Monitoring of sea trout post-smolts, 2019

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Shona Marshall
Fisheries Biologist
West Sutherland Fisheries Trust
Gardeners Cottage
Scourie
By Lairg
Sutherland
IV27 4SX

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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 2019).

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 241 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.

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	-	-	-	-	-
May	[+]68	52	[*]62	20	-
June	30	7	-	-	-
July	4	0	[a]17	8	37
August	-	-	-	-	-

([*]plus 13 trout and 30 salmon; [+]plus 173; [a]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). 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 3 estuaries. The length distribution of fish within the estuaries was also similar (Fig. 2), with post-smolts dominating each estuary. A May smolt run is normal for the Sutherland area (WSFT 2019) and this is supported by these data.

Table 2 The percentage of post-smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	-	-	-
May	86	57	-
June	100	-	-
July	100	100	91
August	-	-	-

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. 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 good, although the number of sampling occasions with weight data was low.

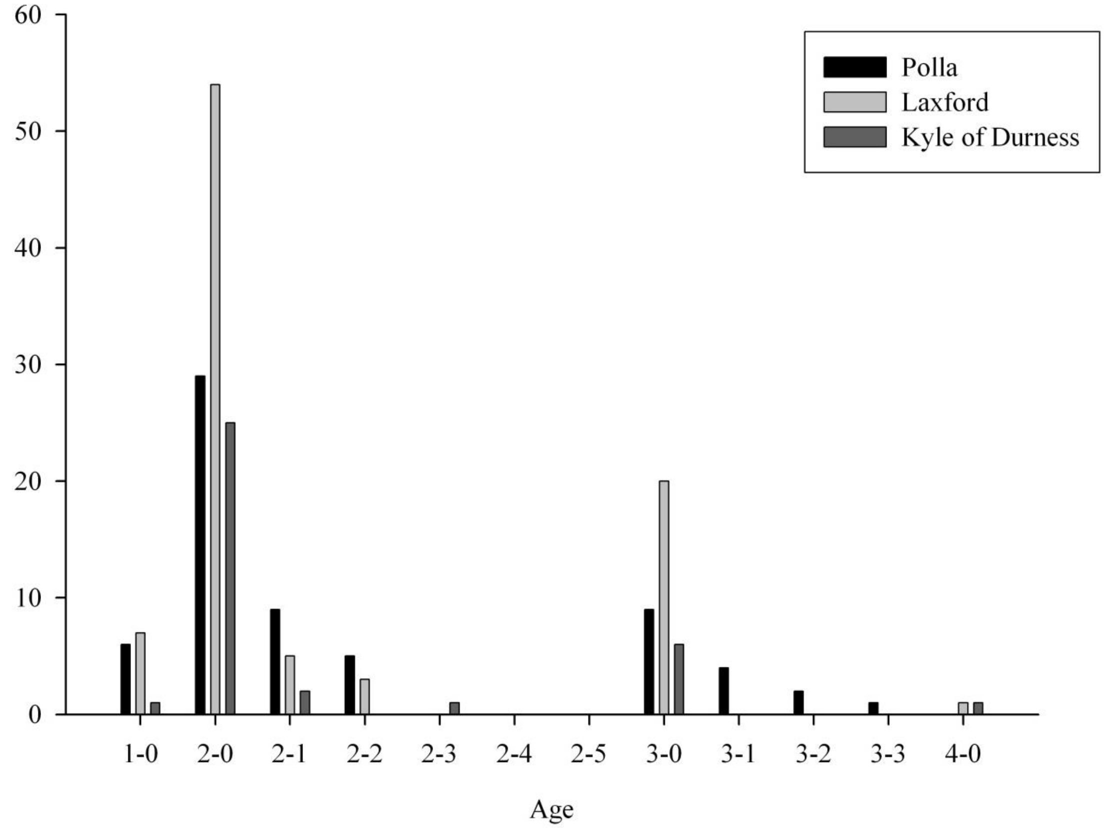

Fig. 1 The number of fish of each age taken in the estuaries

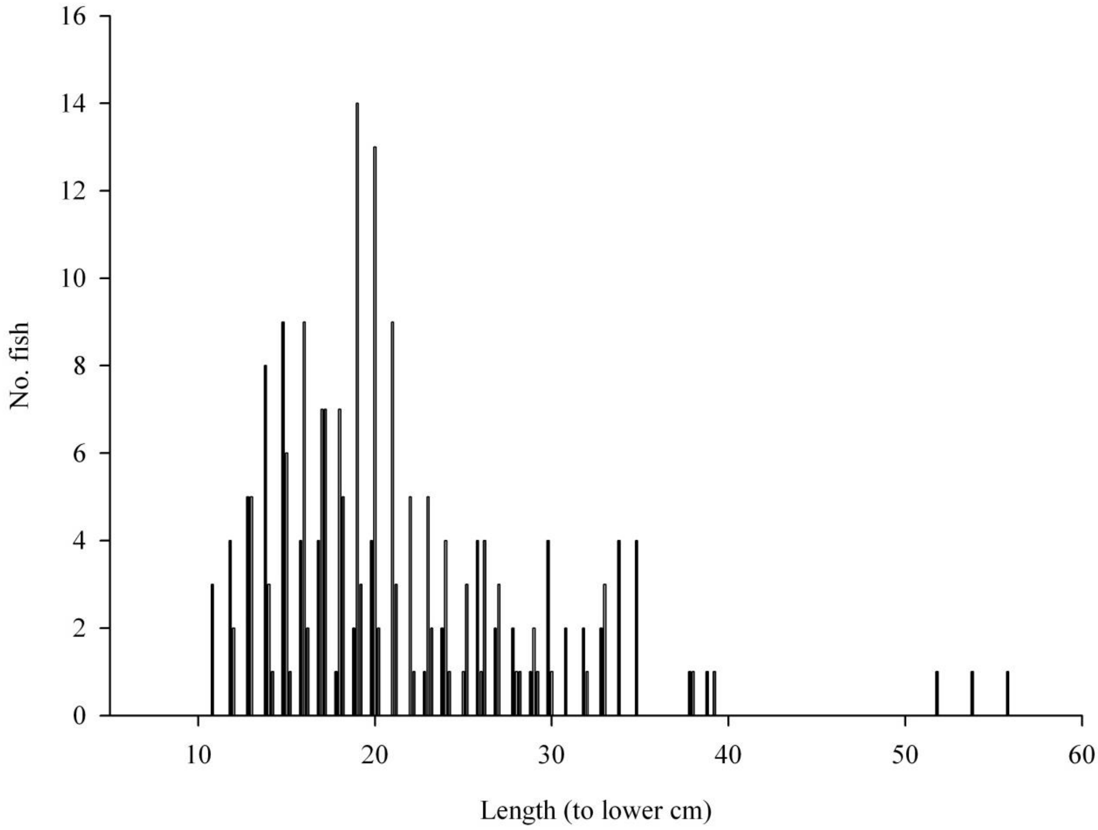

Fig. 2 The number of fish of each length taken in the estuaries

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.)
May	211.74 ± 28.16	-	-
June	170.47 ± 24.87	54.27 ± 24.37	1.04 ± 0.08
July	133.25 ± 7.18	23.25 ± 4.99	0.97 ± 0.09
August	-	-	-

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	170.18 ± 51.83	-	-
June	-	-	-
July	179.65 ± 41.59	77.65 ± 57.27	1.14 ± 0.09
August	-	-	-

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.)
May	-	-	-
June	-	-	-
July	203.09 ± 36.16	103.34 ± 55.96	1.14 ± 0.07
August	-	-	-

Sea Lice Infestations

Sea lice were present to a varying degree in all estuaries (Table 4), throughout the year. The exception to this was July in the Laxford, when no lice were observed. Each estuary showed a mixture of lice stages, with the Chalimus stage dominating (Fig. 3). The total number of lice was highest in both Laxford (Fig. 3a) and Polla (Fig. 3b) during May, and highest overall in the Polla. 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 4 The percentage of sea trout with the salmon louse, by estuary and month

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	-	-	-
May	19	73	-
June	7	-	-
July	0	41	43
August	-	-	-

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 5 (Laxford), 6 (Polla) & 7 (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 within the Laxford during May and June only, at relatively low densities (Table 5). The pattern of lice present in the June sample would appear to reflect a wild population, as demonstrated by Gargan, *et al.* 2003. While Chalimus dominate the May samples *Caligus* were present during May only, with a total of 32 lice on 6 fish.

The neighbouring cages contained fish at the start of the survey period, being harvested out before the end. Lice numbers were low throughout the year with *Caligus* dominating the population. The numbers seen and the pattern of infection do not mirror the densities within the sweep net.

Table 5 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
May	2.63	0 - 44	13.77	1 - 44	0
June	0.57	0 - 16	8.5	1 - 16	0
July	0	0	0	0	0
August	-	-	-	-	-

Polla

Lice were present in significant numbers during May, with *Caligus* also present in high numbers. Although the abundance declined significantly in July (Table 6), there were still high numbers of lice present. *Caligus*, however, declined in July, being present on only one fish (4).

Table 6 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	52.53	0 - 263	72.38	1 - 263	35.5
June	-	-	-	-	-
July	4.53	0 - 31	11.00	1 - 31	0
August	-	-	-	-	-

Within the neighbouring cages, numbers of adult female lice over this period are given in Table 7:

Table 7 Average adult female lice per fish

	Kempie	Sian
April	0.39	1.00
May	0.25	0.59
June	1.60	0.50
July	1.25	0.08
August	1.42	0.38
September	F	0.67

There was an increased number of adult female *Lepeophtheirus* on the Sian cages in April, subsequently followed by a decline. This pattern was reversed at the Kempie site, where low numbers were followed by an increase in numbers from June.

Kyle of Durness

Lice were present within the Kyle of Durness sample (Table 8). Densities were low and there was a mix of stages present (Fig. 3c). 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	-	-	-	-	-
July	0.92	0 - 6	2.13	1 - 6	0
August	-	-	-	-	-

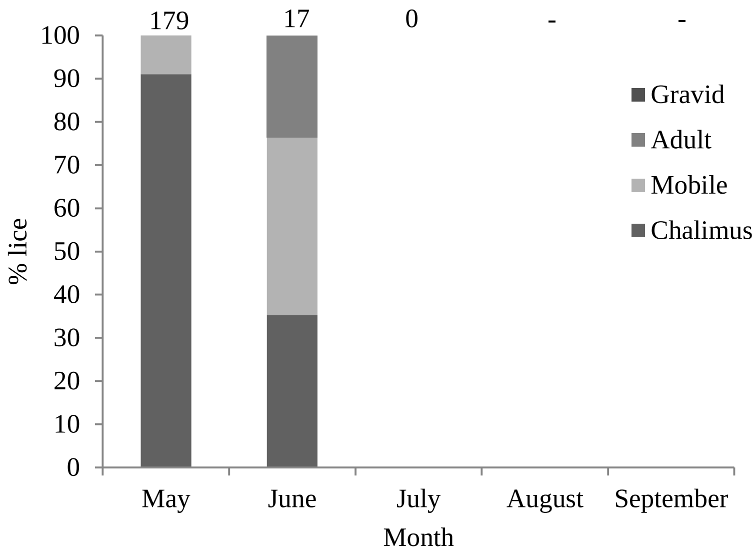

Fig. 3a Showing the proportion of each stage of lice within Laxford Bay samples, by month. The total number of lice is given at the top.

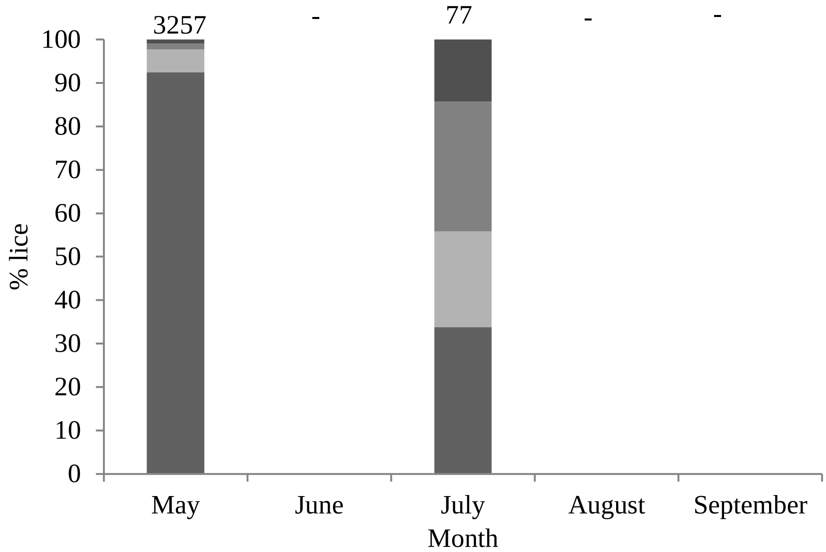

Fig. 3b Showing the proportion of each stage of lice within the Polla estuary samples, by month. The total number of lice is given at the top.

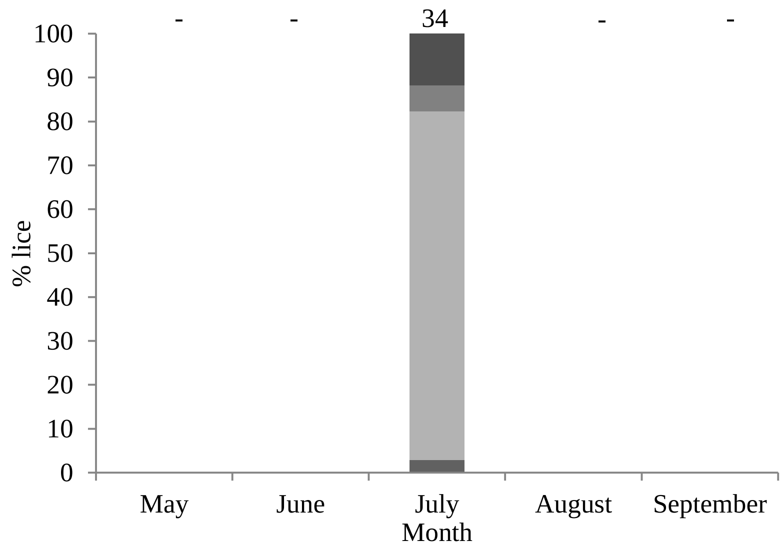

Fig. 3c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

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. 4 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 during 2019 were considered to be high, indicating that population changing effects are likely to have occurred in this area. In contract, the Laxford and Kyle of Durness showed a low potential risk. The Laxford and Polla data continue to show a biannual pattern in risk, reflecting the stage of production within the farm.

Sampling within the Kyle of Durness has been more restricted than the other 2 estuaries, but 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, it may reflect the tidal flows around the west coast.

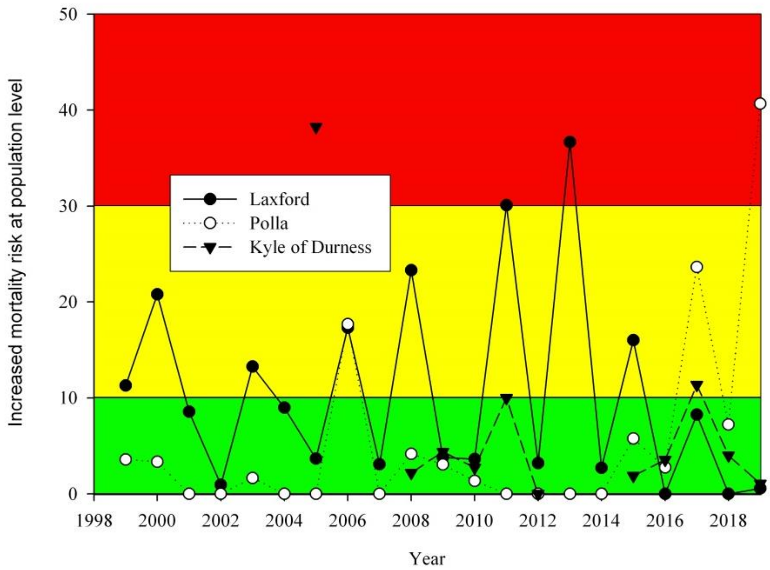

Fig. 4 Showing the increased mortality risk at population level created by sea lice

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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