Monitoring of sea trout post-smolts, 2023

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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 sea lice on fish farms and sea trout (Marshall 2003; WSFT 2023).

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. As gill health has increasing become a problem within the aquaculture industry an assessment of the gills has also been added to the sampling programme.

Materials & Methods

Two estuaries, Laxford Bay and Polla estuary 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 staged, i.e. chalimus, mobile, adult and gravid female, and the gills visually assessed for disease. Differences between the number examined and tagged (Table 1) reflect the presence of recaptures, the size of trout involved or difficulties in loading the injector. Injection of the tags in fish <15 cm 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 203 fish in the Polla during May (Table 1). This is similar to the findings in 2022, but different from previous years where the greatest catches were in the Laxford (WSFT 2023). 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.

Table 1 The number of fish examined and tagged by estuary and month

	Laxford Bay		Polla estuary	
Month	No. examined	No. tagged	No. examined	No. tagged
April	3	0	-	-
May	[+]39	13	[*]33	0
June	[a]19	0	2	1
July	-	-	-	-
August	18	13	30	18
September	-	-	0	0

([+]plus 7 salmon smolts; [*]plus 170 sea trout released; [a]plus 1 sea trout)

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 of 2 years (S2), although there were several S3's also present. In addition, an S1 was observed in both the Polla and Laxford. The length distribution of fish within the estuaries was similar (Fig. 2). While post-smolts dominated both estuaries (Table 2), there were several mature fish seen, with the greatest number in the Polla.

Table 2 The percentage of post-smolts within the catch

Month	Laxford Bay	Polla estuary
April	67	-
May	76	86
June	54	100
July	-	-
August	75	67
September	-	-

The presence of post-smolts 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 and Table 3b for the Polla estuary. The condition index was good throughout the year for the Polla, but poor condition was observed in the Laxford during May and June.

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	170.5 ± 13.44	50.00 ± 9.90	1.00 ± 0.04
May	179.57 ± 25.69	54.57 ± 25.03	0.89 ± 0.17
June	220.5 ± 38.99	119.50 ± 75.07	0.95 ± 0.12
July	-	-	-
August	193.67 ± 31.78	92.25 ± 53.46	1.17 ± 0.31
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.)
April	-	-	-
May	167.48 ± 18.01	51.75 ± 16.37	1.05 ± 0.20
June	174.00 ± 25.46	59.00 ± 24.04	1.09 ± 0.02
July	-	-	-
August	224.88 ± 39.83	137.38 ± 64.63	1.13 ± 0.14
September	-	-	-

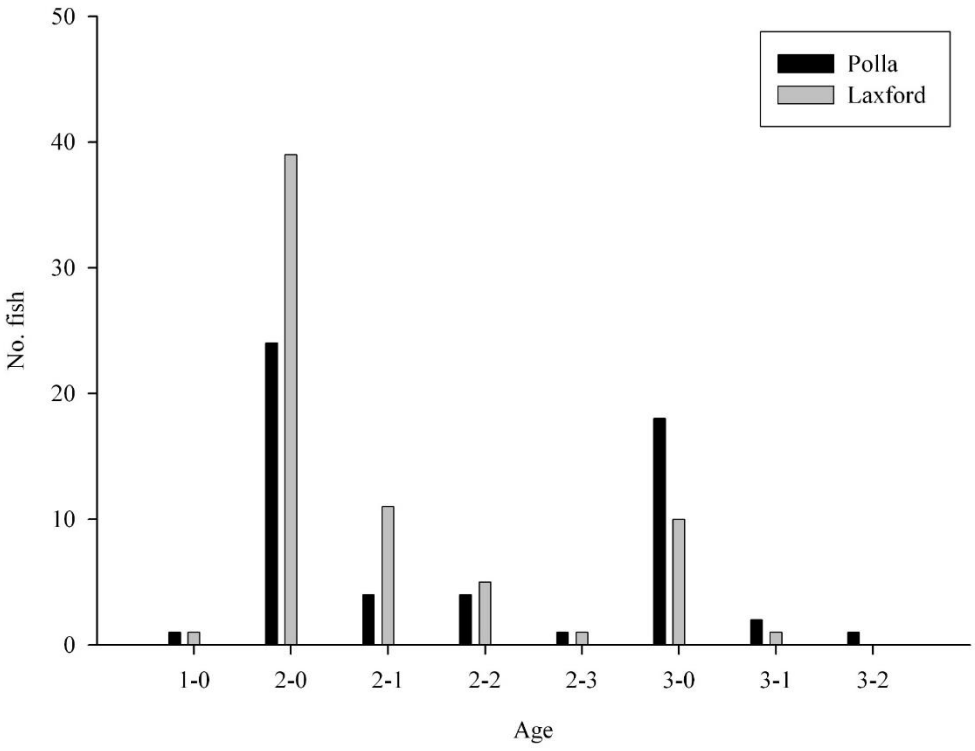

Fig. 1 The number of fish of each age taken in the estuaries

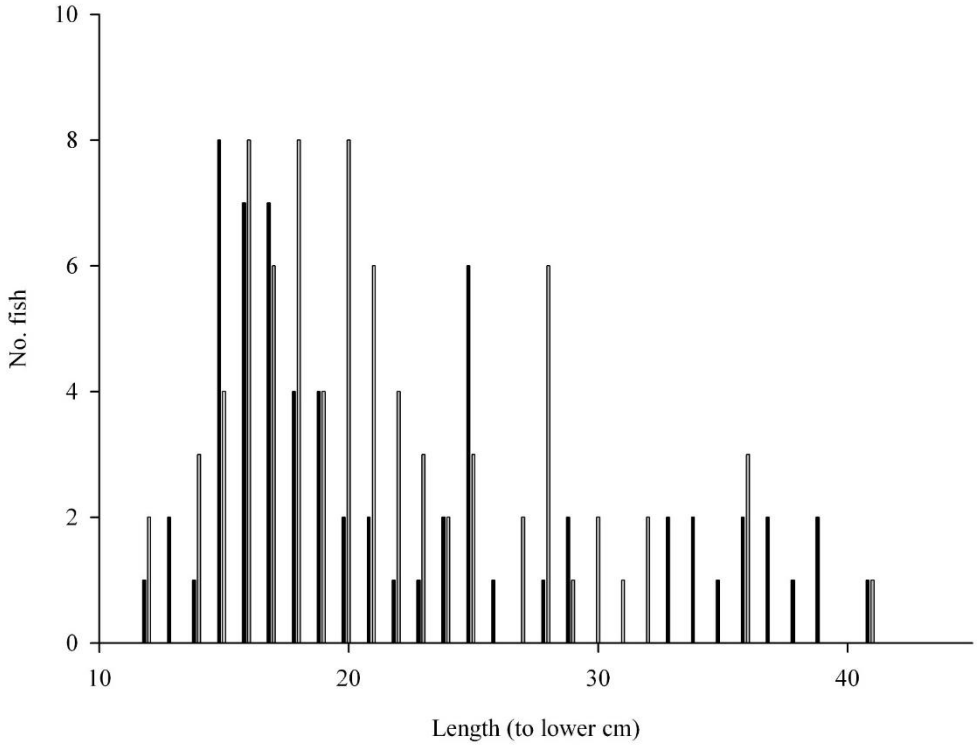

Fig. 2 The number of fish of each length taken in the estuaries

Recaptures

There were 2 recaptures during 2023, both within Laxford Bay. The growth of recaptured trout is shown in Table 4. Both were tagged and re-captured in the same location. This pattern is common to the

sampling programme over the past 26 years and demonstrates that the majority of sea trout do not stray far from their home rivers. This is further supported by tracking studies in Laxford Bay, showing the migrations within and out the sea loch (https://wsft.org.uk/images/pdf/Laxford_sea_trout_tracking.pdf).

Average monthly growth rates within the Laxford were 3.59 mm and 2.33 g respectively.

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

Tag number		Tagged	Recaptured	Difference
J38	Date	24.6.21	18.5.23	23 mths
	Length (mm)	164	283	119
	Weight (g)	48	226	178
J42	Date	24.6.21	18.5.23	23 mths
	Length (mm)	316	362	46
	Weight (g)	359	288	-71

Figure 3 shows that the specific growth rate (SGR) was low for this estuary. The results from this analysis demonstrate the complexity of trout population dynamics, with the decrease in weight experienced by J42 likely to be a function of sex, age and subsequent spawning activity. However, interactions with external factors, such as food supply and temperature will also cause variations in specific growth rate.

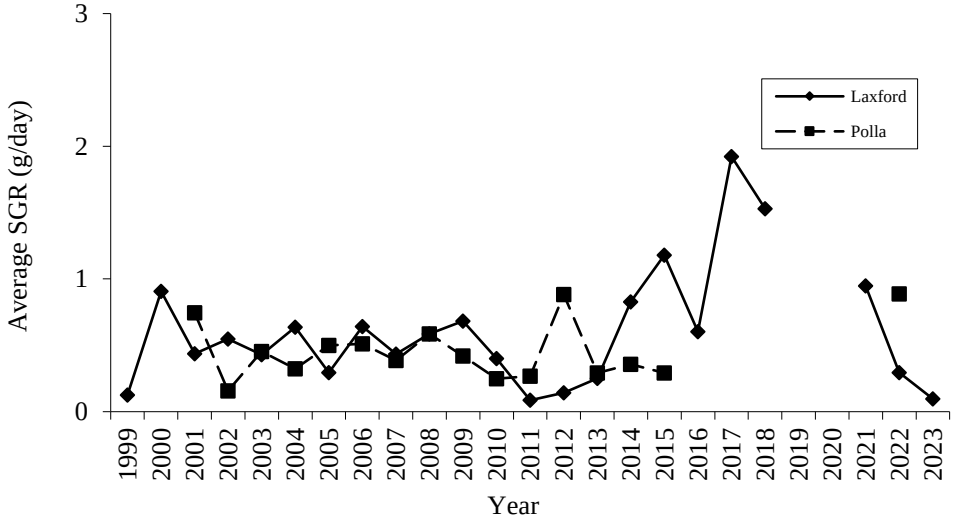

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

Sea Lice Infestations

Sea lice were present to a varying degree in both the Polla and Laxford populations (Table 5) throughout the year, with the exception of the Laxford in April. Both estuaries showed a mixture of lice stages (Fig. 4a & b). The highest numbers were seen in the Polla during May. 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
April	0	-
May	15	85
June	95	100
July	-	
August	33	53
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)). 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.

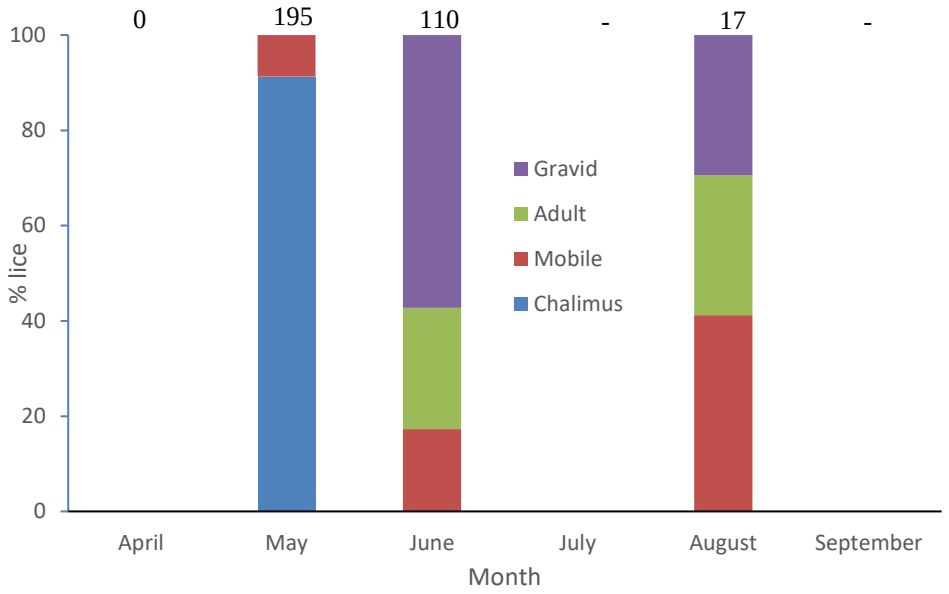

Fig. 4a Showing the proportion of each stage of lice within the Laxford estuary samples, by month. The total number of lice is given at the top.

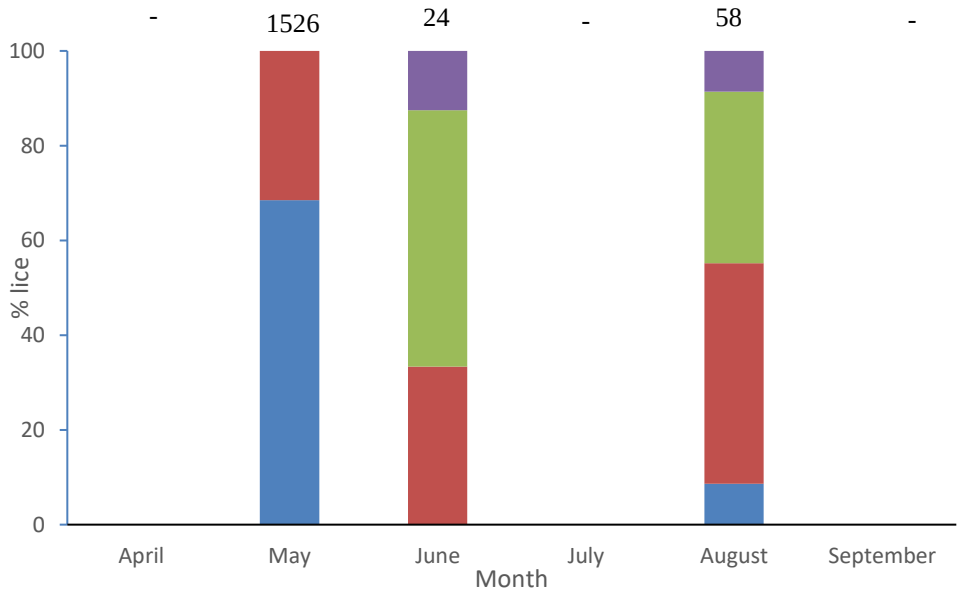

Fig. 4b Showing the proportion of each stage of lice within the Polla estuary samples, by month. The total number of lice is given at the top.

Laxford

Lice were present throughout the year, with the exception of April (Table 6). Abundance increased to June, before dropping significantly in August. The intensity was greatest in May, while the median value was greater in June. This indicates that the fish with lice had greater numbers in May compared to June but that more fish captured in June had lice. *Caligus* were present in May and June on a small number of fish.

The neighbouring cages were fallowed in June 2023. *Lepeophtheirus* numbers were below 0.5 adult females per fish for the 6 weeks prior to fallow. However, *Caligus* were present throughout.

Table 6 The abundance, intensity and median number salmon lice 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	5.00	0 - 54	32.50	2 - 54	0
June	5.79	0 - 21	6.11	1 - 21	5
July	-	-	-	-	-
August	0.94	0 - 6	2.83	2 - 6	0
September	-	-	-	-	-

Polla

Lice were present throughout the year (Table 7), with abundance decreasing from a high in May. *Caligus* were only present in May.

Within the neighbouring cages, Sian was harvested out in May, while Kempie remained fallow throughout the year. *Lepeophtheirus* numbers were below 0.5 adult females per fish before harvest following treatment in early April.

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	-	-	-	-	-
May	46.24	0 - 180	54.50	1 - 180	37
June	12.00	11 - 13	12.00	11 - 13	12
July	-	-	-	-	-
August	1.93	0 – 11	3.63	1 - 11	1
September	-	-	-	-	-

Gill condition

Gill disease, primarily Amoebic Gill Disease (AGD) and Proliferative Gill Disease (PGD), are becoming increasingly problematic within the aquaculture industry. However, from papers and discussions with professionals it appears that wild fish are not a significant reservoir for *Paramoeba perurans* and this pathogen seems key in driving gill disease outbreaks in farms, even if other pathogens contribute to PGD, so its absence in wild fish may reduce vulnerability to gill disease. Further, wild fish are at a lower density and can avoid the environmental conditions likely to trigger poor gill health, i.e. plankton and poor water quality. Thus, gill disease is not seen as a concern within wild fish populations, although the need for more information is noted. As part of this the decision was taken to visually assess the gills during this survey.

While both AGD and PGD were identified in both estuaries, this was in a small number of fish. Within the Polla AGD was identified in 4 fish, while PGD was present in 3. Within the Laxford, 6 fish were identified with AGD and 1 with PGD. In all cases, bar 1, the levels were low. In one instance within the Polla the PGD damage to the gills was significant.

In addition to the visual checks, Loch Duart undertook gill swabs on 2 of the larger fish from the Laxford in May, checking for *Paramoeba perurans*, *Deszmozoon lepeophtherii* and *Branchiomonas*. Only 2 fish were swabbed due to the size of the other fish. Within these fish only *Branchiomonas* was found, present within both fish. Loch Duart have anecdotal evidence that *Branchiomonas* has a link with AGD infections. It is intracellular so the fish have some level of control of the infection through an immune response and therefore it can be an interesting indicator of the immune health of the fish. However, the level found here would not be considered a problem in a healthy fish (B. Osborne, *pers. comm.*).

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, the potential risk in the Laxford for 2023 is low at 7.40% increased risk of mortality. In contrast, the Polla has a high increased risk of mortality at 38.71%.

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.

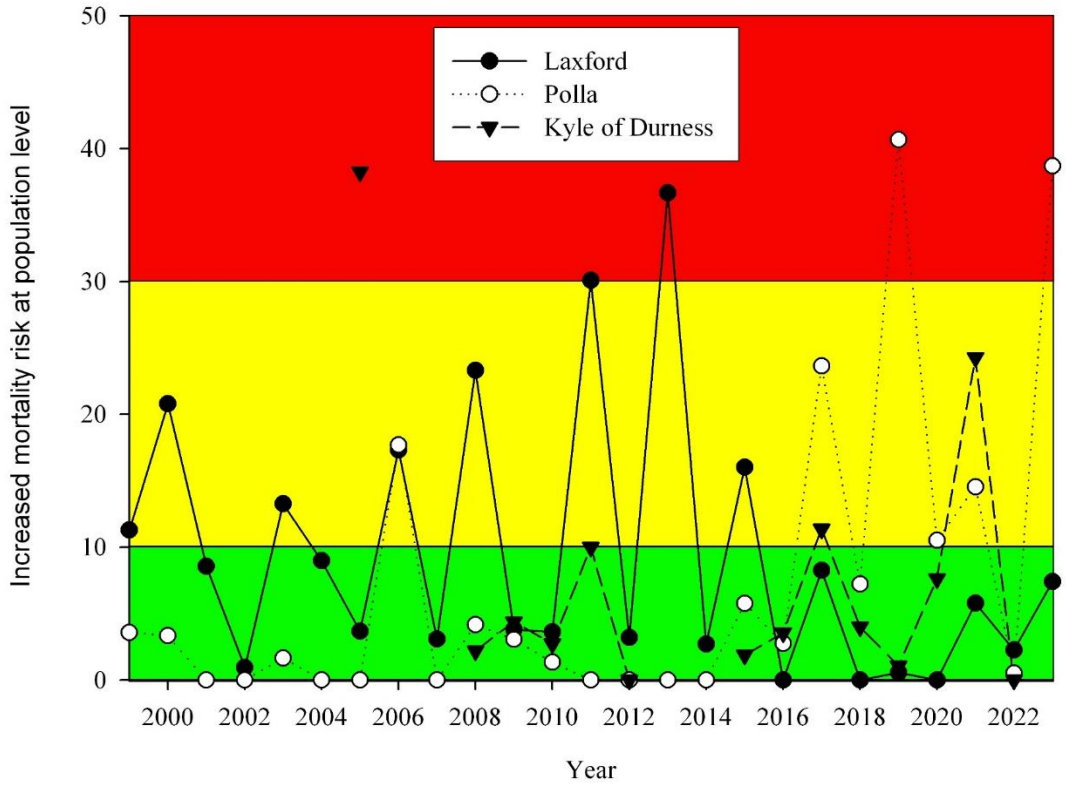

Fig. 5 Showing the increased mortality risk at population level created by sea lice

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 gill disease continues to be assessed. If possible, this should be extended to other areas.
3. 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.

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