Monitoring of sea trout post-smolts, 2018

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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 2018).

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 April to September, 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 173 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.

2018 was an exceptional year within the estuary sampling. While total number of post-smolts within the netting has been higher, particularly in the Laxford, the 7 grilse taken in the July samples has not been seen previously. This is likely to reflect the low river flow delaying the running of the fish.

Similarly within the July samples from the Polla. While large fish are not uncommon in the Polla netting, such a large number of sea trout greater than 1 kg in one net is unusual. This is again likely to be a reflection of the weather and the fish being unable to run into the river.

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
April	5[*]	4	-	-	-
May	44[+]	22	64[a]	22	-
June	47	32	3	0	3
July	10[b]	7	54[c]	31	2
August	1	0	57	33	-
September	-	-	-	-	-

([*]plus 1 lost; [+]plus 129; [a]plus 3 salmon; [b]plus 7 grilse; [c]plus 2 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, although the Polla produced a greater number of mature fish (Fig. 1). Few fish were taken in the Kyle of Durness nets this year. 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 the Polla and Laxford. The length distribution of fish within the estuaries was also similar (Fig. 2), with post-smolts dominating each estuary. However there were a few larger fish within the Polla samples.

The majority of the fish examined were from the 2018 smolt run (Fig. 1; Table 2). A May smolt run is normal for the Sutherland area (WSFT 2018) and this is supported by these data. With no sweeps possible in September we could not confirm the presence of the autumn run witnessed in previous years (WSFT 2018).

Table 2 The percentage of smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	80	-	-
May	95	100	-
June	80	100	100
July	89	76	100
August	100	98	-
September	-	-	-

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 2018 were taken in the same location as originally tagged. Further information on the usage of the estuary by sea trout will be acquired from the Laxford sea trout tracking undertaken in 2018 and to be reported elsewhere.

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. The condition index was variable, with poor condition being recorded in each estuary. In the Laxford and Kyle of Durness this was at the start of the year, with condition improving with time at sea. However the Polla showed a more mixed pattern and indicated a decline in June following smolting. The low value in August may be a reflection of equipment failure but will be monitored in 2019.

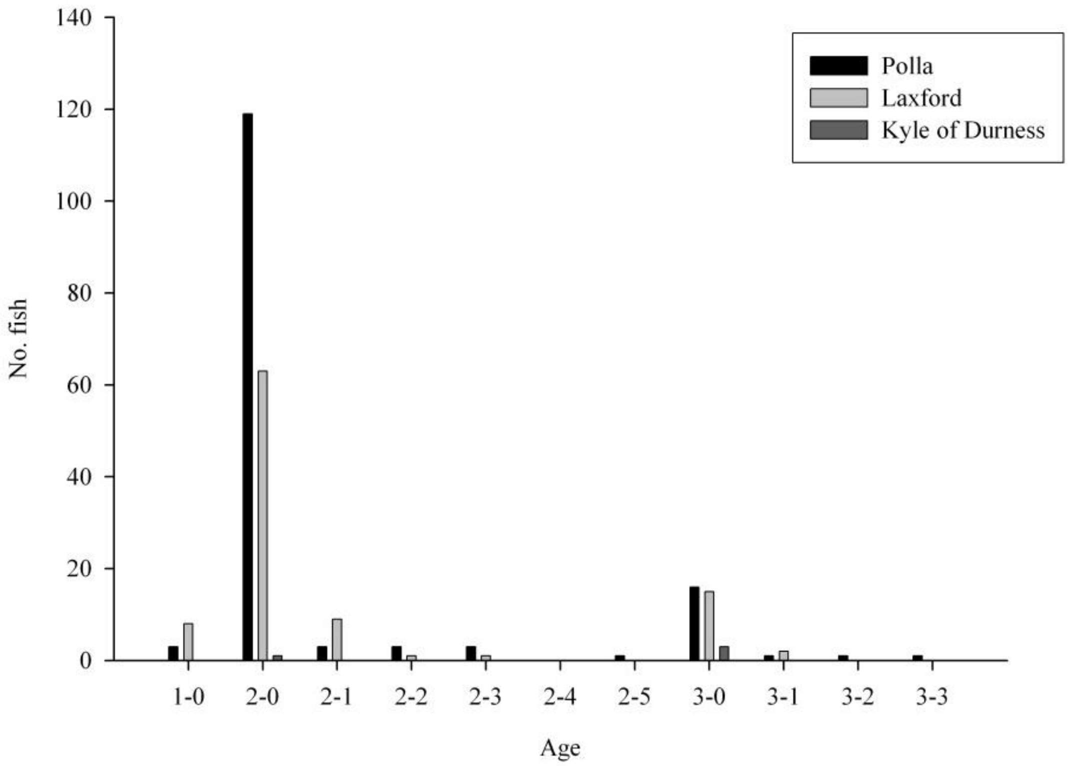

Fig. 1 The number of fish of each age taken in the estuaries

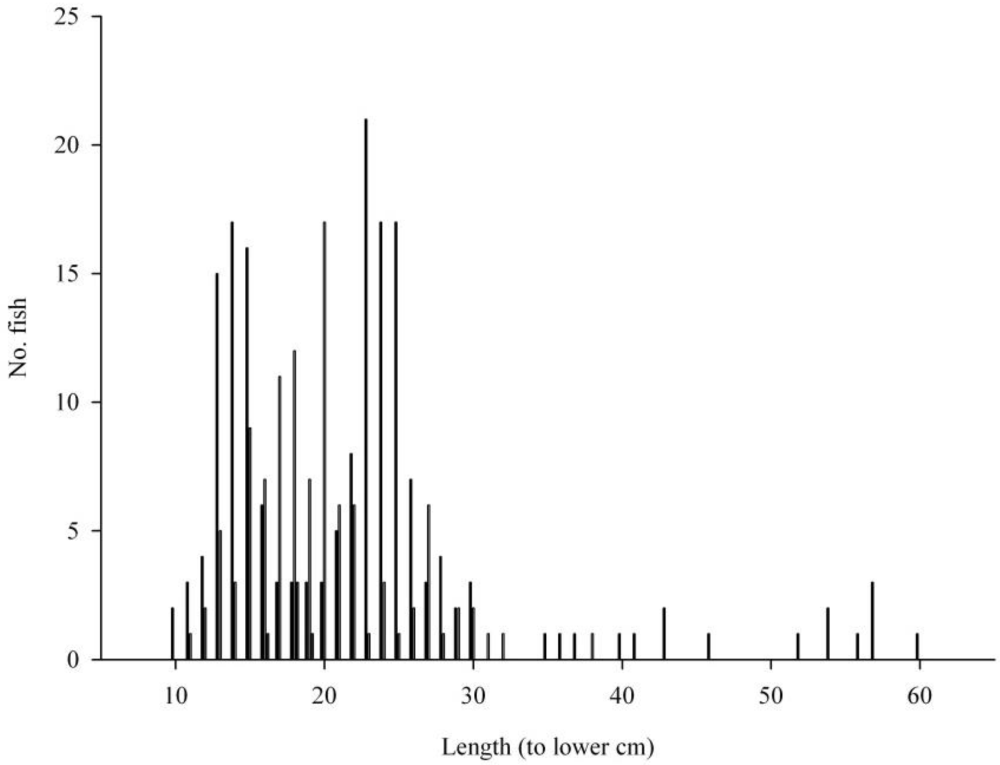

Fig. 2 The number of fish of each length taken in the estuaries

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.)
April	204.80 ± 44.79	81.20 ± 62.40	0.83 ± 0.05
May	205.00 ± 31.59	87.00 ± 42.36	0.95 ± 0.13
June	170.03 ± 30.29	53.23 ± 26.06	1.05 ± 0.28
July	184.63 ± 40.63	76.63 ± 40.46	1.12 ± 0.10
August	181.00	62.00	1.05
September	-	-	-

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.)
May	149.02 ± 20.83	36.86 ± 17.48	1.07 ± 0.16
June	128.33 ± 17.95	18.00 ± 5.57	0.84 ± 0.10
July	241.53 ± 32.22	159.94 ± 53.29	1.07 ± 0.10
August	234.04 ± 30.06	76.26 ± 27.74	0.57 ± 0.08
September	-	-	-

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.)
May	-	-	-
June	182.00 ± 13.11	40.00 ± 8.00	0.66 ± 0.02
July	181.00 ± 0.00	65.00 ± 7.07	1.10 ± 0.12
August	-	-	-
September	-	-	-

Recaptures

There were 8 recaptures during 2018, all within the Laxford estuary. The growth of recaptured trout is shown in Table 4. Of the recaptured trout, 3 were originally tagged in 2016, 1 in 2017 and the rest in 2018. All fish were tagged and re-captured in the same location. This pattern is common to the sampling programme over the past 21 years and demonstrates that the majority of sea trout do not stray far from their home rivers.

Average growth rates within the Laxford were 7.92 mm, and 16.22 g per month. This is lower than that seen in 2017.

Figure 3 shows that the specific growth rates (SGR) in the Laxford, while lower than that seen in 2017 remains high compared to levels seen previously within this estuary. 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.

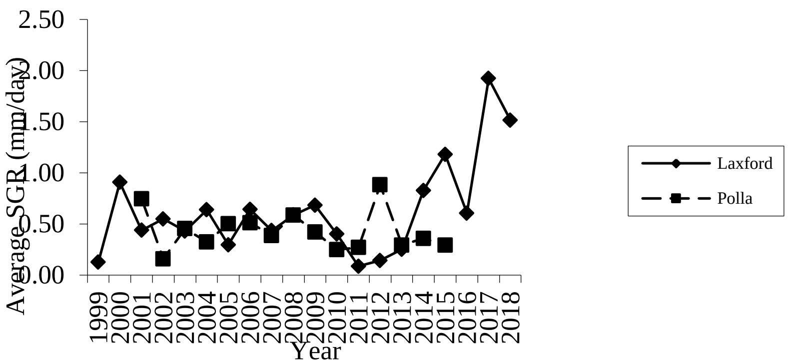

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

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

Tag number		Tagged	Recaptured	Difference
N53	Date	6.6.16	23.4.18	22 mths
	Length (mm)	156	284	128
	Weight (g)	34	138	104
O77	Date	17.4.18	15.5.18	1 mth
	Length (mm)	194	204	10
	Weight (g)	59	78	19
*O81	Date	23.4.18	15.5.18	1 mth
	Length (mm)	149	161	12
	Weight (g)	28	47	19
P96	Date	13.6.18	13.7.18	1 mth
	Length (mm)	212	231	19
	Weight (g)	92	130	38
P83	Date	13.6.18	13.7.18	1 mth
	Length (mm)	301	312	11
	Weight (g)	241	330	89
+P43	Date	21.5.16	13.7.18	26 mths
	Length (mm)	178	368	190
	Weight (g)	45	489	444
N82	Date	29.4.17	13.7.18	15 mths
	Length (mm)	182	323	141
	Weight (g)		353	
+N25	Date	6.6.16	14.7.18	25 mths
	Length (mm)	153	349	196
	Weight (g)	31	424	393

(*tagged in Badna Bay; +caught by rod & line)

Sea Lice Infestations

Sea lice were present to a varying degree in all estuaries (Table 5), although there were several sampling occasions with no lice observed. Each estuary showed a mixture of lice stages, with mobile to adult stages dominating (Fig. 4). Total number of lice was low in both the Laxford (Fig. 4a) and the Kyle of Dionard (Fig. 4c) but higher in the Polla (Fig. 4b). The total number of lice increased with time in all estuaries. 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.

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

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	0	-	-
May	0	0	-
June	5	0	34
July	60	39	100
August	0	89	-
September	-	-	-

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.

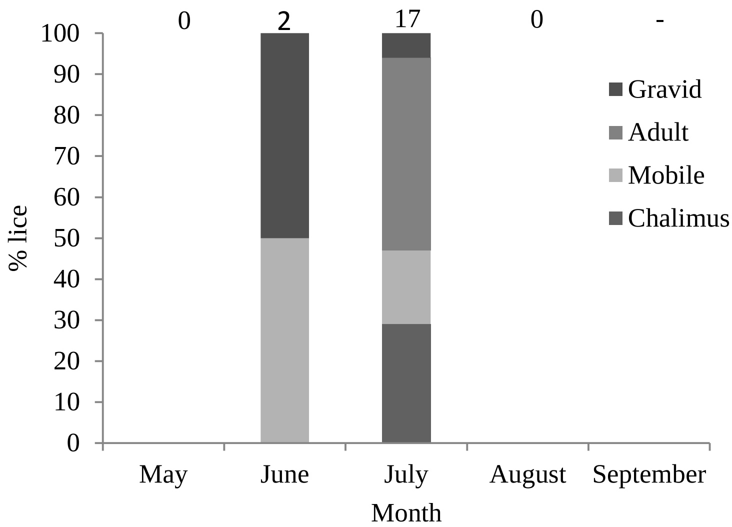

Fig. 4a Showing the proportion of each stage of lice within Laxford Bay samples, by month. The total number of lice is given at the top.

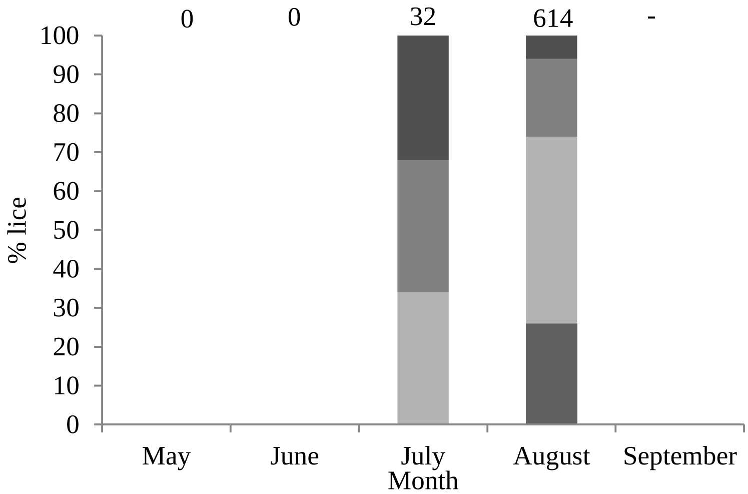

Fig. 4b Showing the proportion of each stage of lice within the Polla estuary samples, by month. The total number of lice is given at the top.

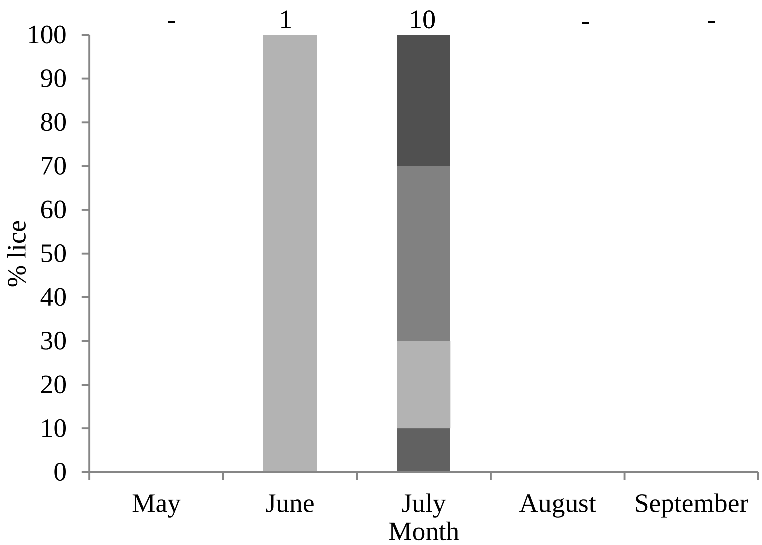

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

Laxford

Lice were present within the Laxford during June and July only, at low densities (Table 6). The pattern of lice presence would appear to reflect a wild population, as demonstrated by Gargan, *et al.* 2003. Very few *Caligus* were present on the fish, again in June (1) and July (2).

The neighbouring cages contained fish throughout this survey period. Lice numbers were well controlled throughout the year with few *Caligus* as well, a reflection of the situation within the sweep nets.

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
April	0	0	0	0	0
May	0	0	0	0	0
June	1	1	1	1	1
July	1.70	0 - 8	2.83	1 - 8	1
August	0	0	0	0	0
September	-	-	-	-	-

Polla

Lice were only present in July and August within the survey. Abundance increased significantly in August (Table 7) with maturation and breeding of the population (Fig. 4b). As with *Lepeophtheirus*, *Caligus* were only present in July (6) and August (104), increasing with time.

This pattern was not reflected in the neighbouring cages, where *Lepeophtheirus* densities were low over the sampling period. *Caligus* numbers did, however, rise in August, similar to that seen in 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
May	0	0	0	0	0
June	0	0	0	0	0
July	0.59	0 - 4	1.52	1 - 4	0
August	10.21	0 - 38	11.41	1 - 38	9
September	-	-	-	-	-

Kyle of Durness

Lice were present on both sampling occasions in the Kyle of Durness (Table 8). Densities were low and there was a mix of stages present in August (Fig. 4c). There were no *Caligus* present on the fish sampled.

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
May	-	-	-	-	-
June	0.33	0 - 1	1	1	0
July	5	4 - 6	5	4 - 6	5
August	-	-	-	-	-
September	-	-	-	-	-

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 risk in each estuary during 2018 were considered to be low, indicating that population changing effects are unlikely throughout the area. The Laxford data continue to show a biannual pattern in risk, reflecting the stage of production within the farm. While this pattern was not previously seen within the Polla samples, it has been witnessed in the last 4 years.

Sampling within the Kyle of Durness has been more restricted than the other 2 estuaries, but again, there would appear to be a slight pattern within the data. While not an exact reflection, this would appear to follow the Laxford more closely than the Polla. While not significant, it may reflect the tidal flows around the west coast.

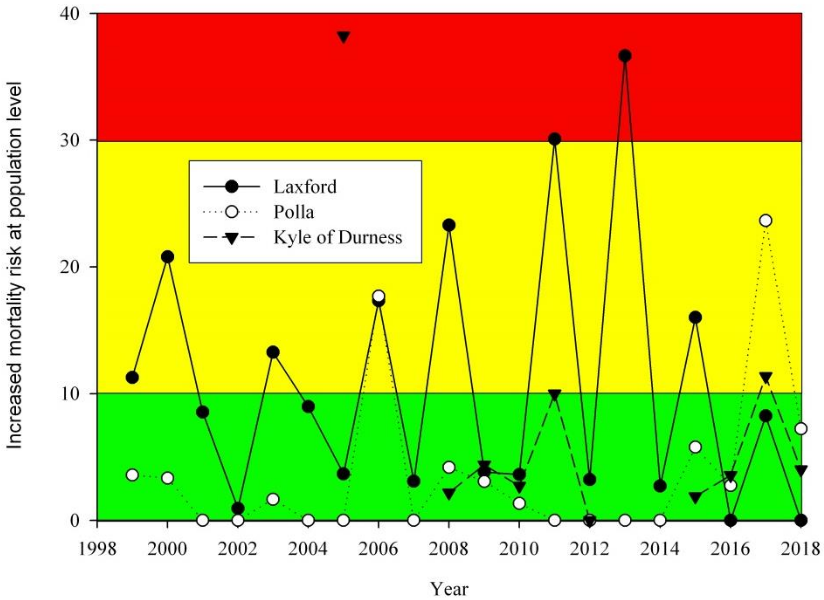

Fig. 5 Showing the increased mortality risk at population level created by sea lice

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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