Upper Loch Linnhe sea trout monitoring

2022

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Introduction

Coastal seine netting was undertaken in Upper Loch Linnhe by Lochaber Fisheries Trust (LFT) in 2022 to monitor for sea lice (*Lepeophtheirus salmonis*) infestation pressure on local populations of sea trout (*Salmo trutta*).

L. salmonis are a native copepod parasite that naturally occur in the marine environment. They are an ectoparasite, attaching to fish externally and are host-specific to salmonid species. Potential impacts associated with sea lice infections on host fish include mechanical damage, stress, reduced osmo-regulatory function and mortality.

There are concerns associated with sea lice interactions between finfish farming operations and local wild fish populations. Three finfish aquaculture sites are currently operating within the Upper Loch Linnhe zone (Figure 1).

Data collected from sea trout monitoring undertaken in 2022 will help to inform the Upper Loch Linnhe Environmental Management Plan (EMP).

Methodology

Seine netting was undertaken at three separate locations within Upper Loch Linnhe: Camusnagaul, Bunree and Leven (Figure 1). Surveys were scheduled on a monthly frequency where possible between May and September 2022 (Table 1), aiming to sample as many sea trout as was possible, and practicable.

A 50m x 3.0m seine net was used for all netting surveys. At each site the seine net was deployed from the shore using a rowing boat to set the net in a semi-circle before being retrieved from the shore. As many sweeps of the net as possible were completed at each site on each visit. Surveys were timed to coincide with incoming tide and slack water period around high tide times.

Trout were anaesthetised prior to data collection on length, weight and counts of sea lice. This was undertaken according to the protocol prescribed by Scottish Fisheries Coordination Centre (SFCC, 2008). Data on the physical characteristics and sea lice burdens of the trout sampled were recorded to calculate the following:

- Prevalence of lice – number/percentage of trout sampled with a sea lice burden.
- Abundance of lice – the average (mean) number of sea lice per trout.
- Intensity of infection – the average (mean) number of lice per infected trout.
- Lice were categorised in one of four life stages: the two attached stages copepodid and chalimus; the mobile stage (sub-adults and adults) and the ovigerous stage (gravid females with egg strings).

Additional information was recorded on sea lice grazing damage and physical damage caused by predators on the seat trout.

Any non-target species were recorded and immediately returned to the area of capture after each sweep of the net.

Following processing all trout were allowed to fully recover before being returned to the area of capture.

Analysis was carried out using the Taranger *et al*. (2015) risk assessment framework which aims to categorise the increased lice-related risk of mortality to individual trout according to the number of lice present in relation to the body weight of the fish (no. lice/g^{-1}).

The Taranger risk assessment framework assumes that small sea trout post-smolts (<150g body weight) will suffer 100% lice-related marine mortality, or premature return to freshwater, if they are infected with >0.3 lice/g^{-1} fish weight. Furthermore, the lice-related marine mortality is estimated to be 50% if the infection is between 0.2 and 0.3 lice/g^{-1} fish weight, 20% if the infection rate is between 0.1 and 0.2 lice/g^{-1} fish weight, and finally 0% lice-related mortality if the salmon lice infection is <0.1 lice/g^{-1} fish weight.

For larger sea trout (over 150g) the risk analysis assumes that increased lice-related mortality or compromised reproduction will be 100% in the group if they have >0.15 lice/g^{-1} fish weight, 75% for lice infections between 0.10 and 0.15 lice/g^{-1} fish weight, 50% for lice infections between 0.05 and 0.10 lice/g^{-1} fish weight, 20% for lice infections between 0.01 and 0.05 lice/g^{-1} group and 0% if the salmon lice infection is <0.01 lice/g^{-1} fish weight.

Total increased lice-rated mortality risk or premature return to freshwater is calculated as the sum of the increased mortalities for each of the different “infection classes” in the sample, reflecting the distribution of the intensity of salmon lice infections of the different individuals sampled. The total risk to each infection class was further scored according to the system proposed by Taranger *et al*. (2012) as low (up to 10% estimated increase in mortality), moderate (between 10 and 30% increase), and high (if the increase is calculated as 30% or more).

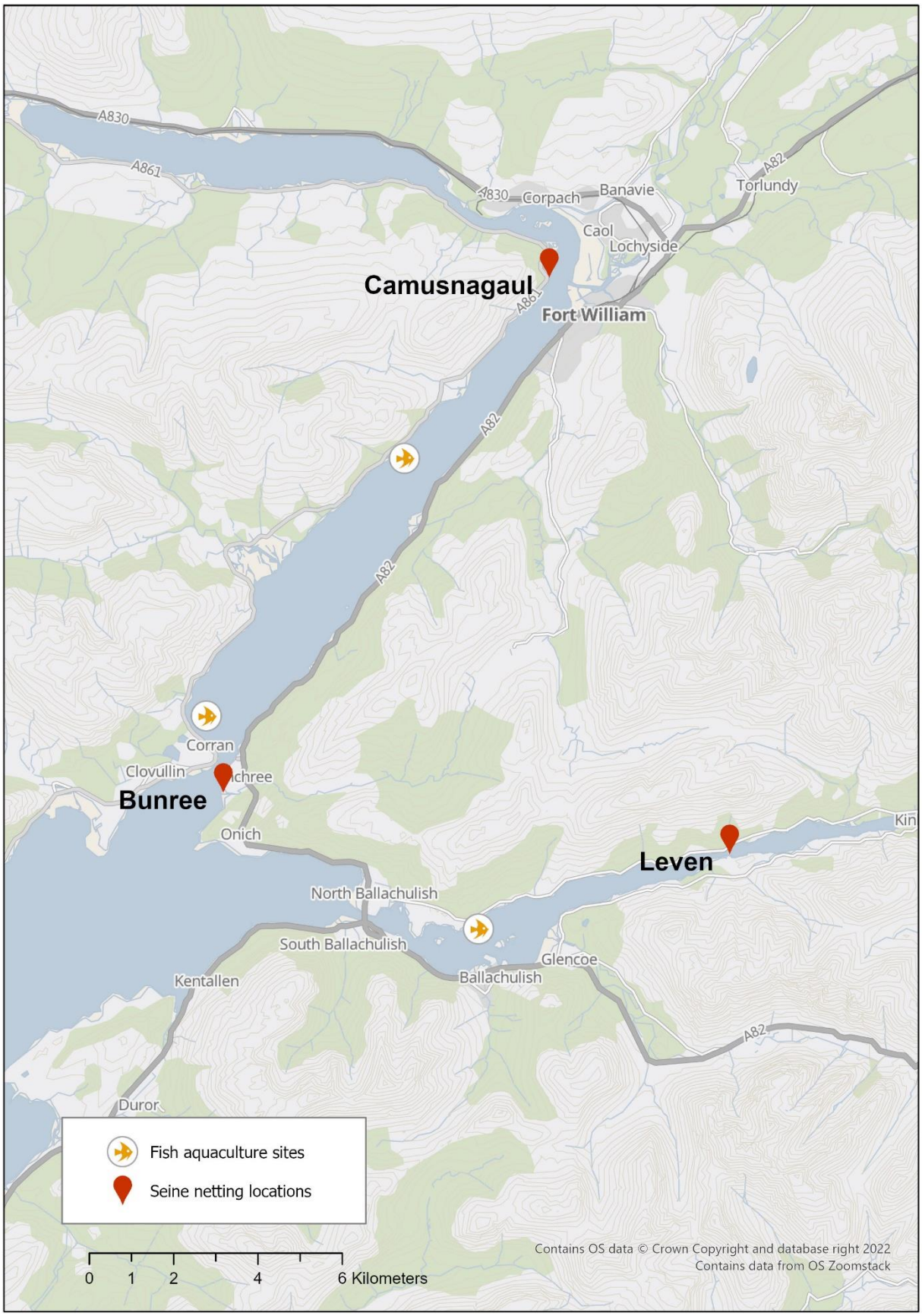

Figure 1. Map of seine netting locations and finfish aquaculture sites, Upper Loch Linnhe

Table 1. Seine netting site locations and dates surveyed

Site	Location	Month surveyed	Date(s) surveyed (No. of visits)	Production week
Camusnagaul	NN0958074931	May	25/05/22 & 27/05/22	21
		June	03/06/22 - 08/06/22 (3)	22 / 23
		July	13/07/2022	28
		August	22/08/22 & 24/08/22	34
Bunree	NN0184862724	May	30/05/2022	22
		July	05/07/22 & 06/07/22	27
		August	15/08/22 & 16/08/22	33
		September	06/09/22 & 21/09/22	36 / 38
Leven	NN1386061269	June	09/06/22 & 13/06/22	23 / 24
		July	11/07/2022	28

Results

Ten surveys were completed across the three seine netting locations between 25th May and 21st September, four at Camusnagaul, four at Bunree and two at Leven. All but one of the surveys consisted of one or two separate visits, the one exception being June at Camusnagaul, when three visits were made between 3rd and 8th June (Table 1). When more than one visit was made to a site, visits were kept as close together as possible and within five days of each other where practicable so that they could be grouped and analysed as one sample. This was possible in all cases except for the September survey at Bunree when separate visits were made on 6th September and 21st September. On this occasion, these two visits were also grouped together for analysis as one 'sample' in September.

Data for all sea trout caught have been divided into two categories for analysis and presentation of results, trout <150g and trout >150g, in accordance with the Taranger analysis approach as described above. Raw data from all surveys is included in Appendix C.

Sea trout numbers

Numbers of trout varied throughout the survey period. Trout <150g were caught in every survey at all sites whilst trout >150g were recorded in three out of four months at Camusnagaul and in half of the surveys at Bunree and Leven.

The highest number of trout <150g recorded in a month was in June at Camusnagaul, when 125 individuals were caught. The highest number of trout >150g was also recorded in the June survey at Camusnagaul, when 37 individuals were caught.

Table 2. Number of sea trout caught per site per sample

Site	Month	Number of trout caught		
		<150g	>150g	Total
Camusnagaul	May	26	8	34
	June	125	37	162
	July	2	0	2
	August	22	3	25
Bunree	May	27	4	31
	July	5	0	5
	August	14	2	16
	September	5	0	5
Leven	June	11	2	13
	July	4	0	4

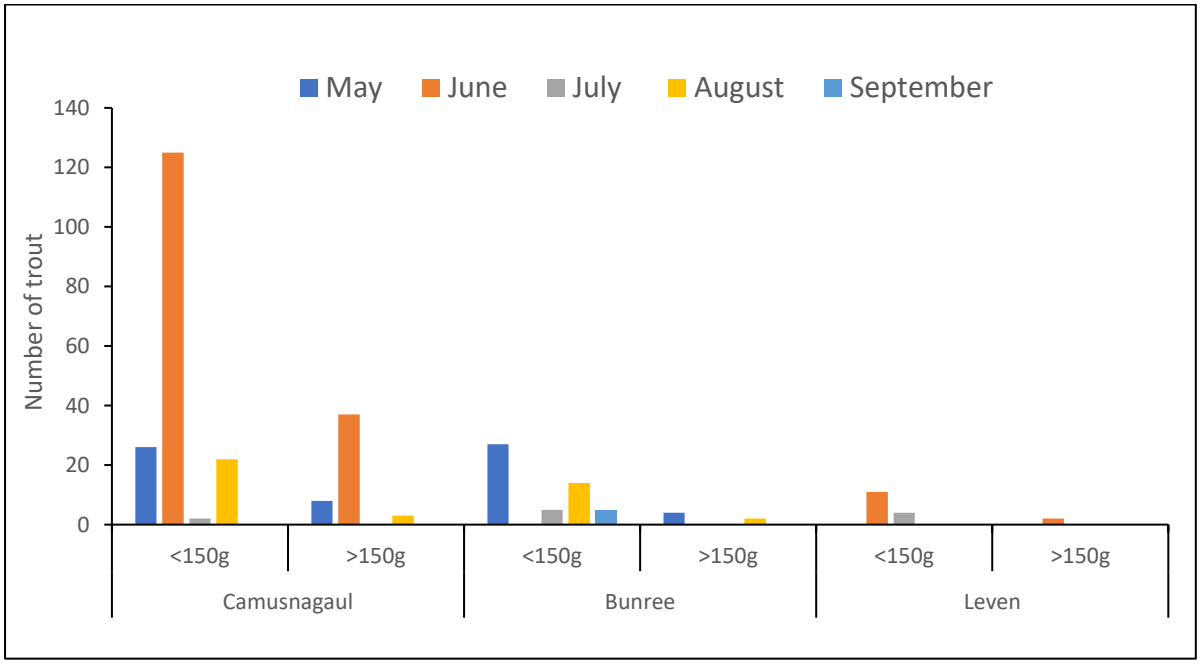

Figure 2. Total number of sea trout in each size category per site per month

Sea lice prevalence, abundance & intensity

Sea lice prevalence (% of trout infected with lice), abundance (mean number of lice per trout) and intensity (mean number of lice per infected trout) scores have been calculated for trout <150g and >150g at each site for the entire survey period May - September (Table 3 and Figure 3). This includes all life stages of lice recorded.

Sea lice prevalence, abundance and intensity scores have also been calculated and included for both size categories of trout per sample per site (Table 4 and Figure 4).

Table 3. Sea lice prevalence, abundance and intensity per site across the entire survey period

Site	Prevalence (% of trout infected)		Abundance (Mean number of lice/trout)		Intensity (Mean number of lice/infected trout)	
	<150g	>150g	<150g	>150g	<150g	>150g
Camusnagaul	90.86	87.50	16.25	27.35	17.88	31.26
Bunree	58.82	100.00	10.24	7.83	17.40	7.83
Leven	73.33	50.00	8.93	5.00	12.18	10.00

Table 4. Sea lice prevalence, abundance and intensity scores per site per sample

Site	Month	Prevalence (% of trout infected)		Abundance (Mean number lice/trout)		Intensity (Mean number lice/infected trout)	
		<150g	>150g	<150g	>150g	<150g	>150g
Camusnagaul	May	84.62	75.00	12.77	5.38	15.09	7.17
	June	92.80	91.89	18.53	32.95	19.97	35.85
	July	100.00	-	38.00	-	38.00	-
	August	86.36	66.67	5.41	17.00	6.26	25.50
Bunree	May	55.56	100.00	11.48	9.75	20.67	9.75
	July	60.00	-	11.40	-	19.00	-
	August	57.14	100.00	8.50	4.00	14.88	4.00
	September	80.00	-	7.20	-	9.00	-
Leven	June	81.82	50.00	11.82	5.00	14.44	10.00
	July	50.00	-	1.00	-	2.00	-

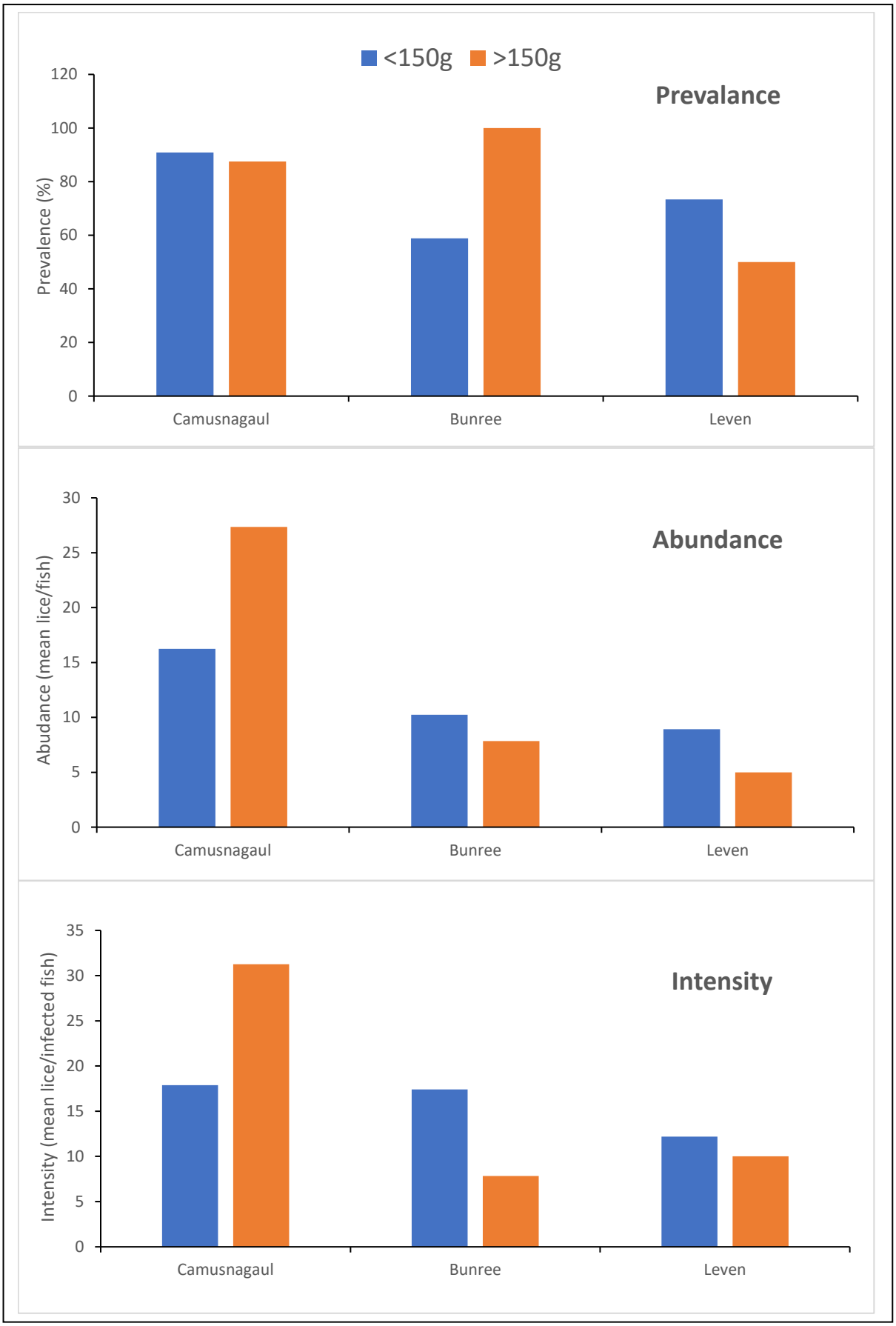

Figure 3. Sea lice prevalence, abundance & intensity per site across the entire survey period

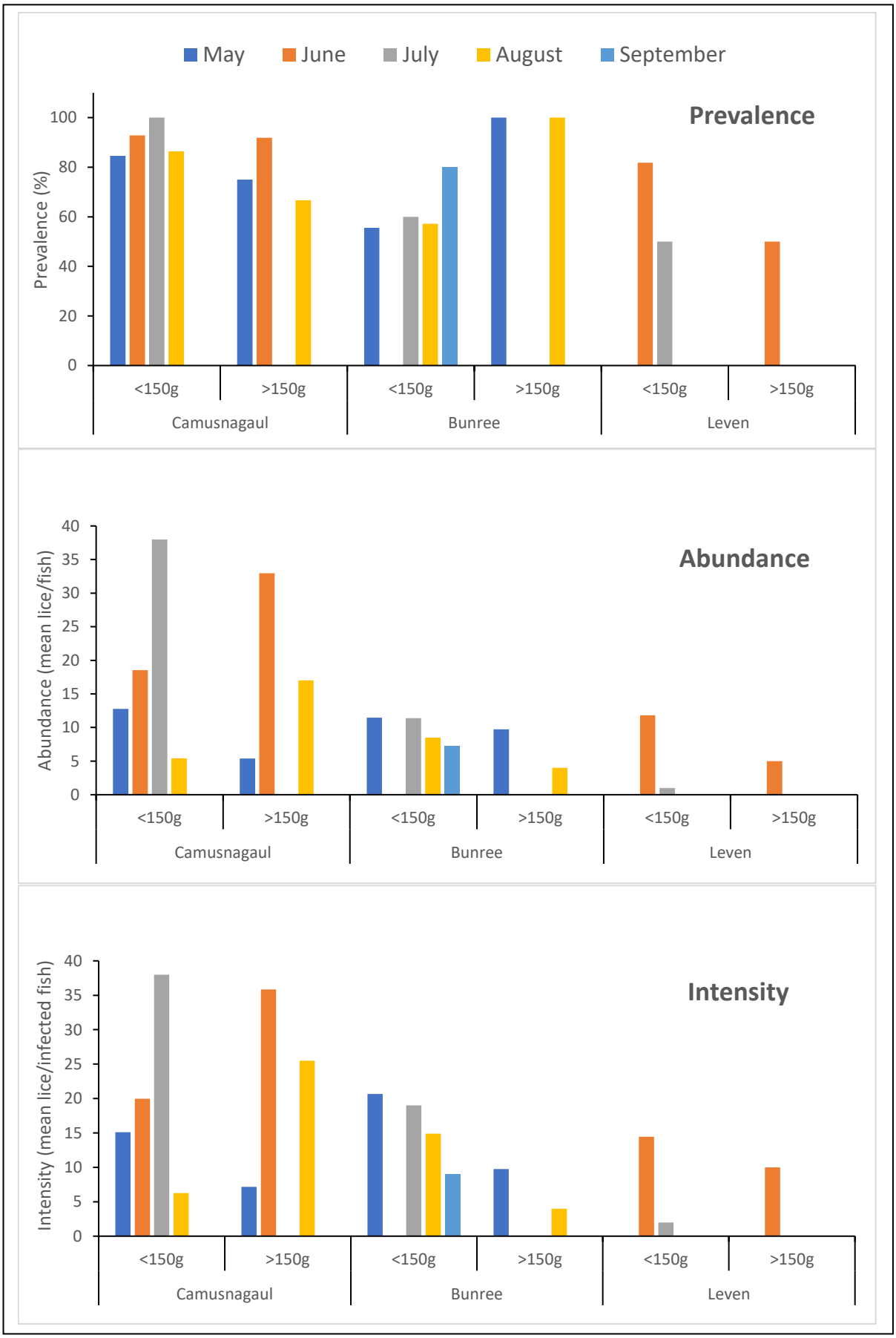

Figure 4. Sea lice prevalence, abundance & intensity per site per sample

Risk assessment

Survey data has been assessed against the risk index proposed by Taranger, *et al*. (2015). The Taranger threshold ranges and associated percentage risk categories are described in the Methodology section above and are also included in Appendix A.

The proportion (%) of sea trout <150g which falls within each risk assessment category has been summarised for each site for the entire survey period, including a total risk score (%) (Table 5 and Figure 5).

The total estimated increase in lice-related mortality risk or premature return to freshwater for trout <150g across the entire survey period for all three sites ranged between 25.69% (Bunree) and 50.52% (Camusnagaul), equating to a 'moderate' and 'high' overall risk, respectively.

Table 5. Proportion (%) of trout <150g per risk category per site across the entire survey period

Site	Proportion (%) of trout <150g per risk assessment category				Total risk (%)
	<0.1	0.1 - 0.2	0.2 - 0.3	>0.3	
Camusnagaul	33.14	12.79	12.21	41.86	50.52
Bunree	58.82	15.69	5.88	19.61	25.69
Leven	53.33	13.33	13.33	20.00	29.33

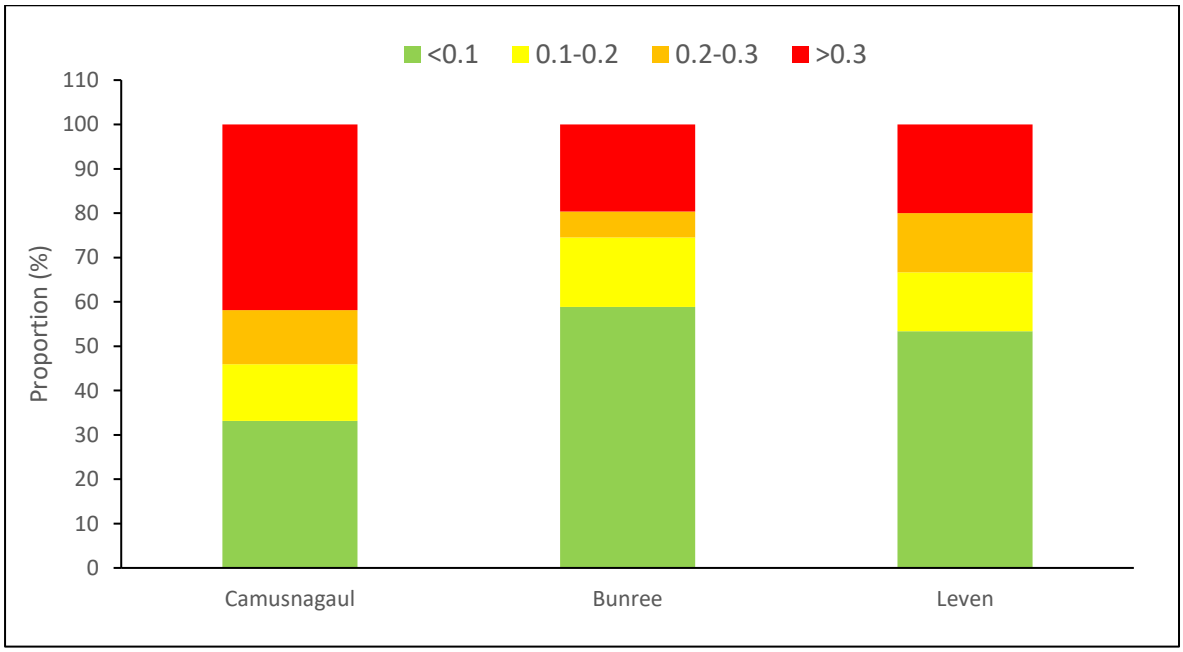

Figure 5. Proportion (%) of trout <150g per risk category per site across the entire survey period

The proportion (%) of sea trout >150g within each risk assessment category is summarised for each site for the entire survey period, including a total risk score (%) (Table 6 and Figure 6).

Total estimated increase in lice-related mortality or compromised reproduction risk for trout >150g for the entire survey period across all sites ranged between 25% (Leven) and 31.67% (Bunree), equating to a 'moderate' and 'high' overall risk, respectively.

Table 6. Proportion (%) of trout >150g per risk category per site for the entire survey period

Site	Proportion (%) of trout >150g per risk assessment category					Total risk (%)
	<0.01	0.01 - 0.05	0.05 - 0.10	0.10 - 0.15	>0.15	
Camusnagaul	24.49	48.98	10.20	2.04	14.29	30.71
Bunree	16.67	33.33	50.00	0.00	0.00	31.67
Leven	50.00	0.00	50.00	0.00	0.00	25.00

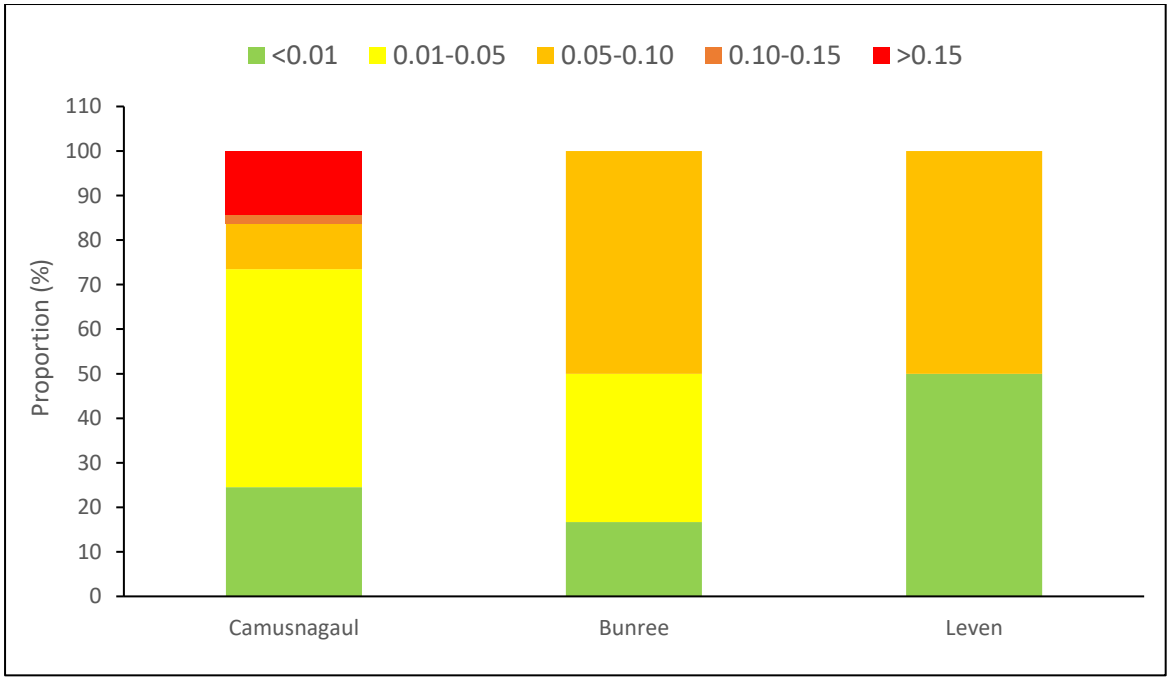

Figure 6. Proportion (%) of trout >150g per risk category per site for the entire survey period

The proportion (%) of sea trout <150g which fall into each Taranger risk assessment category has been summarised for each sample at each site, including a total sum of the increased mortalities for each of the different "infection classes" in each sample (%) (Table 7 and Figure 7).

For samples at Camusnagaul, the majority of sea trout sampled had lice burdens >0.3 lice/g^{-1} in the May, June and July samples, and in August 63.64% of trout sampled had <0.1 lice/g^{-1}. For Bunree, the largest proportion of trout had lice burdens <0.1 lice/g^{-1} for all four samples. For Leven, the largest proportion of sea trout sampled had lice burdens <0.1 lice/g^{-1} for both samples.

Total risk score (%) from surveys across all sites for sea trout <150g varied between 15% (August at Bunree, indicating a 'moderate' overall risk to the sea trout sampled) to 100% (July at Camusnagaul, indicating a 'high' overall risk to the sea trout sampled).

Table 7. Proportion (%) of trout <150g per risk category per sample

Site	Month	Proportion (%) of trout <150g per category per month				Total risk (%)
		<0.1	0.1 - 0.2	0.2 - 0.3	>0.3	
Camusnagaul	May	34.62	3.85	7.69	53.85	58.46
	June	27.87	13.11	14.75	44.26	54.26
	July	0.00	0.00	0.00	100.00	100.00
	Aug	63.64	22.73	4.55	9.09	15.91
Bunree	May	55.56	14.81	3.70	25.93	30.74
	July	60.00	0.00	20.00	20.00	30.00
	Aug	64.29	21.43	7.14	7.14	15.00
	Sept	60.00	20.00	0.00	20.00	24.00
Leven	June	36.36	18.18	18.18	27.27	40.00
	July	100.00	0.00	0.00	0.00	0.00

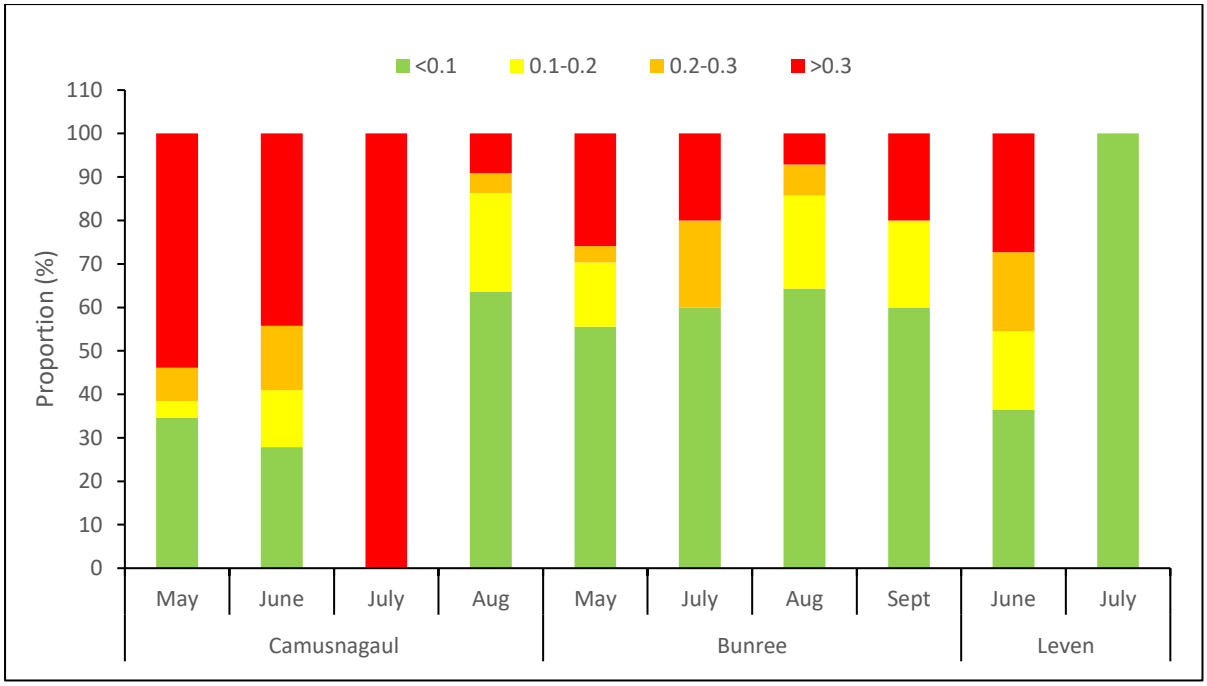

Figure 7. Proportion (%) of trout <150g per risk category per sample

The proportion (%) of sea trout >150g which fall into each Taranger risk assessment category has been summarised for each sample at each site, including a total sum of the increased mortalities for each of the different "infection classes" in each sample (%) (Table 8 and Figure 8).

For all samples at Camusnagaul, the largest proportion of sea trout had lice burdens <0.01 lice/g^{-1} in May and 0.01-0.05 lice/g^{-1} in June, whilst in August the proportion of lice-infected trout was equal between three categories: <0.01, 0.10-0.15 and >0.15 lice/g^{-1}. For Bunree, the largest proportion of trout had a lice burden of 0.05-0.10 lice/g^{-1} in May, whilst in August the proportion of lice-infected trout was equal between two categories: <0.01 and 0.01-0.05 lice/g^{-1}. For Leven, the proportion of lice-infected sea trout was equal between <0.01 and 0.05-0.10 lice/g^{-1} in June.

Total risk score (%) from monthly surveys across all sites for trout >150g varied between 10% (August at Bunree, indicating a 'low' overall risk) to 58.33% (August at Camusnagaul, indicating a 'high' overall risk).

Table 8. Proportion (%) of trout >150g per risk category per sample

Site	Month	Proportion (%) of trout >150g per category per month					Total risk (%)
		<0.01	0.01 - 0.05	0.05 - 0.10	0.10 - 0.15	>0.15	
Camusnagaul	May	66.67	16.67	16.67	0.00	0.00	11.67
	June	17.50	57.50	10.00	0.00	15.00	31.50
	July	0.00	0.00	0.00	0.00	0.00	0.00
	Aug	33.33	0.00	0.00	33.33	33.33	58.33
Bunree	May	0.00	25.00	75.00	0.00	0.00	42.50
	July	0.00	0.00	0.00	0.00	0.00	0.00
	Aug	50.00	50.00	0.00	0.00	0.00	10.00
	Sept	0.00	0.00	0.00	0.00	0.00	0.00
Leven	June	50.00	0.00	50.00	0.00	0.00	25.00
	July	0.00	0.00	0.00	0.00	0.00	0.00

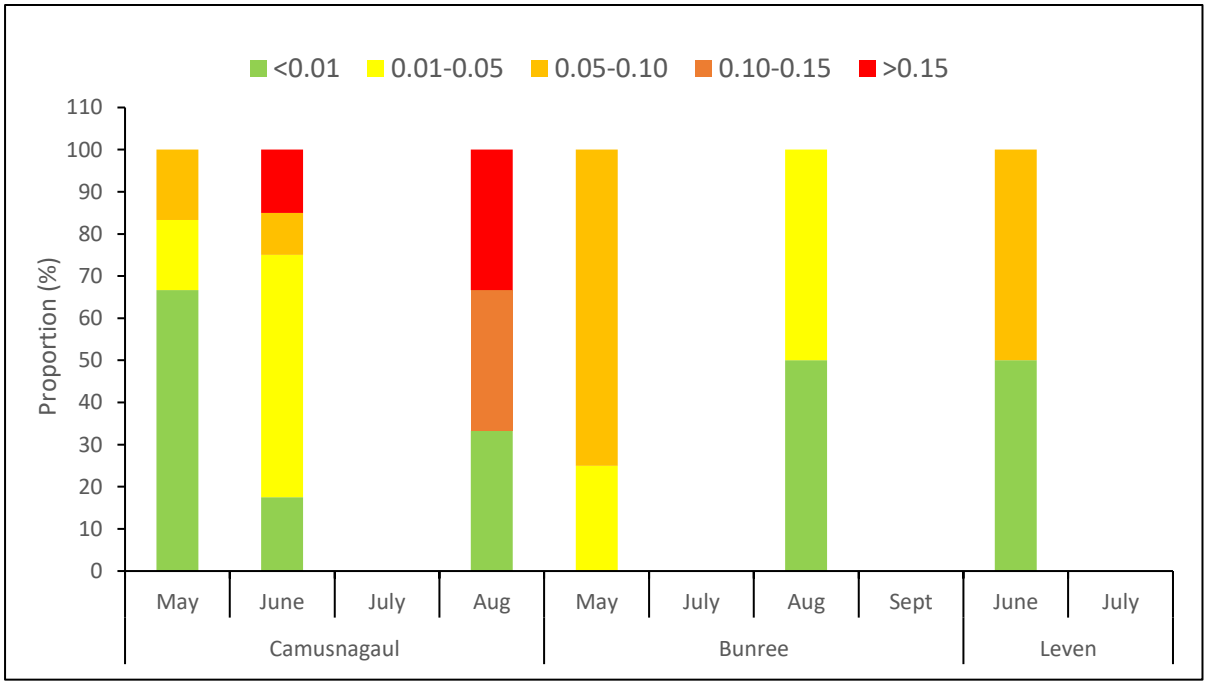

Figure 8. Proportion (%) of trout >150g per risk category per month

Historic data

Historic seine netting data are available for Camusnagaul (2018 and 2021) and Bunree (2018 and 2019). This has been summarised and compared with data collected during 2022 netting surveys, comparing total numbers of trout caught and sea lice prevalence, abundance and intensity scores for each year surveyed (Table 9 and Figure 9).

Table 9. Total number of sea trout caught, sea lice prevalence, abundance and intensity per year, for trout <150g and >150g, Camusnagaul and Bunree

Total number of trout per year				
Year	Camusnagaul		Bunree	
	<150g	>150g	<150g	>150g
2018	34	4	15	1
2019	-	-	15	8
2021	175	13	-	-
2022	175	48	51	6
Prevalence (% sea trout sampled which had a lice burden)				
Year	Camusnagaul		Bunree	
	<150g	>150g	<150g	>150g
2018	32.35	75.00	66.67	0.00
2019	-	-	93.33	100.00
2021	96.57	100.00	-	-
2022	90.86	87.50	58.82	100.00
Abundance (Mean number of lice/sea trout)				
Year	Camusnagaul		Bunree	
	<150g	>150g	<150g	>150g
2018	0.88	12.50	2.80	0.00
2019	-	-	8.80	12.88
2021	52.07	74.62	-	-
2022	16.25	27.35	10.24	7.83
Intensity (Mean number of lice/infected sea trout)				
Year	Camusnagaul		Bunree	
	<150g	>150g	<150g	>150g
2018	2.73	16.67	4.20	0.00
2019	-	-	9.43	12.88
2021	53.92	74.62	-	-
2022	17.88	31.26	17.40	7.83

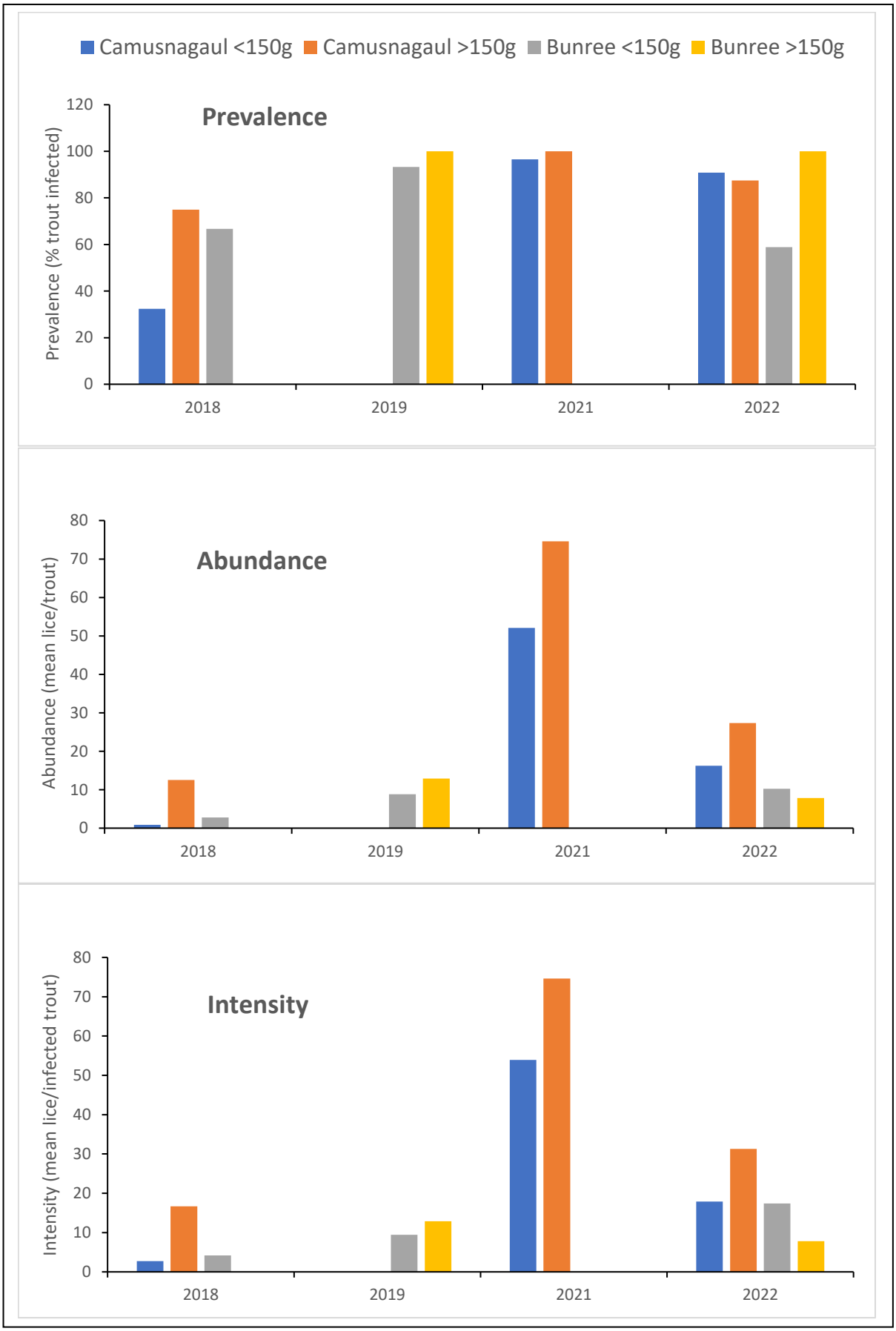

Figure 9. Sea lice prevalence, abundance and intensity, Camusnagaul and Bunree, 2018 - 2022

Taranger risk assessment scores, including total risk scores (%), have been calculated for the historic data collected at Camusnagaul and Bunree. This has been summarised for each year of data collected (2018, 2021 and 2022 for Camusnagaul and 2018, 2019 and 2022 for Bunree) for sea trout <150g (Table 10 and Figure 10) and sea trout >150g (Table 11 and Figure 11).

Total risk assessment scores for the years surveyed at each site are summarised for trout <150g (Figure 12) and trout >150g (Figure 13).

Table 10. Trout <150g per risk assessment category, Camusnagaul and Bunree, 2018 - 2022

Site	Year	Proportion (%) of trout <150g per category				Total risk (%)
		<0.1	0.1 - 0.2	0.2 - 0.3	>0.3	
Camusnagaul	2018	94.12	5.88	0.00	0.00	1.18
	2021	13.14	10.86	5.71	70.29	70.29
	2022	33.14	12.79	12.21	41.86	50.52
Bunree	2018	93.33	6.67	0.00	0.00	1.33
	2019	25.00	18.75	31.25	25.00	44.38
	2022	58.82	15.69	5.88	19.61	25.69

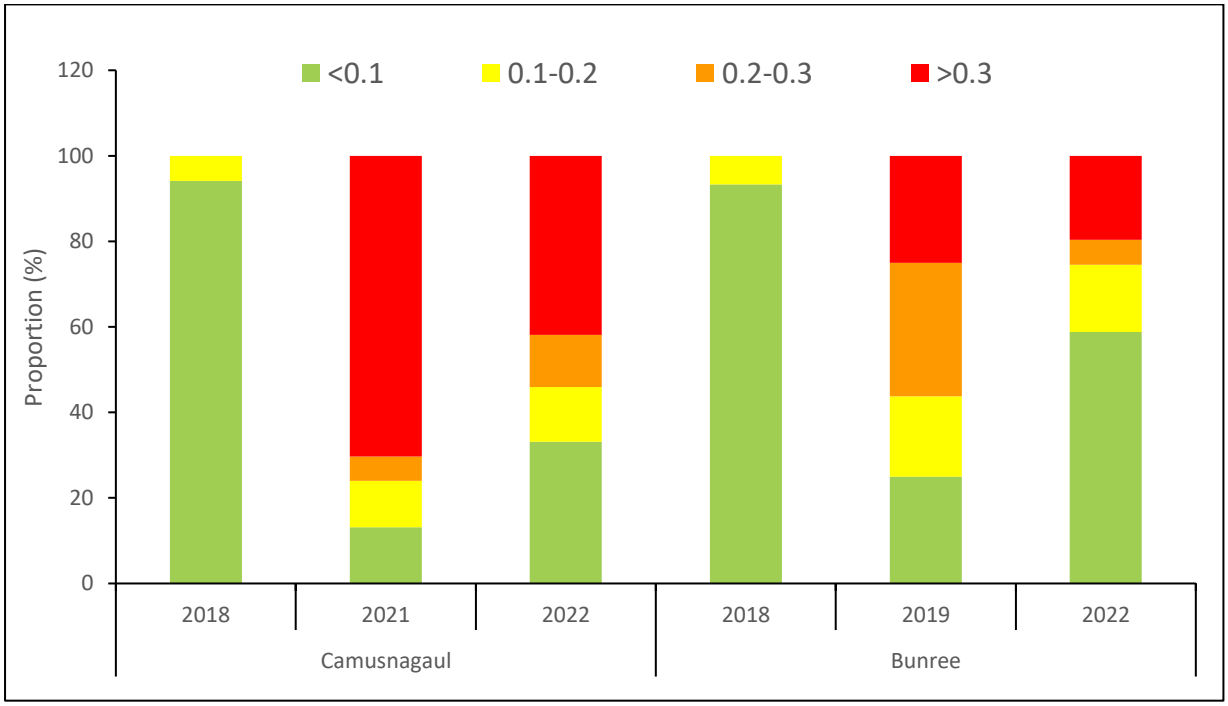

Figure 10. Proportion of trout <150g per risk assessment category, Camusnagaul and Bunree

Table 11. Trout >150g per risk assessment category, Camusnagaul and Bunree, 2018 – 2022

Site	Year	Proportion (%) of trout >150g per category					Total risk (%)
		<0.01	0.01 - 0.05	0.05 - 0.10	0.10 - 0.15	>0.15	
Camusnagaul	2018	25.00	50.00	0.00	25.00	0.00	28.75
	2021	0.00	23.08	23.08	0.00	53.85	70.00
	2022	24.49	48.98	10.20	2.04	14.29	30.71
Bunree	2018	100.00	0.00	0.00	0.00	0.00	0.00
	2019	0.00	50.00	50.00	0.00	0.00	35.00
	2022	16.67	33.33	50.00	0.00	0.00	31.67

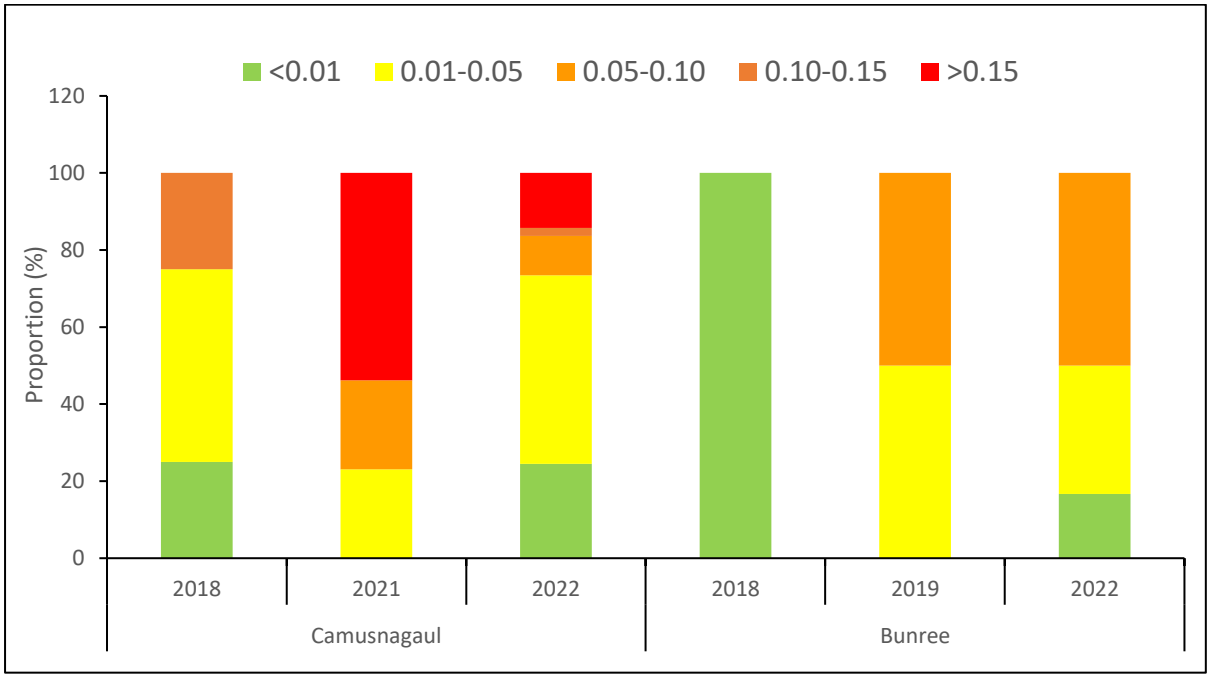

Figure 11. Proportion of trout >150g per risk assessment category, Camusnagaul and Bunree

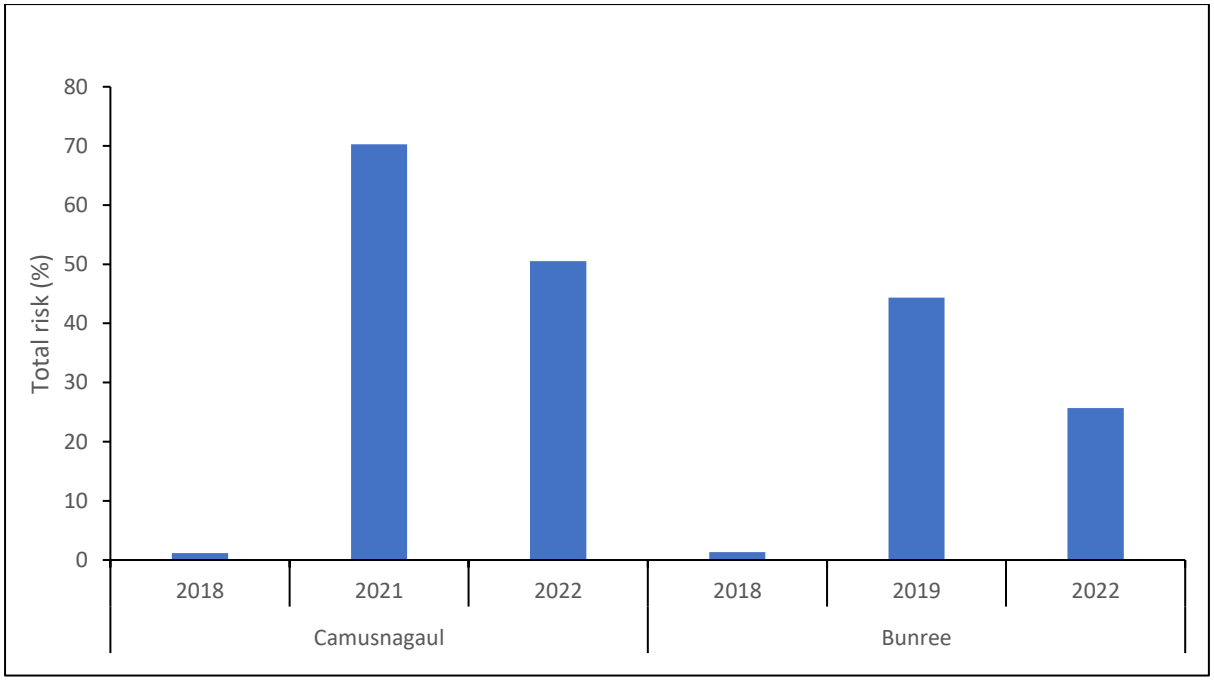

Figure 12. Total risk scores (%) for trout <150g, Camusnagaul and Bunree, 2018 – 2022

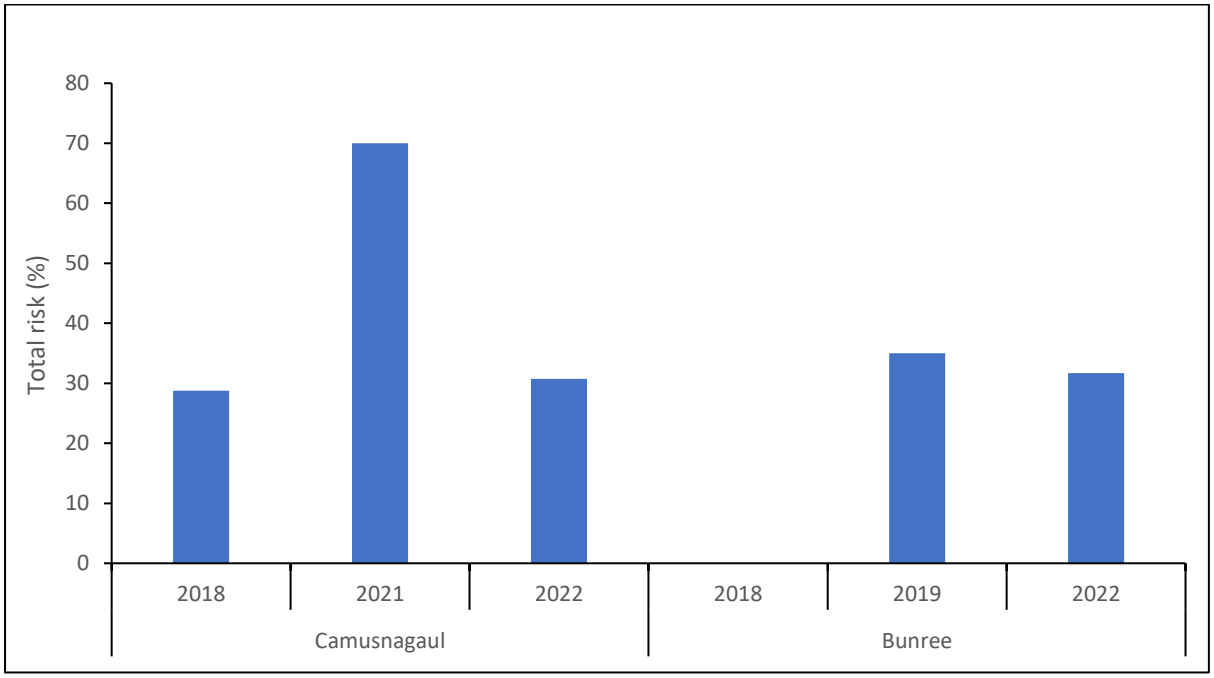

Figure 13. Total risk scores (%) for trout >150g, Camusnagaul and Bunree, 2018 – 2022

Discussion

Total numbers of sea trout caught at each site were variable throughout the survey period and some sites were more productive than others. When low numbers of trout were caught, additional visits to a site were undertaken (within five days where possible) to try to increase the sample size of the survey. There are many variables that influence fish behaviour and affect survey results, either alone or in combination, including, location, weather, tidal conditions, time of day and/or season. Low numbers of sea trout caught in some of the surveys may be a result of one of or any combination of these variables.

Sea lice burdens of sea trout <150 grams at Camusnagaul in 2022 averaged 12.77 lice per fish in May, 18.53 lice per fish in June, 38.0 lice per fish in July and 5.41 lice per fish in August. Using the Taranger analysis, the overall estimated mortality risk of sampled sea trout was 58.46% in May, falling to 54.26% in June, rising to 100% in July and then 15.91% in August. This is categorised as being high risk for May, June and July samples, and medium risk for the August sample. The equivalent Taranger analysis for the sea trout that were sampled >150g showed a high overall risk of increased lice-related mortality across the entire survey period (30.71%).

Sea lice burdens of sea trout <150 grams at Bunree in 2022 averaged 11.48 lice per fish in May, 11.40 lice per fish in July, 8.50 lice per fish in August and 7.20 lice per fish in September. Using the Taranger analysis, the overall estimated mortality risk of sampled sea trout was 30.74% in May, falling to 30.0% in July and 15.0% in August and then rising to 24.0% in September. This is categorised as being high risk for the May sample and medium risk for the July, August and September samples. The equivalent Taranger analysis for the sea trout that were sampled >150g showed a high overall risk of increased lice-related mortality (31.67%).

Sea lice burdens of sea trout <150 grams at Leven in 2022 averaged 11.82 lice per fish in June and 1.0 lice per fish in July. Using the Taranger analysis, the overall estimated mortality risk of sampled sea trout was 40.0% in June, falling to 0% in July. This is categorised as being high risk for the June sample and low risk for the July sample. The equivalent Taranger analysis for the sea trout that were sampled >150g showed a medium overall risk of increased lice-related mortality (25.0%).

Overall, lice levels on sampled sea trout in 2022 were of great concern as sampled sea trout consistently had lice levels expected to cause mortality (Ives *et al.*, 2023), particularly those at Camusnagaul.

Impacts of sea lice on wild fish are a function of the total number of lice in the environment, which results from both the average number of sea lice per farmed fish, and the number of fish stocked on the farm. Open net fish farming has significantly increased the number of host fish for sea lice, and data collected throughout the west coast of Scotland shows that the proportion of individual sea trout with stress-inducing sea louse burdens increases with the mean weight of salmon on the nearest fish farm and decreased with distance from that farm (Marine Scotland Science, 2021). There are three fish farms operating in the Upper Linnhe area, Gorsten (Mowi), Linnhe (Mowi) and Loch Leven (Mowi). Sea lice data submitted from fish aquaculture sites show average adult female

lice numbers on farmed fish on these sites throughout the survey period were between, 0.0 – 1.83 average adult female lice per fish at Gorsten, 0.09 – 0.85 average adult female lice per fish at Linnhe and 0.08 – 0.54 average adult female lice per fish at Loch Leven (Appendix B).

When we consider the historical data at Camusnagaul, sea lice burdens of sea trout <150g averaged 0.88 lice per fish in 2018, 52.07 lice per fish in 2021 and 16.25 lice per fish in 2022. Using the Taranger analysis, the overall estimated mortality risk of sampled sea trout was 1.18% in 2018, rising to 70.29% in 2021 and falling to 50.52% in 2022. This is categorised as being low risk in 2018 and high risk in both 2021 and 2022. The equivalent Taranger analysis for the sea trout that were sampled >150g showed a medium overall risk of increased lice-related mortality in 2018 (28.75%) rising to a high overall risk of increased lice-related mortality in 2021 (70.0%) and 2022 (30.71%).

Considering the historical data at Bunree, sea lice burdens of sea trout <150g averaged 2.80 lice per fish in 2018, 8.80 lice per fish in 2019 and 10.24 lice per fish in 2022. Using the Taranger analysis, the overall estimated mortality risk of sampled sea trout was 1.33% in 2018, rising to 44.38% in 2019 and falling to 25.69 in 2022. This is categorised as being low risk in 2018, high risk in 2021 and medium risk in 2022. The equivalent Taranger analysis for the sea trout that were sampled >150g showed a low overall risk of increased lice-related mortality in 2018 (0.0%) rising to a high overall risk of increased lice-related mortality in 2019 (35.0%) and 2022 (31.67%).

A site near Ardgour was initially included in the 2022 survey programme (grid ref NN0159165823). However, after five separate visits to this location in April and early May, only two small trout were captured. Due to poor results it was decided to trial a site at Bunree (NN0184862724) as this location had been survey historically and produced sea trout. In the first survey at Bunree a total of 31 sea trout were caught and it was decided to continue surveying at this location for the remainder of the season in place of the Ardgour site. The Bunree site will be included as a permanent replacement location in the 2023 monitoring programme to provide consistent and comparable data.

2023 netting surveys are scheduled to begin in April, weather dependent, and with the experience and local knowledge gained in 2022 it is proposed to complete a full monitoring programme at all Upper Loch Linnhe sites in 2023. Future seine netting at these sites will be scheduled to avoid spring tides and strong winds at exposed sites as much as possible. It is also proposed that daily timing of future surveys will be varied to monitor whether this could influence survey results.

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Scotland's aquaculture - sea lice data https://scottishepa.maps.arcgis.com/apps/webappviewer/index.html?id=2218824350e5470e8026076d4138da58

Appendix A

Table of risk assessment categories for sea trout <150g and >150g (Taranger, *et al,* 2015).

Salmonids <150g		Salmonids >150g	
Lice per g/fish weight	Estimated increase in lice-related mortality or premature return to freshwater (%)	Lice per g/fish weight	Estimated increase in lice-related mortality or compromised reproduction (%)
>0.3	100	>0.15	100
0.2 - 0.3	50	0.10 - 0.15	75
0.1 - 0.2	20	0.05 - 0.10	50
<0.1	0	0.01 - 0.05	20
		<0.01	0

Appendix B

Weekly sea lice count for Upper Linnhe fish aquaculture sites (https://scottishepa.maps.arcgis.com)

Site	Month surveyed	Production week	Fish aquaculture site sea lice count (Weekly average adult female lice)		
			Gorsten	Linnhe	Loch Leven
Camusnagaul	May	21	0.22	0.1	0.15
	June	22 / 23	0.31 / 0.59	0.29 / 0.66	0.41 / 0.41
	July	28	1.13	0.32	0.14
	August	34	1.7	0.66	0.16
Bunree	May	22	0.31	0.29	0.41
	July	27	0.91	0.27	0.08
	August	33	0.96	0.85	0.54
	September	36 / 38	1.63 / 0	0.13 / 0.09	0.16 / 0.43
Leven	June	23 / 24	0.59 / 1.83	0.66 / 0.78	0.41 / 0.44
	July	28	1.13	0.32	0.14

Appendix C

2022 Upper Loch Linnhe seine netting raw data

Site	Date	Fish No.	Length (mm)	Weight (g)	Sea lice count				
					Stage 1	Stage 2	Stage 3	Stage 4	Total
Camus	25/05/22	1	352	-	1	0	1	0	2
		2	320	-	1	2	2	0	5
		3	276	172	0	0	0	0	0
		4	160	374	0	13	0	0	13
		5	151	33.2	16	8	2	0	26
		6	129	22	0	7	0	0	7
		7	154	40.5	1	1	2	0	4
		8	125	21.1	0	0	0	0	0
		9	167	42.7	0	1	2	0	3
		10	130	22.9	4	0	9	0	13
		11	133	21.6	8	0	0	0	8
		12	139	28	6	2	0	0	8
		13	156	36.2	0	0	0	0	0
		14	209	99.4	1	0	0	0	1
		15	215	98.6	0	1	0	0	1
		16	259	168	12	0	4	0	16
		17	265	169	0	0	0	0	0
	27/05/22	1	135	19	0	9	21	0	30
		2	122	18.9	40	7	1	0	48
		3	110	14.5	0	0	0	0	0
		4	162	44.1	17	3	1	0	21
		5	95	9.1	0	0	0	0	0
		6	121	20.4	0	4	0	0	4
		7	158	40	5	4	0	0	9
		8	162	43.2	12	11	9	0	32
		9	191	69	32	20	2	0	54
		10	245	149.6	0	0	1	0	1
		11	132	21.7	9	0	1	0	10
		12	150	33.4	10	0	1	0	11
		13	128	22	9	0	0	0	9
		14	138	25.5	13	0	0	0	13
		15	150	35.6	6	13	0	0	19
		16	434	920	0	0	5	1	6
		17	308	562	0	0	1	0	1
	03/06/22	1	168	50	0	6	1	0	7
		2	161	42.7	0	1	0	0	1
		3	151	37.2	6	4	0	0	10
		4	131	26.2	0	0	0	0	0

		5	148	30	3	16	12	0	31
		6	369	400	0	0	0	0	0
		7	356	388.2	0	0	0	0	0
		8	149	36.1	2	5	21	0	28
		9	146	33.1	0	17	22	0	39
		10	136	26.5	0	0	1	0	1
		11	212	97	0	0	0	0	0
		12	147	30	19	0	0	0	19
		13	138	27.1	2	0	0	0	2
		14	148	34.9	0	3	0	0	3
		15	161	43.8	20	12	9	0	41
		16	152	35.4	1	0	0	0	1
		17	132	24.2	2	0	9	0	11
		18	188	75.9	12	0	8	0	20
		19	144	34	0	2	0	0	2
		20	133	23.5	0	3	4	0	7
		21	97	10.3	0	0	0	0	0
		22	305	301.1	1	2	1	1	5
		23	352	449	0	2	2	0	4
		24	348	455.2	3	35	3	2	43
		25	369	572.9	18	190	7	5	220
		26	239	141.3	0	1	0	0	1
		27	266	187.1	110	148	2	0	260
		28	310	201.7	151	0	0	1	152
		29	346	420.5	0	3	1	0	4
		30	320.7	416.7	0	5	1	0	6
		31	384.1	666.2	0	0	0	0	0
		32	159	39.1	6	27	0	0	33
		33	178	31.8	3	23	0	0	26
		34	165	44.6	2	8	2	0	12
		35	135	22.9	4	43	2	0	49
		36	192	76.3	0	0	0	0	0
		37	153	37.9	2	0	0	0	2
		38	151	32.5	0	12	0	0	12
		39	158	31.2	0	6	2	0	8
		40	190	71.3	7	12	2	0	21
		41	152	34.5	7	2	4	0	13
		42	138	24.6	4	3	0	0	7
		43	181	57	37	58	15	0	110
		44	202	98.2	12	12	3	0	27
		45	247	162.3	24	17	1	0	42
		46	180	56.7	2	0	0	0	2
		47	135	24.8	75	43	3	0	121
		48	295	261.1	25	47	68	0	140
		49	165	47.3	4	3	0	0	7

	50	160	46.7	0	0	1	0	1
	51	150	39.6	2	8	0	0	10
	52	161	42.5	0	22	5	0	27
	53	187	65.3	0	14	9	0	23
	54	138	29.4	0	0	1	0	1
	55	158	36.5	0	7	9	0	16
06/06/22	1	292	248.9	1	1	5	0	7
	2	269	179.7	0	0	2	0	2
	3	360	464.3	2	23	0	2	27
	4	352	531.6	0	13	8	1	22
	5	312	338.3	0	7	0	0	7
	6	368	529.2	0	39	12	0	51
	7	314	330	0	3	1	2	6
	8	275	216.2	0	3	0	1	4
	9	328	376.7	0	2	0	0	2
	10	303	261.7	4	8	2	1	15
	11	293	277.4	0	2	0	1	3
	12	297	273.1	0	4	0	0	4
	13	276	208.1	4	0	1	0	5
	14	288	218.9	6	0	0	1	7
	15	266	183	2	5	0	0	7
	16	312	373.6	0	0	4	0	4
	17	354	400	0	4	2	0	6
	18	322	355.9	0	9	1	0	10
	19	265	177.3	0	2	0	1	3
	20	262	192.2	18	139	11	0	168
	21	151	41.8	0	28	2	0	30
	22	189	63.4	0	16	1	0	17
	23	173	52.1	0	1	0	1	2
	24	249	158.2	0	0	0	0	0
	25	251	154.1	0	0	3	0	3
	26	219	104.4	0	0	4	0	4
	27	265	191.4	0	0	5	0	5
	28	251	141.5	0	23	1	0	24
	29	149	35.4	0	11	0	0	11
	30	174	45.1	0	14	2	0	16
	31	231	130.4	51	66	2	0	119
	32	146	30.4	0	2	0	0	2
	33	138	23.9	2	19	2	0	23
	34	147	29.3	1	6	1	0	8
	35	160	38.9	7	4	0	0	11
	36	165	43.7	0	0	0	0	0
	37	165	45.2	3	1	3	0	7
	38	160	43.4	2	3	1	0	6
	39	162	44.2	1	3	0	1	5

	40	165	41	1	1	4	0	6
	41	155	37.4	2	2	0	0	4
	42	169	48.9	0	2	0	0	2
	43	253	157.6	2	1	1	0	4
	44	168	45.7	0	0	1	0	1
	45	159	41.9	3	0	1	0	4
	46	149	33	0	23	7	0	30
	47	175	53.2	4	34	2	0	40
	48	151	40.1	0	18	0	0	18
	49	156	37.2	0	47	2	0	49
	50	159	38.2	0	28	0	0	28
	51	195	74.2	0	36	9	0	45
	52	171	48.5	0	16	1	0	17
	53	241	138.6	0	0	2	0	2
	54	152	36.2	0	17	0	0	17
	55	249	32.1	0	0	0	0	0
	56	174	50.3	0	6	1	0	7
	57	174	57.7	0	12	2	0	14
	58	134	27.2	0	9	0	0	9
	59	158	34.2	3	5	0	0	8
	60	131	21.3	0	1	0	0	1
	61	140	26.6	0	1	0	0	1
	62	169	47.8	6	5	0	1	12
	63	155	38.1	12	15	0	0	27
	64	169	48	1	1	4	0	6
	65	156	37.6	29	7	0	0	36
	66	181	53.4	20	3	0	0	23
	67	189	52.1	7	1	0	0	8
	68	151	35.9	7	4	0	0	11
	69	188	66.9	16	9	1	0	26
08/06/22	1	297	244.1	2	0	1	0	3
	2	354	387.2	0	0	5	0	5
	3	180	61.0	11	1	0	0	12
	4	131	23.1	11	18	0	0	29
	5	191	66.8	12	14	0	0	26
	6	135	24.4	8	18	0	0	26
	7	270	172.2	3	5	0	0	8
	8	112	16.0	0	0	0	0	0
	9	165	43.0	38	16	1	0	55
	10	170	50	4	0	0	0	4
	11	138	27.9	1	2	0	0	3
	12	169	48.1	5	1	0	0	6
	13	156	43.1	0	1	0	0	1
	14	198	75.8	34	36	1	0	71
	15	157	38	1	2	0	0	3

	16	142	29.4	7	24	0	0	31
	17	167	52.1	14	63	0	0	77
	18	161	51.7	5	14	0	0	19
	19	151	36.5	1	0	0	0	1
	20	192	73.2	11	0	21	0	32
	21	151	34.3	5	0	2	0	7
	22	174	49.3	31	0	16	0	47
	23	162	42.7	17	0	0	0	17
	24	129	22.1	11	1	0	0	12
	25	121	18.7	0	0	2	0	2
	26	162	44.1	24	0	1	0	25
	27	194	74.2	41	3	1	0	45
	28	132	24.4	3	0	0	0	3
	29	178	60.7	0	0	0	0	0
	30	162	42.7	19	0	28	0	47
	31	139	28.8	8	0	13	0	21
	32	159	38.9	0	7	14	0	21
	33	154	39.6	0	5	3	0	8
	34	133	22.8	16	22	27	0	65
	35	164	48.8	0	0	2	0	2
	36	141	27	1	0	0	0	1
	37	135	27.4	0	43	11	0	54
	38	141	31.9	0	3	6	0	9
13/07/22	1	149	36.9	23	4	3	0	30
	2	131	26.1	38	5	3	0	46
22/08/22	1	213	92.6	0	12	0	0	12
	2	172	57.2	8	10	1	0	19
	3	138	30	1	0	0	0	1
	4	212	99.7	1	7	0	0	8
	5	164	47.2	0	1	0	0	1
	6	162	46.1	0	1	0	0	1
	7	280	210	0	0	0	0	0
	8	266	184.8	3	29	0	0	32
	9	273	186	2	17	0	0	19
	10	132	25.4	0	3	1	0	4
	11	149	35.1	0	1	0	0	1
	12	151	34.9	0	0	1	0	1
	13	120	18.3	2	0	0	0	2
	14	247	149.6	0	25	1	0	26
	15	134	26	2	0	0	0	2
	16	170	54.9	0	2	0	0	2
	17	182	70	6	20	0	0	26
	18	127	23.5	0	1	0	0	1
	19	126	21.4	0	5	0	0	5
	20	136	27.9	1	0	0	0	1

	24/08/22	1	135	24.4	0	0	0	0	0
		2	127	22.0	0	3	0	0	3
		3	150	39.5	0	0	0	0	0
		4	187	73	0	1	2	0	3
		5	146	35.2	0	0	0	0	0
Bunree	30/05/22	1	256	187.4	4	4	2	0	10
		2	163	49.7	0	0	0	0	0
		3	151	39.3	6	0	0	0	6
		4	165	42.8	51	0	0	0	51
		5	138	29.3	0	0	0	0	0
		6	152	35.7	66	38	0	0	104
		7	163	46	0	0	0	0	0
		8	131	26.4	0	0	0	0	0
		9	134	23.1	6	2	0	0	8
		10	145	30.3	0	1	1	0	2
		11	159	50.9	0	0	0	0	0
		12	182	59.6	26	21	1	0	48
		13	192	73.2	12	2	0	0	14
		14	148	38.2	8	0	0	0	8
		15	141	30.8	0	0	0	0	0
		16	286	230.8	1	1	2	0	4
		17	147	33.2	0	0	0	0	0
		18	299	262.5	14	0	1	0	15
		19	256	163.2	9	0	1	0	10
		20	135	24.4	1	11	3	0	15
		21	151	40	2	0	0	0	2
		22	160	47.8	0	0	0	0	0
		23	129	22.7	2	0	0	0	2
		24	133	22	0	0	0	0	0
		25	135	24.7	0	0	0	0	0
		26	142	35.5	29	4	0	0	33
		27	125	18.6	2	1	0	0	3
		28	149	36.4	12	0	0	0	12
		29	140	32.8	0	0	0	0	0
		30	129	22.2	0	0	0	0	0
		31	120	18	2	0	0	0	2
	05/07/22	1	162	46.2	11	0	1	0	12
		2	109	13	0	0	0	0	0
		3	191	85.7	26	5	13	0	44
		4	115	20	0	0	0	0	0
		5	131	27.5	1	0	0	0	1
	15/08/22	1	215	105.4	0	0	0	0	0
		2	216	88.3	8	42	3	0	53
		3	196	82.6	5	4	1	0	10
		4	143	38	0	0	0	0	0

		5	157	49.2	0	0	0	0	0
		6	183	64.9	0	3	0	0	3
		7	231	127.3	3	16	2	0	21
		8	293	251.4	0	1	0	0	1
	16/08/22	1	185	70	0	0	0	0	0
		2	179	68.7	9	0	0	0	9
		3	209	97.9	1	0	0	0	1
		4	162	51.1	0	0	0	0	0
		5	201	103.4	0	0	0	0	0
		6	146	33.9	0	3	0	0	3
		7	193	78.3	1	15	3	0	19
		8	304	263.5	0	3	4	0	7
	06/09/22	1	149	40.3	0	0	0	0	0
		2	201	87.2	0	4	1	0	5
		3	161	44	0	24	0	0	24
	21/09/22	1	163	52	2	0	0	0	2
		2	145	34.1	5	0	0	0	5
Leven	09/06/22	1	256	165.8	0	0	0	0	0
		2	109	14.8	1	0	0	0	1
		3	158	46.5	10	0	15	0	25
		4	165	50.6	0	2	3	0	5
		5	130	25.6	31	17	22	0	70
		6	101	11.6	3	0	0	0	3
		7	112	15.8	8	0	0	0	8
		8	110	14.9	0	0	0	0	0
		9	250	166.2	7	3	0	0	10
		10	135	28.3	4	4	0	0	8
		11	161	46.1	2	2	1	0	5
		12	161	46.1	2	2	1	0	5
	13/06/22	1	122	21.7	0	0	0	0	0
	11/07/22	1	126	26.1	0	0	0	0	0
		2	153	47.8	0	0	0	0	0
		3	152	38	0	1	0	0	1
		4	168	51.2	0	1	2	0	3