Loch Alsh, Loch Duich and Loch Hourn Management Area EMP Report

2024 Wild Fish and Sea Lice Monitoring Programme

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EXECUTIVE SUMMARY

- As part of the Mowi Loch Alsh, Loch Duich and Loch Hourn Environmental Management Plan (EMP), sea trout and sea lice monitoring programmes were conducted in Loch Hourn in the summer and electrofishing surveys were carried out in the Rivers Arnisdale and Shiel by the Skye and Lochalsh Rivers Trust.
- A new coastal fyke net was trialled in Loch Hourn as part of the sea trout monitoring programme and proved to be an effective method of surveying the population, with over 40 sea trout caught in 72 hours in June 2024.
- Sea lice were present on 97% of fish caught in June and elevated lice burdens were observed on multiple individuals.
- There was an estimated Moderate risk of increased lice-related marine mortality to the local sea trout at the time of the June survey based on the observed sea lice burdens on sampled sea trout.
- Only one sea trout was caught when the net was deployed a second time at the end of August and it had a lice burden of one sea louse.
- Electrofishing in the River Arnisdale demonstrated that observed juvenile salmon levels were below the national benchmark predicted density.
- Electrofishing surveys on the River Shiel were added to the EMP this year. The highest number of salmon fry recorded in the SLRT area during the 2024 field season was reported at one of the sites in the main stem of the Shiel (N=184). However salmonid densities were below the national benchmark at the other two surveyed sites.
- Salmonid densities in this area are at low enough levels that any additional negative impacts from environmental and anthropogenic influences in freshwater and marine habitats, like elevated sea lice burdens, could result in severe and harmful effects on local fish populations. Every effort should be made to limit the risks facing salmon and trout in the SLRT area.

1.0 INTRODUCTION

This document summarises the overall findings of native salmonid population monitoring conducted in Loch Hourn and the Rivers Arnisdale and Shiel as part of an Environmental Management Plan (EMP) for the Mowi Scotland Loch Alsh, Loch Duich and Loch Hourn management area (Figures 1.1 & 1.2). National Grid References (NGR) for each location relevant to this document can be found in the table below (Table 1.1).

Location	National Grid Reference (NGR)
Lochalsh (Sron) farm	NG 78324 25594
Ardintoul farm	NG 82177 24131
Loch Duich farm	NG 89313 23192
Loch Hourn (Creag an T'Sagairt) farm	NG 80101 09810
River Arnisdale	NG 84985 09346
River Shiel	NG 92844 19299

Table 1.1. List of NGR for relevant sites in the general Loch Alsh, Loch Duich, and Loch Hourn area and the freshwater catchments and associated sea lochs monitored as part of this EMP.

The EMP work programme was agreed between Mowi and the Skye and Lochalsh Rivers Trust (SLRT) in 2024 and SLRT conducted the work reported here. The salmonid species monitored for this EMP are *Salmo salar* (Atlantic salmon) and *Salmo trutta* (brown trout).

The purpose of this work programme was to gather information on current juvenile salmonid densities in the Rivers Arnisdale and Shiel using electrofishing methods and monitor local anadromous brown trout populations (hereafter referred to as sea trout) in the marine environment of Loch Hourn.

During the marine monitoring work, special focus was given to the sea lice burdens of captured sea trout, specifically *Lepeophtheirus salmonis* and *Caligus elongatus*. There is a large body of scientific research that demonstrates that the presence of open net-pen salmonid aquaculture can result in increased densities of sea lice in the surrounding water column (Thorstad et al., 2015; Shephard et al., 2016). Wild salmonids migrating through and feeding in areas where salmonid aquaculture is present are exposed to the increased parasite levels, which can lead to elevated lice burdens (Taranger et al., 2015). High parasite loads on a wild salmonid can result in physiological damage, a decline in fish health and condition, and ultimately lead to increased levels of mortality amongst wild fish populations (Ives *et al*., 2023).

This monitoring work aims to identify impacts (short- and long-term) affecting wild salmonids that could be related to salmon farming activity in the Loch Alsh, Duich, and Hourn management area and to provide data to inform responsive adaptive management procedures delivered by local Mowi teams.

Figure 1.1. Site map with the Mowi Scotland Loch Hourn site, SLRT sea trout monitoring site and Arnisdale electrofishing sites identified.

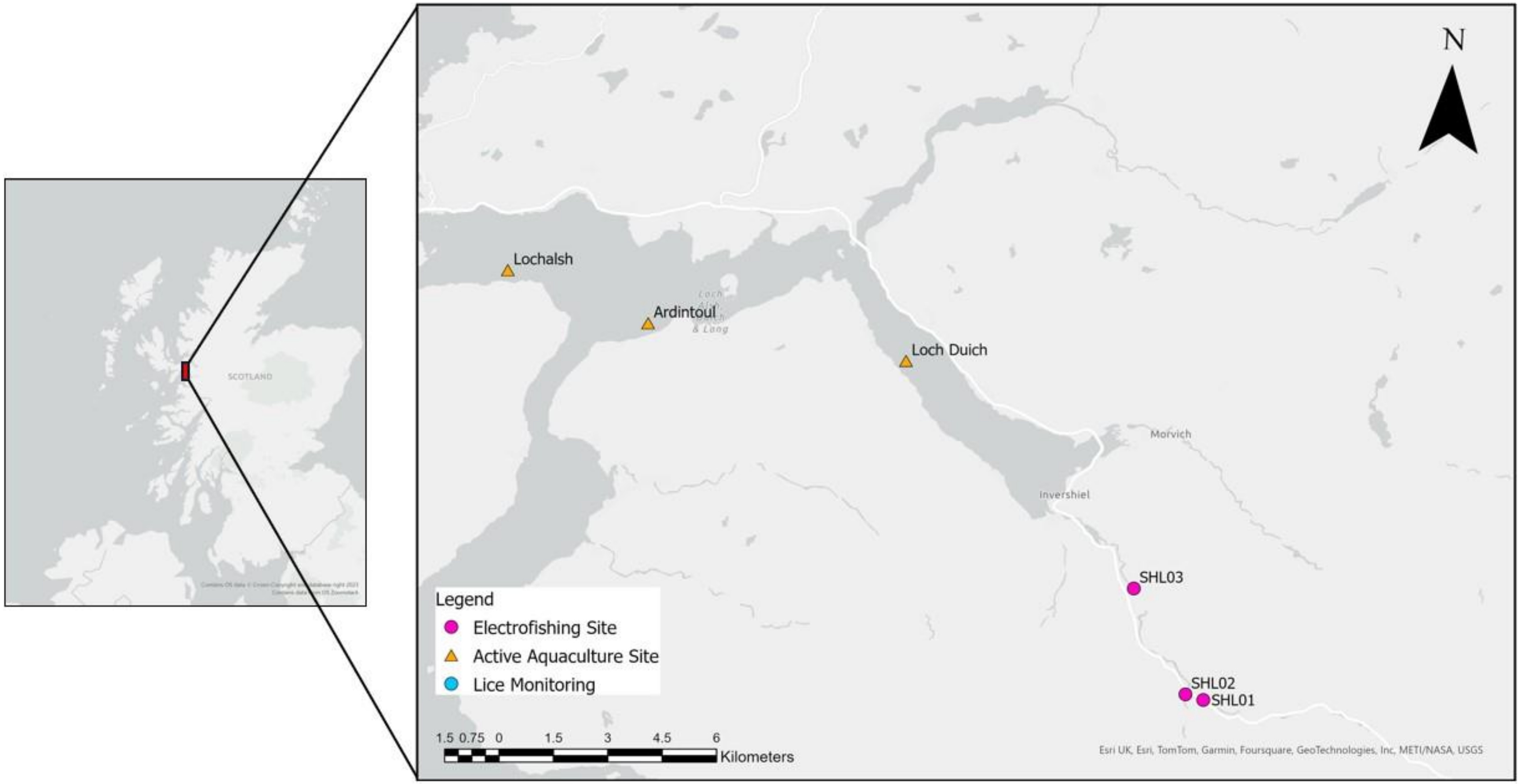

Figure 1.2. Site map with the Mowi Scotland farms identified in Loch Duich and Loch Alsh, as well as the River Shiel electrofishing sites.

The agreed 2024 EMP programme included two sea trout monitoring surveys, aiming to capture as many anadromous salmonids as possible per survey and a day of electrofishing at historical sites in each river (Figure 1.1).

2.0 METHODS

2.1 Sea trout and sea lice monitoring

In the agreed EMP work plan, one sea trout monitoring session was scheduled to occur in the spring survey period (1st April-15th June) and a second session in the summer survey period (16th June-30th September). Due to inclement weather and scheduling conflicts, both monitoring sessions occurred in the summer survey period, but several months apart (Table 2.1). For the purposes of this report, the data of each session will be reported separately. The first survey will be referred to as the June sampling session (18th- 20th June) and the second survey will be referred to as the September sampling session (30th August- 2nd September).

Survey site	Survey method	Date	Location (NGR)
ARNT04	Electrofishing	31 August	NG 87056 09504
ARNT06	Electrofishing	31 August	NG 85643 09766
ARNT08	Electrofishing	01 September	NG 86266 09706
SHL01	Electrofishing	08 September	NG 97503 13707
SHL02	Electrofishing	08 September	NG 97015 13860
SHL03	Electrofishing	08 September	NG 95585 16781
Loch Hourn	Coastal fyke netting	18-20 June 30 Aug-02 Sept	NG 8417 309435

Table 2.1. Monitoring site locations, sampling methodologies and 2024 survey dates.

A coastal fyke net was deployed by boat with the assistance of the Mowi Creag an T'Sagairt (Loch Hourn) site staff. The fyke net was attached at a perpendicular angle to the shoreline at three points via a leader net and two wing nets. Fish migrating around the coast would be intercepted by the leader net and subsequently funnelled into a series of non-return chambers where they were held until the net was emptied. The main body of the net was tensioned at four points around the outside of the heart of the net and by a fifth anchor point at the tail of the net. The net was checked and emptied every day.

Sea trout caught in the coastal fyke net were processed on the Mowi pontoon, approximately 500m from the location of the net.

2.1.1 Fish processing

All captured salmonids were processed according to Scottish Fisheries Coordination Centre (SFCC) protocol. Each fish was anaesthetised using MS-222, measured to fork-length (mm) and weighed (g). A subset of sampled fish had a scale sample and a fin clip taken for future research. Additionally, any *L. salmonis* found on the fish were counted and categorised by life stage:

- Juvenile- attached copepodid and chalimus life stages
- Mobile- preadult and adult life stages
- Ovigerous females- gravid female life stage

If *Caligus elongatus* were found on the fish, they were counted separately but not categorised by life stage. Once a fish had been processed, it was allowed to recover in a holding tank before being released back into the water.

Other captured fish species (by-catch) were identified and counted without the use of anaesthetic and immediately released back into the water.

2.1.2 Sea lice data analysis

Data from the physical characteristics (length and mass) of the sampled salmonids and their sea lice burdens were used to calculate the following:

- Condition factor (K) – coefficient of the condition of the fish (Ricker, 1975)
- Abundance of lice- the mean number of sea lice per fish in a sampled population
- Prevalence of lice- number/percentage of all fish sampled with a sea lice burden
- Intensity of infection- the mean number of lice per infected fish in a sampled population

Analysis was also carried out using the Norwegian risk assessment framework created by Taranger *et al*. (2015) to categorise the increased lice-related risk of mortality to individual sea trout according to the number of lice present in relation to the mass of the fish (no. lice/g^{-1}). The framework assumes that small sea trout post-smolts (<150 g) will suffer 100% lice-related marine mortality, or premature return to freshwater, if they are infected with >0.3 lice/g^{-1} fish mass. If the lice infection of a sea trout is between 0.2 and 0.3 lice/g^{-1} fish mass, the additional lice-related marine mortality is estimated to be 50%, if the infection rate is between 0.1 and 0.2 lice/g fish mass, the additional mortality is estimated to be 20%, and if the salmon lice infection rate is <0.1 lice/g^{-1} fish mass, it is estimated that there will be little to no lice-related mortality. Each sea trout within a sampled population will fall into one of these four categories (or “infection classes”) based on their lice burden. The percentage of the sampled population that falls into each “infection class” is then reported.

Additionally, overall increased lice-related risk of marine mortality to a sampled population, or premature return to freshwater, is calculated as the sum of the expected lice-related mortalities for each of the “infection classes”. The overall risk of additional mortality to a sampled population is then scored according to the system proposed by Taranger *et al*.

(2015) as Low Risk (up to 10% estimated increase in overall mortality), Moderate Risk (between 10 and 30% increase in overall mortality), and High Risk (if the overall mortality increase is calculated as 30% or more).

Similarly to Taranger *et al.* (2015), sea trout from these EMP surveys were grouped into two subsets, those with a mass of less than 150g and those with a mass of more than 150g. The risk index included in the EMP report is designed for fish weighing less than 150g. The same methodology has been used to assess risk for fish with a mass of more than 150g, but this will result in a more conservative estimate of lice-related mortalities for these larger fish.

2.2 Electrofishing

A mixture of fully and semi-quantitative electrofishing surveys were conducted at three sites in the River Arnisdale (31st August & 1st September) and three sites in the River Shiel (8th September) using SFCC electrofishing protocols (Figure 1.1 & Table 2.1). This protocol was primarily designed to survey 0+ and >0+ age classes of salmon and trout. Fully quantitative electrofishing requires at least 3 passes or “rounds” of electrofishing at the same site in order to report the most accurate estimate of fish density. The majority of sites were selected to replicate previous surveys and monitor for temporal changes in juvenile salmonid densities.

The electrofishing equipment used was an E-Fish Solutions backpack unit that provided a smooth direct current output of variable voltage which was modified on a site-by-site basis to reflect the water conductivity at each location. Voltage was regulated upwards to maximise catches at sites with low conductivity and downward to minimise negative effects on fish in areas of high conductivity.

All salmonids collected during the survey period were processed following SFCC protocols, anaesthetised using MS-222, identified for species, counted, and measured to fork-length (mm). The fish were allowed to recover from the anaesthetic in a holding tank before being returned to the river unharmed.

2.2.1 Electrofishing data analysis

To account for differing sampling effort between rivers and between years, catch data were corrected to a catch per unit effort (CPUE) metric expressed as the number of fish collected per minute electrofishing.

The salmon data collected during the 2024 survey were also entered into an electrofishing data analysis app maintained by the Marine Directorate as part of the National Electrofishing Programme for Scotland (NEPS). The app uses the submitted data to obtain estimates of the total density of salmon fry and parr at a particular site (Marine Directorate, 2024). Additionally, the density estimates can be compared to a benchmark, or expected density, for the site. This app will be referred to hereafter as the NEPS app.

3.0 RESULTS

The raw data collected from this monitoring programme are reported in Appendix A. The sea lice counts from individual fish farms that are referenced in this report can be found at https://aquaculture.scotland.gov.uk/.

3.1 Sea trout and sea lice monitoring

3.1.1 Sampled population characteristics

A total of 47 sea trout were caught over the two sampling periods in Loch Hourn, 46 during the 18th -20th June session and one during the 30th August- 2nd September session (Appendix A).

On the second day of the June netting session, wind speeds increased unexpectedly while SLRT staff were recording physical data and lice counts, making it impossible to finish processing the fish safely. The fish that had not been processed (N=9) were released back into the water to avoid harm to staff or animals. Because there are no data associated with these nine individuals, they have been removed from the dataset, leaving 37 sea trout to be included in the analysis. The following table (Table 3.1) summarises the general characteristics (mean ± Standard Deviation (SD)) of the sea trout caught in Loch Hourn in 2024.

Loch Hourn Sea Trout Physical Characteristics Summary Table						
	June Sampling Period			**September Sampling Period**		
	<150 g	**>150 g**	**All Fish**	**<150 g**	**>150 g**	**All Fish**
N	36	1	37	1	0	1
Fork length (mm)	198.4 ± 17.0	272.0	200.4 ± 20.6	173.0	0.0	173.0
Mass (g)	92.9 ± 22.1	183.0	95.3 ± 26.3	54.0	0.0	54.0
Condition factor (k)	1.2 ± 0.1	0.9	1.2 ± 0.1	1.0	0	1.0

Table 3.1. A summary table of the number of sea trout (N) caught in the June and September survey periods in Loch Hourn. Fish have been divided into three groups (<150g, >150g, All Fish) and the mean physical characteristics (mean ± SD) of each group caught during both surveys are reported here.

3.1.2 Sea lice burdens of sea trout

The *L. salmonis* burdens of sea trout sampled in 2024 in Loch Hourn were summarised as the mean numbers (mean ± SD) of “Juvenile”, “Mobile”, and “Ovigerous Female” life stages (as described in the Methods section of this report) found on wild fish during each survey. The mean number (mean ± SD) of *Caligus elongatus* found during each survey is reported separately. Additionally, the abundance, prevalence, and the intensity of *L. salmonis* burdens were calculated. The results are reported below and have been divided between June and September sampling periods and by fish mass (Table 3.2).

Sea Lice Burden Summary Table						
	June			**September**		
	<150 g	**>150 g**	**All Fish**	**<150 g**	**>150 g**	**All Fish**
N	36	1	37	1	0	1
Caligus	0.9 ± 1.3	1.0	0.9 ± 1.3	0.0	0.0	0.0
Juvenile stage	5.5 ± 4.5	10.0	5.7 ± 4.5	0.0	0.0	0.0
Mobile stage	5.7 ± 3.5	10.0	5.8 ± 3.5	0.0	0.0	0.0
Ovigerous female stage	1.3 ± 1.4	3.0	1.3 ± 1.4	1.0	0.0	1.0
***L. salmonis* Abundance**	12.5 ± 6.9	23.0	12.8 ± 7.0	1.0	0.0	1.0
***L. salmonis* Prevalence %**	97%	100%	97%	100%	0%	100%
No. of infected fish	35	1	36	1	0	1
***L. salmonis* Intensity**	12.9 ± 6.7	23.0	13.2 ± 6.8	1.0	0	1.0

Table 3.2. The number of sea trout (N) caught during each session in Loch Hourn and the summarised results of their sea lice burdens (mean ± SD), divided by fish mass (<150g, >150g, and All Fish). No sea trout weighing more than 150g was caught during the September sampling session.

3.1.2.1 Abundance

The overall abundance of sea lice (the mean number of *L. salmonis*/fish in a sampled population) on wild sea trout in the June survey was 12.8 ± 7.0 lice/fish (Table 3.2) with individual lice levels ranging from 0 to 29 lice/fish. The abundance of sea lice on sea trout caught in June and weighing less than 150g was lower (12.5 ± 6.9 lice/fish) than the sea lice abundance reported on the single sea trout weighting more than 150g captured during the same session (23.0 lice).

One sea trout was caught during the September sampling session and this fish had one attached sea louse (Table 3.2).

3.1.2.2 Prevalence

The overall prevalence of sea lice (the overall percentage of the sampled sea trout infected by *L. salmonis*) in the June survey was 97% (N=36) (Table 3.2). Only one sea trout weighing less than 150g was found without attached lice.

The single sea trout caught during the September sampling period did have a louse attached, resulting in a 100% prevalence of sea lice during the second sampling session in 2024 (Table 3.2).

3.1.2.3 Intensity

The overall intensity of sea lice burdens (the mean number of *L. salmonis* per infected sea trout in a sampled population) in the June survey was 13.2 ± 6.8 lice/fish (Table 3.2). When examining differences between weight classes, the lice intensity found amongst fish weighing less than 150g was slightly lower (12.9 ± 6.7 lice/fish, N=36) than the overall intensity.

The overall intensity of lice burdens in the September survey was 1 louse/fish (N=1).

3.1.3 Risk Analysis

3.1.3.1 June sampling period

The *L. salmonis* burdens per gram of fish mass for sea trout under 150g (N=36) and sea trout over 150g (N=1) that were caught during the June sampling session in Loch Hourn are categorised below (Table 3.3) using the salmon lice risk index developed by Taranger *et al.* (2015). This is recorded as a proportion (%) of fish which fell into each risk category, or "infection class", during the June survey. Also included in Table 3.3 is a mortality score (%) that reports the overall risk of increased lice-related mortality to each weight class of the sampled sea trout population.

		Salmon lice risk index infection classes				
Fish Mass	**N**	**<0.1 lice/g^{-1}**	**0.1-0.2 lice/g^{-1}**	**0.2-0.3 lice/g^{-1}**	**>0.3 lice/g^{-1}**	**% Mortality**
<150g	36	39%	41%	17%	3%	19.4%
>150g	1	0%	100%	0%	0%	20%

Table 3.3. Salmon lice risk index results for two weight classes (<150g and >150g) of sea trout (N) caught during the June sampling session in Loch Hourn. The proportions (%) of the sampled sea trout populations that fall into each "infection class" of the lice risk index based on L. salmonis burdens of each fish are reported here. The % Mortality column reports the overall risk of mortality to the sea trout population based on the "infection class" results (Low Risk - <10% mortality, Moderate Risk – 10%-30% mortality, High Risk – >30% mortality) (Taranger et al., 2015).

Of the 36 sampled sea trout weighing less than 150g, 39% reported a lice burden of <0.1 lice/g^{-1} meaning they were expected to experience little to no sea lice-related marine mortality at the time of the survey (Table 3.3 & Figure 3.1). Approximately 58% of <150g sea trout (N=21) reported a lice burden of 0.1-0.3 lice/g^{-1} and were expected to experience between 20%-50% increased lice-related marine mortality. A further 3% of the sampled population (N=1) reported a lice level of >0.3 lice/g^{-1} and was expected to face 100% lice-related marine mortality.

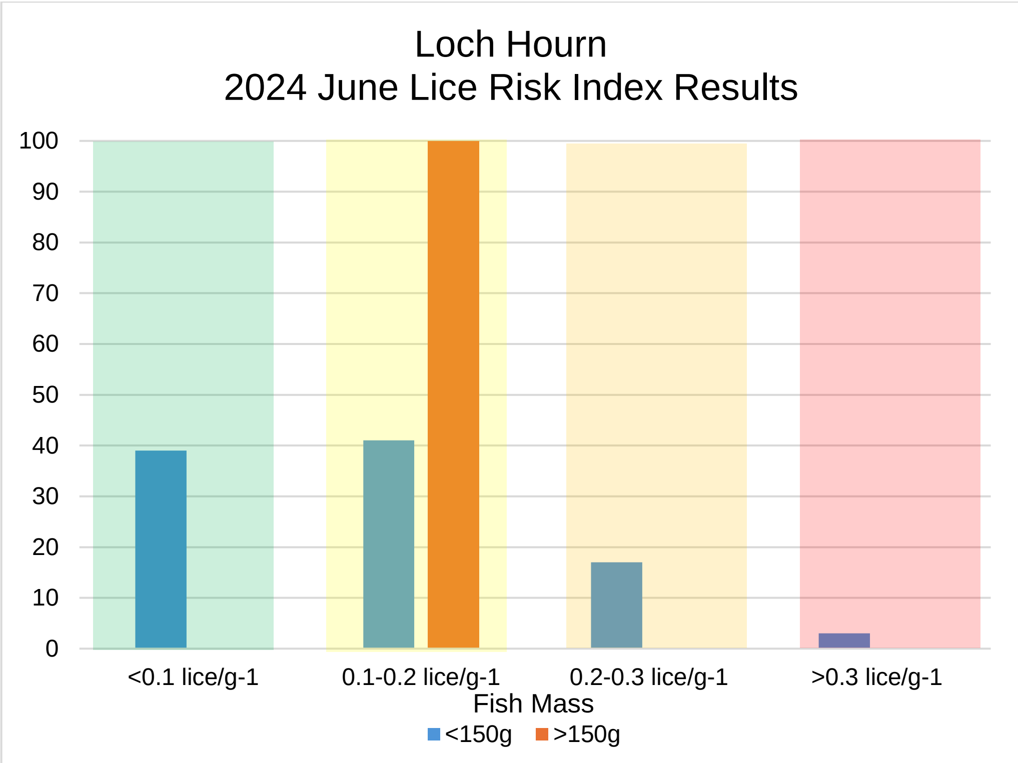

Figure 3.1. The proportions (%) of sea trout sampled in the June survey in Loch Hourn that fall into each "infection class" of the salmon lice risk index (Table 3.3). The sampled individuals have also been split by mass (<150g (blue) and >150g (orange)) within each infection class. The proportions of fish in the green shaded infection class were expected to experience little to no lice-related mortality, while the additional shaded infection classes represent 20% (yellow), 50% (orange), and 100% (red) increased lice-related mortality.

The one sea trout caught in June that weighed more than 150g had a lice burden of 0.1-0.2 lice/g^{-1} and was expected to experience 20% increased lice-related marine mortality.

There was a Moderate Risk (19.4-20%) that sea trout in both weight classes would experience increased lice-related mortality at the time of the survey (Table 3.3).

3.1.3.2 September sampling period

No sea trout weighing more than 150g were caught during the September survey in Loch Hourn. The *L. salmonis* burdens per gram of fish mass for sea trout are categorised below (Table 3.4) using the salmon lice risk index developed by Taranger *et al.* (2015). This is recorded as a proportion (%) of fish which fell into each risk category, or "infection class", during the September sampling session. Also included in Table 3.4 is a mortality score (%) that reports the overall risk of increased lice-related mortality to the sampled sea trout population.

Sea lice risk index infection classes						
Fish Mass	N	<0.1 lice/g^{-1}	0.1-0.2 lice/g^{-1}	0.2-0.3 lice/g^{-1}	>0.3 lice/g^{-1}	% Mortality
<150g	1	100%	0%	0%	0%	0%
>150g	0	0%	0%	0%	0%	0%

Table 3.4. Salmon lice risk index results for two weight classes (<150g and >150g) of sea trout (N) caught during the September survey in Loch Hourn. No sea trout weighing more than 150g was caught during this period. The proportions (%) of the sampled sea trout populations that fall into each "infection class" of the lice risk index based on L. salmonis burdens of each fish are reported here. The % Mortality column reports the overall risk of mortality to the sea trout population based on the "infection class" results (Low Risk - <10% mortality, Moderate Risk – 10%-30% mortality, High Risk – >30% mortality) (Taranger et al., 2015).

The sea trout caught during the September sampling session reported a lice burden of <0.1 lice/g^{-1} and was expected to experience little to no lice-related marine mortality (Table 3.4 & Figure 3.2).

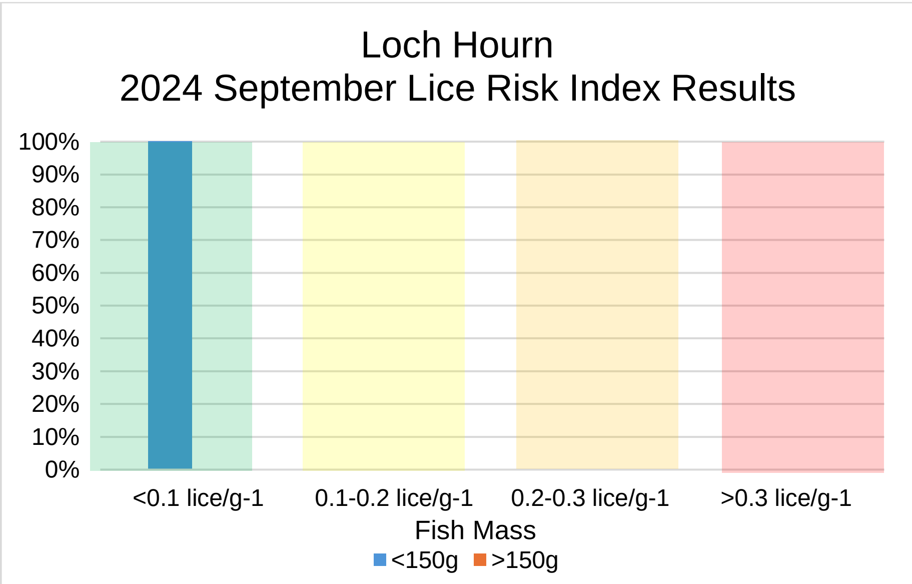

Figure 3.2. The proportions (%) of sea trout sampled in the September survey in Loch Hourn that fall into each "infection class" of the salmon lice risk index (Table 3.4). The sampled individuals have also been split by mass (<150g (blue) and >150g (orange)) within each infection class. The proportions of fish in the green shaded infection class were expected to experience little to no lice-related mortality, while the additional shaded infection classes represent 20% (yellow), 50% (orange), and 100% (red) increased lice-related mortality.

3.1.4 Historic sea lice risk analysis

In 2021 and 222, the sea trout caught in Loch Hourn reported no lice which was thought to be reflective of their limited time in the marine environment prior to sampling. Comparison of this year's data with previous surveys does not provide evidence of temporal changes in sea lice levels in Loch Hourn but it is hoped that with further monitoring, a clearer picture can be formed.

3.1.5 Other fish and by-catch

Large numbers of pollock, along with small numbers of Atlantic herring and mackerel were caught in the net during the September sampling session. Several large shoals of whitebait (a collective term for juvenile marine fish often seen feeding in large groups in coastal areas) were also observed from the boat during the netting session but these fish were small enough to swim through the mesh of the coastal net and were not caught.

3.2 Electrofishing

3.2.1 River Arnisdale

Three semi-quantitative electrofishing surveys were conducted at Sites ARNT04, ARNT06, and ARNT08 (Figure 1.1 & Table 2.1). Each site was electrofished for a minimum of 20 minutes (Appendix A).

Juvenile salmon were caught at all three sites. Site ARNT06 reported the largest number of juvenile salmon with a total of 16 fry and two parr (Appendix A). Site ARNT04 reported the lowest number of juvenile salmon with one fry and three parr. Small numbers of juvenile trout were caught at Site ARNT04 (N=5) and ARNT08 (N=1), but no trout were caught at Site ARNT06.

European eels (*Anguilla anguilla*) were recorded at all sites visited in the River Arnisdale with a total of 24 individuals recorded across the three sites (Appendix A).

3.2.1.1 Catch per unit effort (CPUE)

The data were corrected for sampling effort using a catch per unit effort (CPUE) metric and compared to the data from the most recent electrofishing surveys conducted at the same sites to investigate potential temporal changes in fish density.

Changes in the CPUE values for juvenile Atlantic salmon were seen across all sites on the River Arnisdale. Site ARNT04 was the only site where an increase in salmon CPUE was observed, with the value increasing from 0.7 (2023) to 0.16 (2024) (Table 3.5 & Figure 3.3). The only site where an increase in trout CPUE was calculated was Site ARNT04 where the value increased from 0.07 (2023) to 0.20 (2024) (Table 3.5 & Figure 3.3). This was the highest trout CPUE reported at Site ARNT04 in the last three years.

Site	Year	Salmon CPUE	Trout CPUE
ARNT04	2022	0.16	0.05
	2023	0.07	0.07
	2024	0.16	0.20
ARNT06	2022	0.13	0.07
	2023	1.07	0.00
	2024	0.90	0.00
ARNT08	2022	0.51	0.01
	2023	1.24	0.03
	2024	0.68	0.04

Table 3.5. Catch per unit effort (fish per minute electrofishing) for Sites ARNT04, ARNT06, and ARNT08 located in the River Arnisdale (2022-2024).

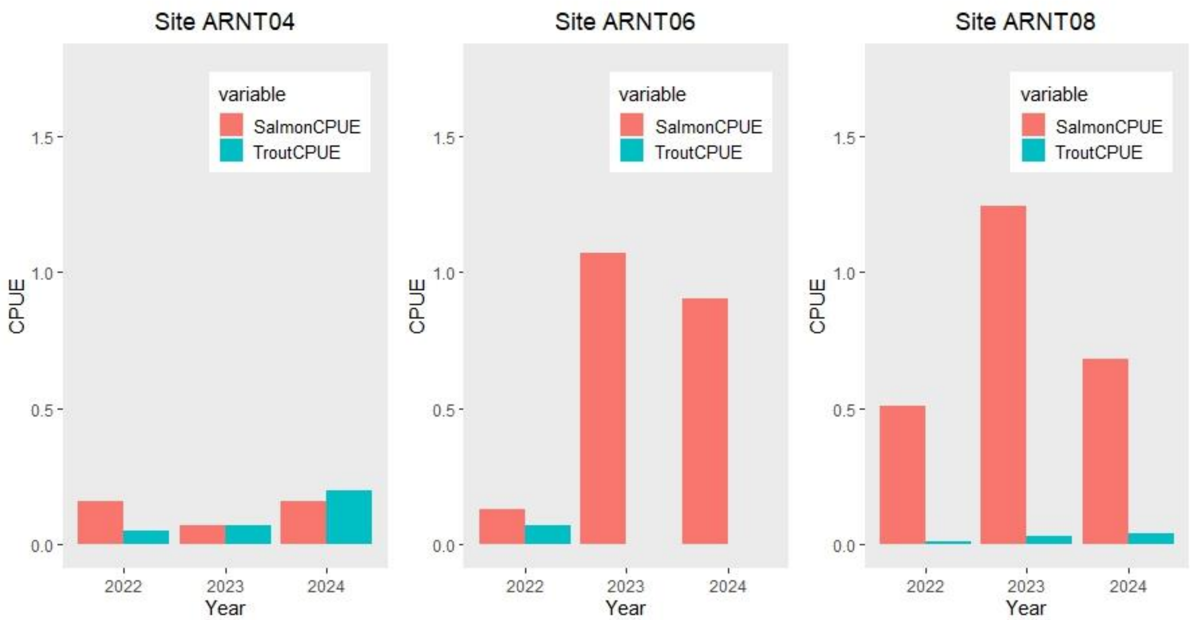

Figure 3.3. Annual catch per unit effort (fish per minute electrofishing) for Sites ARNT04, ARNT06, and ARNT08 in the River Arnisdale (2024) and the data from the most recent surveys prior to 2024 that occurred at the same sites.

3.2.1.2 Expected densities

The observed densities of salmon fry and parr were compared to benchmark densities (average expected densities) calculated by the NEPS app. The difference between observed and predicted densities can be found below (Table 3.6).

Site	Salmon Life stage	N	Area (m^2)	Observed Density (life stage/m^2)	Benchmark Fry Density (fry/m^2)	Benchmark Parr Density (parr/m^2)	Density Difference (life stage/m^2)
ARNT04	Fry	1	73.5	0.02	0.40	0.10	-0.37
	Parr	3	73.5	0.07	0.40	0.10	-0.03
ARNT06	Fry	16	111.4	0.25	0.40	0.08	-0.14
	Parr	2	111.4	0.03	0.40	0.08	-0.05
ARNT08	Fry	15	100	0.26	0.40	0.08	-0.13
	Parr	2	100	0.03	0.40	0.08	-0.05

Table 3.6. Number of juvenile salmon (N) recorded at each electrofishing site, and the observed and predicted densities of each life stage as calculated by the NEPS app (Marine Directorate, 2024). Where the observed density was higher than predicted, the increase is noted in green and where the observed density was lower than predicted, the decrease is noted in red.

Observed densities of both salmon fry and parr were found to be lower than predicted at all three surveyed sites on the River Arnisdale. The largest difference in fry density was found to be at Site ARNT04, where the predicted density and observed density had a difference of -0.37 fry/m^2. The largest difference in salmon parr density was at Sites ARNT06 and ARNT08 which both had a difference of -0.05 parr/m^2 between the observed and predicted densities.

3.2.2 River Shiel

A fully quantitative, three pass electrofishing survey was conducted at Site SHL03 and two semi-quantitative electrofishing surveys were conducted at Sites SHL01 and SHL02 (Table 2.1). The semi-quantitative sites were fished for a minimum of 28 minutes (Appendix A).

Juvenile salmon were caught at all three sites. Site SHL03 reported the largest number of juvenile salmon with 184 fry and six parr (Appendix A). Site SHL02 reported the lowest number of juvenile salmon, four parr but no fry. Small numbers of juvenile trout (less than 10 individuals) were caught at all three sites. Site SHL03 reported the largest number of juvenile trout with six trout fry.

No eels were recorded at survey locations in the River Shiel (Appendix A).

3.2.2.1 Catch per unit effort (CPUE)

The data were corrected for sampling effort using a catch per unit effort (CPUE) metric and compared to the data from the most recent electrofishing surveys conducted at the same sites to investigate potential temporal changes in fish densities.

Monitoring sites on the River Shiel were added to the Loch Alsh, Loch Duich and Loch Hourn EMP work programme for 2024. The highest salmon CPUE was reported at Site SHL03, and the highest CPUE for trout was reported at Site SHL02 (Table 3.7 & Figure 3.4).

Site	Year	Salmon CPUE	Trout CPUE
SHL01	2024	0.57	0.04
SHL02	2024	0.21	0.21
SHL03	2024	2.41	0.08

Table 3.7. Catch per unit effort (fish per minute electrofishing) for Sites SHL01, SHL02, and SHL03 located in the River Shiel (2024).

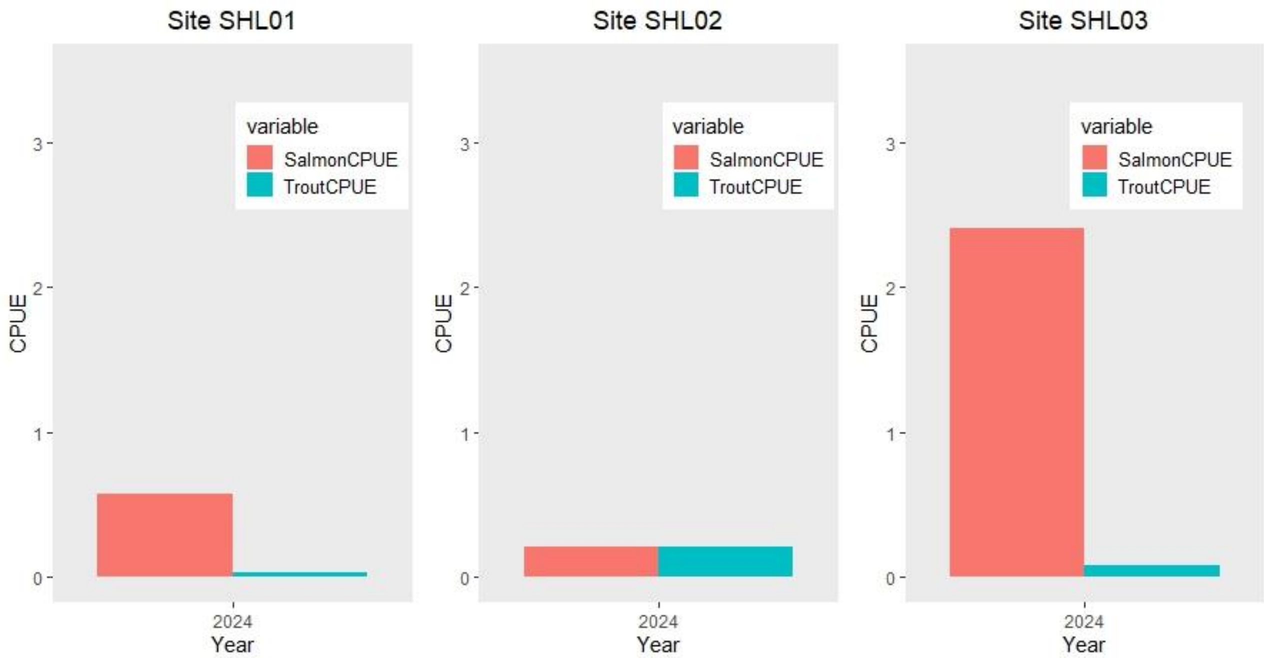

Figure 3.4. Catch per unit effort (fish per minute electrofishing) for Sites SHL01, SHL02 and SHL03 on the River Shiel (2024).

3.2.2.2 Expected densities

The observed densities of salmon fry and parr were compared to benchmark densities (average expected densities) calculated by the NEPS app. The difference between observed and predicted densities can be found below (Table 3.8).

Site	Salmon Life stage	N	Area (m^2)	Observed Density (life stage/m^2)	Benchmark Fry Density (fry/m^2)	Benchmark Parr Density (parr/m^2)	Density Difference (life stage/m^2)
SHL01	Fry	10	92.2	0.19	0.34	0.12	-0.15
	Parr	6	92.2	0.10	0.34	0.12	-0.02
SHL02	Fry	0	64.6	0.00	0.12	0.07	-0.12
	Parr	4	64.6	0.10	0.12	0.07	0.03
SHL03	Fry	170	144	1.25	0.02	0.01	1.23
	Parr	4	144	0.03	0.02	0.01	0.02

Table 3.8. Number of juvenile salmon (N) recorded at each electrofishing site and the observed and predicted densities of each life stage as calculated by the NEPS app (Marine Directorate, 2024). Where the observed density was higher than predicted, the increase is noted in green and where the observed density was lower than predicted, the decrease is noted in red.

The observed densities of salmon fry and parr were lower than the NEPS predicted densities at Site SHL01. However, both observed salmon densities exceed the predicted densities of Site SHL03, particularly the fry density which reported a difference of +1.23 fry/m^2.

Site SHL02 reported a lower than predicted fry density (difference of -0.12 fry/m^2) but a slightly higher than predicted parr density (+0.03 parr/m^2).

4.0 DISCUSSION

4.1 Sea trout and sea lice monitoring

Several different sampling methods have been used to monitor sea trout populations in Loch Hourn in previous years, but they yielded low numbers of fish and were considered unsuccessful. The coastal fyke net was used for the first time in Loch Hourn in 2024 and proved effective at catching sea trout. This location should be used in future monitoring efforts.

Sea lice burdens on sea trout captured during the June netting session varied, but approximately 60% of fish were expected to experience some level of increased lice-related marine mortality due to the number of parasites they hosted at the time of the survey. These elevated parasite burdens could be related to nearby fish farming activity.

The Mowi Creag an T'Sagairt salmon farm in Loch Hourn was stocked with fish at the start of May 2024 after a nine-week fallow period. The farm did report a steady increase in the number of female lice found on farmed salmon the month before the coastal net was deployed on the 18th June. The lice levels from the farm reported 0.14 adult female lice/fish during the week of 20th May and increased to 0.52 adult female lice/fish during the week of 10th June. Lice treatments were successfully carried out around this time and the following week (w/c 17th June), lice levels on the salmon farm had declined to 0.06 adult female lice/fish. However, wild sea trout in the area would have been exposed to increasing levels of lice in the water column for a month prior to the SLRT survey which could have increased their own lice burdens and resulted in the numbers of parasites observed during the June survey.

One sea trout was caught during the September survey. The lack of sea trout during this session could have been related to weather conditions. Heavy rains were present for most of August 2024 and preliminary reports from recreational angling across Skye and Lochalsh reported higher than usual numbers of returning adult salmonids through the month while rivers were in spate. It is possible that the local finnock and adult sea trout feeding in Loch Hourn could have taken advantage of high water levels in local rivers and re-entered freshwater systems in August. Sea trout entering the rivers in August could be related to parasite burdens (i.e. ‘de-lousing’ behaviour (Aldven & Davidsen, 2017)) or part of an individual’s migration to their natal spawning ground ahead of the spawning season later in the year. However, it is not possible to confirm this hypothesis due to a lack of available data regarding the movements of sea trout in Loch Hourn and local river catchments.

4.2 Electrofishing

From the results of the 2024 electrofishing surveys it is evident that that salmon populations are present in both the Rivers Shiel and Arnisdale but are, for the most part, operating at low levels, particularly in the latter. From the NEPS app results, observed salmon fry densities in the Arnisdale are below the expected densities predicted by the model at all surveyed sites. This could suggest that a low level of successful spawning occurred in 2023, caused by low numbers of returning adults or redd washout. Alternatively, the lack of juvenile salmonids in the electrofishing sites could be due to a displacement of fish in the main stem of the river during the high rainfall and spate events experienced in August prior to the electrofishing surveys.

In recent years of electrofishing in the Arnisdale, the number of salmon parr caught at each site has been low, usually with only two to three individuals per site. While this could be the result of site bias (surveying sites that are more appropriate for fry rather than older fish), it could also hint at a larger issue that survival rates for juvenile salmon decline after their first year in river due to a lack of suitable resources and habitat. Additional research could investigate different areas along the river to determine if higher densities of salmon parr can be found elsewhere to the historic electrofishing sites.

Consistent low numbers of juvenile trout have been observed at sites along the River Arnisdale since SLRT monitoring began in 2021. It is possible that the available habitat at the survey sites is more suited to salmon (faster flowing water, main stem of the river, etc.) and that juvenile trout are occupying the slower flowing tributaries and upper reaches of the catchment. Previous monitoring of the upper reaches of the river (not conducted by SLRT) found populations of residential brown trout above impassible falls, but there is limited information available regarding the proportions of residential and anadromous adult trout that contribute to the Arnisdale trout population. Future monitoring could investigate other parts of the river that contain more suitable trout habitat to determine the range of the species within the catchment.

The presence of European eels within the Arnisdale River demonstrates that the catchment is utilised by other migratory species that should be considered when examining the overall health of the river.

In the River Shiel, densities of juvenile salmon were lower than the NEPS app predicted at Site SHL01, but higher than predicted at Site SLH03. The presence of over 180 fry at Site SHL03 indicated that adult salmon are successfully spawning in this area. Suitable spawning substrate was evident in and around the site and supports this hypothesis. As 2024 was the first year that the Shiel has been surveyed for an EMP programme, further monitoring is needed to investigate possible temporal trends for both salmon and trout populations.

5.0 CONCLUDING COMMENTS

The addition of new sites and new sampling methods to the 2024 Loch Alsh, Duich and Hourn EMP programme resulted in good catch numbers of both sea trout in Loch Hourn and juvenile salmonids in a possible spawning area in the River Shiel. These data facilitate the further understanding of the existing salmonid populations in the SLRT area.

Although the number of fish caught at both the aforementioned sites were some of the largest total catches reported from SLRT monitoring work in 2024, it is likely that the present densities of salmonids are substantially lower than the historical catches of fish that were previously found in the area.

Wild salmonids in Skye and Lochalsh, and across Scotland, are facing increasing pressures in both marine and freshwater habitats. Every effort should be made to reduce the environmental and anthropogenic risks that negatively impact the survival of both Atlantic salmon and brown trout.

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