Monitoring of sea trout post-smolts, 2022

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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 2022).

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 533 fish in the Polla during May (Table 1). While the largest catches are normally found in May, these are usually found in the Laxford rather than the Polla (WSFT 2022). 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.

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	*51	0	43	22	1
May	$^{+}$36	8	^{a}50	16	-
June	$^{+}$0	0	-	-	0
July	-	-	^{b}31	10	-
August	^{c}34	21	-	-	-
September	42	19	-	-	-

(*plus 98 released; $^{+}$reduced sweep area; ^{a}plus 483 released; ^{b}plus 31 released; ^{c}2 sweeps undertaken)

The by-catch from the netting in each area was as expected from previous years, with few species and low numbers observed. High water or a lack of volunteers resulted in the cancellation of several nettings.

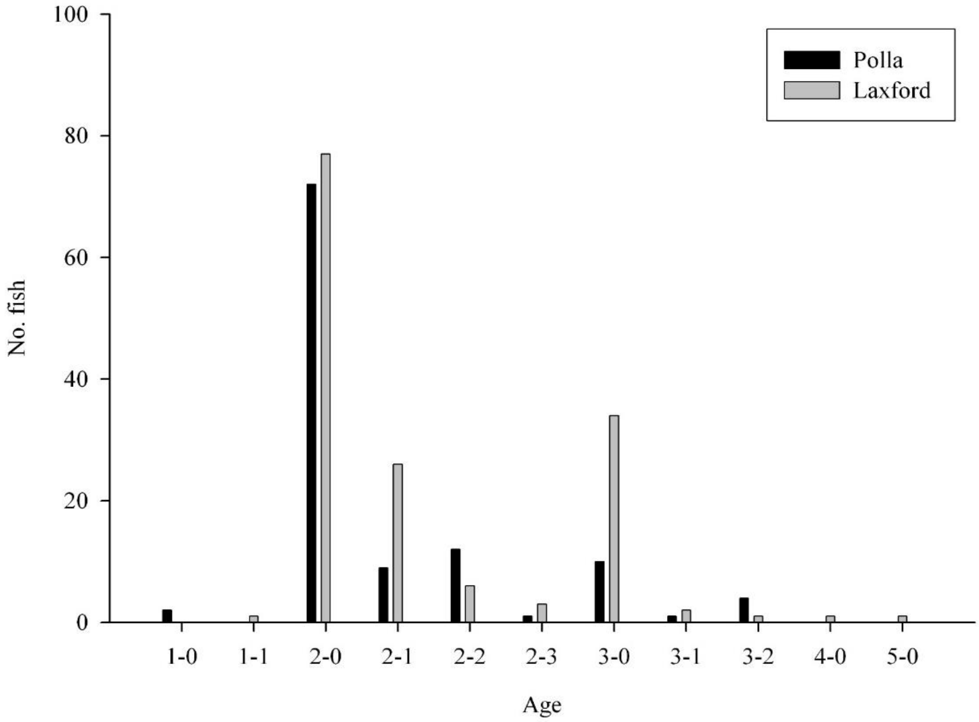

Fig. 1 The number of fish of each age taken in the estuaries

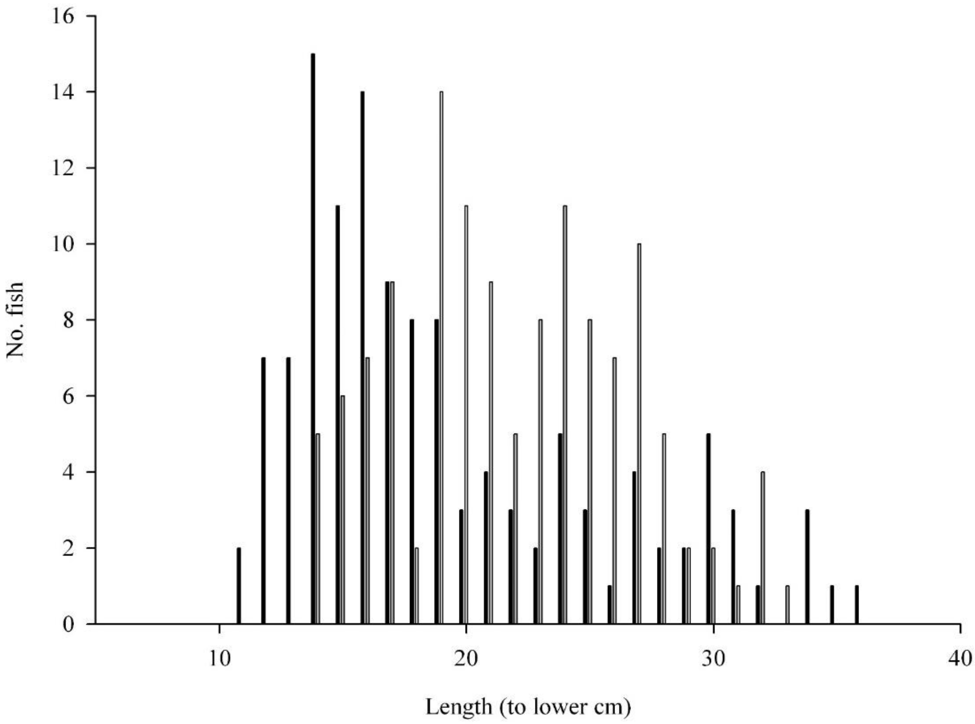

Fig. 2 The number of fish of each length taken in the estuaries

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, S1's were observed in small numbers in both the Polla and Laxford. The length distribution of fish within the estuaries was similar, although with Laxford fish being slightly larger (Fig. 2). The greatest size range was found in the Polla. While post-smolts dominated both estuaries (Table 2), there were several mature fish seen, with the largest in the Polla.

Table 2 The percentage of post-smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	73	61	0
May	94	85	-
June	-	-	-
July	-	85	-
August	52	-	-
September	79	-	-

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 both 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	211.36 ± 34.61	100.60 ± 48.50	1.10 ± 0.64
May	178.94 ± 25.01	60.63 ± 24.07	1.02 ± 0.10
June	-	-	-
July	-	-	-
August	196.71 ± 32.32	100.53 ± 58.24	1.19 ± 0.17
September	233.71 ± 33.31	147.55 ± 51.88	1.11 ± 0.11

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	164.30 ± 28.25	47.50 ± 22.84	1.01 ± 0.07
May	157.15 ± 24.19	44.95 ± 22.93	1.08 ± 0.13
June	-	-	-
July	193.39 ± 35.69	96.09 ± 43.99	1.18 ± 0.13
August	-	-	-
September	-	-	-

Recaptures

There were 5 recaptures during 2022, 2 within the Polla estuary and 3 within Laxford Bay. The growth of recaptured trout is shown in Table 4. Of the recaptured trout, 4 were tagged in 2022 and 1 in 2021. All fish were tagged and re-captured in the same location. This pattern is common to the sampling programme over the past 25 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 in and from the sea loch (https://wsft.org.uk/images/pdf/Laxford_sea_trout_tracking.pdf).

Average growth rates within the Polla were 19.2 mm, and 103 g per month. Within the Laxford these were 7 mm and 15.2 g respectively.

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

Tag number		Tagged	Recaptured	Difference
[a]J91	Date Length (mm) Weight (g)	19.4.22 235 -	19.5.22 256 196	1 mth 21 -
[a]J77	Date Length (mm) Weight (g)	19.4.22 299 285	11.7.22 351 595	3 mths 52 310
[b]J74	Date Length (mm) Weight (g)	22.9.21 250 158	12.8.22 325 363	11 mths 75 205
[b]K54	Date Length (mm) Weight (g)	12.8.22 229 238	12.9.22 238 153	1 mth 9 15
[b]K74	Date Length (mm) Weight (g)	12.8.22 210 108	12.9.22 215 120	1 mth 5 12

([a]tagged and caught in the Polla; [b]tagged and caught in the Laxford)

Figure 3 shows that the specific growth rate (SGR) in the Polla is higher than that seen previously, but that the Laxford is low compared to recent years. The results from this analysis demonstrate the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature.

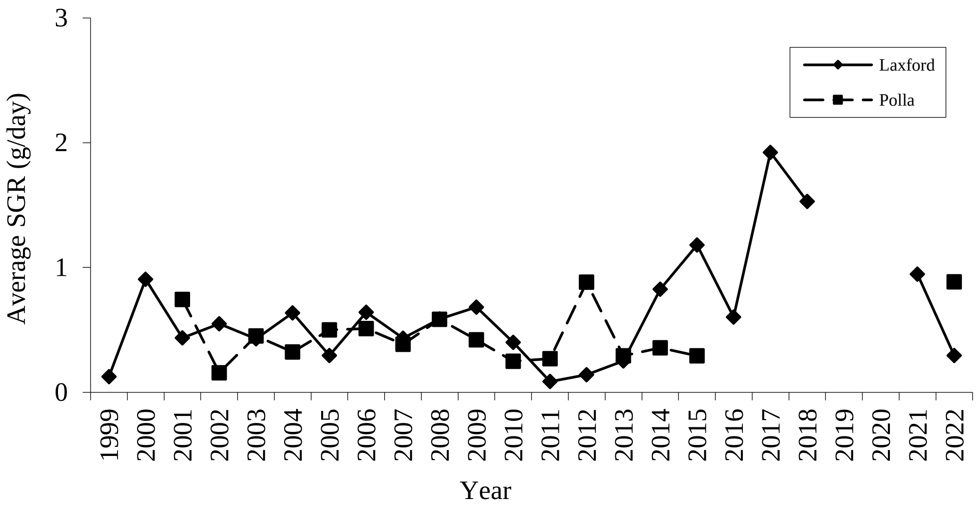

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

Sea Lice Infestations

Sea lice were present to a varying degree at both the Polla and Laxford (Table 5) throughout the year. With only one fish captured in the Kyle of Durness, this system has not been included in the analysis. Both estuaries showed a mixture of lice stages (Fig. 4a & b). The highest numbers were seen in the Laxford during September. 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	16	0
May	0	0	-
June	-	-	-
July	-	19	-
August	32	-	-
September	59	-	-

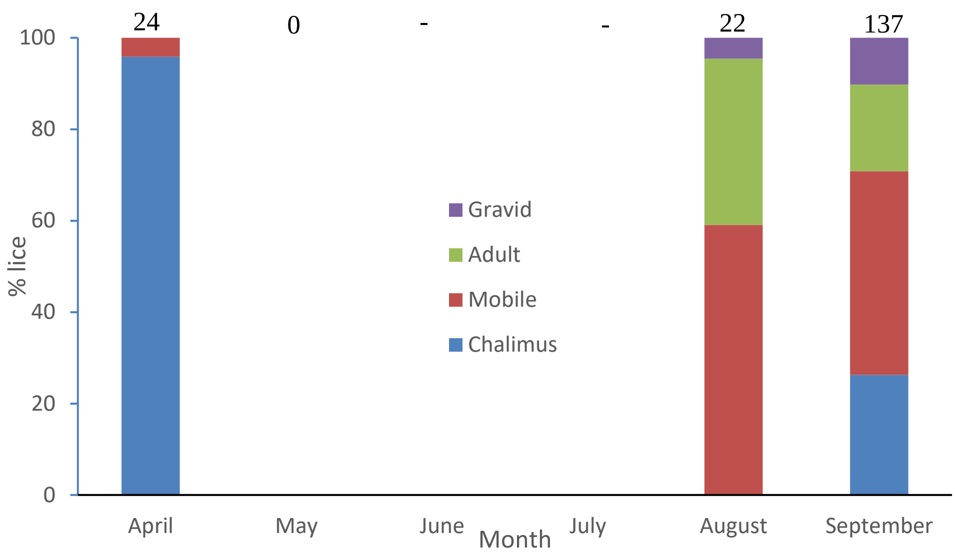

Fig. 4a Showing the proportion of each stage of lice within the Laxford estuary samples, by month. The total number of lice is given at the top.

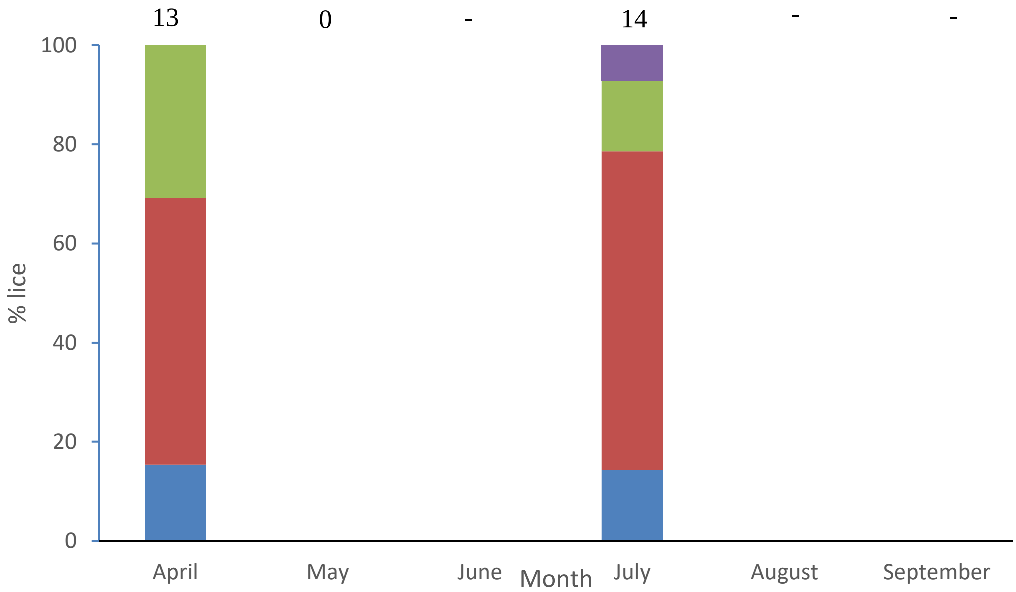

Fig. 4b Showing the proportion of each stage of lice within the Polla estuary samples, by month. The total number of lice is given at the top.

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.

Laxford

Lice were present throughout the year, with the exception of May (Table 6). Abundance increased over this time, although the intensity was greatest in April indicating that the few fish with lice had greater numbers than in September when prevalence was greater but numbers of lice per infected fish lower. *Caligus* were present in August and September on a small number of fish.

The neighbouring cages were stocked in October 2021. *Lepeophtheirus* numbers have been zero or very low (<0.03 adult females per fish) throughout this period. However, *Caligus* were present throughout, being at higher numbers in August and September.

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	0.47	0 - 19	8	1 - 19	0
May	0	0	0	0	0
June	-	-	-	-	-
July	-	-	-	-	-
August	0.65	0 - 6	2	1 - 6	0
September	3.26	0 - 35	5.48	1 - 35	1

Polla

Lice were present in April and July (Table 7), with abundance increasing between the 2 months. *Caligus* were only present in July.

Within the neighbouring cages, Sian was stocked in March, while Kempie remained fallow. *Lepeophtheirus* numbers have been zero or very low (<0.02 adult females per fish) throughout this period.

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	0.30	0 - 3	1.86	1 - 3	0
May	0	0	0	0	0
June	-	-	-	-	-
July	0.42	0 - 7	2.17	1 - 7	0
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. 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 all estuaries examined was considered to be low for 2022. In this instance, the Laxford showed the highest ‘risk’ at 2.27% increased mortality.

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.

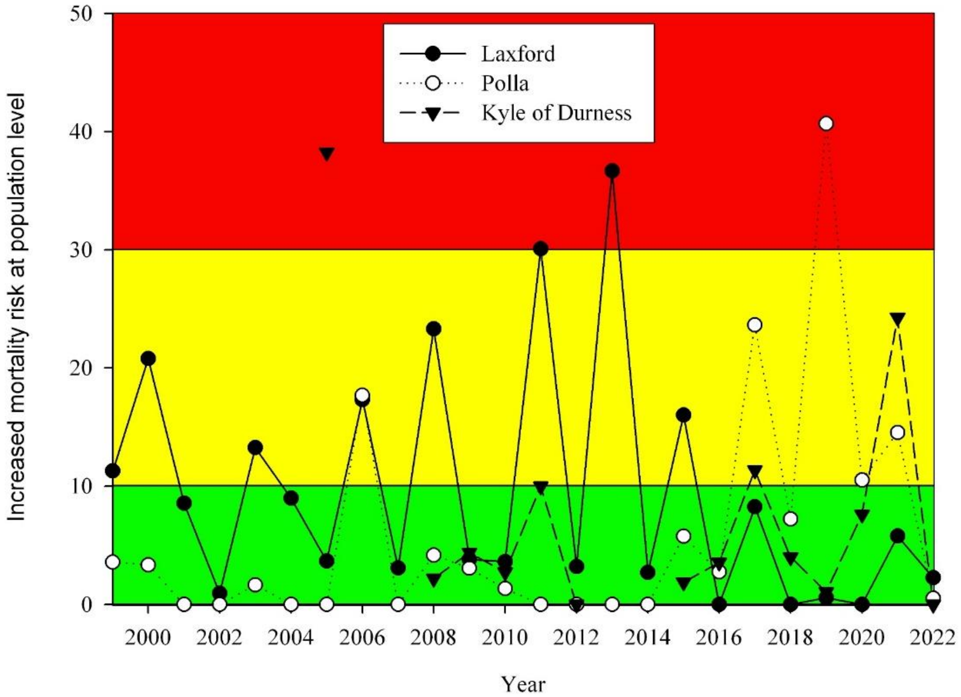

Fig. 5 Showing the increased mortality risk at population level created by sea lice

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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