	1 mth
	Length (mm)	156	175	19
	Weight (g)	34	-	-

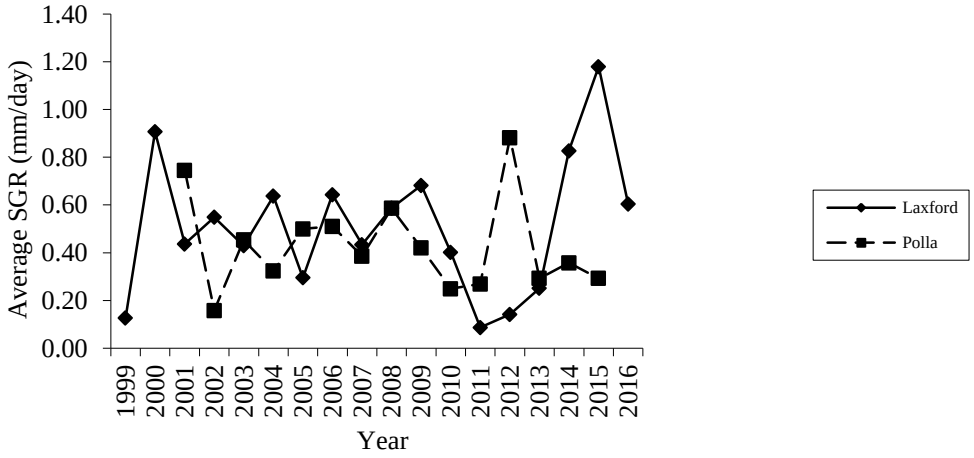

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

Sea Lice Infestations

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

Month	Laxford Bay	Polla estuary	Kyle of Durness
March	0	-	-
April	0	-	-
May	0	13	-
June	0	17	23
July	14	-	77
August	-	-	-
September	-	-	100
October	0	100	-

Sea lice were present to a varying degree in all estuaries (Table 5), with lice found during all sampling occasions in both the Polla and Kyle of Durness. Lice were found in the Laxford during July only, comprising of mobile stages (Fig 4a). The Polla samples demonstrated a mixture of lice stages over the year, although only Chalimus were present in May and no Chalimus in October (Fig. 4b). As with the

Polla, the Kyle of Durness sea trout also carried a mixture of lice stages although there were a greater number of adults and gravids than seen in the Polla (Fig. 4c). Total lice numbers were exceptionally low in the Laxford but much higher in the other two systems. The greatest numbers of lice were found in the Kyle of Durness in July. However, the total lice number per sample is dependent on sample size and the use of abundance and intensity data give a better assessment of the situation.

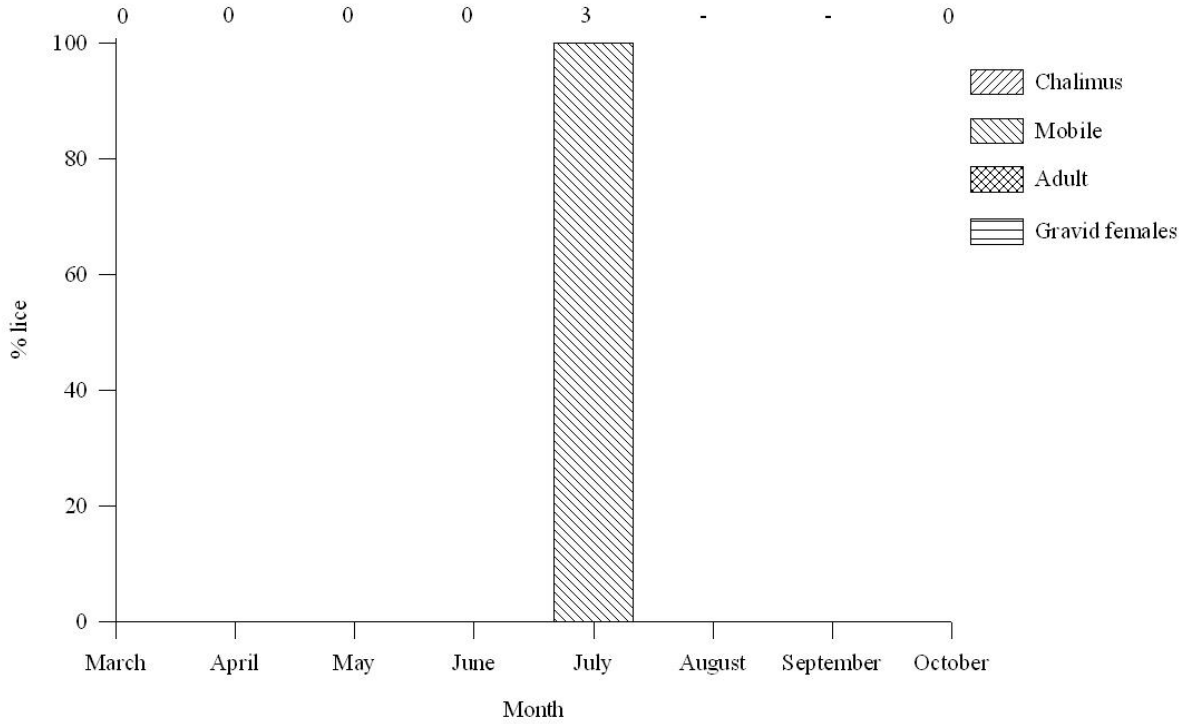

Fig. 4a Showing the proportion of each stage of lice within the Laxford samples, by month. The total number of lice is given at the top.

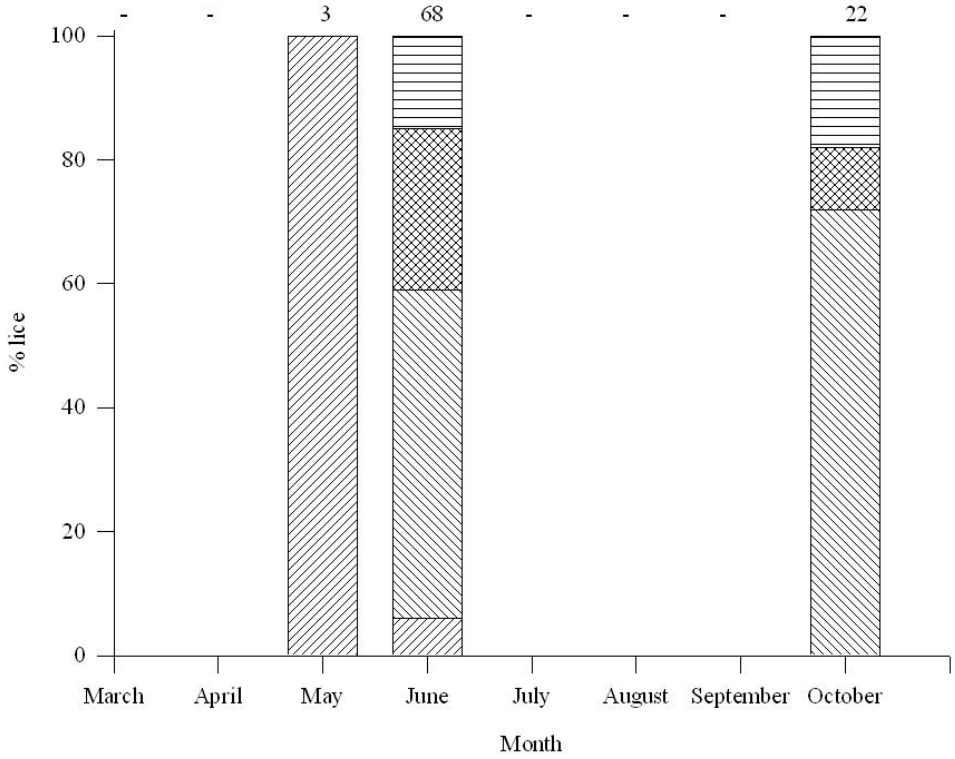

Fig. 4b Showing the proportion of each stage of lice within the Polla samples, by month. The total number of lice is given at the top.

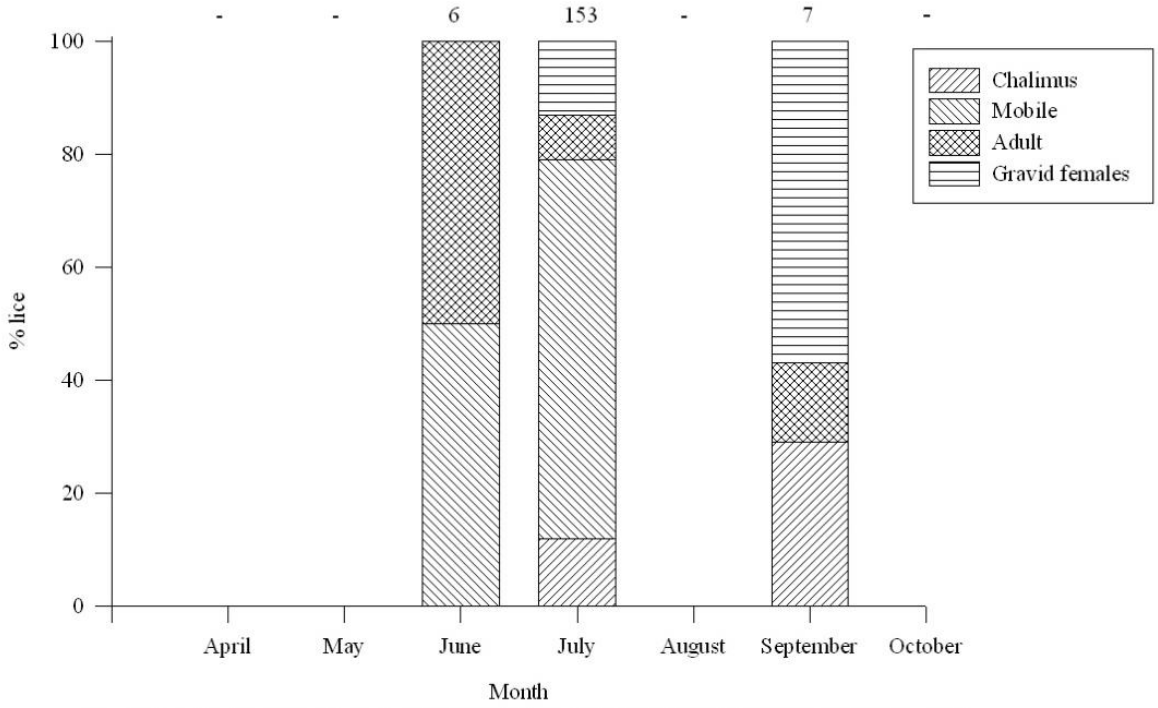

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

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 (Tables 6 (Laxford), 7 (Polla) & 8 (Kyle of Durness)). The use of intensity will give a more accurate impression of the degree of infestation, 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 by a single heavily infected individual.

Laxford

Lice were only present on one occasion within the Laxford, and in low numbers on one fish (Table 6). All three lice were mobiles (Fig. 4a). There were no *Caligus* found within the survey.

The neighbouring cages have been fallow since May, when the broodstock were removed and therefore no comparisons are possible.

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	0	0	0	0	0
April	0	0	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	0.43	0 - 3	3	3	0
August	-	-	-	-	-
September	-	-	-	-	-
October	0	0	0	0	0

Polla

The abundance of lice as shown in Table 7 shows a peak in lice during October. However this is misleading as it is made up of a single fish. However there was a general increase in numbers between May and June. The May sample was made up of Chalimus, with some evidence of maturation following (Fig. 4b). Gravid lice were present in each of the remaining months, with very few chalimus present in June and none in October. *Caligus* were present on a small number of fish during June and October, always at low numbers (1 – 5).

The neighbouring cages were restocked with S1 fish in February. Numbers of *Lepeophtheirus* were low throughout the season, although *Caligus* numbers increased through the summer. This is in direct contract the findings within the wild population.

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	-	-	-	-	-
May	0.38	0 - 3	3	3	0
June	1.62	0 - 18	9.71	1 - 18	0
July	-	-	-	-	-
August	-	-	-	-	-
September	-	-	-	-	-
October	22	22	22	22	22

Kyle of Durness

The abundance of lice as shown in Table 8 was higher than that found in other parts of the area. This was further highlighted by the fact that the majority of the fish examined were found to have lice present, as seen from the median values. There was a mix of stages present, with potential maturation observed within the population (Fig. 4c). *Caligus* were present in July and September, but in low numbers.

Table 8 The abundance, intensity and median value of the salmon louse on wild sea trout in 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	-	-	-	-	-
May	-	-	-	-	-
June	0.46	0 - 3	2	1 - 3	0
July	3.26	0 - 10	4.25	1 - 10	2
August	-	-	-	-	-
September	3.50	2 - 5	3.50	2 - 5	3.5
October	-	-	-	-	-

A risk assessment of the lice numbers present within the wild trout

Taranger, *et al.* (2014) gives a method to assess the increased mortality risk to salmonid populations based on the number of lice present per gram of fish. This is based on physiological effects determined from laboratory experiments taken from literature, and the use of sentinel cages within fjords.

The data are treated differently depending on fish size and give a potential increased risk of mortality to each fish, with increasing risk as the number of lice increase. Thus, 0.1 – 0.2 lice/g will give a 20% increased risk of mortality to a salmonid of < 150g. In order to determine the likely population effect, the proportion of fish within the population appearing in each band is calculated and a population risk determined. Fig. 5 gives the results by year for each estuary, with the banding indicating whether the risk is low (green), moderate (yellow) or high (red). Within the green zone it can be taken that there is minimal risk to the population, while the yellow and red zones show potentially population altering impacts.

From this, it can be seen that the potential risks within the Polla estuary are low throughout the study period, with the exception of 2006, when increased lice levels were observed. This is a positive reflection on the situation within the estuary, not perhaps seen in previous analyses based solely on lice abundance. It may, however, be more reflective of the rod catches, which have remained steady or increasing with time.

In contrast, the Laxford analysis would indicate that sea lice populations are creating a potential population changing effect on a regular basis. While there is a biannual effect observed, primarily giving a moderate effect, on 2 years, 2011 and 2013, this was identified as high. This is perhaps a better reflection of the impression drawn from the previous analyses of the abundance data, but serves to highlight the population changes observed with the rod catches. In 2016, however, a risk of 0 was calculated for the Laxford population. While a low level of risk was expected, given the trends of the previous years, this is unusual for the estuary.

Sampling within the Kyle of Durness has been more restricted than the other 2 estuaries, but results would indicate that there is a low risk to the population arising from the lice burdens within the population. The exception to this was in 2005, where a high potential risk was recorded. Catch records, again, mirror to some extent the potential risk to the population identified.

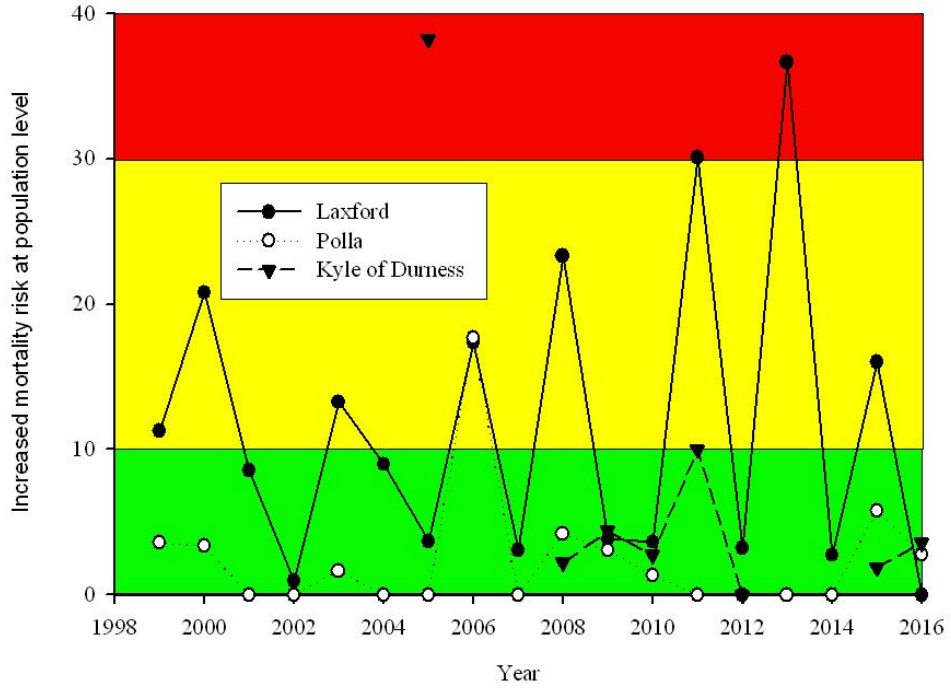

Fig. 5 Showing the increased mortality risk at population level created by sea lice

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 further research into the dynamics of the sea trout population in both marine and freshwaters be undertaken. This should also examine the relationship between the resident and migratory components of the population.
3. It is recommended that additional research on the sea lice population be undertaken.

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