MOWI Scotland Ltd

Wild Salmonid Sea Lice Monitoring – Special Areas of Conservation (SACs): Lochaber and Isle of Mull – 2023 Survey Report

Alexandria McAlpine and Matthew Heeps

Client: **MOWI Scotland Ltd**

Address: **Stob Ban House**

Glen Nevis Business Park

Fort William

PH33 6RX

Project reference: **P00011168**

Date of issue: **November 2023**

Project Director: **Nicola Teague**

Project Manager: **Matthew Heeps**

APEM Ltd
Riverview
A17 Embankment Business Park
Heaton Mersey
Stockport
SK4 3GN

Tel: 0161 442 8938
Fax: 0161 432 6083

Registered in England No. 02530851

Report should be cited as:

"APEM (2023). Wild Salmonid Sea Lice Monitoring – Special Areas of Conservation (SACs): Lochaber and Isle of Mull - 2023. Survey Report P00011168. Client: MOWI Scotland Ltd, November 2023, v1.0, 26 pp."

Revision and Amendment Register

Version Number	Date	Section(s)	Page(s)	Summary of Changes	Approved by
1.1	27/11/23	ALL	ALL	First draft to client	LV

Contents

1. Introduction 1

1.1 Background 1

1.2 Site Overview 4

1.3 Report Aims 4

2. Methods 5

2.1 Monitoring Locations 5

2.2 Seine Netting 8

2.3 Fyke Netting 10

2.4 Sea Lice Enumeration Procedure 11

3. Results 12

3.1 Survey Results 13

3.2 Sea Lice 14

4. Discussion and Recommendations 19

4.1 Discussion 19

4.2 Future Monitoring Recommendations 20

4.3 Equipment Considerations 21

List of Figures

Figure 1.1: Flow Diagram of the Ongoing Monitoring Required for the Expansion of the Isle of Muck Salmon Farm. 3

Figure 1.2: Proximity of Isle of Muck Salmon Farm to SAC Survey Locations - Glen Beasdale, River Moidart, Ardnamurchan Burn and Mingary Burn (2023). 4

Figure 2.1: APEM fisheries scientists, seine netting at Sanna (Ardnamurchan Burns SAC) – July 2023 9

Figure 2.2: Orange buoys showing fyke net placements at the mouth of Mingary Burn, Mull (September 2023). 11

Figure 3.1: Gravid Sea Lice on the damaged underside of a Sea Trout - Ardnamurchan Burns SAC – July 2023. 15

List of Tables

Table 2.1: Survey Dates, Site Locations, NGR and Adopted Methodology – Sea Lice Monitoring Surveys (July 2023)..... 6

Table 2.2: Survey Dates, Site Locations, NGR and Adopted Methodology – Sea Lice Monitoring Surveys (September 2023)..... 7

Table 3.1: July 2023 Sea Lice Monitoring Results 13

Table 3.2: September 2023 Sea Lice Monitoring Results 13

Table 3.3: Sea Lice Monitoring Results - July 2023 Surveys..... 16

Table 3.4: Sea Lice Monitoring Results – September 2023 Surveys 17

Table 3.5: Percentage of Captured Salmonids Populated by Sea Lice (by SAC) - 2023 Monitoring Surveys 18

1. Introduction

1.1 Background

In 2018, MOWI Scotland proposed to modify production levels at the Isle of Muck Salmon Farm. This facility is situated within 35 km of four Special Areas of Conservation (SACs); Glen Beasdale SAC, River Moidart SAC, Mingary Burn SAC (Isle of Mull) and Ardnamurchan Burns SAC. The historical implication regarding the rearing of farmed salmon in marine aquaculture facilities is that holding large numbers of farmed salmon in sea cages provides an environment in which sea lice can thrive in unnaturally high numbers. As a consequence of this, the risk of attachment of sea lice increases to wild salmonids when in proximity to farmed fish. This risk is a known and academically accepted impact of aquaculture, and a summary of the impacts of sea lice on wild salmonids can be found here: Impacts of lice from fish farms on wild Scottish sea trout and salmon: summary of science - gov.scot (www.gov.scot).

Freshwater pearl mussels (FWPM) (*Margaritifera margaritifera*) are endangered with a decreasing population (Moorkens *et al.,* 2017)[1]. The lifecycle and subsequent success of FWPM recruitment is dependent on the presence of salmonids i.e. Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*) within riverine systems. Juvenile FWPM (Glochidia) attach themselves onto the gills of juvenile salmonids, utilising their host as a transit mechanism to disperse themselves to suitable settlement habitat. Any negative impact on numbers of juvenile salmonids in riverine systems therefore has the potential to impact FWPM populations negatively. NatureScot (NS) (Then known as Scottish Natural Heritage (SNH))

[1] Moorkens E, Cordeiro J, Seddon MB, von Proschwitz T, Woolnough D. 2017. *Margaritifera margaritifera* (errata version published in 2018). The IUCN Red List of Threatened Species 2017: e.T12799A128686456. http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T12799A508865.en Downloaded on 09 January 2020.

requested monitoring of salmonids from the SACs to inform regional management of aquaculture activities.

To assess the potential impact of the modified production levels of the salmon farm on wild salmonid populations, a programme of works is taking place of which APEM contribute to one element. For example, the monitoring of sea lice counts on farmed salmon is being conducted by MOWI. The monitoring of juvenile and adult salmonid abundance within SAC rivers and a control site is being conducted by the Lochaber Fisheries Trust and the monitoring of the sea lice burden of wild salmonids entering and leaving the rivers of the SACs is being conducted by APEM (Figure 1.1).

APEM were commissioned to develop a methodology for a programme of monitoring wild salmonids at the four SACs, to identify whether the modified production levels cause an increase in sea lice numbers upon the salmonids. Following extensive discussion with stakeholders, including NatureScot, Marine Scotland (MS), Highland Council (HC), Lochaber Fisheries Trust (LFT) and Lochaber District Salmon Fisheries Board (LDSFB), a methodology was developed and agreed with MOWI Scotland. This incorporated a multimethod approach, using seine and fyke netting to ensure effective surveying of challenging conditions.

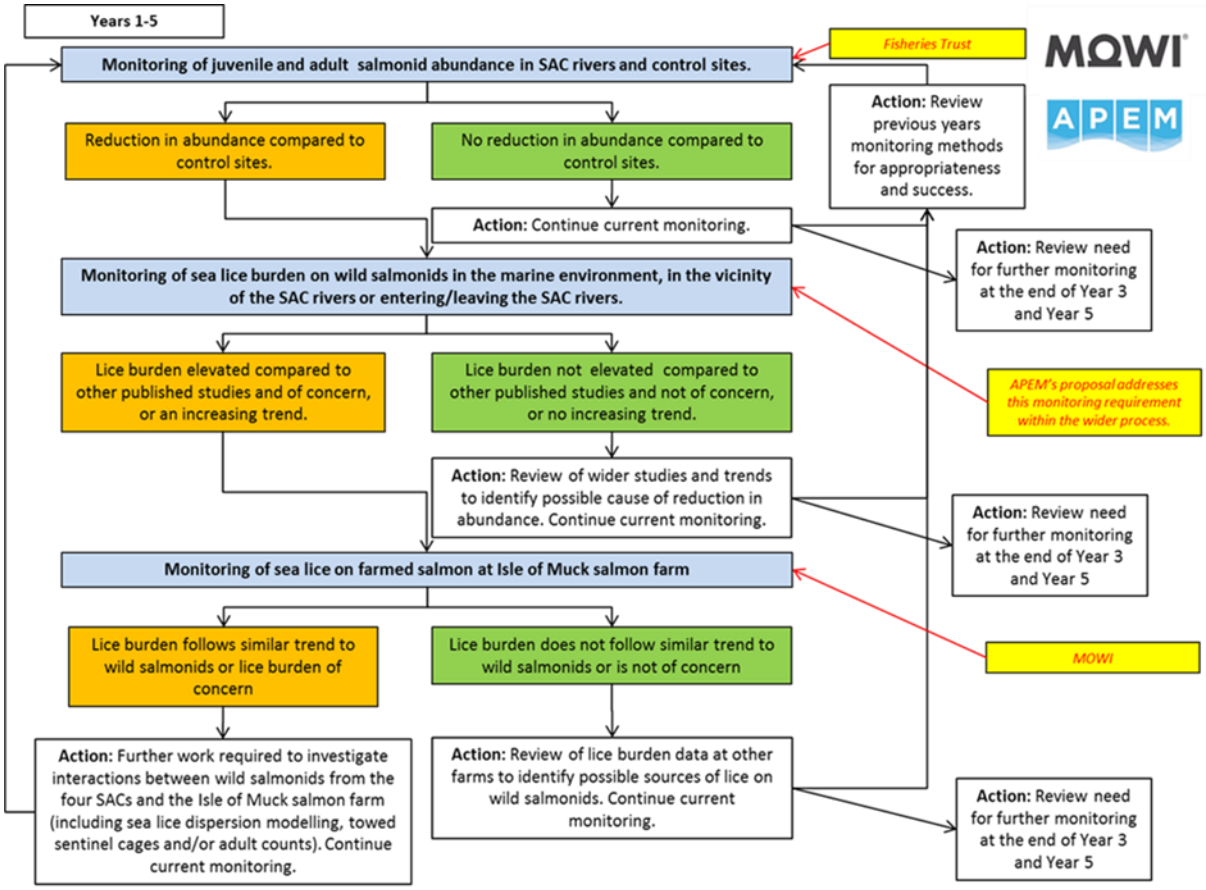

Figure 1.1: Flow Diagram of the Ongoing Monitoring Required for the Expansion of the Isle of Muck Salmon Farm.

An initial proof of concept survey for assessing sea lice burden on wild salmonids was undertaken in July 2019, with an additional baseline survey undertaken between October and November 2019, reporting in March 2020. The reporting of these surveys outlined recommendations for future monitoring and subsequent development of this data set. Consequently, APEM were commissioned to undertake further years of surveys in 2020, 2021, 2022 and 2023 to continue adding context and robustness to the initial results. APEM Surveys from 2020 to 2022 have recorded a total capture of 89 wild sea trout for examination for presence and enumeration of sea lice.

1.2 Site Overview

The 4 SACs for which this monitoring is required are; Glen Beasdale SAC, River Moidart SAC, Ardnamurchan Burns SAC and Mingary Burn SAC, on the west coast of Scotland. These SACs are designated for their populations of FWPM. Figure 1.2 details the locations of these SACs and their proximity to the Isle of Muck salmon farm.

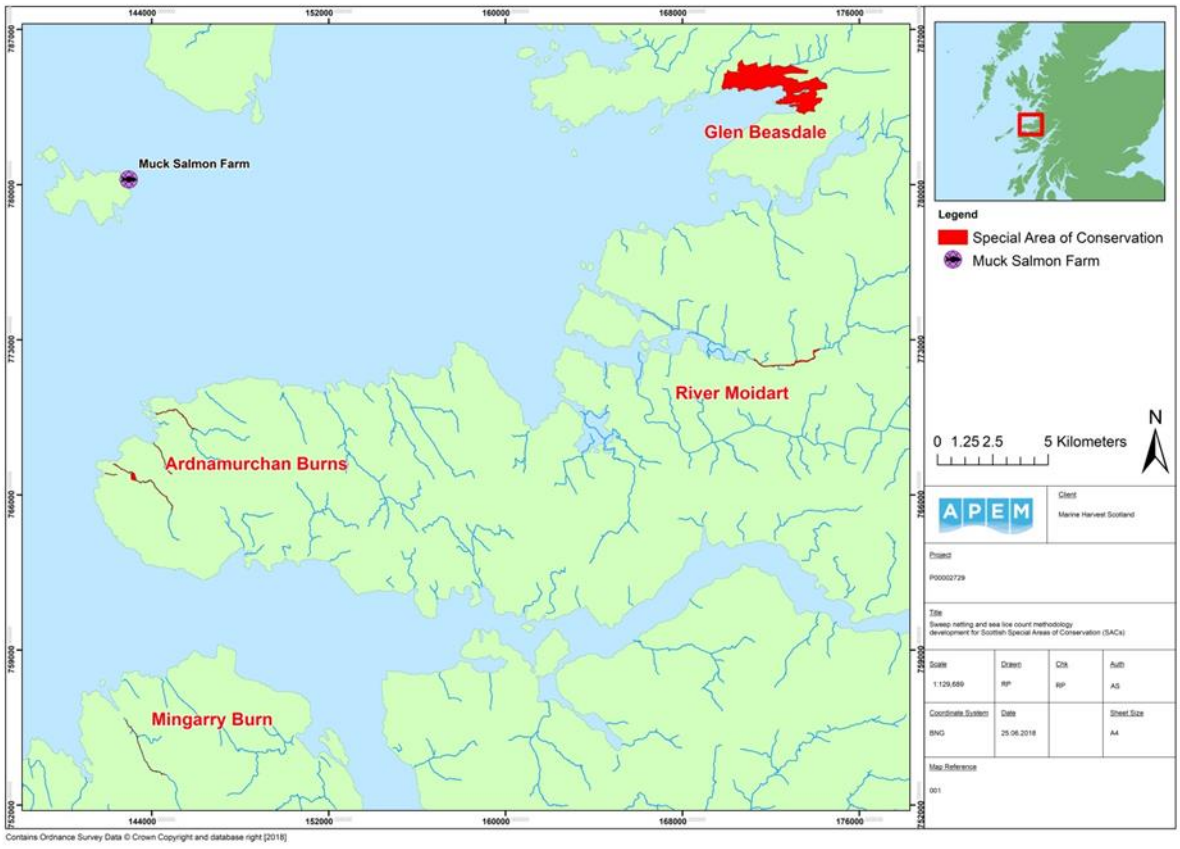

Figure 1.2: Proximity of Isle of Muck Salmon Farm to SAC Survey Locations - Glen Beasdale, River Moidart, Ardnamurchan Burn and Mingary Burn (2023).

1.3 Report Aims

The aims of this report are to:

- Provide a detailed account of the multimethod fisheries surveys to capture wild salmonids within the 4 SAC locations described above for the bi-annual (July and September) surveys conducted in 2023.
- Record the results of these surveys, with specific reference to the number of sea lice on each fish captured at each survey location.
- Report fisheries data from each multimethod approach, in addition to recording sea lice counts.
- Provide a comparison with data obtained between 2019 to 2022, and;
- Provide any recommendations for further monitoring in 2024.

2. Methods

Permissions for fisheries monitoring (*Scientific Research Derogation* and *Consent to Catch Salmon*) were obtained from Marine Scotland Science prior to the commencement of the 2023 monitoring surveys.

Surveys took place in July and September 2023. Seine and fyke nets were deployed for the capture of wild salmonids.

2.1 Monitoring Locations

Several sites within each of the SACs, which held the potential for capturing wild salmonids, were identified in 2019. For purposes of consistency and development of the existing data set, the subsequent 2020, 2021, 2022, and 2023 surveys have focused on these same sites, whilst also exploring other viable survey location options.

Access to established monitoring sites within Glen Beasdale SAC were not permitted in 2023, therefore, the primary focus of the sea lice monitoring surveys this year remained within Ardnamurchan Burns SAC at Sanna Bay and the Mingary Burn SAC on Mull, which had produced migratory salmonids during surveys undertaken in 2020, 2021, and 2022. The survey team were unable to access the Mingary Burn SAC on Mull during the July survey due

to poor weather conditions preventing safe transit to the area. Access to the Ardnamurchan Burns SAC at Sanna Bay area was clear throughout the July survey. Strong South/South-Westerly winds prevailed for much of the survey period however shelter provided by the land permitted safe, uninhibited access to the survey area and deployment and retrieval of seine nets without incident.

Following the July survey, and after consultation with MOWI, it was agreed that the September 2023 sea lice monitoring surveys should be conducted from within the Mingary Burn SAC on Mull, to provide additional depth to the available data from this site. The surveys were subject to persistently inclement weather throughout the course of the survey week. One day of scheduled survey time was lost to the high winds and heavy rainfall, which created an environment that would not have been safe to work in at any of the licensed locations.

Details of all sites surveyed in 2023, including NGRs and methodology utilised are provided in Tables 2.1 and 2.2 below.

Table 2.1: Survey Dates, Site Locations, NGR and Adopted Methodology – Sea Lice Monitoring Surveys (July 2023).

Date	Sample Area	SAC	Grid Reference	Methodology
02/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting
03/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting
04/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting
05/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting
06/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting
07/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting

Table 2.2: Survey Dates, Site Locations, NGR and Adopted Methodology – Sea Lice Monitoring Surveys (September 2023).

Date	Sample Area	SAC	Grid Reference	Methodology
23/09/2023	Loch Mingary	Mingary Burn SAC	NM 42484 56892	Fyke Netting
23/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke Netting
24/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke Netting
25/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke Netting
26/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke Netting
27/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke Netting

To ensure the best chance of optimal survey results, the surveys at Ardnamurchan Burns SAC were designed to focus catch effort on areas known to hold fish over low water, where more productive seine netting methods could be prioritised. At Mingary Burn SAC where (due to the site conditions and water depth) seine netting is not an available option, fyke nets were utilised as the most suitable monitoring method. River Moidart SAC is an auxiliary site to be used when the other options are unavailable due to the fyke netting being unproductive. Sites surveyed in 2023 are detailed below:

- Ardnamurchan Burns SAC, a composite site including four rivers: Allt a Bhriaghlann, Allt Grigadale, Allt Sanna and Sruthan Bhràigh nan Allt. This site was surveyed in July, using seine nets.
- Mingary Burn SAC, this SAC extends through the Mingary Burn up to Loch An Torr. This site was surveyed in September using fyke nets.

The first round of monitoring surveys, conducted in 2019, helped pinpoint specific locations within the SACs that held migratory salmonids during low tidal conditions. This knowledge

was expanded during the 2020 surveys, where specific locations were identified as key fish-holding areas over low tide, particularly within Ardnamurchan Burns SAC and Mingary Burn SAC. The 2021, 2022 and subsequent 2023 surveys have continued to target these areas, in an effort to improve catch efficiency. In addition, the following factors were also considered before commencement of the 2023 monitoring surveys:

- Proximity of the survey site to the relevant SACs, with priority given to sites within, or immediately adjacent to, these areas.
- Location of each survey site in relation to the downstream tidal limit, to minimise potential detachment of sea lice from their host fish, as occurs within a short space of time, once these migratory fish enter freshwater.
- The level of assistance provided by each potential site through natural morphological constraint and effective corralling of target fish into limited areas of water over low tidal conditions.
- Suitability of potential survey site in terms of its' morphological compatibility with the licensed methods being used to conduct this monitoring.
- Ability of the surveyors to access the survey site fully and safely with full equipment requirements to carry out the monitoring as per the agreed methodology.
- Likelihood based upon historic rod catch knowledge and more recent data from the 2019 - 2022 monitoring surveys, of catching target species from the SACs in question, within the marine environment.

2.2 Seine Netting

Seine netting was one of the primary survey methods utilised during the 2023 monitoring programme and was conducted at Sanna beach, as detailed in Tables 3.1 within the results section of this report. Long seine nets (>50 m) were operated with two fixed ropes for hauling and herding the fish. This technique permitted the sampling of relatively large areas in short periods of time as well as the capture and release of fish without significant stress or harm.

Seine net surveys were conducted over low tide, targeting areas where it was considered likely that migratory salmonids would be holding, awaiting the incoming tide to attempt to move upstream.

The seine nets utilised for the July survey were 53 m x 4 m nets, with a 20 mm mesh diameter. These nets are of proven efficiency on this project, allowing small, by-catch fish species to escape, whilst retaining migratory salmonids within the net. Nets were deployed both manually from the shore, as well as with assistance of a small rigid inflatable boat (RIB), where conditions benefited from its' use (Figure 2.1).

Figure 2.1: APEM fisheries scientists, seine netting at Sanna (Ardnamurchan Burns SAC) – July 2023.

2.3 Fyke Netting

Fyke nets were utilised as a secondary surveying method where conditions precluded the use of seine nets, such as excessive depth of water or terrain. Nets stood 1 m high and consisted of two cone-shaped interconnecting 14 mm mesh nets separated by a 5 m leader (Figure 2.2). Fyke nets were deployed by hand or with assistance of a small rigid inflatable boat (RIB), where conditions benefited from its' use. Nets were placed vertically near the river mouth at low tidal conditions and retrieved 2 hours after high water, approximately 6 hours later. Stakes and blocks were used as anchors for the nets, preventing displacement during the tidal cycle. All fyke nets are fitted with otter guards, but remain observed constantly for the presence of otters and seals, as an additional precaution.

In 2023, fyke netting was conducted during the September survey only, with the Mingary Burn on Mull being the only site where this method was employed.

Figure 2.2: Orange buoys showing fyke net placements at the mouth of Mingary Burn, Mull (September 2023).

2.4 Sea Lice Enumeration Procedure

Captured fish were visually assessed to identify species. In the event no salmonids were present, fish were released to ensure minimal disturbance to bycatch species. For seine netting, this was achieved by opening out the seine to allow fish to swim free, or untying the cod end of the fyke. Both methods ensure minimal unnecessary handling of the fish themselves. Any fish physically caught in the net and unable to release themselves were then gently removed using best practice fish handling techniques to ensure they remained undamaged. Captured salmonids were transferred to knotless, rubber mesh nets and holding troughs for further examination. Individuals were swiftly measured, photographed, and

assessed for sea lice presence, sea lice attachment spots, black spot disease and additional notes (such as prominent scars or marks).

Sea lice count metrics recorded during the survey included:

- Prevalence (the percentage of infested fish in the sample).
- Abundance (mean number of lice in the sample) and;
- Intensity (mean number of lice per infected fish).

Observed sea lice were counted and assigned to life stages (e.g., juvenile, mobile and gravid female following Moore *et al.,* 2018)[2]. Best practice handling techniques for fish were followed from capture to release and air exposure was kept to a minimum during the entire process. Following the completion of the enumeration process, and in the interests of fish welfare, all sea lice are carefully removed and destroyed from each captured fish, prior to their release. All fish were fully recovered and only released back into the approximate location of capture when at good equilibrium.

3. Results

A full summary of each of the monitoring surveys, including date, location, methodology, effort and capture can be found in Table 3.1 and Table 3.2, within the survey results section below.

[2] Moore I, Dodd JA, Newton M, Bean CW, Lindsay I, Jarosz P, Adams CE 2018. The influence of aquaculture unit proximity on the pattern of *Lepeophtheirus salmonis* infection of anadromous Salmo trutta populations on the Isle of Skye, Scotland. Journal of Fish Biology 92: 1849-1865.

3.1 Survey Results

In 2023, two rounds of monitoring surveys were conducted, one in July and one in September. A total of 11 sea trout were captured in July (Table 3.1), with a further 7 captured in September (Table 3.2) equating to a total of 18 sea trout for sea lice enumeration processing in 2023. This was the result of deploying 48 seine net hauls and 16 fyke nets between the July and September monitoring.

Table 3.1: July 2023 Sea Lice Monitoring Results

Date	Sample Area	SAC	Grid Reference	Capture Method	Number of Net Deployments	Sea Trout Captured
02/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting	8	4
03/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting	8	1
04/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting	8	0
05/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting	8	3
06/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting	8	0
07/07/2023	Sanna Beach	Ardnamurchan Burns SAC	NM 44355 69602	Seine Netting	8	3
Total					48	11

Table 3.2: September 2023 Sea Lice Monitoring Results

Date	Sample Area	SAC	Grid Reference	Capture Method	Number of Net Deployments	Sea Trout Captured
22/09/2023	Mingary Burn	Mingary Burn SAC	NM 42484 56892	Fyke netting	0*	0
22/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke netting	2	0
23/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke netting	4	2
24/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke netting	4	1

25/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke netting	3	2
26/09/2023	Mingary Burn	Mingary Burn SAC	NM 42671 56063	Fyke netting	3	2
Total					16	7

***Indicates day of survey lost to unsuitable/unsafe weather conditions.**

3.2 Sea Lice

The information presented in Tables 3.3, 3.4 and 3.5 below detail sea lice data from both July and September monitoring surveys in 2023. In total, 18 sea trout were examined, with 153 sea lice found present across 7 of the fish. Of these sea lice, 25% were gravid adults (Figure 3.1), 49% were mobile, 26% were juveniles. All fish found with sea lice were caught during the July 2023 surveys within Ardnamurchan Burns SAC.

When comparing total fish caught to sea lice observed, the average (± standard deviation; SD) number of sea lice per fish was 8.5 (± 15.90), an increase on the recorded figure 0.83 (± 0.24) from the 2022 survey. The maximum and minimum of sea lice on one fish was 57 and 0, respectively. Of the 18 sea trout examined, 7 (38.89%) showed presence of sea lice. The average sea lice burden of the 7 populated fish (± SD) was 21.86 (± 19.38), again increased from the recorded figure of 1.90 (± 0.31) recorded in the 2022 survey.

Looking more closely at average sea lice burden per site, the 11 sea trout captured within Ardnamurchan Burns SAC during the July survey recorded an average sea lice burden of 13.91 (± 18.62). This site was not repeated in the September 2023 survey, so we are unable to determine any seasonal variation of lice burden for this site in 2023.

Figure 3.1: Gravid Sea Lice on the damaged underside of a Sea Trout - Ardnamurchan Burns SAC – July 2023.

Table 3.3: Sea Lice Monitoring Results - July 2023 Surveys

ID Serial	Method	Date	Location	Time	Tide	Species	Life Stage	Fork Length (mm)	Total Length (mm)	Juvenile Sea Lice	Mobile Sea Lice	Gravid Lice	Total Lice	Dorsal Lice Damage (0 – 3)*
1	Seine	02/07/2023	Sanna Bay	13:15	Low	Sea trout	Post Smolt	180	190	0	0	0	**0**	0
2	Seine	02/07/2023	Sanna Bay	14:00	Low	Sea trout	Post Smolt	220	230	0	9	4	**13**	0
3	Seine	02/07/2023	Sanna Bay	14:00	Low	Sea trout	Post Smolt	185	195	0	0	0	**0**	0
4	Seine	02/07/2023	Sanna Bay	14:30	Low	Sea trout	Post Smolt	190	200	0	0	0	**0**	0
5	Seine	03/07/2023	Sanna Bay	14:15	Low	Sea trout	Adult	380	390	14	15	5	**34**	3
6	Seine	05/07/2023	Sanna Bay	15:15	Low	Sea trout	Adult	350	360	9	18	2	**29**	3
7	Seine	05/07/2023	Sanna Bay	15:55	Low	Sea trout	Adult	400	410	13	23	21	**57**	3
8	Seine	05/07/2023	Sanna Bay	15:55	Low	Sea trout	Post Smolt	200	210	0	0	0	**0**	0
9	Seine	07/07/2023	Sanna Bay	16:25	Low	Sea trout	Post Smolt	220	230	1	0	0	**1**	0
10	Seine	07/07/2023	Sanna Bay	17:10	Low	Sea trout	Post Smolt	190	200	0	7	3	**10**	0
11	Seine	07/07/2023	Sanna Bay	17:10	Low	Sea trout	Post Smolt	180	190	3	3	3	**9**	0
Total								**n/a**	**n/a**	**40**	**75**	**38**	**153**	**n/a**

Average	**251.5**	**261.5**	**3.64**	**6.82**	**3.45**	**13.91**	**0.82**
**Lice damage to dorsal fin (0= no damage; 1=<33% damage; 2=33-66% damage; 3=>66% damage*							

Table 3.4: Sea Lice Monitoring Results – September 2023 Surveys

ID Serial	Method	Date	Location	Time	Tide	Species	Life Stage	Fork Length (mm)	Total Length (mm)	Juvenile Sea Lice	Mobile Sea Lice	Gravid Lice	Total Lice	Dorsal Lice Damage (0 – 3)*
1	Fyke	23/09/2023	Mingary Burn SAC	14:30	High	Sea trout	Post Smolt	175	180	0	0	0	**0**	0
2	Fyke	23/09/2023	Mingary Burn SAC	14:30	High	Sea trout	Post Smolt	170	175	0	0	0	**0**	0
3	Fyke	24/09/2023	Mingary Burn SAC	15:00	High	Sea trout	Post Smolt	170	175	0	0	0	**0**	0
4	Fyke	25/09/2023	Mingary Burn SAC	15:40	High	Sea trout	Post Smolt	195	200	0	0	0	**0**	0
5	Fyke	25/09/2023	Mingary Burn SAC	15:40	High	Sea trout	Post Smolt	165	170	0	0	0	**0**	0
6	Fyke	26/09/2023	Mingary Burn SAC	16:10	High	Sea trout	Post Smolt	165	170	0	0	0	**0**	0
7	Fyke	26/09/2023	Mingary Burn SAC	16:10	High	Sea trout	Post Smolt	170	175	0	0	0	**0**	0
Average								**170**	**178**	**0**	**0**	**0**	**0**	**0**
**Lice damage to dorsal fin (0= no damage; 1=<33% damage; 2=33-66% damage; 3=>66% damage)*														

Table 3.5: Percentage of Captured Salmonids Populated by Sea Lice (by SAC) - 2023 Monitoring Surveys

	Post Smolt			Adult			2023 Total % Populated
Location:	**Populated**	**Clean**	**% Populated**	**Populated**	**Clean**	**% Populated**	
Ardnamurchan SAC	4	4	50%	3	0	100%	63.63%
Mingary Burn SAC	0	7	0%	n/a	n/a	n/a	0%*

4. Discussion and Recommendations

4.1 Discussion

A low catch of 3 migratory sea trout during the July 2022 survey has prevented a sample size suitable for comparison from the July 2023 survey. In July 2021, however,26 sea trout were caught within Ardnamurchan Burns SAC compared with 11 sea trout caught in 2023. Of the 26 sea trout captured in 2021, there was a recorded average sea lice burden of 28.23 (± 5.13) in comparison to 13.91 (± 18.62) at the same site in 2023.

Due to the July 2023 survey being restricted to the Ardnamurchan Burns SAC through bad weather, the Autumn 2023 survey was conducted exclusively on Loch Mingary, at the request of MOWI, to increase the quality and amount of data from this site.

In September 2023, 7 sea trout were recorded at Loch Mingary, 100% of which were free of sea lice at time of capture. The 2022 Autumn survey was completed at Ardnamurchan Burns SAC, with 20 sea trout captured of which 50% were free of sea lice at time of capture. A total of 15 (75%) of these fish showed signs of current or prior damage from the presence of sea lice. Due to the difference in geographical proximity to each other, no comparison should be drawn with regard to numbers of sea trout affected by sea lice at each site during the Autumn. However, previous Autumn surveys have shown a consistently low sea lice burden on sea trout, in comparison to results obtained from Summer surveys, during this season. Loch Mingary showed no signs of sea lice on the 7 sea trout caught using fyke nets. The low sea lice burden figures for Ardnamurchan Burns SAC October 2022 (0.95 (± 0.27)) and October 2021 (0.54 (± 0.37)) provides further evidence that lice burdens are potentially seasonal and consistently lower in Autumn when temperatures are lower. Whether there is any link to seasonality of lice burdens on wild salmonids and aquaculture practices within the region is not possible to establish without analysis of fish (and/or lice) numbers present within local

cage farms throughout the year.This is something that could be considered as a next step in developing the monitoring programme.

4.2 Future Monitoring Recommendations

To understand the potential impacts of sea lice on wild salmonids from the increased production at the Isle of Muck Salmon Farm it is recommended that monitoring surveys are repeated in 2024. The surveys will aim to provide more robust temporal and spatial data to give further context to the existing data set by developing an understanding of trends in both the numbers and distribution of the sea lice present upon wild salmonids.

It is recommended that the 2024 surveys continue to broaden the accessible survey area and expand the available data set where possible. Means of achieving this would include;

- An increased frequency of surveying across the year (to provide greater context to data regarding seasonality of sea lice burden);
- Potential incorporation of additional fyke netting effort of sites within the Moidart SAC and;
- Returning to the Glen Beasdale SACs monitoring locations, should MOWI be able to secure permission to survey these areas once more.

Due to time pressures from the existing survey structure, any expansion may require surveys to be more frequent than have been previously scheduled, which will need to be discussed and agreed with MOWI prior to deployment in 2024.

Any increase on the current 2-survey strategy will need to retain comparative surveys in both Summer and Autumn, to allow effective comparison with previously acquired data, and further develop understanding of the extent to which seasonal variation in the prevalence of sea lice is relevant to the results obtained. This strategy will also optimise continuity between results and provide robustness to comparison between annual data sets.

4.3 Equipment Considerations

Regarding the selection of survey equipment going forward, it is recommended that seine net surveys in 2024 are conducted with the continued use of a larger (20 mm diameter) mesh net, which is more efficient in reducing bycatch, specifically lesser sandeels (*Ammodytes tobianus*), and time lost between deployments of the seine net. The use of fyke nets at Mingary Burn, supplemented by rod and line fishing, remains the most practicable means of surveying this site. Due to their compatibility with the terrain and site conditions, these methods would also be employed as the most effective at Moidart SAC, should surveys in 2024 be undertaken in this location.