Monitoring of sea trout post-smolts, 2015

A report to the West Sutherland Fisheries Trust, Report No. WSFT2/16

January 2016

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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 2015).

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 924 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, with the exception of September in the Laxford, when a good collection of codling, cuddies and shrimp were captured.

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	[a]72	49	-	-	-
May	[b]80	36	-	-	-
June	[c]68	21	21	15	44
July	[d]4	4	26	12	14
August	7	5	[e]29	23	7
September	0	0	32	20	3

([a]plus 97 sea trout & 1 salmon smolt; [b]plus 844 sea trout & 2 salmon smolts; [c]plus 129; [d]1 lost from basket; [e]1grilse)

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 two estuaries was similar, with the Laxford returning a greater number of mature fish (Fig. 1). This differs from previous years, when the Polla has returned the more mature fish. 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 both the Laxford and the Polla estuaries. The length distribution of fish within the estuaries was different (Fig. 2), with the Kyle of Durness returning primarily post-smolts.

A proportion of the fish examined were from previous smolt runs, although the Kyle of Durness catch was primarily post-smolt throughout the year (Fig. 1; Table 2). While a May smolt run is normal for the Sutherland area (WSFT 2014), there were a large proportion of smolts taken in the April samples from the Laxford indicating that some smolts may have run earlier. Smolts dominate the later samples in both the Laxford and the Kyle of Durness, suggesting that mature fish have left the area, possibly into the river.

Table 2 The percentage of smolts within the catch

Month	Laxford Bay	Polla estuary	Kyle of Durness
April	93	-	-
May	68	-	-
June	67	94	95
July	100	82	93
August	100	48	100
September	-	73	100

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 bar one of the tagged fish recaptured during 2015 were taken in the same location as originally tagged (Badna Bay and the Laxford sharing an estuary). The exception was a fish originally tagged in the Laxford and recaptured in the Polla. This confirms findings from previous years (WSFT 2014).

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. Problems with the weigh scales, occasioned by strong winds interfering with the reading, meant that the Kyle of Durness fish were not weighed in September. Condition index in both the Polla and Kyle of Durness were good throughout the year. The Laxford showed a similar condition index throughout the year, but this was on the lower side of good.

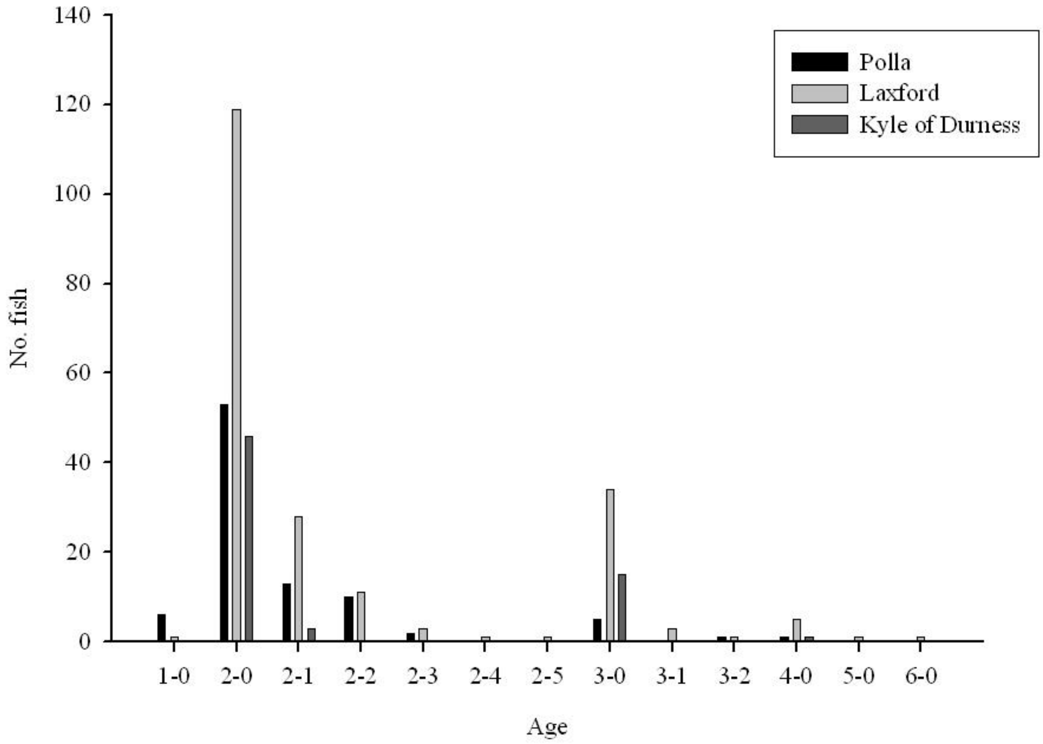

Fig. 1 The number of fish of each age taken in the estuaries

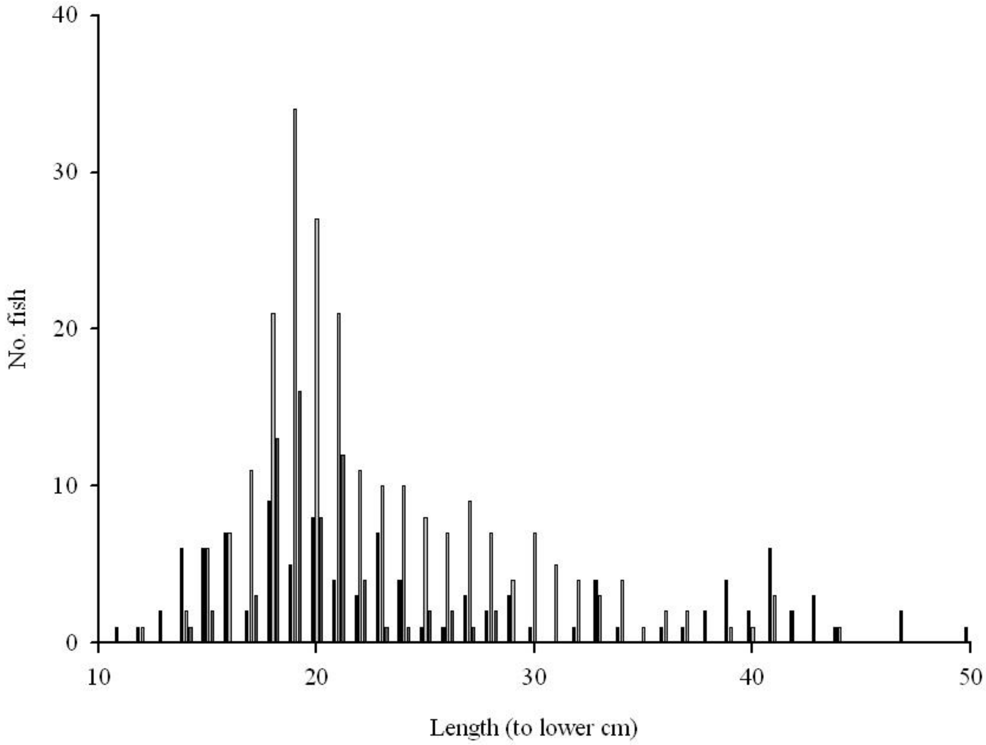

Fig. 2 The number of fish of each length taken in the estuaries

Length appears to vary with time, although no discernible pattern can be seen. This reflects the movement of post-smolts within the estuaries for feeding and shelter, and the movement of sea trout between marine feeding areas and the river. During 2015 there was evidence of good feeding at sea, with a number of small gadoids taken during the September sweep in the Laxford.

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	213.11 ± 95.63	34.04 ± 58.46	0.92 ± 0.12
May	203.57 ± 27.51	84.23 ± 34.78	0.96 ± 0.10
June	191.56 ± 26.55	69.34 ± 28.62	0.94 ± 0.12
July	179.50 ± 28.10	58.50 ± 24.88	0.97 ± 0.06
August	206.29 ± 25.84	91.71 ± 42.78	0.99 ± 0.15
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	-	-	-
June	170.06 ± 41.43	62.53 ± 56.86	1.03 ± 0.32
July	172.61 ± 33.91	63.61 ± 44.04	1.10 ± 0.06
August	213.86 ± 28.06	109.57 ± 52.87	1.06 ± 0.10
September	222.44 ± 42.29	130.25 ± 97.72	2.00 ± 3.29

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.)
April	-	-	-
May	-	-	-
June	204.44 ± 23.04	92.00 ± 35.31	1.04 ± 0.07
July	189.46 ± 21.85	83.67 ± 19.74	1.28 ± 0.40
August	207.86 ± 25.27	93.00 ± 34.51	1.00 ± 0.10
September	203.00 ± 15.13	-	-

Recaptures

There were 55 recaptures during 2015, all within the estuary netting. Three fish from the Laxford were recaptured twice, while one from the Polla (O20) was recaptured on 3 occasions. The growth of recaptured trout is shown in Table 4a for Laxford Bay and Table 4b for the Polla estuary. Of the recaptured trout, 1 was originally tagged in 2010, 3 in 2013, 21 in 2014, with the rest in 2015. This gives yet more information on sustained growth rates and demonstrates the potential effectiveness of the tagging programme. As Badna Bay and the River Laxford share an estuary at the location of the netting station, all bar one of the recaptured fish were taken from the area of tagging. This pattern is common to the sampling programme over the past 18 years and demonstrates that the majority of sea trout do not stray far from their home rivers. The exception was a fish tagged in the Laxford and recaptured in the Polla.

Average growth rates within the Laxford were 5.81 mm, and 12.38 g per month. Within the Polla average growth rates were 10.40 mm and 39.07 g. Both growth rates are lower than those seen in 2014, but still good within the Laxford and within the range seen in the Polla.

Figure 3 shows that the specific growth rate (SGR) in the Laxford is the highest recorded during this survey. While this is encouraging it is important to remember that one year does not spell a reversal. However it is encouraging and was apparent in the appearance of the fish within the netting, which were plump and well conditioned. Within the Polla the situation appears less positive, although in reality the fish were in very good condition and this is likely to reflect a slow winter growth in the adult fish. While the SGR is low compared to that seen in previous years, this reflects the time of recapture, with many fish taken following a winter period of low growth. The results demonstrate the complexity of trout population dynamics and the interactions with external factors, such as food supply and temperature.

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

Tag number		Tagged	Recaptured	Difference	Recapture (2)	Difference (2)
L72	Date	10.9.14	17.4.15	7 mths		
	Length (mm)	175	190	15		
	Weight (g)	66	-	-		
L07	Date	14.7.14	23.4.15	9 mths	16.6.15	2 mths
	Length (mm)	274	308	34	309	1
	Weight (g)	-	-	-	258	-
*M26	Date	19.4.15	20.4.15	1 day		
	Length (mm)	192	192	0		
	Weight (g)	61	69	8		
*M32	Date	19.4.15	20.4.15	1 day		
	Length (mm)	184	184	0		
	Weight (g)	63	59	-4		
J19	Date	16.5.15	20.4.15	11 mths		
	Length (mm)	194	301	107		
	Weight (g)	53	230	177		
*M17	Date	13.4.15	20.4.15	0.25 mths	16.6.16	2 mths
	Length (mm)	217	218	1	228	10
	Weight (g)	-	90	-	116	26
*M30	Date	19.4.15	20.4.15	1 day		
	Length (mm)	168	169	1		
	Weight (g)	34	45	11		
M76	Date	20.4.15	19.5.15	1 mth		
	Length (mm)	270	270	0		
	Weight (g)	186	199	13		
J75	Date	13.6.14	19.5.15	11 mths		
	Length (mm)	174	271	97		
	Weight (g)	59	205	146		
M97	Date	20.4.15	19.5.15	1 mth		
	Length (mm)	195	198	0		
	Weight (g)	70	75	5		
J85	Date	13.6.14	19.5.15	11 mths		
	Length (mm)	155	210	55		
	Weight (g)	45	94	49		
M55	Date	20.4.15	19.5.15	1 mth		
	Length (mm)	310	312	2		
	Weight (g)	216	332	16		
*M39	Date	20.4.15	19.5.15	1 mth		
	Length (mm)	193	198	5		
	Weight (g)	75	78	3		
M92	Date	20.4.15	19.5.15	1 mth		
	Length (mm)	205	208	3		
	Weight (g)	87	100	13		
M67	Date	20.4.15	19.5.15	1 mth		
	Length (mm)	266	266	0		
	Weight (g)	180	187	7		
L43	Date	10.9.14	19.5.15	8 mths		
	Length (mm)	285	309	24		
	Weight (g)	280	262	-18		
M57	Date	20.4.15	19.5.15	1 mth	16.6.15	1 mth
	Length (mm)	256	256	0	260	4
	Weight (g)	155	164	9	167	3
L42	Date	10.9.14	19.5.15	8 mths		
	Length (mm)	314	331	17		
	Weight (g)	363	333	-30		
L14	Date	14.7.15	19.5.15	10 mths		
	Length (mm)	175	232	57		
	Weight (g)	56	184	128		

	Date	6.5.15	19.5.15	0.5 mths		
*N12	Length (mm)	181	184	3		
	Weight (g)	55	59	4		
	Date	13.6.14	19.5.15	11 mths		
J87	Length (mm)	171	284	113		
	Weight (g)	52	227	175		
	Date	16.5.14	19.5.15	12 mths		
J28	Length (mm)	165	285	120		
	Weight (g)	-	216	-		
	Date	21.5.14	19.5.15	12 mths		
*J54	Length (mm)	194	294	100		
	Weight (g)	68	197	129		
	Date	8.5.14	19.5.15	12 mths		
*I68	Length (mm)	179	324	145		
	Weight (g)	46	312	266		
	Date	20.4.15	16.6.15	2 mths		
M41	Length (mm)	193	215	18		
	Weight (g)	74	108	34		
	Date	25.7.13	16.6.15	23 mths		
H37	Length (mm)	385	400	15		
	Weight (g)	612	826	214		
	Date	11.6.10	16.6.15	5 yrs		
D13	Length (mm)	184	410	226		
	Weight (g)	64	723	659		
	Date	25.7.13	16.6.15	23 mths		
H43	Length (mm)	346	413	67		
	Weight (g)	479	702	223		
	Date	22.5.14	16.6.15	13 mths		
*J57	Length (mm)	199	315	116		
	Weight (g)	77	302	225		
	Date	18.4.13	16.6.15	26 mths		
*G12	Length (mm)	315	447	132		
	Weight (g)	272	886	614		
	Date	19.5.15	16.6.15	1 mth		
N69	Length (mm)	235	244	9		
	Weight (g)	134	142	8		
	Date	16.5.14	16.6.15	13 mths		
J37	Length (mm)	172	320	148		
	Weight (g)	-	310	-		
	Date	13.6.14	16.6.15	12 mths		
J90	Length (mm)	162	265	103		
	Weight (g)	43	202	159		
	Date	14.7.14	16.6.15	11 mths		
L25	Length (mm)	211	270	59		
	Weight (g)	94	174	80		
	Date	13.6.14	16.6.15	12 mths		
J74	Length (mm)	193	292	99		
	Weight (g)	82	265	183		
	Date	20.5.15	16.6.15	1 mth		
M51	Length (mm)	235	241	6		
	Weight (g)	116	130	14		
	Date	14.7.14	16.6.15	11 mths		
L13	Length (mm)	251	328	77		
	Weight (g)	159	336	177		
	Date	16.5.14	16.6.15	13 mths		
J44	Length (mm)	218	293	75		
	Weight (g)	-	214	-		
	Date	25.4.15	16.6.15	2 mths		
*N03	Length (mm)	202	204	2		
	Weight (g)	68	81	13		

N69	Date Length (mm) Weight (g)	19.5.15 235 134	17.8.15 249 175	3 mths 14 41		
*M23	Date Length (mm) Weight (g)	18.4.15 164 43	17.8.15 202 81	4 mths 38 38		

*Tagged in Badna Bay trap;

Table 4b The lengths and weights of recaptured trout within the Polla estuary

Tag number		Tagged	Recaptured	Difference	Recaptured (2)	Difference (2)
*M86	Date Length (mm) Weight (g)	20.4.15 277 193	17.6.15 300 280	2 mths 23 97		
I32	Date Length (mm) Weight (g)	30.4.14 335 376	14.7.15 470 1336	15 mths 135 960		
I37	Date Length (mm) Weight (g)	30.4.14 292 235	14.7.15 393 660	15 mths 101 425		
I24	Date Length (mm) Weight (g)	30.4.14 259 196	14.7.15 436 852	15 mths 177 656		
O20	Date Length (mm) Weight (g)	17.6.15 276 -	14.7.15 292 286	1 mth 16 -	14.8.15 295 280	1 mth 3 -6
J96	Date Length (mm) Weight (g)	16.6.14 171 51	14.8.15 374 543	14 mths 203 492		
O54	Date Length (mm) Weight (g)	14.8.15 408 771	15.9.15 412 736	1 mth 4 -35		
O68	Date Length (mm) Weight (g)	14.8.15 184 72	15.9.15 202 82	1 mth 18 10		
O35	Date Length (mm) Weight (g)	14.7.15 182 63	15.9.15 207 81	2 mths 25 18		
O20	Date Length (mm) Weight (g)	14.8.15 295 280	15.9.15 297 281	1 mth 2 1		

*tagged in the Laxford

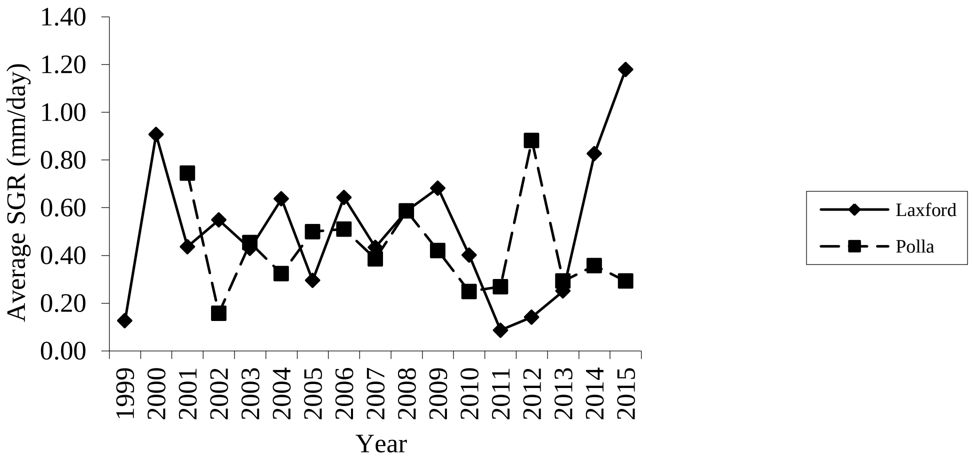

Fig. 3 Showing the average SGR for fish within the Laxford and Polla estuaries, by year

Sea Lice Infestations

Sea lice were present to a varying degree in all estuaries (Table 5), with lice found during all sampling occasions. Chalimus dominated the Laxford catches with a small number of mobiles also found in June and July (Fig. 4a). A small number of adults were also present in June. The Polla samples demonstrated a mixture of lice stages on each sampling occasion (Fig. 4b). As with the Polla, the Kyle of Durness sea trout also carried a mixture of lice stages (Fig. 4c). Total lice numbers were low in the Kyle of Durness but much higher in the other two systems. In particular, the numbers of lice in the Laxford during April, May and June were significant, declining rapidly in July and August. The Polla also showed high numbers during June and September, with a dip in numbers during July and August. 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	25	-	-
May	25	-	-
June	31	76	23
July	75	38	71
August	29	79	100
September	-	63	100

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 abundance within the Laxford samples increased steeply to June, before declining slightly over the following 2 months (Table 6). There was no maturation of lice observed within the sample, with chalimus dominating the population throughout (Fig. 4a). *Caligus* were present on a small number of fish during June and July, with high numbers (69) seen on one fish in June.

The neighbouring cages were stocked in October 2014, giving growing fish within the site during the survey period. As with the wild fish, *Caligus* populations were low. However, the farm contained *Caligus* during July and August, slightly later than the sea trout population. *Lepeophtheirus* figures have followed a similar pattern to those on the farm, although the mixture of stages is greater within the farm. However pre-adult/mobile stages dominate within the cages.

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	5.44	0 - 84	21.78	2 - 84	0
May	8.59	0 - 102	34.35	3 - 102	0
June	11.43	0 - 85	37.00	1 - 85	0
July	10.00	0 - 15	13.33	11 - 15	12.5
August	8.00	0 - 40	28.00	16 - 40	0
September	-	-	-	-	-

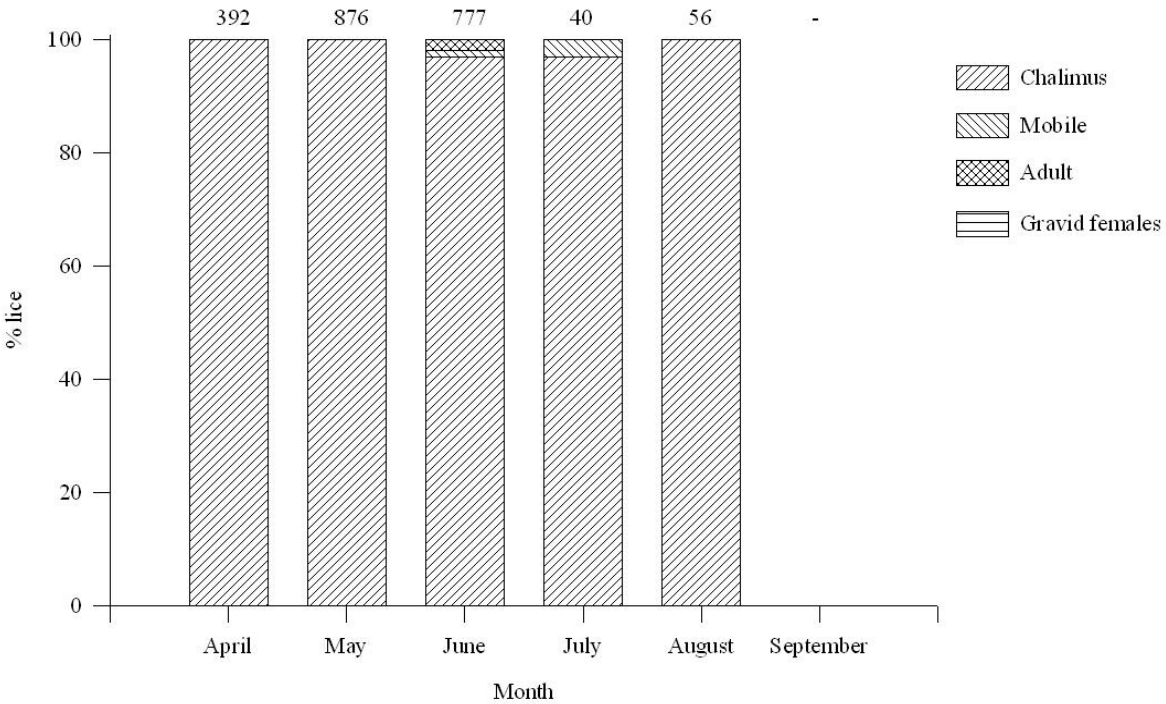

Fig. 4a Showing the proportion of each stage of lice within the Laxford samples, by month. The total number of lice is given at the top.

Polla

The abundance of lice as shown in Table 7 shows a peak in lice during June, before declining during the rest of the year. The June sample was made up of immature lice, chalimus and mobile, with some evidence of maturation following (Fig. 4b). Gravid lice were present in each of the remaining months, with very few chalimus present in September. *Caligus* were present in each month, with the exception of July. The highest number of *Caligus* was found on the fish in June.

The neighbouring cages were fallow throughout the sampling period and therefore no comparisons were possible.

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	-	-	-	-	-
June	26.10	0 - 141	34.25	1 - 141	4
July	2.31	0 - 17	6.00	1 - 17	0
August	3.03	0 - 10	3.83	1 - 10	2
September	3.25	0 - 18	5.2	1 - 18	1

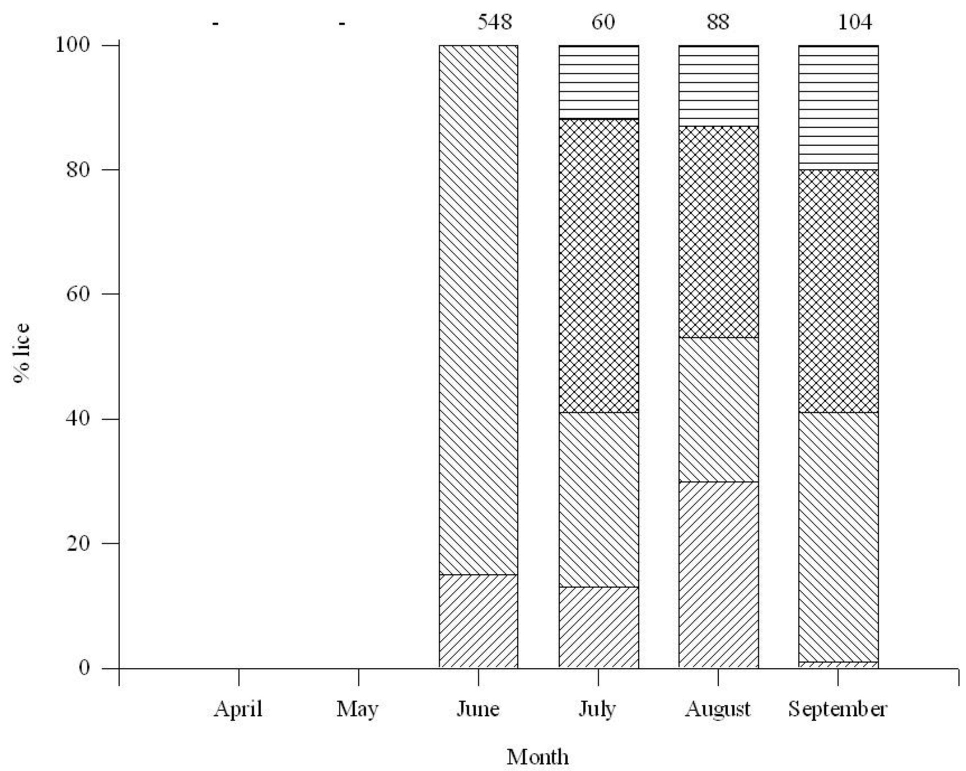

Fig. 4b Showing the proportion of each stage of lice within the Polla samples, by month. The total number of lice is given at the top.

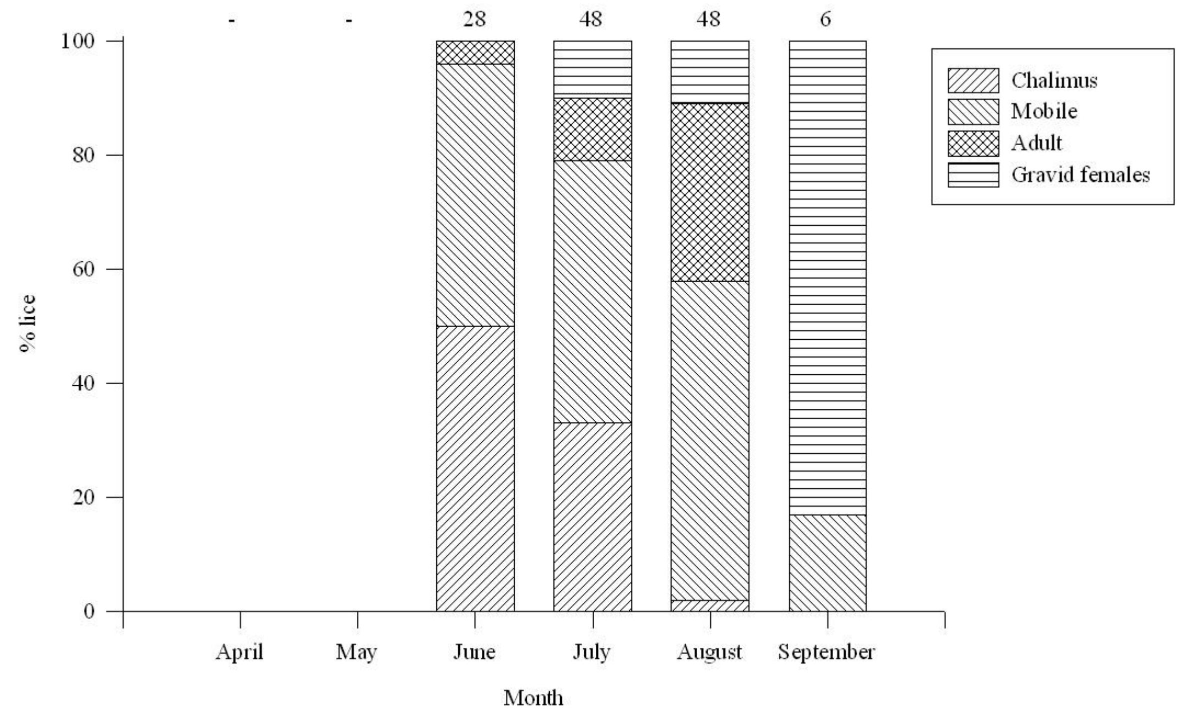

Fig. 4c Showing the proportion of each stage of lice within the Kyle of Durness samples, by month. The total number of lice is given at the top.

Kyle of Durness

The abundance of lice as shown in Table 7 was relatively low, being highest in August. There was a mix of stages present, with potential maturation observed within the population (Fig. 4c).*Caligus* were present in June and August, but there were few individuals on a small number of fish.

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	0.64	0 - 12	2.80	1 - 12	0
July	1.43	0 - 3	2.00	1 - 3	1.5
August	6.86	3 - 10	6.86	3 - 10	7
September	2.00	1 - 4	2.00	1 - 4	1

A risk assessment of the lice numbers present within the wild trout

A recently published paper (Taranger, *et al.*2014) demonstrated a method to assess the increased mortality risk to salmonids based on the number of lice present per gram of fish. This was 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 risks within the Polla estuary are low throughout the study period, with the exception of 2006, when increased lice levels were observed. This is a positive reflection on the situation within the estuary, not perhaps seen in previous analyses based solely on lice abundance. It may, however, be more reflective of the rod catches, which have remained steady with time.

In contrast, the Laxford analysis would indicate that sea lice populations are creating a potential population changing affect on a regular basis. While there is a biannual effect observed, primarily giving a moderate effect, in 2011 and 2013 this was identified as high. This is perhaps a better reflection of the impression drawn from the previous analyses of the abundance data, but serves to highlight the population changes observed within the rod catches.

Sampling within the Kyle of Durness has been more restricted than the other 2 estuaries, but results would indicate that there is a low risk to the population arising from the lice burdens within the population. The exception to this was in 2005, where a high potential risk was recorded. Catch records, again, mirror to some extent the potential risk to the population identified.

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.

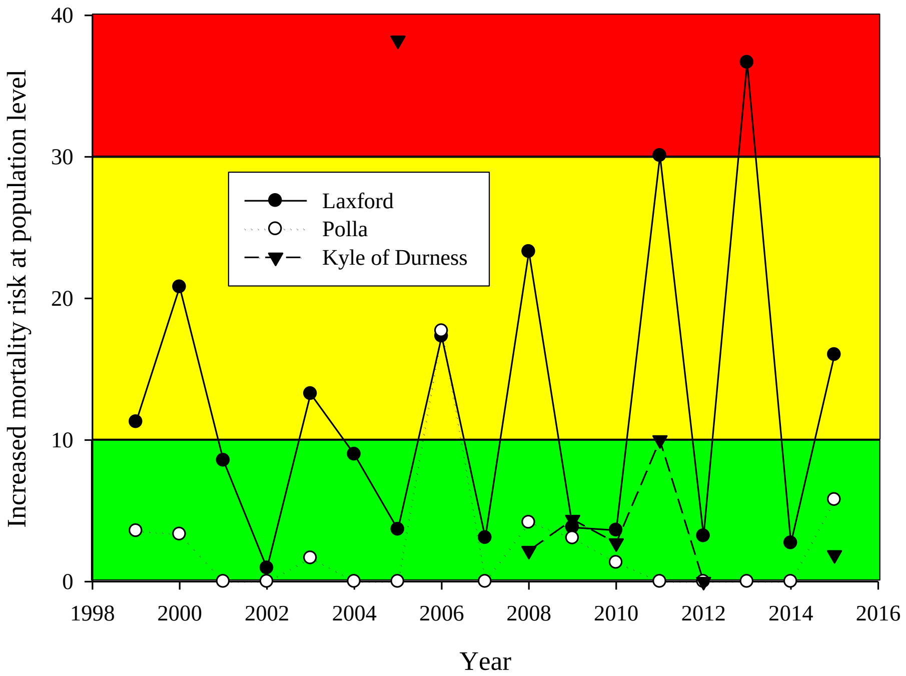

Fig. 5 Showing the increased mortality risk at population level created by sea lice

References

Butler, J.R.A. (2002). Salmonids and sea louse infestations on the west coast of Scotland: sources of infection and implications for the management of marine salmon farms. *Pest Mgmt. Sci*. 58: 595 – 608.

Marshall, S. (2003). Incidence of sea lice infestations on wild sea trout compared to farmed salmon. *Bull. Eur. Ass. Fish Pathol.* 23(2): 72 – 79.

Taranger, G.L., Karlsen, Ø., Bannister, R.J., Glover, K. A., Husa, V., Karlsbakk, E., Kvamme, O., Boxaspen, K. K., Bjørn, P. A., Finstad, B., Madhun, A. S., Morton, C. & Svåsand, T. ((2014). Risk assessment of the environmental impact of Norwegian Atlantic salmon farming. *ICES J. Mar. Sci. dor 10. 1093/icesjms/fsu132.*

WSFT (2015). Monitoring of sea trout post-smolts, 2013. Unpubl. Report to the West Sutherland Fisheries Trust, Report No. WSFT2/15.

Acknowledgements

Thanks must be given to the many people who assisted with the sampling over the past year and without whom the project could not have been completed, particularly Ross Barnes, John Craig, Dave Debour, Andrew Marsham and Rex Onions. Thanks also to Reay Forest and Rispond Estates and the River Dionard Committee of Management for permitting the work to be undertaken. This project has received partial funding from the North & West DSFB and the Scottish Government *via* RAFTS.