Monitoring of sea trout post-smolts, 2021

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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 regard to sea lice (Marshall 2003; WSFT 2021).

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.

Materials & Methods

Three estuaries, Laxford Bay, Polla estuary and 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.

All sea trout were removed, with an aim of 50 fish to be anaesthetised with Tricaine Pharmaq and examined. Their 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. 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.

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 179 fish in the Polla during August (Table 1). This contrasts to previous years in both timing and location but is likely to reflect the fact that the largest catches are normally found in May when no sweep netting was undertaken as a result of high river levels. 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 each area was as expected from previous years, with few species and low numbers observed. The exception to this was the mature mullet taken in the Kyle of Durness during September.

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	32	19	19	8	0
May	-	-	-	-	-
June	34	27	9	3	4
July	*76	3	28	0	16
August	6	1	+52	0	-
September	16	8	-	-	14

(*plus 12 released; +plus 127 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 estuaries was similar, with a predominant smolt age in the rivers of 2 years (S2), although there were a number of S3's also present. S1's were also observed in small numbers in both the Polla and Laxford. The length distribution of fish within the estuaries was also similar, although with a greater range in size in the Polla and Laxford (Fig. 2). Post-smolts dominated the Polla and Laxford samples (Table 2). There were several mature fish taken in all estuaries, with the largest being seen in the Polla.

Table 2 The percentage of post-smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	59	56	-
May	-	-	-
June	81	100	25
July	74	71	36
August	83	85	-
September	73	-	54

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.

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 generally good if variable. The poorest condition was found in the Laxford during August and September.

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	169.44 ± 24.52	57.81 ± 35.58	1.12 ± 0.43
May	-	-	-
June	175.00 ± 20.34	60.71 ± 21.42	1.09 ± 0.05
July	231.35 ± 35.39	142.20 ± 56.89	1.08 ± 0.09
August	231.60 ± 41.21	119.80 ± 59.51	0.88 ± 0.11
September	247.64 ± 25.33	149.91 ± 44.30	0.82 ± 0.09

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.)
April	152.11 ± 19.09	37.11 ± 16.19	1.00 ± 0.12
May	-	-	-
June	138.56 ± 29.92	15.67 ± 4.16	1.41 ± 1.04
July	223.94 ± 41.53	127.00 ± 60.82	1.08 ± 0.16
August	242.67 ± 19.80	193.54 ± 52.05	1.36 ± 0.43
September	-	-	-

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

Month	Mean length (± s.d.) (mm)	Mean weight (± s.d.) (g)	Mean Condition Index (± s.d.)
April	-	-	-
May	-	-	-
June	249.25 ± 27.58	154.00 ± 47.87	0.97 ± 3.86
July	211.40 ± 36.27	113.20 ± 59.15	1.12 ± 0.03
August	-	-	-
September	221.43 ± 26.43	106.29 ±24.78	1.00 ± 0.20

Recaptures

There were 4 recaptures during 2021, all within the Laxford estuary. The growth of recaptured trout is shown in Table 4. Of the recaptured trout all were tagged in 2021. All fish were tagged and re-captured in the same location. This pattern is common to the sampling programme over the past 24 years and demonstrates that the majority of sea trout do not stray far from their home rivers.

Average growth rates within the Laxford were 17.75 mm, and 30.5 g per month.

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

Tag number		Tagged	Recaptured	Difference
J54	Date	24.6.21	26.7.21	1 mth
	Length (mm)	195	201	6
	Weight (g)	-	92	-
J53	Date	24.6.21	26.7.21	1 mth
	Length (mm)	184	206	22
	Weight (g)	-	109	-
J46	Date	24.6.21	26.7.21	1 mth
	Length (mm)	201	228	27
	Weight (g)	93	137	44
J57	Date	24.6.21	23.8.21	2 mths
	Length (mm)	183	215	32
	Weight (g)	67	101	34

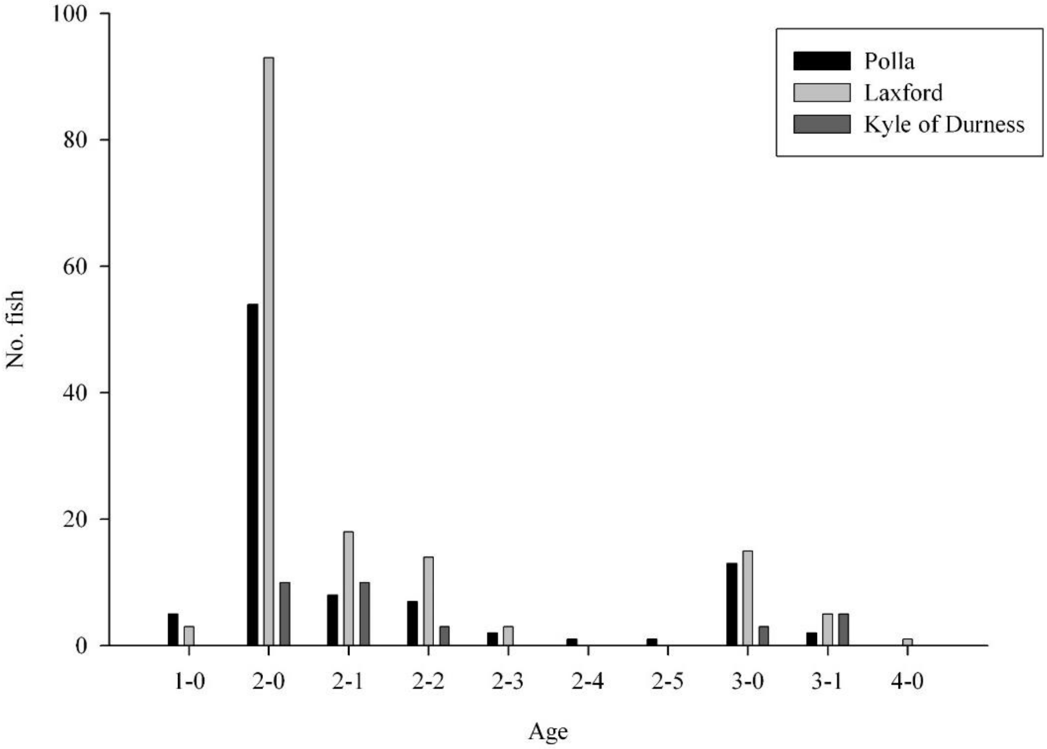

Fig. 1 The number of fish of each age taken in the estuaries

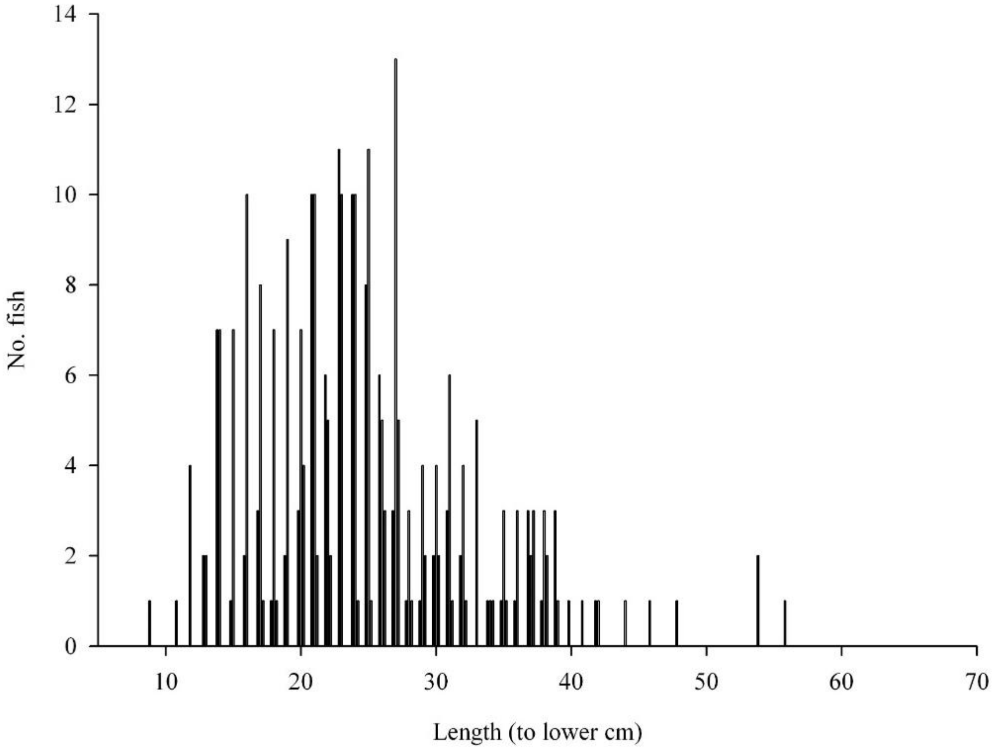

Fig. 2 The number of fish of each length taken in the estuaries

Figure 3 shows that the specific growth rates (SGR) in the Laxford, while lower than that seen in recent years remains high compared to levels seen previously within this estuary. The results from this analysis demonstrate the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature.

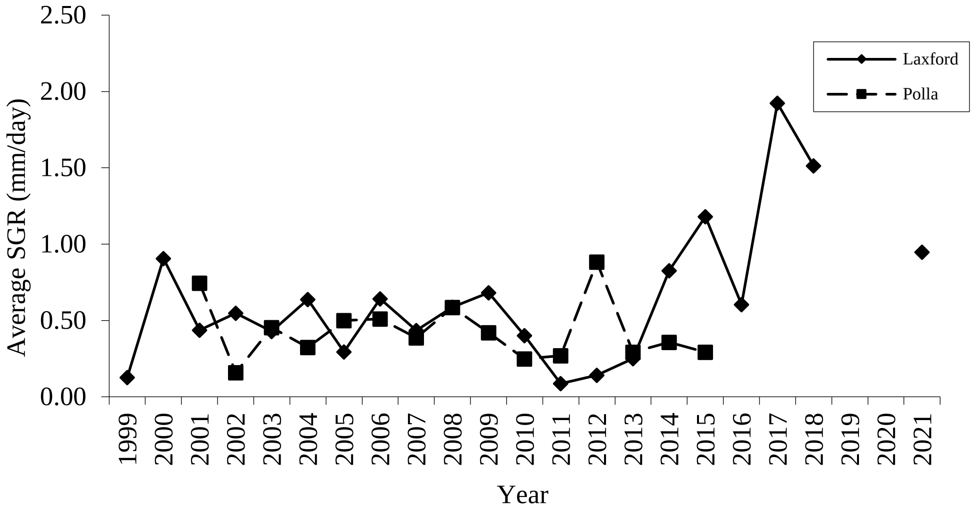

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

Sea Lice Infestations

Sea lice were present to a varying degree at all sites (Table 5), throughout the year. Each estuary showed a mixture of lice stages, although Chalimus were not present in the Kyle of Durness (Fig. 4a - c). Lice numbers were variable over the year, with the highest numbers seen 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.

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

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	6	47	-
May	-	-	-
June	35	33	100
July	80	93	100
August	67	48	-
September	50	-	93

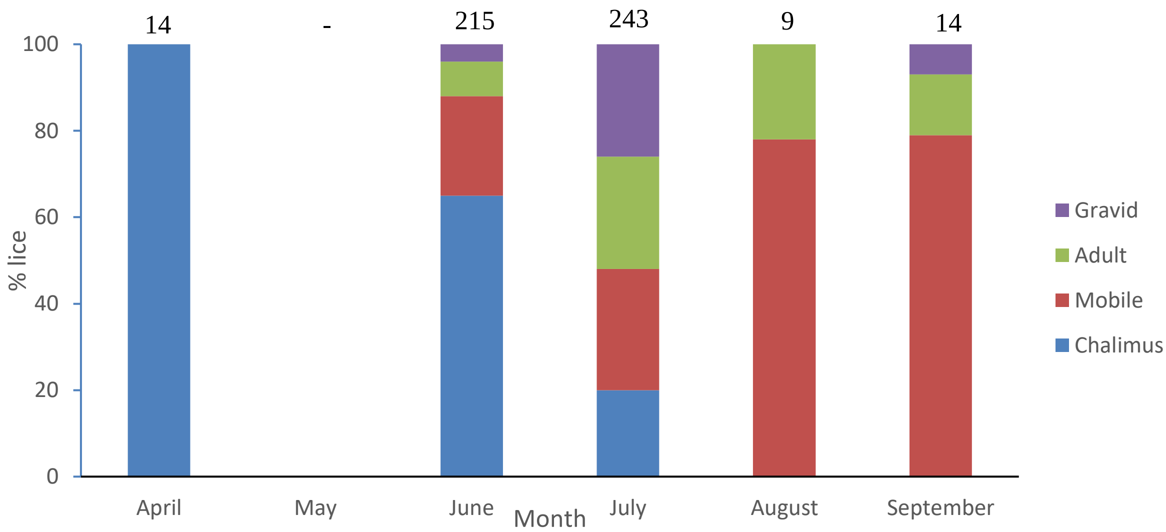

Fig. 4a Showing the proportion of each stage of lice within the Laxford estuary samples, by month. The total number of lice is given at the top.

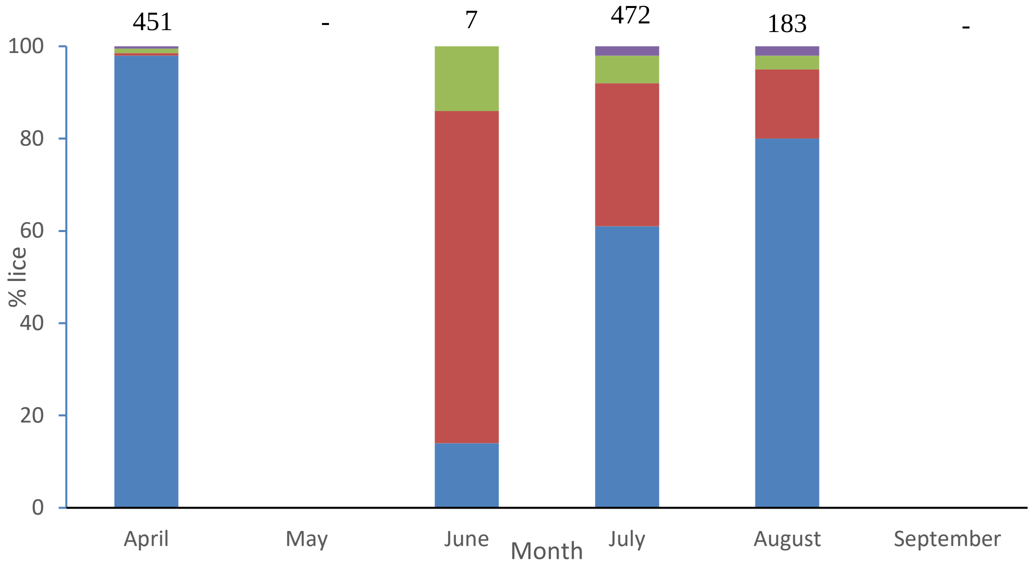

Fig. 4b Showing the proportion of each stage of lice within the Polla estuary samples, by month. The total number of lice is given at the top.

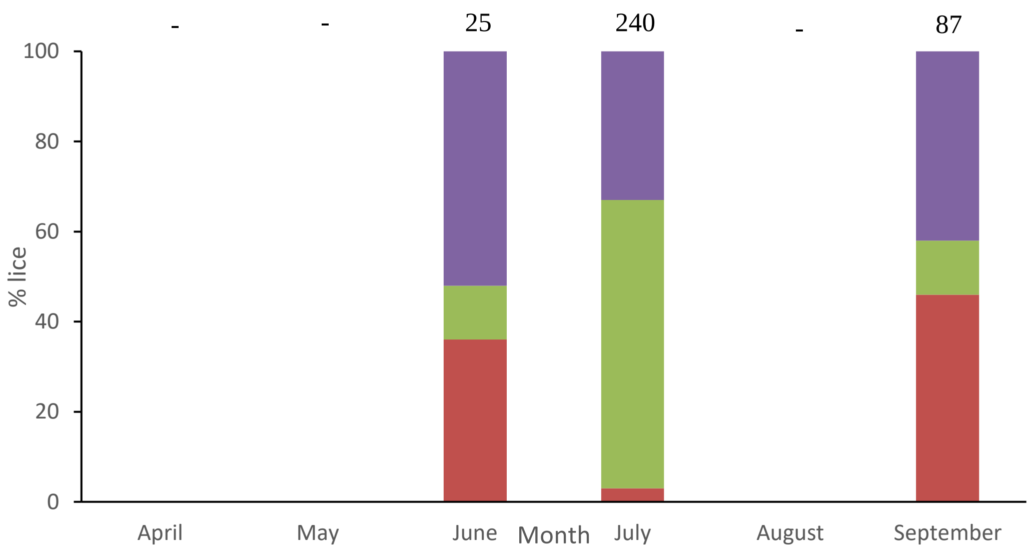

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

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 present throughout the year (Table 6), with abundance decreasing from June to September. *Caligus* were present in April, June and July, on a small number of fish.

The neighbouring cages were fallowed from July. *Lepeophtheirus* numbers were zero or very low during April and May. An increase was noted after that, but values remained below Code of Good Practice levels, with the exception of the week commencing 14 June, when adult female levels rose to 0.70. However, *Caligus* dominated the population.

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	1	0 - 20	16	12 - 20	0
May	-	-	-	-	-
June	6.32	0 - 60	17.92	1 – 60	0
July	3.20	0 - 26	3.98	1 - 26	2
August	1.5	0 - 3	2.25	1 - 3	1.5
September	0.88	0 - 4	1.75	1 - 4	0.5

Polla

Lice were present throughout the year (Table 7), with abundance declining from June. *Caligus* were also present each month, with the exception of June.

Within the neighbouring cages, the sites remained stocked for most of the survey period. Kempie was fallowed in the week commencing 30 August and Sian the week of 11 October. Adult females were present at both sites throughout the period, while fish were present, at numbers near or above Code of Good Practice levels.

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
April	23.74	0 - 109	50.11	5 - 109	0
May	-	-	-	-	-
June	0.78	0 - 4	2.33	1 - 4	0
July	17.79	0 - 55	19.15	2 - 55	13
August	3.52	0 - 34	7.32	1 - 34	0
September	-	-	-	-	-

Kyle of Durness

Lice were present within the Kyle of Durness throughout the year (Table 8). Densities varied by month, with no pattern discernible, but remained relatively high. In contrast to the other sites, there were no Chalimus found within the Kyle of Durness samples. *Caligus* were present on the fish during June and September.

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
April	-	-	-	-	-
May	-	-	-	-	-
June	6.25	4 - 12	6.25	4 - 12	4.5
July	15.00	2 - 30	15.00	2 - 30	13
August	-	-	-	-	-
September	6.21	0 - 16	6.69	2 - 16	6

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. 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 the Polla estuary and Kyle of Durness during 2021 was considered to be medium, indicating that there are potentially population changing effects likely to have occurred. In contrast, the Laxford showed a low potential risk for this year. The Laxford results do, however, show an increased risk when compared to 2020.

The Laxford and Polla data continue to show a biannual pattern in risk, reflecting the stage of production within the farm. While sampling within the Kyle of Durness has been less regular over time than the other 2 estuaries, there would appear to be no real pattern within the data. However, the peaks in potential risk do appear to follow the Laxford more closely than the Polla. While not significant, this may reflect the tidal flows around the west coast.

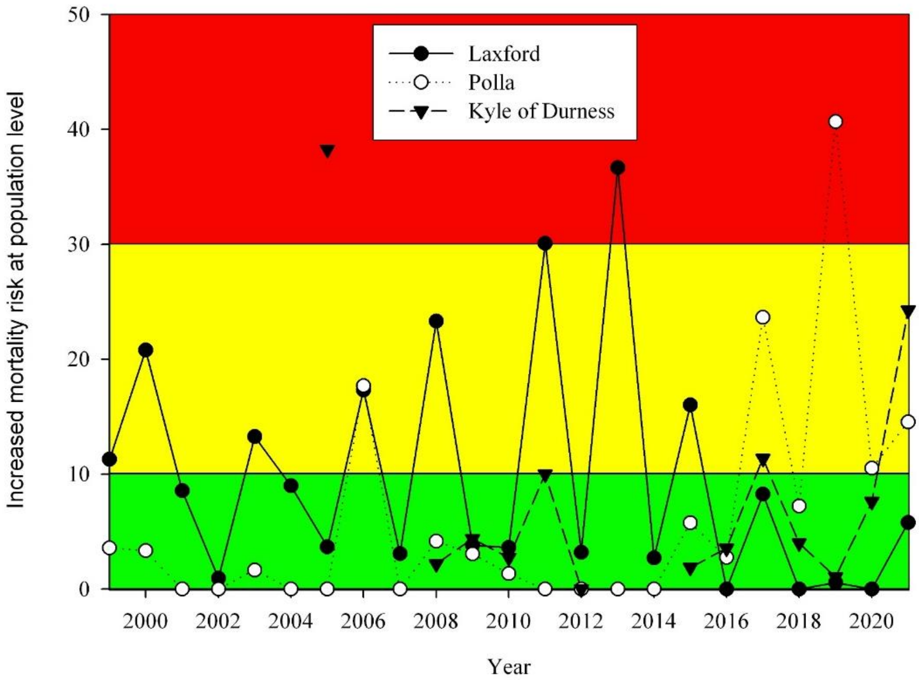

Fig. 5 Showing the increased mortality risk at population level created by sea lice

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. In particular the development of lice dispersal models may help to understand the dynamics within the area.
4. It is recommended that the use of isotope analysis is examined as a determinant to the source of lice within both the farmed and wild populations.

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