The occurrence of the parasitic sea louse (*Lepeophtheirus salmonis,* Krøyer) on sea trout (*Salmo trutta*) in the Wester Ross Fisheries Trust area in 2007 and 2008 with recommendations for monitoring and management

Peter Cunningham, Wester Ross Fisheries Trust, info@wrft.org.uk
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1. Introduction

The parasitic copepod (*Lepeophtheirus salmonis* Krøyer), commonly known as the sea louse, is a major health problem for both farmed and wild salmonids (salmon and sea trout) (Revie, et al., 2009).

Although catches of wild salmon and sea trout from river systems in Wester Ross fluctuated widely during the last few decades, stocks of both species collapsed during the late 1980s and early 1990s. In the west of Scotland, the sea trout collapse has been linked with sea lice epizootics[1]. Similar conclusions have been reached in Ireland and Norway (e.g. Tulley et al., 1999; Gargan et al., 2003; Bjorn et al., 2001; Grimnes et al., 2000).

To learn more about sea lice infestations on sea trout, WRFT began monitoring sea lice abundance on early-returned post-smolt sea trout during the month of June in the Dundonnell, Gruinard and Ewe river estuaries in 1997. In 1998 the post-smolt sampling programme was extended to 17 river estuaries in the west of Scotland as part of a collaborative study by the Association of West Coast Fisheries Trusts (AWCFT). Initial results were presented and implications for the management of marine salmon farm discussed in Butler, 2002.

Within the WRFT area, the Trust continued a programme of lice monitoring at Dundonnell and Poolewe until 2007, and promoted a surveillance programme to encourage anglers to report lice levels on rod caught sea trout within other parts of the area and enable opportunistic sampling. This approach addressed two objectives:

1. to continue to develop a clearer understanding of year to year patterns of lice infection of sea trout, in relation to climate, sea conditions, and salmon farming activities in nearby areas.
2. to gather additional information by responding to reports of sea lice epizootic, in order to investigate the severity of an epizootic, its extent and distribution, and possible causes.

Monitoring and surveillance results were reported to all stakeholders with an interest in sea lice.

In addition to monitoring by WRFT, much work has been carried out over the past ten years by the Fisheries Research Services (FRS) Shieldaig Project to learn more about sea lice and sea

[1] An epizootic is defined as a disease which affects animals as an epidemic does mankind (Chambers 20th Century Dictionary). In the context of sea trout and sea lice, we refer to the occurrence of sea trout with high levels of sea lice infection (average of 30 or more lice per fish in a sample of 10 or more consecutive fish), or 'early-returned' sea trout with evidence of high level of sea louse infection (scarring and eroded fins).

trout. FRS Shieldaig Project Annual reports have presented results from sea lice monitoring programmes in Loch Torridon and from the fish traps in the Shieldaig River (e.g. Raffell *et al* 2007).

In 2008, WRFT embarked upon a programme of sweep netting for sea trout, as part of the Tripartite Working Group [TWG]'s Northwest Scotland Regional programme of support for the Area Management Agreement process. With financial support from the Scottish Government, the trust purchased a sweep net, a small boat, and carried out netting for sea trout in Loch Ewe, Loch Gairloch and Loch Carron. In addition to WRFT sites, the TWG's Regional Development Officer carried out sweep net sampling in Loch Kanaird, Little Loch Broom and Loch Long.

As a result of this alternative netting programme, the traditional sampling at Poolewe using a gill net was not carried out in 2008. However, the traditional sampling for early-returned sea trout using a fyke net at the mouth of the Dundonnell River continued, with support from Dundonnell and Eilean Darach Estates.

This report reviews the results of lice monitoring on wild sea trout within the WRFT area up to and including 2007 and 2008. Following a summary of sea lice biology and ecology, and a review of relationships between sea lice, sea trout and salmon farming, the following questions are addressed:

1. How have sea lice affected sea trout populations in different parts of the WRFT area?
2. How does the timing and occurrence of sea lice epizootics relate to salmon farming within the WRFT area?
3. What lessons have been learned for future lice monitoring / surveillance of wild fish in the WRFT area?
4. What can be done to reduce the levels of sea lice infection in the WRFT area?

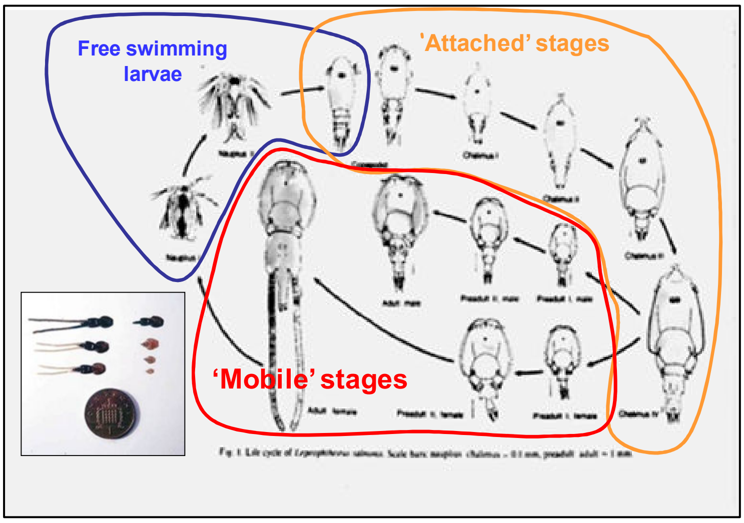
2. Summary of sea lice biology and ecology

In Scotland two species of sea lice parasitise wild and farmed salmonids: *Lepeophtheirus salmonis* (Krøyer 1837) and *Caligus elongatus* (Nordmann 1832). Of the two species, *L. salmonis* is the larger and more abundant. Whereas *C. elongatus* is known to parasitise more than 80 species of fish, the major species of interest *L. salmonis* is principally confined to salmonids (Revie, 2008). To date and knowledge of WRFT biologist, wild sea trout or salmon with more than 10 *Caligus elongatus* have not been recorded within the WRFT area.

The biology of *L. salmonis* was reviewed by Boxaspen, 2006. Sea lice have a relatively simple life history with attached juveniles and mobile pre-adult and adult stages on the host fish (Figure 2.1). Gravid females produce a series of egg strings, which give rise to free living planktonic stages before settlement on a host.

L. salmonis has a total of ten life-cycle stages, comprising 2 free swimming *naupplii* larval stages, a *copepodid* stage when the larval louse seeks a host, 4 attached *chalimus* stages, then 2 *mobile* pre-adult stages, and an *adult* stage. Recent work has shown that in addition to the infectious *copepodid* stage, mobile lice are able to move from one fish to another if fish come into close proximity with each other (Pert, *pers comm.* 2008). The presence of mobile lice on a post-smolt sea trout therefore does not necessarily mean that the fish has been in the sea for the length of time the louse has taken to grow from the copepodid stage (see Figure 2.2).

Figure 2.1 The life cycle of Lepophtheirus salmonis (based on Schram, 1993). The photograph (inset) shows three adult female lice with egg strings (left) and pre-adult and adult male and female lice (right).



Sea lice feed on the mucus, skin and blood of host fish. They are able to multiply rapidly. A female louse can produce at least 11 sets of egg strings after a single fertilisation and live for over 200 days. Each egg string contains several hundred eggs.

The rate of development and reproduction is dependent upon water temperature. Even at low water temperatures (below 5°C), lice are able to reproduce (Boxaspen, 2006). As the water temperature rises in the spring, the rate of reproduction increases (Figure 2.2).

Figure 2.2 Rates of development of Lepeophtheirus salmonis vs. water temperature. This diagram has been developed from a number of sources (see text for further info.)

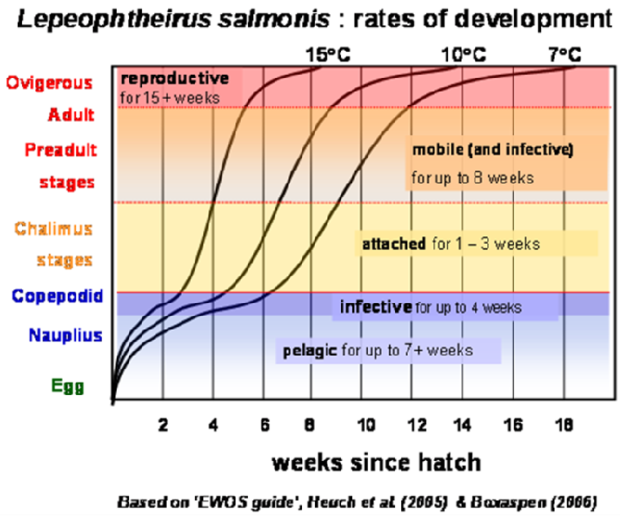
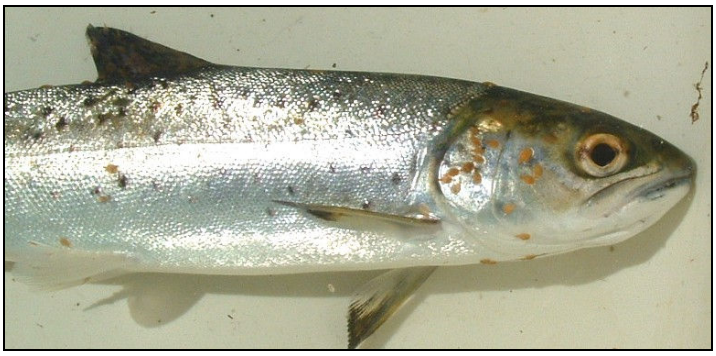


Figure 2.3 Sea lice infection on finnock taken in the River Ewe

This finnock taken from the River Ewe in May 2007 had over 300 lice on it. Nearly all were small chalimus (attached) stages, suggesting recent infection (within 1 - 2 weeks prior to capture).



Finnock taken in the River Ewe in May 2007. A high proportion of sea lice on this fish were pre-adult stage 1 lice; of similar age, suggesting less recent infection than the fish above. Note that the fish is very thin, and dorsal fin eroded. Dorsal fin damage tends to be associated with chalimus attachment.

Head of sea trout taken in the River Ewe in July 2008. The lice include both small and larger pre-adult and adult lice suggesting infection several weeks earlier. Head damage tends to be associated with feeding by 'mobile' lice. This fish was otherwise in good condition and had fed well at sea prior to returning to freshwater.

3. Sea lice, sea trout and salmon farming around Wester Ross: some background information

3.1. Sea lice and sea trout, links to salmon farming: initial studies

The salmon louse (*Lepeophtheirus salmonis*) is a naturally occurring parasite of wild salmon and sea trout. The natural host-parasite relationship is finely balanced. Prior to salmon farming, wild sea trout or salmon with ten or more sea lice were frequently seen, but following the development of the salmon farming industry from the late 1980s onwards, much higher numbers of lice (in excess of 50 lice) were commonly seen on wild sea trout in areas near salmon farms.

A link between lice levels on sea trout and salmon farming has not been easy to prove. Within Scotland, investigations of sea lice infection of sea trout began in the early 1990s. One of the initial questions was whether levels of lice infection of sea trout varied with distance from salmon farms. McVicar *et al* 1993 showed that levels of sea lice infection were highest in NW Scotland in areas adjacent to salmon farms (Figure 3.1). Samples where the mean number of lice per fish exceeded 20 were only taken from estuaries adjacent to salmon farms. However, even in areas away from salmon farms, some fish carried over 40 lice (for example a sea trout with 46 *L. salmonis* from the Eachaig estuary in 1991[2]) so the link to salmon farming was far from clear.

Figure 3.1 The occurrence of sea lice on sea trout sampled from rivers estuaries around Scotland in 1991 and 1992. Reproduced from McVicar et al 1993.

Table 1

Occurrence of *Lepeophtheirus salmonis* and *Caligus elongatus* (in parenthesis) on wild sea trout caught in the estuaries of different Scottish rivers

Area	River	No Fish	% Infected with lice	Mean number of lice/fish	Maximum number of lice/fish
			1991		
East	Don	4	100	4.5	9
	Ythan	13	100	5.0	11
	(Ythan)	(13)	(85)	(10.6)	(49)
North	Hope	8	25	1.4	10
N West	Ewe	4	75	20.5	38
	Squod	2	100	7.0	12
	Morar	19	100	23.8	83
West	Euchar/Creran	3	100	5.0	9
Clyde	Eachaig	20	75	10.7	46
			1992		
N West	Ewe	8	100	63.9	216

[2] Since then, a 'natural' sea louse epizootic has been reported from Loch Torridon in 2006. Sea trout were infected with some samples carrying an average of over 20 lice (Raffell *et al*, 2007). Lice levels on farms in Loch Torridon were very low, and the lice infected fish first recorded at the end of May were assumed to have come either from 'natural sources' sources. [note: that beyond Loch Torridon, the next nearest salmon farms are by Rona, about 20km away.] Despite this 'natural' epizootic, marine survival of wild and stocked sea trout from the Shieldaig system was the highest on record in 2006.

To further investigate a possible link with salmon farming, a cage experiment was carried out (McVicar et al 1993). 10 sea trout of farmed origin and 10 sea trout of wild origin were stocked into cages in sea lochs in the west of Scotland. Fish in the cages in Little Loch Broom, located in closest proximity to an active salmon farm carried the highest numbers of *L. salaris* after the first 20 days. However, once again, no firm conclusions were reached.

Figure 3.2 Results of an experiment in 1993 to rates of sea lice infection of sea trout in different sea lochs in the West of Scotland. Reproduced from McVicar et al 1993.

Table 2

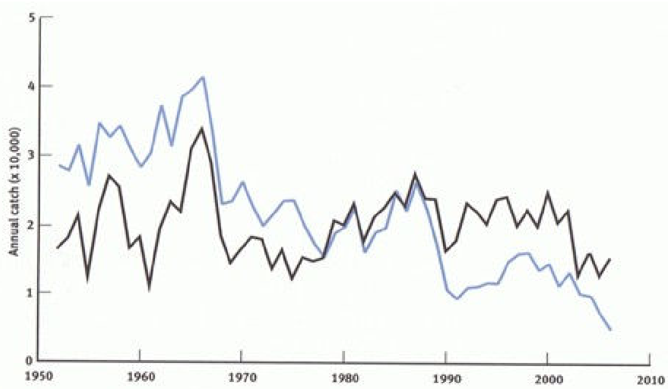
Accumulation of sea lice *Lepeophtheirus salmonis* and *Caligus elongatus* (in parenthesis) on sea trout of farmed and wild origin within the first 20 days of being caged in different localities

Area	Miles to fish farms	Stock	Sea days	*L. salmonis* Fish No inf/uninf	(*Caligus*) Fish No inf/uninf	Lice *L.s* (C) Average No/fish	Lice *L.s* (C) Max No/fish
Loch Eriboll	1		14				
		Wild		1/9	(0)	1.2 (0)	6 (0)
		Farmed		5/10	(0)	1.5 (0)	2 (0)
L Loch Broom	<0.5		18				
		Wild		10/10	(4/10)	14.2 (0.5)	25 (2)
		Farmed			(2/10)	19.7 (0.2)	36 (1)
Holy Loch	12		17				
		Wild		5/10	(0)	0.1 (0)	1 (0)
		Farmed		8/10	(0)	0.7 (0)	2 (0)

3.2 Decline in sea trout catches: a link to sea lice epizootics?

The two tables reproduced above were presented at a meeting in Inverness on 24 November 1993. Dr R. G Shelton (then director of the FRS freshwater laboratory) who opened the meeting described having seen evidence of widespread moderate reductions in the availability of sea trout to fisheries in Scotland. So far as the West Highland scene was concerned, he described seeing 'sudden unprecedented declines, way beyond any national trends in sea trout catches'. Figure 3.3 contrasts the decline in West coast sea trout catches with that of east coast catches.

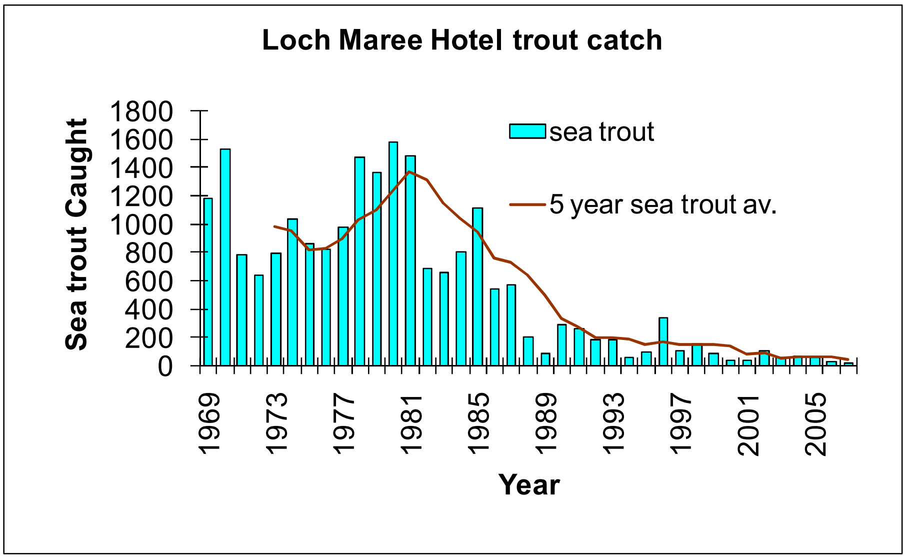
Figure 3.3 Total Annual rod catch (retained and released) of sea trout reported by east coast (black line) and west coast fisheries. Reproduced from FRS Fisheries series No. Fis/2007/1 September 2007.



3.3 Sea lice and the decline of sea trout fisheries in Wester Ross.

T he principle sea trout fishery in the WRFT area was the Loch Maree Hotel fishery. At this more local level, the decline in sea trout catches to very low levels was particularly acute (Figure 3.4). As a result of the collapse in stocks, fishing effort tailed off from 10 or more boats per day in the 1980s to less than one per day during the season from the late 1990s onwards.

Figure 3.4 Recorded sea trout catches at Loch Maree Hotel (1969 – 2007)



Butler and Walker (2006)[3] reviewed the collapse of the sea trout stock in the River Ewe system, presenting a detailed analyses of data relating to catches, weights, marine growth rates (from scale reading), timings of return to freshwater and marine survival. The collapse which began in 1988 was characterised by 'three coincidental alterations' in the sea trout stock. Firstly, the abundance of fish declined sharply to levels not previously recorded. Secondly, there was an increased proportion of smaller fish and their mean weight fell. Scale analyses showed that this was due to a significant decline in marine growth rates. Thirdly, the timing of the primary sea trout freshwater migration advanced by approximately one month from July to June, and finnock returned earlier in May and June.

They concluded that the presence of sea lice epizootics in Loch Ewe related to production cycles at salmon farms within Loch Ewe, and the resulting premature-return of post smolts, finnock and older sea trout suggests that this is the primary anthropogenic factor concerned. 'While other environmental issues may also be influential, a resolution to the sea lice problem is likely to contribute significantly to the restoration of the Ewe sea trout stock.'

With regard to sea lice data that has been collected in 2007 and 2008, the two year cyclicity of sea lice epizootics is investigated further in part 4.4.

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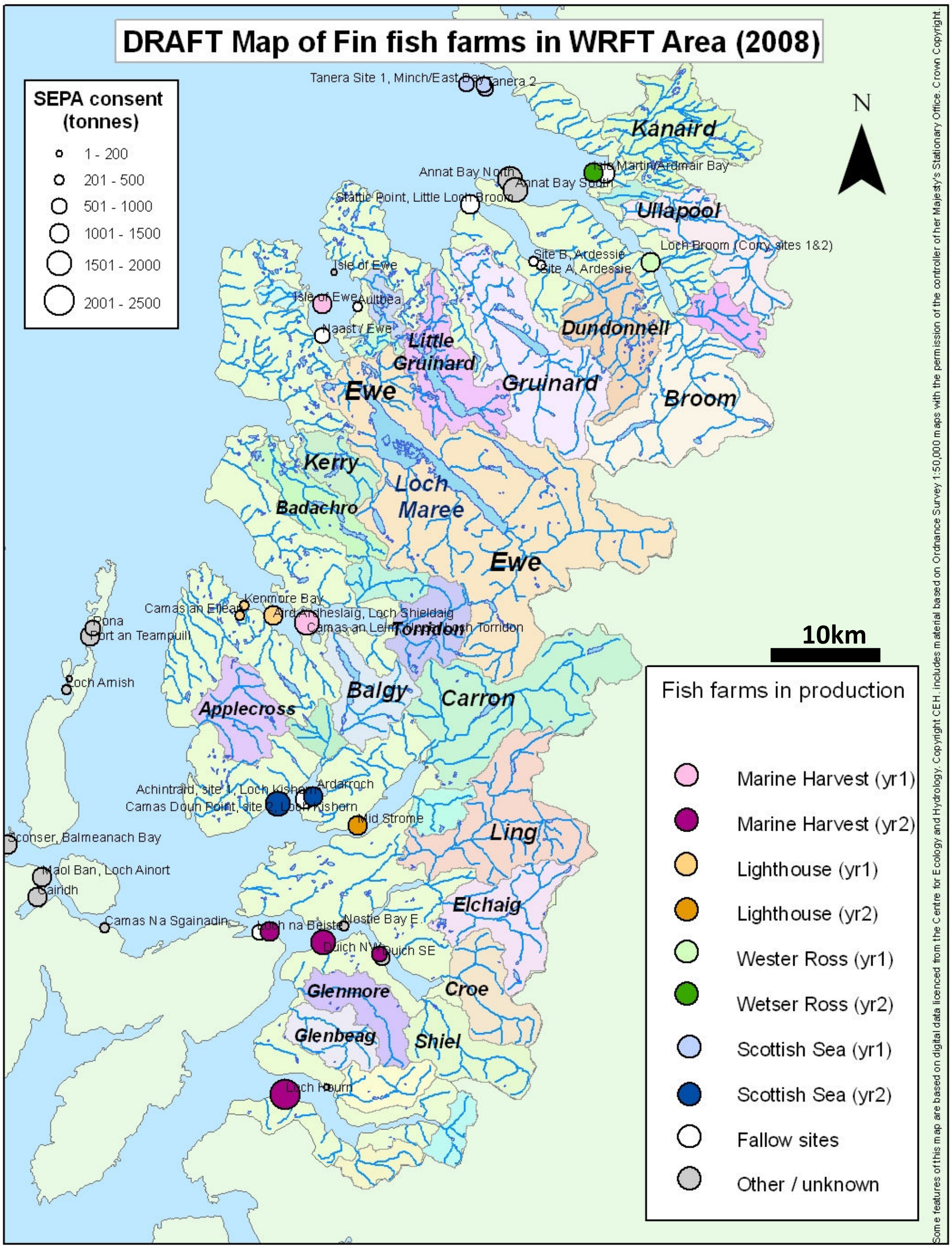
[3] *Butler, J.R.A. & Walker, A.F. (2006)*, **Characteristics of the Sea Trout *Salmo trutta* Stock Collapse in the River Ewe (Wester Ross, Scotland), in 1988-2001**. In Sea Trout: Biology, Conservation and Management. Published Online: 15 Nov 2007, Pages: 45-59

3.4 Salmon farming in the WRFT area in 2008

Since the late 1980s, production of farmed salmon within the WRFT area has continued to grow. Farms have become larger. The locations of marine salmon farms within the WRFT area (as at summer 2008) are shown in Figure 3.5. Note that in 2008 many sites were fallow, and for some (e.g. Annat Bay sites) no lease or planning permission had been granted.

Figure 3.5 Map of salmon farms in the WRFT area, showing SEPA consented biomass for 2008.



In 2008, four companies had active marine cage salmon farms in the WRFT area. Marine Harvest operated one farm in Loch Ewe (two other MH sites in Loch Ewe have been fallow since 2005), one farm in Loch Torridon, two in Loch Alsh, two in Loch Duich and one in Loch Hourn. Scottish Sea Farms had two active sites by the Summer Isles (outer Loch Broom) and two in Loch Kishorn. Lighthouse of Scotland had three active sites in Loch Torridon and one in Loch Carron; and Wester Ross Fisheries (formerly Wester Ross Salmon) had two active sites – one in Loch Kanaird, and one in upper Loch Broom.

The only sea lochs within the WRFT without active marine salmon farms in both 2007 and 2008 were Loch Gairloch and Gruinard Bay. In 2008, the salmon farms in Little Loch Broom (Ardessie and Stattic Point) were fallow.

Since the late 1980s, there has been a trend towards consolidation of production at larger salmon farms within the WRFT area. In Loch Ewe, Marine Harvest ceased salmon production at Naast and Aultbea sites in 2005 when production at the Isle Ewe site was initiated. In Loch Torridon, production ceased at the Diabaig site upon an increase in biomass being granted at the farm in upper Loch Torridon. In 2008, most active farms had a consented biomass of 1000 tonnes or more. In 2008 Marine Harvest sought increases in biomass consents to over 2000 tonnes for farms in Loch Torridon, Loch Alsh and Loch Hourn.

Following the signing of the Triparite Working Group [TWG] Concordat in 2000, Area Management Agreements (AMAs) were signed between representatives of fish farming companies and wild fisheries, for the Loch Carron area, Loch Torridon Area (both in 2002), Loch Ewe (2005) and Loch Alsh – Duich – Hourn (2005). Despite lengthy discussions, no agreement had been reached for the Loch Broom – Little Loch Broom area. Salmon farm production cycles were synchronised in the Loch Torridon AMA area, the Loch Carron AMA area and Loch Alsh-Duich-Hourn AMA area. However, because of the small size of the company and need to maintain steady supply of fish, WRF sites in the Loch Broom area remained unsynchronised.

3.5 Numbers of wild fish vs. numbers of farmed fish in WRFT area: towards an understanding of infection pressures in Wester Ross

The sea louse *Lepeophtheirus salmonis* is host-specific to salmonid fish (salmon and sea trout). An understanding of the dynamics of *L. salmonis* populations requires an understanding of the occurrence and distribution of suitable host fish. Occasionally immature *L. salmonis* are found on other fish (e.g. sticklebacks) but there is no evidence that they are able to grow to become adult lice except on salmonids Revie et al 2009. Wild fish can act as hosts for lice which produce larvae that infect farmed fish; farmed salmon can act as hosts for lice which produce the larvae that infect wild fish. Around Wester Ross wild and farmed fish share the same waters, though the relative numbers of wild fish and farmed fish vary from sea loch to sea loch.

The following estimation of relative numbers of wild vs. farmed fish follows that of Butler (2002). In addition to ‘wild salmon and sea trout’ and ‘farmed salmon’, Butler 2002 and others have suggested that ‘escaped farmed salmon’ may also contribute to infection pressure in coastal waters.

Wild fish

Of wild fish in coastal waters around Wester Ross, adult salmon and sea trout that have been in the sea for longer than about 8 weeks (see Figure 2.2) may host ovigerous sea lice that can act as sources of infection for other fish. Salmon smolts leave coastal waters within a few days of entry from freshwater, and are not considered to remain in coastal waters long enough to host ovigerous lice that can act as sources of infective larval lice; until they return. Crude estimates of the number of wild fish in local waters can be made using information from net catches, rod catches, trap catches and from estimates of smolt production based on the accessible area of suitable productive habitat in WRFT rivers (as presented in WRFT River Fishery Management Plans – see Cunningham, 2008).

Salmon numbers

Historically, the most productive salmon river system for rod fishing was the Gruinard, followed by the River Ewe system, Carron, Broom, Little Gruinard and Ullapool (see Table 3.1).

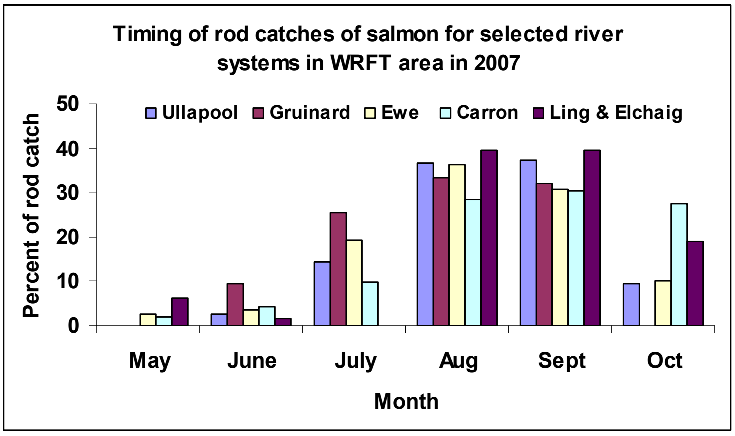
Table 3.1 *Highest recorded rod catches of salmon taken from rivers in WRFT area (from north to south) in recent decades to provide indication of productive potential. From the mid 1980s, escaped farm salmon may have been represented in some of the high catches (e.g. Balgy, where farm salmon which escaped as smolts may have been included) although in recent years these have been recorded separately where anglers have recognised them as such.*

River	High rod catch of salmon	Year
Kanaird	95	1986
Ullapool	(269) 122	(1927) 1985
Lael	5+	1970s
Broom	163	1974
Dundonnell	76	1987
Gruinard	450	1978
Little Gruinard	130+	late 1980s
Ewe	394	1979
Kerry	20+	?
Badachro	42	1973
Torridon	30+	?
Balgy	65	1987
Applecross	100+	?
Carron	262	2007
Ling	105	1985
Elchaig	50+	?
Croe	130	1974
Shiel	97	1987
Glenmore	63	1980
Glenbeag	14	1980
Arnisdale	65	1981
Barrisdale	5	1970 & 1980

In addition, netting stations took many more salmon from some areas, including, until the 1980s, typically 1,500 – 3,000 fish per year respectively from Gruinard Bay, Red Point and the Loch Duich – Glenelg area. Many of these fish (particularly in south) would have been destined for rivers out with the WRFT area. Based on rod catches representing 10 – 15% of the salmon run, during the ten year period, 1998 – 2008, the number of adult salmon returning to rivers within the WRFT area between May and October is likely to have been in the region of 10,000- 15,000 salmon and grilse. Note however, that rod catches during recent years have been below historic 'highs' for most systems. It is unlikely that at any point in time more than a few thousand adult salmon would have been present in any sea loch. Few adult wild salmon, except kelts as they return to the sea, are likely to be present in coastal waters during the critical period for sea lice infection, March to May.

In recent years the main runs of salmon returning to rivers in Wester Ross have been from mid June - July onwards. Returning adult salmon are not thought to linger in coastal waters, except when held up in river estuaries by low flows. In June 2008, two adult salmon caught in the Kanaird estuary by the sweep net, may have been delayed from entering freshwater by low flows.

Figure 3.6 Timing of rod catches of salmon for selected river systems in Wester Ross



From calculations presented in WRFT fisheries management plans based on habitat surveys and juvenile fish data, the River Ewe is thought to have the potential to produce the highest numbers of wild salmon smolts (Table 3.2). Although salmon smolts may become infected with sea lice in local waters as they set off on their migration, because of the time it takes for lice to develop, salmon post-smolts are not considered likely to host ovigerous lice that could contribute to sea lice infection pressures in local waters until their return as grilse or as adult salmon, as discussed above.

Table 3.2 *Estimated potential maximum wild salmon smolt output from some major river systems in WRFT area. Figures are from respective WRFT Fisheries Management Plans.*

System	Riverine habitat	Loch habitat	Total
Kanaird	10,298	224	10,522
Ullapool	9,671	3,125	12,796
Broom	6,914	0	6,914
Dundonnell	3,166	0	3,166
Gruinard	16,939	2,759	19,698
Ewe	28,620	21,225	49,845
Balgy	2,360	3,085	5,455
Carron	16,507	Not estimated	16,507+
Ling	9,892	0	9,892

Sea trout

Rod catches of sea trout from river systems in Wester Ross suggest that the number of sea trout entering river systems was comparable to the number of salmon in the past, except for the River Ewe system where there were many more sea trout (Table 3.3). Note however, that since the 1990s, sea trout catches were much lower than historic levels for all systems (Carron rod catch records are incomplete for earlier years) and stocks depleted (see FRS Statistical Bulletins). Net meshes used at netting stations were often too coarse to catch sea trout, except larger fish. These figures provide only an indication of 'maximum' catches of fish in respective systems.

Table 3.3 *High recorded rod catch of sea trout taken from some major rivers in WRFT area (from north to south) in recent decades to provide indication of productive potential.*

River system	Highest recorded rod catch of sea trout	Year
Kanaird	139	1986
Ullapool	81	1982
Broom	143	1982
Dundonnell	125	1988
Gruinard	292	1984
Ewe	2,994	1980
Balgy	300	1980
Carron	150	2005
Ling	109	1990

Wester Ross sea trout are believed to remain largely within coastal waters, at least in the first summer at sea (c. FRS Shieldaig Project Reports: Raffell et al, 2006, 2007). In addition to sea trout smolts, over-wintered finnock and sea trout return to the sea in the spring. Some Wester Ross sea trout may remain in the sea through winter months, though numbers are thought to be low (Walker, *pers comm*.). The number of sea trout in coastal waters is therefore likely to be higher than salmon for most of the year in some sea lochs. In Loch Ewe, the sea trout population, consisting mainly of post-smolts and older sea trout may be as high as 20 - 30,000 fish from May through to July. As most fish return to freshwater in the late summer and autumn, the number of sea trout over-wintering around the WRFT coastline would have been small, and unlike to have exceeded a few thousand fish in 2008.

Little is known about relative numbers of salmon and sea trout smolts. In 2008, a smolt trap was operated on the River Carron; the total number of sea trout smolts trapped was approximate 1/10th of the number of unmarked salmon trapped (Kindness, pers comm.). At the WRFT Tournaig trap, the maximum recorded sea trout smolt run was estimated at 490 smolts in 1999; the maximum salmon smolt run was a little higher at 607 smolts in 2007. Only in the River Ewe - Loch Maree system is the number of sea trout smolts entering the sea likely to be as high, if not higher than the number of salmon smolts.

To summarise, populations of wild salmon and sea trout in the coastal waters of Wester Ross are unlikely to have exceeded 100,000 fish at any time during the year (2008) except, perhaps for a brief period during the salmon smolt migration period in April and May when emigrating salmon smolts were present (emigrating salmon post-smolt would not have contributed to local sea lice infection pressure).

Where would infection pressure be highest?

The highest numbers and concentrations of wild fish returning to or migrating from a river system could be anticipated in Loch Ewe given the size and estimated productivity of the River Ewe system, with much higher numbers of sea trout smolts and older fish in Loch Ewe than other sea lochs in the area. However, even within Loch Ewe it is hard to envisage a scenario where more than 20,000 wild adult salmon and sea trout would be present within Loch Ewe at any point in the year.

Little is known about the movements of salmon and sea trout between sea lochs in the area, and through the area from river systems to the north and south. The Loch Alsh – Duich area is another area where relatively high numbers of salmon and sea trout may occur during the period May – August, compared to other sea lochs in the area.

Farmed fish

Most salmon farming companies operate a two-year production cycle. Salmon smolts, typically of around 60g weight are stocked in the autumn or spring following fallow period of a few weeks. After approximately 12 months, some fish have reached 3kg and harvesting can begin. By this time the on-site biomass of farm salmon will be just below the consented maximum. A salmon farm with a consented biomass of 1,000 tonnes would have approximately 0.5 million fish if the average weight of a farmed fish was approximately 2kg.

Based on consents and production, in 2008 the farmed salmon population in marine cages around within the WRFT area would have exceeded 8 million fish, with the highest concentrations in Loch Carron-Kishorn area, Loch Torridon, Loch Alsh, Duich – Hourn AMG areas (see Figure 3.5). The only salmon farm in operation between Loch Gairloch and Little Loch Broom (inclusive) was the salmon farm in Loch Ewe with 500,000 or more fish.

<u>Conclusions</u>

- About 99% of the suitable hosts for *Lepeophtheirus salmonis* sea lice around the WRFT coastline in 2008 would have been farmed salmon, with a maximum of about 1% of wild fish.

- The proportion of wild fish carrying ovigerous sea lice would have increased from May until August as sea trout numbers and returning adult salmon numbers peaked in coastal waters. (There is very little evidence of more than a few sea trout overwintering in coastal waters carrying ovigerous sea lice).

- The proportion of wild fish to farmed fish may have been highest within the WRFT area in Loch Ewe, given the proximity of the River Ewe system, and lowest in Loch Kishorn given the high biomass of farmed salmon and relatively minor freshwaters systems entering the loch.

- An unknown number of escaped farmed salmon may also act as hosts for ovigerous lice in some years. Catches suggest that in 2008 up to 30% of adult salmon in some areas may have been escaped farm salmon (Loch Long net catch, FRS data).

Understanding and managing sea lice infection pressure

Because of the much larger number of farm fish than wild fish in local waters, even very low infestation rates of sea lice on farmed salmon would have resulted in larger numbers of sea lice *larvae* being released into coastal waters from farmed fish hosts than wild fish hosts (c. Boxaspen, 2006; Skilbrei and Wennevik, 2006).

The aquaculture industries guidance document ‘A CODE OF GOOD PRACTICE FOR SCOTTISH FINFISH AQUACULTURE’ [CoGP] takes no account of the numbers of farmed fish within an area when suggesting targets for sea lice management.

This document suggests the criteria for treatment should be as follows (from CoGP 3.4.3.8):

i) During the period February to June inclusive, coinciding with the appearance of wild juvenile salmonids in the sea, the criterion for treatment is an average of 0.5 adult female ***L. salmonis*** per fish.

ii) During the period July to January inclusive, the criterion for treatment is an average of 1.0 adult female ***L. salmonis*** per fish.’’

So far as the management of infection pressures for wild fish is concerned, this guidance may be inadequate. If a salmon farm doubles in size, there is nothing in the Code of Good Practice to recommend that lice levels per fish be reduced by 50% to maintain the status quo.

For progress to be made towards a sustainable solution to safeguard wild fish populations, an understanding of relative infection pressures from wild and farmed sources within and beyond AMA areas needs to be constantly reviewed. At area management group [AMG] meetings, data which shows lice numbers per farmed fish have been very low does not provide any indication of actual infection pressure unless all participants concerned with ‘managing’ sea lice within the area have knowledge of the number of fish on the farm. What is important is not how many lice there are per farmed fish or wild fish, but how many lice there are in the total population within the area in question. Even when the numbers of ovigerous lice per fish on farmed fish is an order of magnitude (10x) less than that on wild fish, if there are two orders of magnitude (100x) more farmed fish than infected wild fish within the area, the total number of ovigerous lice on farmed fish and the corresponding infection pressure from farmed sources will be 10x that of wild sources[4].

---

[4] For example, if each wild fish harboured an average of 1 ovigerous sea louse and there were 100,000 wild fish in the area, then there would be 100,000 ovigerous lice on wild hosts. If each farm fish had only 0.1 ovigerous louse, and the farm fish population was 10 million, then there would be 1 million ovigerous lice on hosts in fish farms, or ten times more than on wild hosts. At a more local level, the same estimates can, and perhaps should be developed, to compare the relative abundance of ovigerous lice on wild and farmed salmon and sea trout.

The total ovigerous lice population on a salmon farm of 1,000,000 fish with 0.5 ovigerous lice per fish would be 500,000 ovigerous lice. In the crucial period from March to May, such a level of sea lice would represent an infection pressure in surrounding waters of at least one and possibly two orders of magnitude higher than from the ovigerous lice population on wild fish, based on the foregoing estimates of wild fish abundance.

4. Review of sea lice monitoring of wild fish in WRFT area in 2007 to 2008.

4.1 Why monitor sea lice on wild sea trout?

Against a background of declines in sea trout populations, reports of high numbers of sea lice on wild fish and plausible explanatory links to salmon farming in nearby waters, WRFT initiated a programme of sea lice monitoring in 1996. The initial aim of sea lice monitoring was to provide information on the extent and magnitude of sea lice infection of wild sea trout, focussing on the month of June when earlier work had indicated that post-smolt sea trout carrying high levels of sea lice could be caught in river estuaries.

Results of sea lice monitoring studies in Ireland (Gargan et al 2003), and West of Scotland (Butler 2002) supported the hypothesis that nearby salmon farms were a major source of lice in areas where sea trout carried high levels of infection. Furthermore, data from the WRFT Poolewe gill net site, and the FRS Shieldaig Project for years up to 2006 suggested a correlation between lice abundance and salmon farm production cycles in nearby areas (Figure 4.18 & 4.19). Sea lice levels, both in plankton samples in Loch Torridon, and on post-smolt sea trout at Poolewe were highest when nearby salmon farms were in their second year of the salmon farm production cycle (Raffell *et al,* 2007; Cunningham *et al,* 2008). [This is reviewed in part 4.4].

From 2003, sea lice monitoring was funded by Highlands and Islands Enterprise, then from 2006 by the Scottish Government under the auspices of the Tripartite Working Group. From 2008, WRFT received support from the Scottish Government to undertake a new programme of sweep netting for sea trout within the area. The stated aims of monitoring were to inform wild fisheries and farmed fish interests, and Area Management Groups where they were active.

This section of this report presents analyses of available sea lice data collected in the WRFT area during 2007 and 2008. The aim of this review is to consider contemporary relationships between sea lice occurrence on wild fish in the WRFT area and salmon farming in the area in 2007 and 2008. The hypotheses that I attempt to evaluate are:

> ***1.*** *sea trout were infected with higher burdens of sea lice at sites closest to active salmon farms*
> *(null hypothesis: there was no difference in lice burdens on sea trout in relation to distance from active salmon farms)*

This led on to more refined hypothesis:

> ***1a.*** *sea trout were infected with higher burdens of sea lice at sites closest to salmon farms in the second year of the production cycle*
>
> ***1b.*** *sea trout were infected with higher burdens of chalimus sea lice at sites closest to salmon farms in the second year of the production cycle.*
>
> ***1c.*** *sea trout were infected with higher burdens of pre-adult and adult sea lice at sites closest to salmon farms in the second year of the production cycle*

4.2 Methods and locations

Sampling

In 2007 and 2008 live sea trout were sampled using traps, nets, and rod and line.

At **Poolewe**, the use of **gill nets** continued in 2007 as in previous years at the river mouth site behind Pool House Hotel. The objective was to catch a sample of up to 30 post-smolt sea trout during the month of June. One (or two) 22mm mesh size gillnets were set for a period of one hour over high tide and supervised throughout, 5 or 6 days per week. As soon as a fish was captured, it was removed from the net to minimise stress and trauma. As elsewhere, fish were anaesthetised prior to processing; and released back into the estuary after recovery. Ben Rushbrooke and David Mullaney operated the net, with help from Peter Cunningham and Ray Dingwall. Willy Hardy kindly provided a small rowing boat.

At **Dundonnell,** the **fyke net** was set in the river estuary towards the top of the tide in early June in both years in as near the same place as in previous years as possible. In 2007 the trap was operated by Johnie Parry (Ardessie Salmon), Alastair Macdonald (Dundonnell Estate) and Brian Fraser (Eilean Darroch Estate). In 2008 the estates operated the trap with help and supervision from Johnie Parry and Peter Cunningham. The efficiency of the trap was sometimes compromised by periods of high flows and adverse weather. However, the objective was to obtain a sample of up to 30 early returned post-smolt sea trout within the month; and earlier experience had indicated that during years of lice epizootics, this number would be readily reached.

In 2007, **rod and line** was used to catch samples of sea trout in the **River Ewe and River Kanaird**, following reports of infection from ghillies. The objective was to gather data from a large enough sample of fish to clarify the scale of lice infection. Additional samples were collected to gain an understanding of the duration of an epizootic and overall impact on sea trout populations, including a sample subsequently examined by FRS Fish Health Inspectorate, which confirmed all lice on the sampled fish were *Lepeophtheirus salmonis* rather than *Caligus*.

In 2008, **sweep netting samples** were taken from six sea lochs within the WRFT area. The sweep netting programme was initiated as an extension of protocols used in other parts of the west of Scotland at the request of TWG, in order to develop greater standardisation of sampling methodology. Sweep net sampling was carried out using a 50 m x 3m deep sweep net with a stretched mesh of 15 mm. This being the first year that sweep netting had been carried out in Wester Ross there were no established sites (Hayes, 2008). Local ghillies, factors, and river owners amongst others were consulted, and a number of sites were examined for suitability. Of those tried, the 6 sites were chosen with the aim of netting each site 4 or more times between May and July. Sampling took place in Loch Kanaird (River Kanaird Estuary), Little Loch Broom and Loch Loch by Ailsa Hayes and helpers; and from Loch Ewe, Loch Gairloch and Loch Carron (River Carron Estuary) by Peter Cunningham, assisted by David Mullaney, Roger McLachlan, Ben Rushbrooke, Ben Hadfield, and at the River Carron by Jim Raffell, Steve Buttle, Bob Kindness and Richard Wilson. Thanks also to all other helpers (please see acknowledgements.). Sites were netted on the turn of the tide at low water (Kanaird, Loch Long, River Carron) or just before high tide (Loch Kerry, Boor Bay).

After capture, all fish were anaesthetised, measured and examined. The Standard Length (± 1 mm) and weight (± 1 g) were recorded and a scale sample taken. The fish were examined for the presence of sea lice, which were counted and staged. *Lepeophtheirus* and *Caligus* sea lice were not separated in 2007, except in a few cases where adults were distinguished and at sweep netting sites in 2008. Numbers of lice in each of 3 categories (*chalimus* [attached stages]; preadults and adult males [mobile stages]; ovigerous females [with trailing egg sacs]) were counted. The tub in which the fish were anaesthetised was checked for any dislodged lice which were recorded (though these lice have not been included in the analyses that follow later in this report unless it was clear which fish they had been dislodged from).

In previous years when samples of early-returned post-smolt sea trout were frozen and sent to Glasgow University for laboratory examination, small numbers of *Caligus* (less than 10 per fish) were recorded on some fish; over 90% of lice identified on these samples were *Lepeophtheirus.* On post-smolt sea trout taken by rod and line from the River Ewe in June 2003 and examined at FRS Aultbea Marine Cultivation Unit, both *Lepeophtheirus* and *Caligus* were recorded. However, the report from the FRS Fish Health inspector provides no details of relative numbers of the two species. To date, all recorded lice epizootics associated with early-returned post smolt sea trout have been attributed to *Lepeophtheirus* infestation. For the analyses presented, the possible occurrence of small numbers of mis-identified *Caligus* in a sample is not considered to affect the interpretation of results (see part 4.4.1).

Any other parasites or damage to the fish from predators or sea lice were also noted. Scale samples were taken for future reference; adipose fin clips were taken for subsequent DNA analyses and to enable recognition of fish if they were recaptured. In 2008, some fish were tagged using numbered visual implant tags injected into the clear tissue behind the eye of larger sea trout. After a period of recovery, fish were released.

Data analyses

‘Samples’ of fish used in the analyses are of three fish or more (c. Gargan *et al* 2003). For sweep netting, a sample is normally the group of fish taken during the sweep net session on the day. This may be the total catch of fish from several sweeps in the same area. For rod and line sampling, a sample comprises the catch of fish taken during the fishing session on a particular day and place.

However, where numbers of fish caught in a day were small, fish taken over a period of days within a month have been grouped to make up a sample where considered appropriate (e.g. fyke net and gill net sample). Samples are therefore not of equal size, nor do they represent groups of fish caught within an equal time period. These factors are taken into account for the analyses that have been presented.

Of the 404 sea trout in the data set, 398 have been included in a sample in this way. Those not included in the sample analyses are the one fish caught in a sweep at Lochcarron away from the Carron river mouth; and 5 fish caught in the River Ewe above the tidal pool in August 2007 which had clearly been in the river for a long time and had lost their sea lice.

For each fish:

- the **condition index** for the fish was calculated from the length and weight such that: Condition Index = 100 x weight in grams / (length in cm)^3, where
- the **length** is the standard length (to fork of tail).

For a sample of fish (e.g. taken on one day’s sweep netting, or a single rod and line fishing, or a month’s fyke net catch):

- the **abundance** of sea lice is the mean number of lice per fish of all fish in the sample.
- the **prevalence** of sea lice is the % of fish in the sample which had sea lice on them.
- the **intensity** of infection is the mean number of lice per infected fish in the sample.

All sea trout of less than 26cm caught were treated as a separate group. These have sometimes been referred to as ‘post smolt’ sea trout, though in some situations sea trout on their second or subsequent marine excursion may have been included in this group. This can usually be established by scale reading, though not always if a fish has had only a brief non-feeding excursion to the sea the previous year.

To investigate relationships between sea lice abundance, sea trout condition factor, distance to nearest salmon farm, and distance to nearest salmon farm in the second year of the production cycle, data from all samples (sweep netting, gill netting, rod and line, has been used. Data was compiled and analysed using MS Excel. For plotted data, trendlines with equation and r^2 value (goodness of fit) were fitted automatically. The full data set used in these analyses is included in Appendix 1, and summarised in Tables 4.1 and 4.2.

The data set remains small relative to studies such as Gargan *et al* 2003, and Butler 2002. Hypothesis proposed could be further tested by incorporating data from other sea lice monitoring sites in the West of Scotland and beyond (see recommendations), by a ‘RAFTS’ biologists’ working group, or a reformed TWG Scientific working group.

4.3 Results of sea lice monitoring in 2007 and 2008 in relation to salmon farming

4.3.1 Introduction

The full data set (404 fish) for sea lice monitoring in the WRFT area in 2007 and 2008 is presented in Appendix 1. This data set excludes data collected by FRS in Loch Torridon, but includes the results of fyke net sampling (2007 & 2008), gill net sampling (2008), rod and line sampling (2007 and 2008), and sweep net sampling (2008) for the WRFT area (Kanaird, Little Loch Broom, Boor Bay, Kerry Bay, River Carron, Loch Long (Elchaig). The results of sweep net sampling in 2008, including sites in west Sutherland (to the north of the WRFT area) have already been presented by Hayes (2008).

398 fish were grouped into 'samples'. Results of samples have been summarised in Table 4.1 and Table 4.2. These results have been used to investigate relationships between sea lice occurrence, sea trout condition, distance to the nearest active salmon farm, and the distance to the nearest salmon farm in the second year of the production cycle.

4.3.2 Numbers of lice on sea trout

Table 4.1 shows the abundance, prevalence and intensity of sea lice for all fish included in respective samples.

Samples with over 50 lice were collected in both years and from all areas sampled at some time in the period (2007 -2008). Samples with sea lice abundance of over 50 were as follows (north to south):

- River Kanaird sweep net (28 May 2008)
- Dundonnell River fyke net (June 2007)
- River Ewe sea pool by rod and line (May 2007)
- River Carron sweep net (May 2008)
- Loch Long (Elchaig Estuary) sweep net (May-July 2008)

All these sites are in river estuaries.

Samples with sea lice abundance of 20 or less were as follows (north to south):

- River Kanaird sweep net (8 May 2008)
- Little Loch Broom sweep net (May 2008)
- Boor Bay sweep net (May 2008)
- Boor Bay sweep net (Jul-Aug 2008)
- River Ewe rod & line (July 2007)
- Kerry Bay sweep net (May-June 2008)
- Kerry Bay sweep net (July-August 2008)
- River Carron sweep net (July 2008)

Sites at Boor Bay and Kerry Bay were beach sites, further away from river estuaries. None of the samples from these sites had abundance of over 20.

Table 4.1 Summary data for used in analyses sea trout (all sizes and dates of capture).

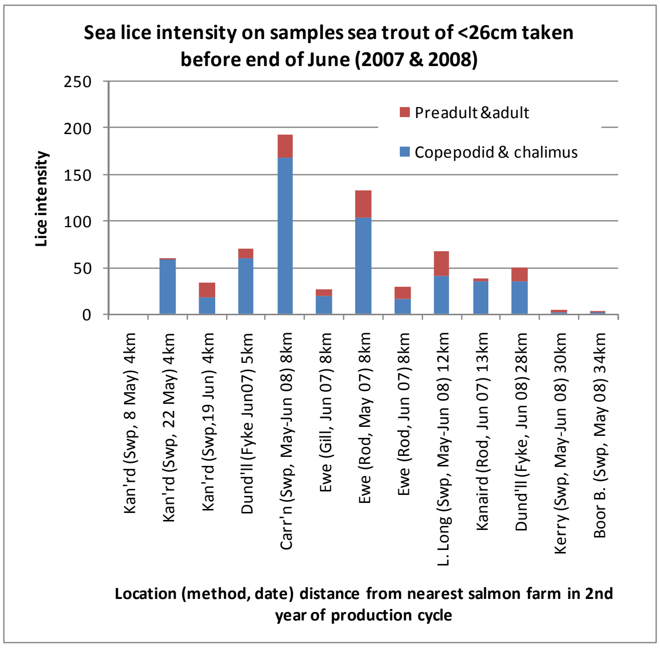
Location	Method	Date	Number of fish		*Lepeophtheirus salmonis*								Distance (km) to nearest farm in 2nd year
					All lice				Copepodid & chalimus		Pre-adult and adult		
			Total	Infected	Total	Abundance	Prevalence	Intensity	Total	Intensity	Total	Intensity	
Dundonnell	Fyke net	Jun-07	20	17	1130	56.50	85.00	66.47	943	55.47	187	11.00	5
Dundonnell	Fyke net	Jun-Jul 2008	20	18	965	48.25	90.00	53.61	507	28.17	458	25.44	28
Ewe	Gill	Jun-07	24	22	787	32.79	91.67	35.77	641	29.14	146	6.64	8
Ewe	Rod	May-07	28	26	2569	91.75	92.86	98.81	2293	88.19	276	10.62	8
Ewe	Rod	Jun-07	38	37	1092	28.74	97.37	29.51	626	16.92	466	12.59	8
Ewe	Rod	Jul-07	38	37	666	17.53	97.37	18.00	416	11.24	250	6.76	8
Kanaird	Rod and line	28-Jun-07	10	8	342	34.20	80.00	42.75	316	39.50	26	3.25	13
River Ewe	Rod and line	Jul-Aug 2008	19	17	387	20.37	89.47	22.76	193	11.35	194	11.41	34
River Carron	Sweep	May-08	22	21	1300	59.09	95.45	61.90	1023	48.71	277	13.19	8
River Carron	Sweep	Jul-08	17	6	122	7.18	35.29	20.33	72	12.00	50	8.33	8
Loch Long	Sweep	May to July 08	7	7	378	54.00	100.00	54.00	227	32.43	151	21.57	12
Kanaird	Sweep net	08 May 2008	37	0	0	0.00	0.00	0.00	0	0.00	0	0.00	4
Kanaird	Sweep net	28 May 2008	33	31	1713	51.91	93.94	55.26	1681	54.23	32	1.03	4
Kanaird	Sweep net	19 June 2008	7	6	210	30.00	85.71	35.00	107	17.83	103	17.17	4
L Loch Broom	Sweep net	May-08	3	2	46	15.33	66.67	23.00	0	0.00	46	23.00	28
Kerry	Sweep net	May-Jun 2008	14	11	247	17.64	78.57	22.45	49	4.45	198	18.00	30
Kerry	Sweep net	Jul-Aug 2008	6	6	94	15.67	100.00	15.67	63	10.50	31	5.17	30
Boor Bay	Sweep net	May-08	40	26	86	2.15	65.00	3.31	63	2.42	23	0.88	34
Boor Bay	Sweep net	Jul-Aug 2008	15	13	50	3.33	86.67	3.85	19	1.46	31	2.38	34

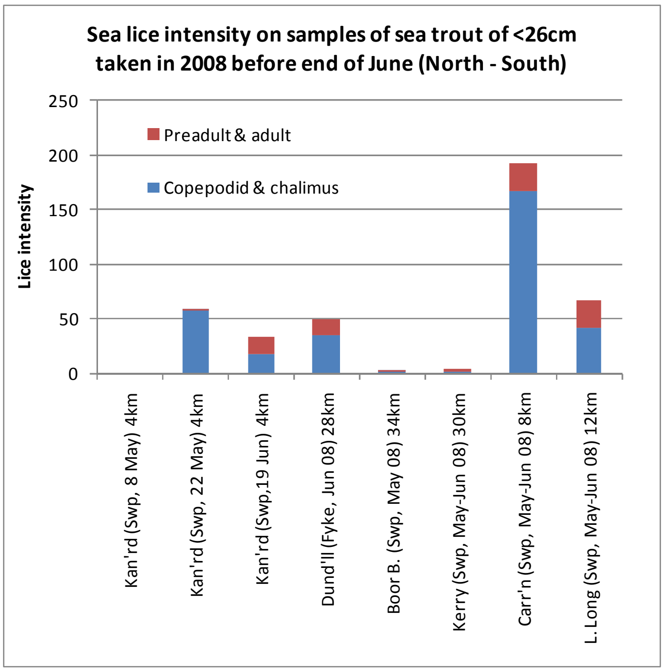
Table 4.2 Summary data use in analyses for sea trout of <26cm caught before the end of June.

Location	Method	Date	Number of fish		***Lepeophtheirus salmonis***							
					All lice				**Copepodid & chalimus**		**Pre-adult and adult**	
			Total	**Infected**	**Total**	**Abundance**	**Prevalence**	**Intensity**	**Total**	**Intensity**	**Total**	**Intensity**
Loch Long	Sweep	May-Jun 08	4	4	266	66.50	100.00	66.50	165	41.25	101	25.25
River Carron	Sweep	May-Jun 08	4	4	770	192.50	100.00	192.50	671	167.75	99	24.75
Kerry	Sweep	May-Jun 08	7	5	21	3.00	71.43	4.20	9	1.80	12	2.40
Boor Bay	Sweep	May-08	40	26	86	2.15	65.00	3.31	63	2.42	23	0.88
Kanaird	Sweep	8-May-08	37	0	0	0.00	0.00	0.00	0	0.00	0	0.00
Kanaird	Sweep	22-May-08	11	10	593	53.91	90.91	59.30	589	58.90	4	0.40
Kanaird	Sweep	19-Jun-08	7	6	201	28.71	85.71	33.50	101	16.83	100	16.67
Dundonnell	Fyke	Jun-08	11	9	442	40.18	81.82	49.11	312	34.67	130	14.44
Dundonnell	Fyke	Jun-07	18	15	1054	58.56	83.33	70.27	888	59.20	166	11.07
Ewe	Gill	Jun-07	18	17	435	24.17	94.44	25.59	321	18.88	114	6.71
Ewe	Rod	May-07	7	7	925	132.14	100.00	132.14	723	103.29	202	28.86
Ewe	Rod	Jun-07	32	31	888	27.75	96.88	28.65	480	15.48	408	13.16
Kanaird	Rod	28-Jun-07	9	9	342	38.00	100.00	38.00	316	35.11	26	2.89

Figure 4.1 shows the average numbers of lice on infected sea trout of less than 26cm in all samples. The highest intensity was for a pooled sample of only three sea trout taken in the River Carron estuary in May – June 2008. The lowest intensity was for a sweep net sample from the River Kanaird on 8th May of zero. Other samples with very low intensity were taken from Kerry bay and Boor bay.

Figure 4.1a Sea lice intensity on samples of sea trout of less than 26cm in length in 2007 and 2008. Distances are to the nearest salmon farm in the second year of the production cycle. Note that the Kerry and Boor Bay sweep net samples were taken by netting onto a beach; all other samples were taken in a river estuary. Figure 4b, the same data for sweep net samples only





Larger sea trout on average had more lice than smaller sea trout (Table 4.3 & Table 4.4), though because of the small size of the data set this relationship was only apparent by splitting the data set into quartiles (each of just over 100 fish). The maximum numbers of lice recorded on any fish in the quartiles was higher for the largest quartile than the lowest quartile. On average there were three or more times as many chalimus (attached) lice on fish than adult or pre-adult lice (mobiles). The maximum number of chalimus lice counted on any fish was 500 (sea trout in estuary of River Carron).

Table 4.3 Average and maximum numbers of sea lice on sea trout taken in WRFT sea lice monitoring samples in 2007 and 2008, grouped into quartiles. Based on data set presented in Appendix 1.

Quartiles

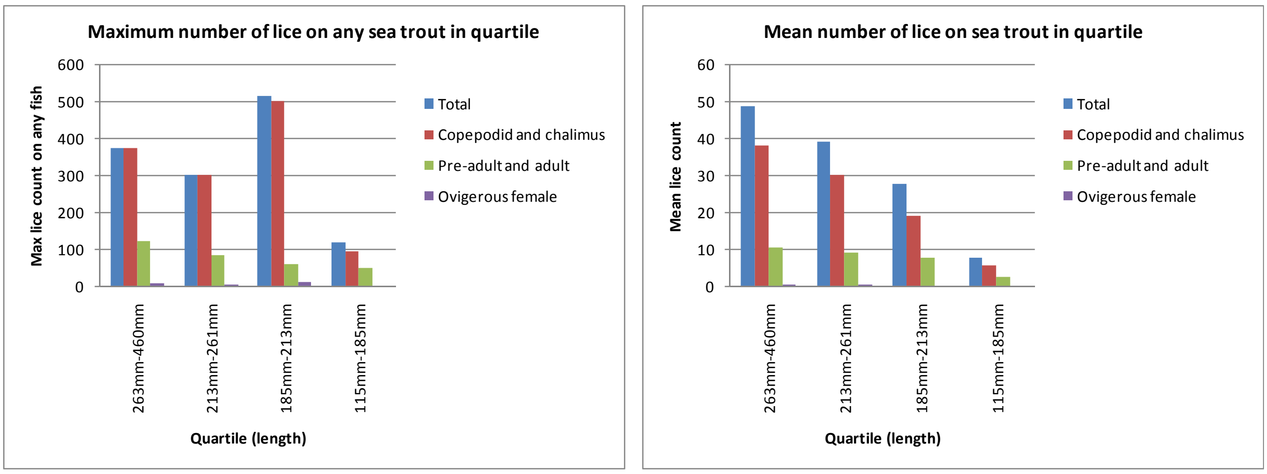
Sea trout length class	Mean length	Chalimus		Pre-adult and adult		Ovigerous female		Total	
(mm)	(mm)	maximum	average	maximum	average	maximum	average	maximum	average
263-460	318.6	372	37.9	120	10.2	7	0.3	374	48.5
213-261	234.9	300	29.9	82	8.8	5	0.3	300	38.9
185-213	199.2	500	18.8	60	7.5	10	0.2	513	27.6
115-185	162.9	93	5.4	47	2.3	1	0.1	118	7.7

Table 4.4 Average and maximum numbers of sea lice on sea trout taken in WRFT sea lice monitoring samples in 2007 and 2008 by length classes. Based on the data set presented in Appendix 1.

Sea trout length class	Number of fish	Chalimus		Pre-adult and adult		Ovigerous female		Total	
(mm)		maximum	average	maximum	average	maximum	average	maximum	average
>400	6	85	27.6	46	16	2	0.5	94	44.2
351-400	16	100	17.6	47	7.6	7	0.4	108	25.7
301-350	36	256	34.3	80	11.8	2	0.5	256	46.6
251-300	59	372	43.6	120	9	2	0.1	374	52.8
201-250	124	500	30.6	82	8.6	3	0.3	513	39.4
151-200	147	93	8.2	60	4.5	2	0.1	78	12.8
≤150	16	26	1.9	15	1.1	0	0	41	3

Figures 4.2 present the data from Table 4.3 graphically. Note that both the maximum number of pre-adult and adult lice and the mean total numbers of lice of all classes are highest on the larger fish quartile than on smaller fish quartile.

Figure 4.2 Maximum (Figure 4.2a) and mean (Figure 4.2b) numbers of sea lice on sea trout sampled in WRFT area in 2007 and 2008 in quartiles according to length.



In 2007, numbers of lice on sea trout taken by rod and line from the sea pool of the River Ewe in May were higher than in June or July (see Figure 4.3). The mean length of fish sampled in May was higher than in June (Figure 4.4). Some of the fish taken in June and July had scars indicating that lice had fallen off – indicating that they had been in freshwater for a week or more. So these counts may under represent the numbers of lice present on the fish upon entry to freshwater.

Figure 4.3 Numbers of lice on sea trout in samples taken from the River Ewe by rod and line in 2007, showing individual lice counts (Figure 3a) and mean lice intensity for infected fish taken during the month.

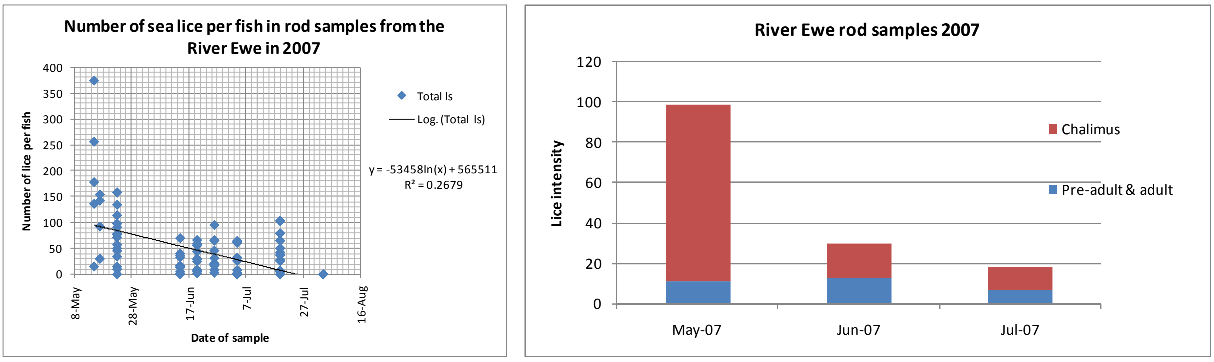
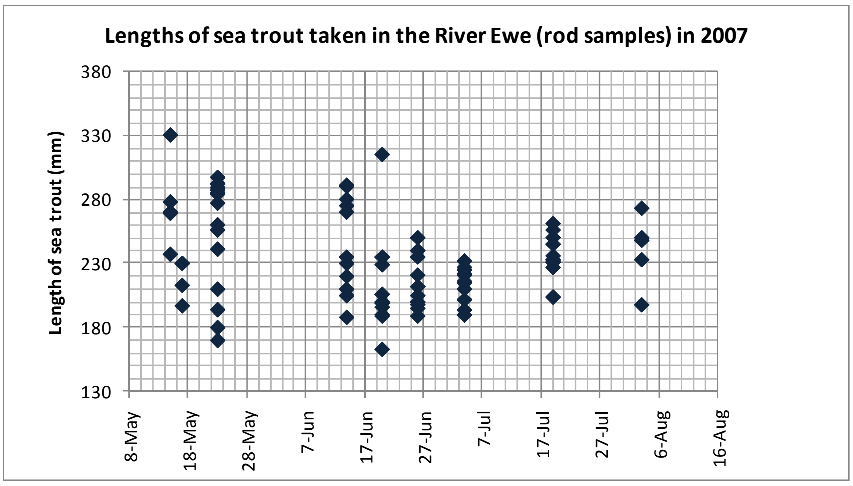
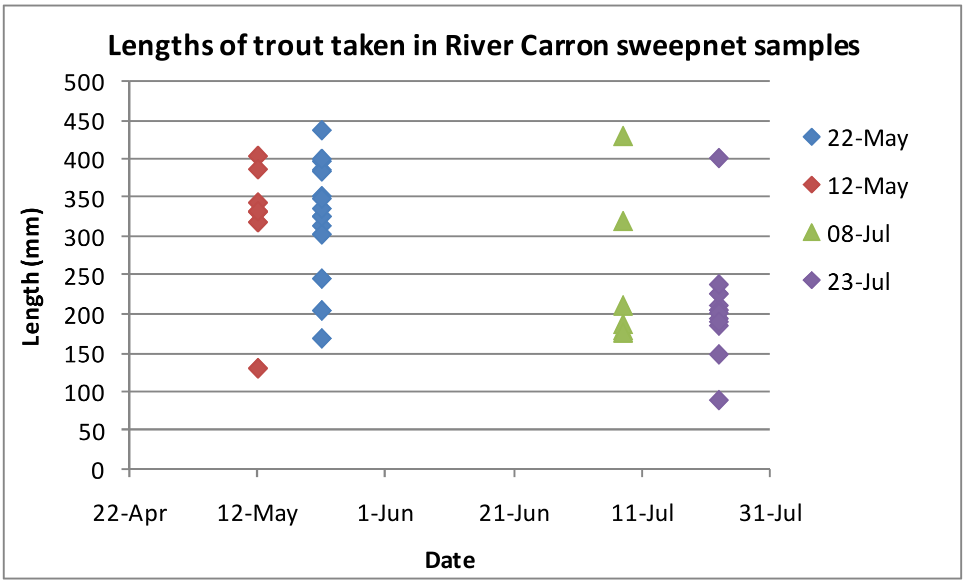


Figure 4.4 Lengths of sea trout taken from the River Ewe, from which lice counted in Figure 4.3.



In 2008, very few fish of less than 26cm were recorded in the catches from the estuary of the River Carron in May and June (Figure 4.5). Those that were caught were heavily infected. Larger sea trout generally had few lice. Some were thought to be slob (estuarine) trout due to yellow colouring on their flanks.

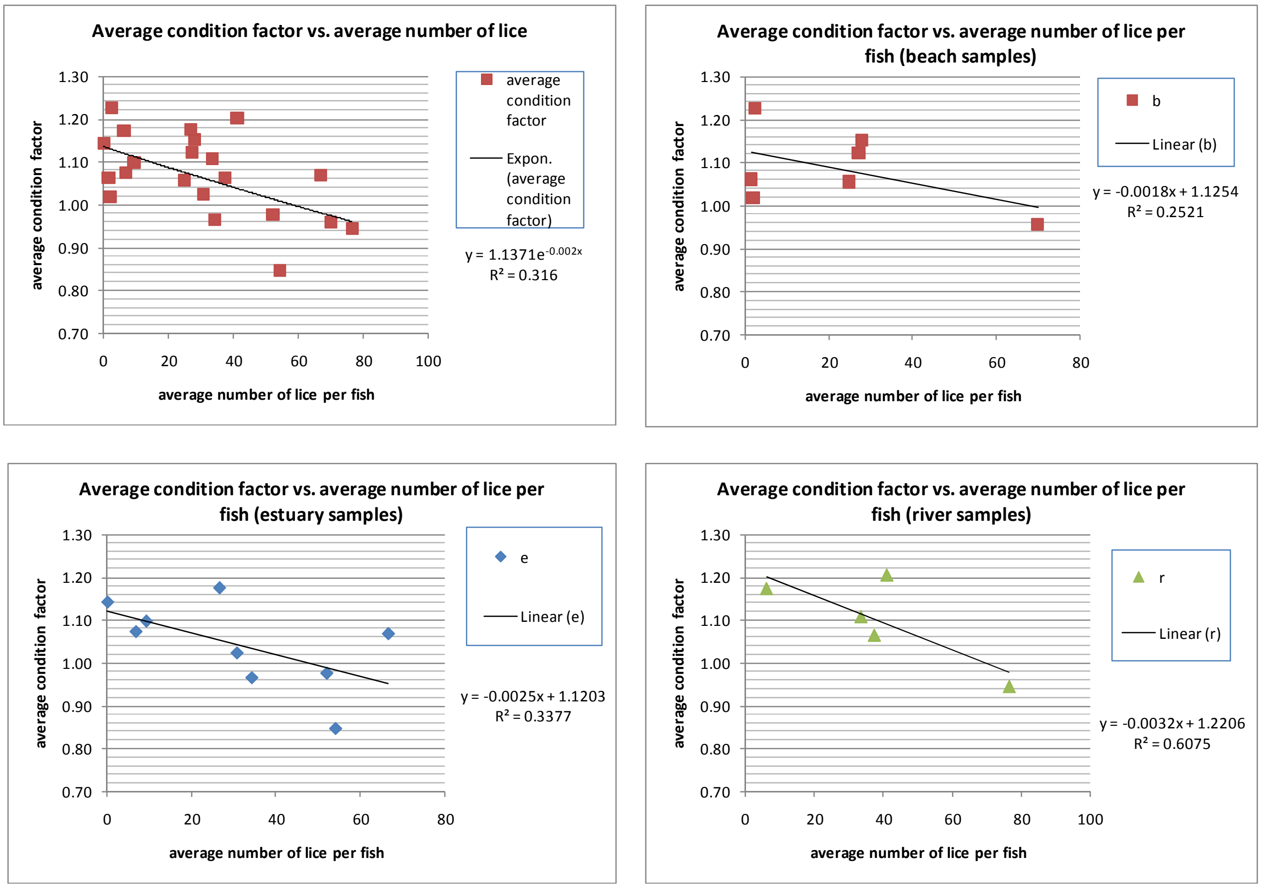
Figure 4.5 Lengths of sea trout taken in sweep net samples at the mouth of the River Carron in 2008.



4.3.3 Condition factor vs. Number of lice on fish

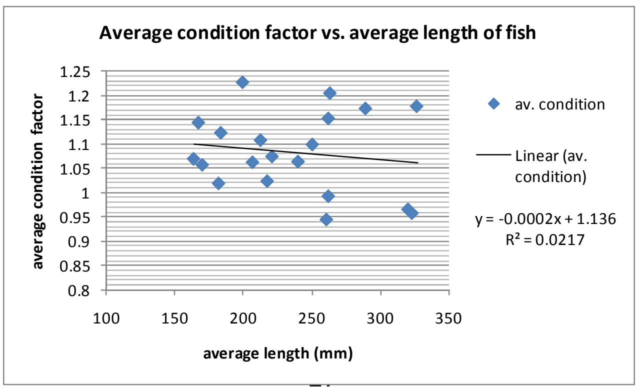
In 2007 and 2008, fish were individually weighed and a condition factor was calculated. Fish with the highest numbers of lice were in poorer condition than those with fewer lice, at river, estuary and beach sites (Figure 4.6).

Figure 4.6 Average condition of sea trout vs. average number of lice per fish for samples from rivers (highest tidal pool), estuary (lower tidal pools) and beach sites. All samples are combined in the first (upper left) graph.



There was no correlation between average condition factor and average length of fish (Figure 4.7)

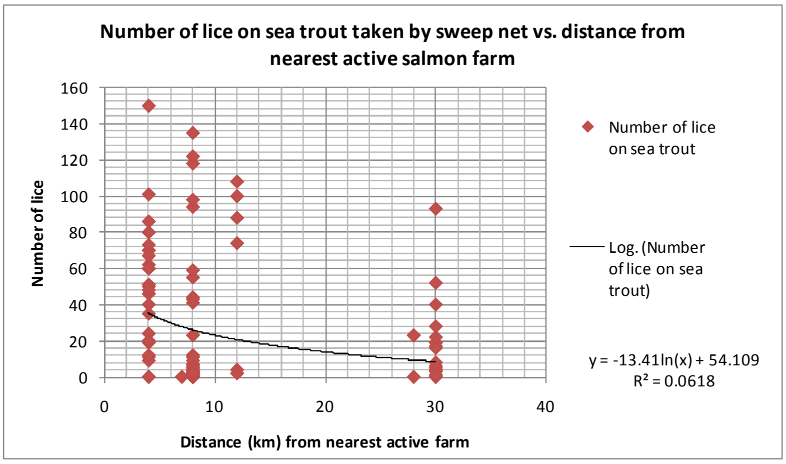
Figure 4.7 Average condition factor vs. average length of fish.



4.3.4 Sea lice vs. Salmon farm production

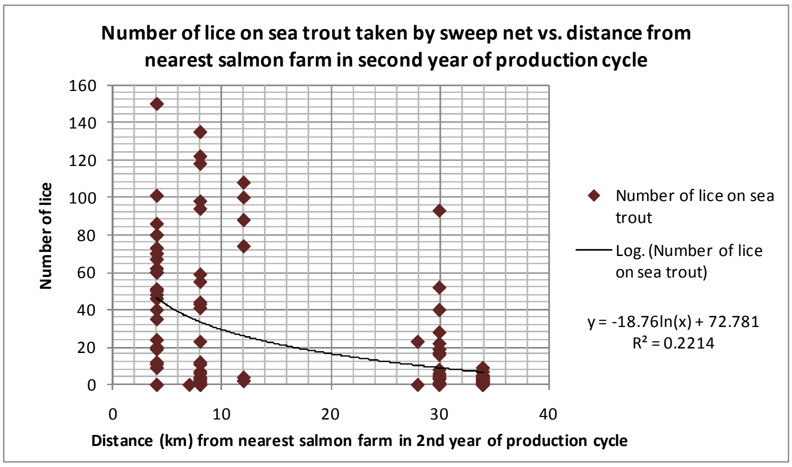
Relationships between lice numbers per fish, abundance or intensity, and distance from fish farms are explored in Figures 4.8 to 4.14. For sweep net samples, there were usually more lice on fish taken in closer proximity to an active fish farm (Figure 4.8) than further away but the trend is weak. The sample from the Kanaird River on 8th May has been removed from this analysis on the grounds that these fish were caught in the estuary early in the season and were on their way into the sea. [The assumption is reviewed from Figure 4.13 including this sample.]

Figure 4.8 Total numbers of lice per sea trout taken in sweep net samples taken in WRFT area in 2008 vs. distance from the nearest active salmon farm. Excludes fish taken in sample on 8th May 2008; a sea trout with 500 lice taken in the Carron in May 2008. Boor Bay samples have been limited to a random 20 fish per sample.



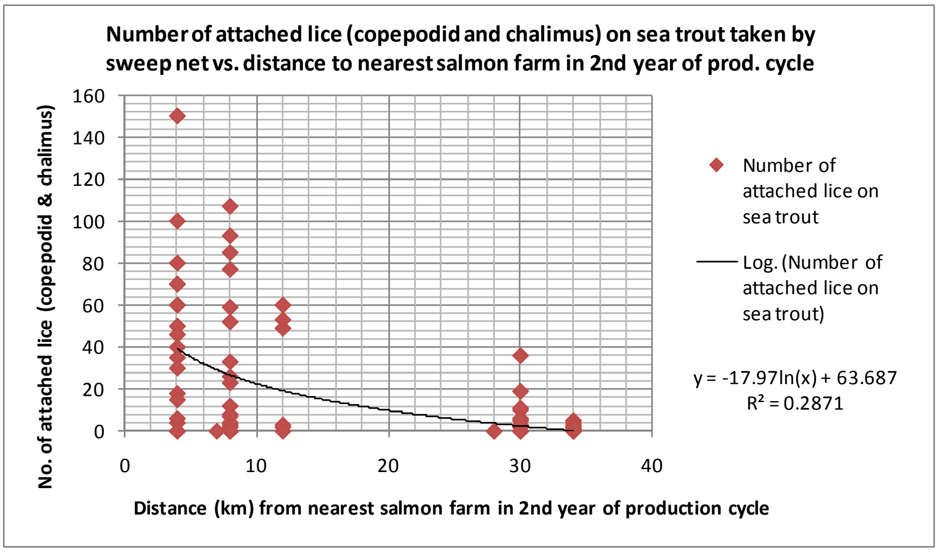
When the total number of lice per fish (same data) was plotted against the distance to the nearest salmon farm in the second year of its production cycle, a stronger correlation was observed (Figure 4.9).

Figure 4.9 Number of lice on sea trout taken by sweep net in WRFT area in 2008 vs. distance from the nearest salmon farm in the second year of the production cycle. Excludes fish taken in sample on 8th May 2008; a sea trout with 500 lice taken in the Carron in May 2008. Boor Bay samples have been limited to a random 20 fish per sample.



The strongest correlation was observed when data for the number of chalimus lice per fish was plotted against the distance to the nearest salmon farm in the second year of its production cycle. The trend line suggested an average of over 25 chalimus lice per fish sampled within 10km of a salmon farm in the second year of its production cycle, but less than 10 chalimus lice per fish further than 25 km from a salmon farm in the second year of its production cycle (Figure 4.10).

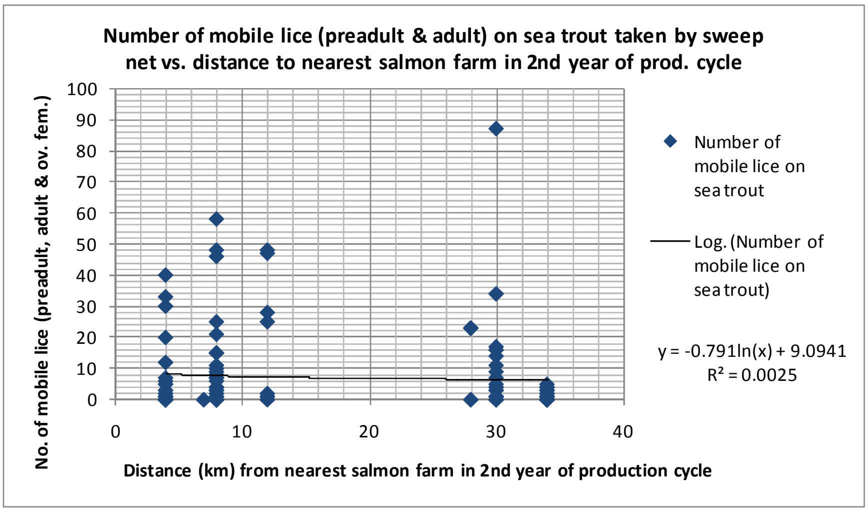
Figure 4.10 Number of chalimus (attached) lice on sea trout taken by sweep net in WRFT area in 2008 vs. distance from the nearest salmon farm in the second year of the production cycle. Excludes fish taken in sample on 8th May 2008; a sea trout with 500 lice taken in the Carron in May 2008. Boor Bay samples have been limited to a random 20 fish per sample.



Out of all the samples (398 fish), of the 73 sea trout with 50 or more copepodid or chalimus (attached) lice, only 5 were more than 20km from a salmon farm in the 2nd year of the production cycle. Out of all the samples, of 162 infected sea trout with 10 or less copepodid or chalimus lice, 62 were more than 20km from a salmon farm in the second year of its production cycle.

In contrast however, there was no correlation when the number of mobile (pre-adult and adult) lice per fish was plotted against distance to the nearest salmon farm in the second year of the production cycle (Figure 4.11).

Figure 4.11 Number of pre-adult and lice on sea trout taken by sweep net in WRFT area in 2008 vs. distance from the nearest salmon farm in the second year of the production cycle.



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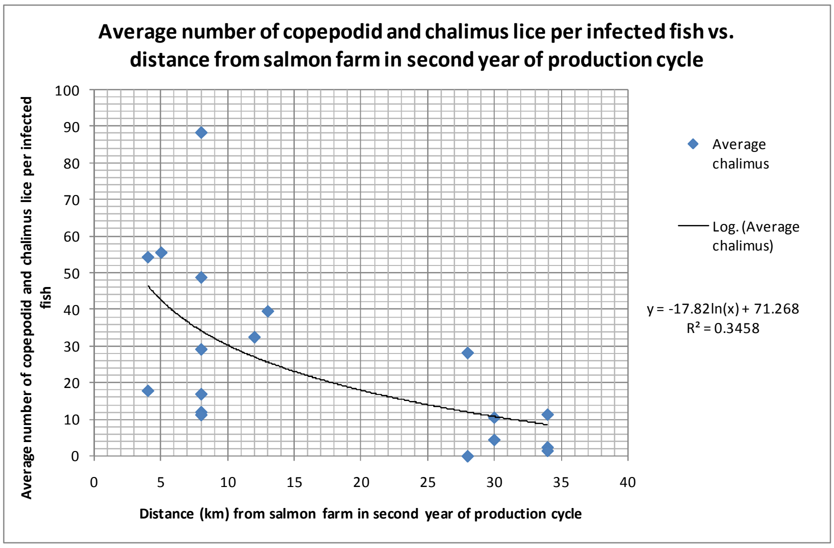
Relationships between lice infection of sea trout and distance to the nearest salmon farm were explored further by plotting the average numbers of lice *per infected fish* against the distance to the nearest salmon farm in the second year of the production cycle (Figures 4.12 – 4.14). Again, the Kanaird sample 8 May 2008 was excluded from the analyses on the basis that these fish were on their way to sea and none were infected.

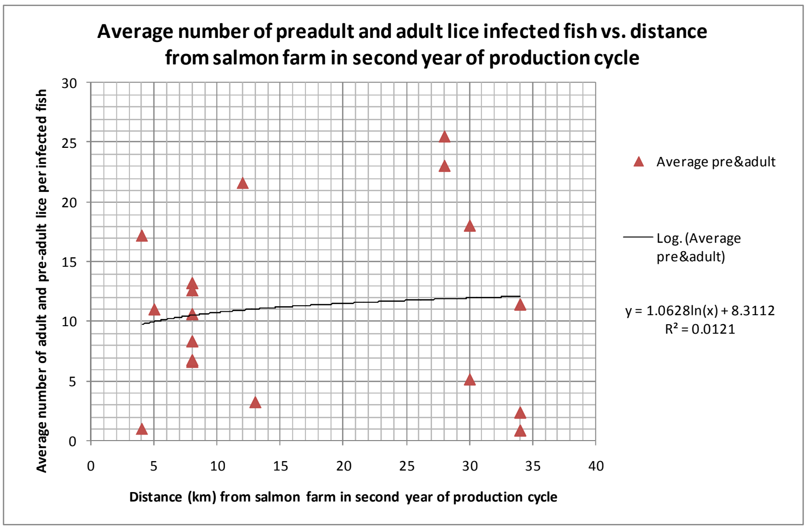
The strongest correlation was again for chalimus lice per infected fish vs. distance to the nearest salmon farm in the second year of the production cycle (Figure 4.12)

Figure 4.12 Average number of copepodid and chalimus lice per infected sea trout in samples vs. distance from salmon farm in second year of the production cycle (excluding Kanaird, 8 May 2008 sample)



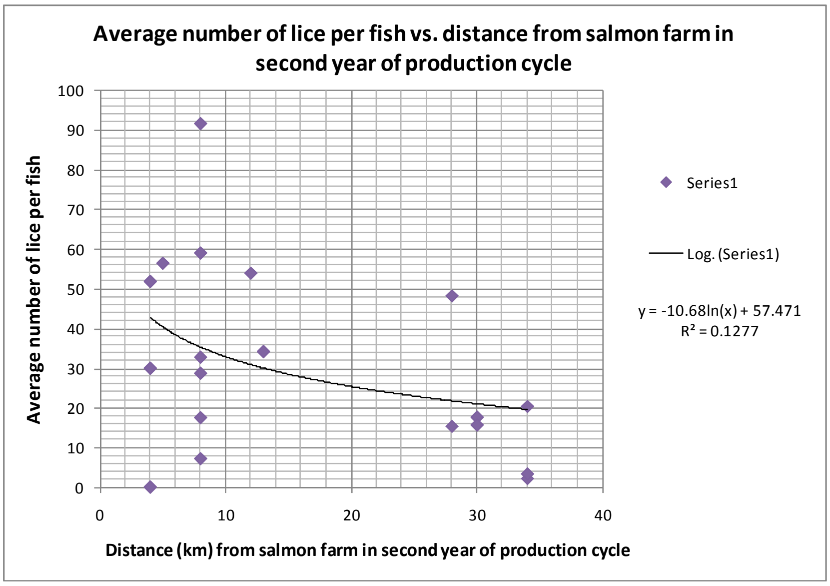
Other analyses again produced weaker correlations: there was a slight increase in the number of pre-adult and adult lice per infected sea trout in samples from sites further away from salmon farms in the second year of the production cycle, but the goodness of fit (r^2) was very weak (Figure 4.13).

Figure 4.13 Average number of pre-adult and adult lice per infected sea trout in samples vs. distance from salmon farm in second year of the production cycle (excluding Kanaird, 8 May 2008 sample).



The trend line for the total number of lice per fish increased from around 20 on average at sites more than 30km from a salmon farm, to over 30 within 20km of a salmon farm, but the goodness of fit was weak (Figure 4.14). Note that the May 8th sample is included in this analysis.

Figure 4.14 Average number sea lice per infected sea trout in samples vs. distance from salmon farm in second year of the production cycle. This graph includes May 08 sample (zero abundance).



As stated in 4.3.2, five of the samples were taken at beach sites further away from river estuaries, including those at Boor Bay and Kerry bay. By removing these samples from the analyses, only two samples more than 25km from the nearest salmon farm in the second year of the production cycle were left for the analyses. Figure 4.15 to 4.17 show that trendlines are much weaker for these analyses. The strongest trend was for an increase in the number pre-adult and adult lice per fish at sites further away from salmon farms in the second year of their production cycle.

Figure 4.15 Average number of pre-adult and adult lice per infected sea trout in samples vs. distance from salmon farm in second year of the production cycle, excluding beach sweep netting samples. This graph includes May 08 sample (zero abundance).

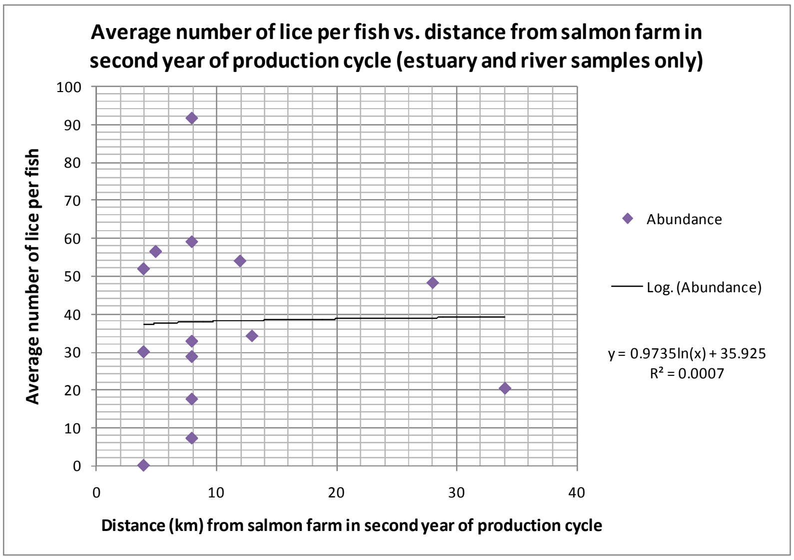


Figure 4.16 Average number of copepodid and chalimus lice per infected sea trout in samples vs. distance from salmon farm in second year of the production cycle excluding beach sweep netting samples (excluding Kanaird, 8 May 2008 sample)

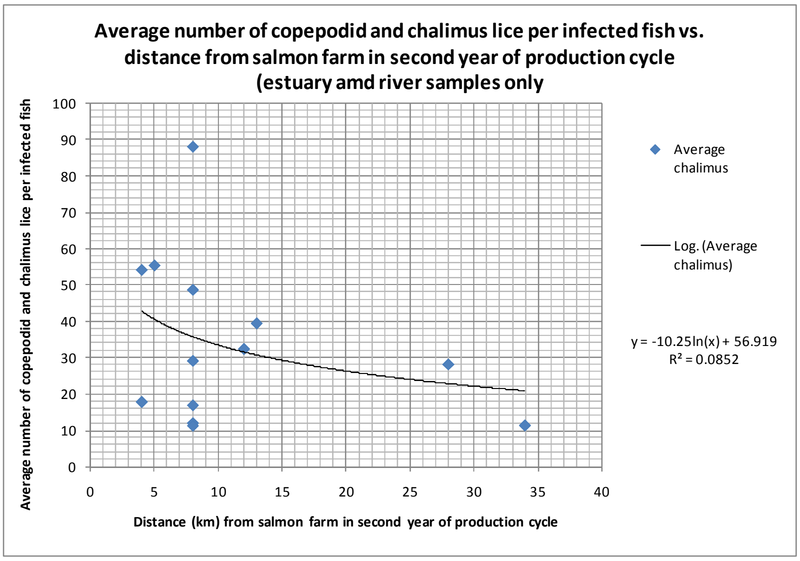
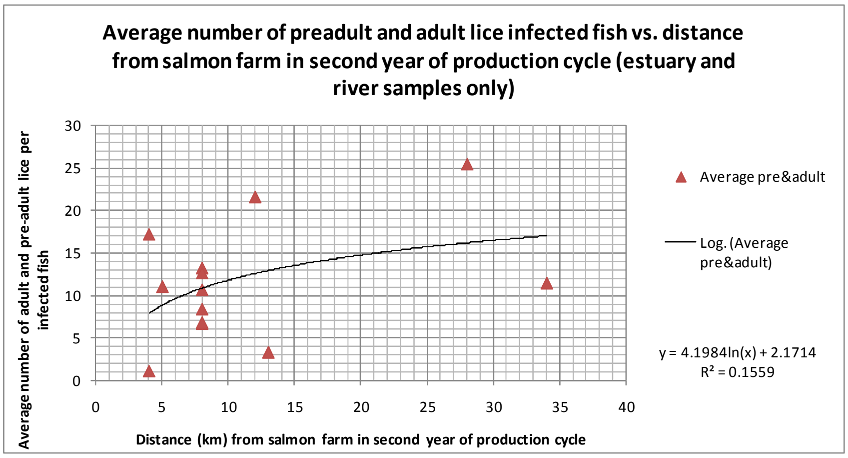


Figure 4.17 Average number of pre-adult and adult lice per infected sea trout in samples vs. distance from salmon farm in second year of the production cycle excluding beach sweep netting samples (excluding Kanaird, 8 May 2008 sample)



4.3.5 Summary of Results

Of the hypotheses that were considered:

> ***1.*** *sea trout were infected with higher burdens of sea lice at sites closest to active salmon farms*
> *(null hypothesis: there was no difference in lice burdens on sea trout in relation to distance from active salmon farms)*
>
> ***1a.*** *sea trout were infected with higher burdens of sea lice at sites closest to salmon farms in the second year of the production cycle*
>
> ***1b.*** *sea trout were infected with higher burdens of chalimus sea lice at sites closest to salmon farms in the second year of the production cycle.*
>
> ***1c.*** *sea trout were infected with higher burdens of pre-adult and adult sea lice at sites closest to salmon farms in the second year of the production cycle*

The strongest trend line was for a reduction in the average number of chalimus lice on infected sea trout in samples further away from salmon farms in the second year of the production cycle (Figure 4.12). Hypothesis 1b is thus the one which showed the strongest correlation.

However, because the sample sizes were small, especially following removal of beach sweep net samples (Figure 4.16), the significance of this observation is questionable. The next section considers the value of these results further.

4.4 Discussion in relation to results of sea lice monitoring in 2007 & 2008

4.4.1 Error and bias

Sampling method and sample sites

Concerns have been expressed that because sea lice data is not collected in a standardised way, it is not possible (or valid) to make interpretations based on data of varied origin. For example, rod and line sampling only catches 'takers' fish which do not go for the fly will not be sampled. Rod and line samples may therefore not be representative of the sea trout population in areas (river estuaries) where sampled.

Sweep netting, has tended to be regarded (e.g. by the TWG) as the preferred sampling method as it is assumed that it is a more consistent and representative method for obtaining a sample of fish. However, because sweep netting can only successfully be used to catch fish over certain types of habitat (e.g. weed free pebbly shore or estuary pool), sweep netting will also mis-represent lice levels on sea trout populations in the area. Because of the tendency of heavily-infected sea trout to seek freshwater c. early returning tendency), sweep net sites away from river estuaries may underestimate overall lice infection levels in a sea trout population. Conversely sweep net samples from intertidal areas may over-estimate levels of lice infection on sea trout.

For these reasons, results need to be interpreted with caution. However, some conclusions can be reached regardless of how fish are caught or where, relative to a river mouth, a sample has been taken. A succession of heavily infected sea trout in a sample, by definition, is indicative of an epizootic, regardless of how fish are caught. Such a sample indicates that there are health problems for at least some of the sea trout in the area; subsequent samples can provide a clearer picture of whether the sample is a 'one off' or whether the fish taken in the sample are indicative of a larger problem.

Misidentification of sea lice

Another challenge to sea lice data sets has been that *Caligus* lice are mis-identified as *Lepeophtheirus* and vice versa. This is possible, and is likely to have occurred to some extent. However, samples or voucher specimens of heavily infected sea trout (>30 lice) in samples taken within Wester Ross in the past and examined by FRS Fish Health Inspectorate have shown that the majority of lice (usually almost all) have been *Lepeotheirus salmonis*. The possibility of high counts of *Caligus* lice on sea trout remains, particularly samples taken away from river estuaries (Caligus lice tend to be lost from sea trout which return to freshwater more rapidly than *Lepeotheirus* .

Inaccurate lice counts

Various methods have been deployed to improve the precision of lice counts, including counting separate parts of fish separately; killing fish and scraping lice off to be counted subsequently. The method used in samples reported here usually requires two or more samplers to count lice, and an agreed figure to be given. Counts may be out by a few percent, particularly on fish where lice are crowded together. Poor light may also lead to some smaller lice stages being overlooked. However, for the purposes of this report, it is assumed that error is evenly or randomly spread between samples.

Small number of fish in sample, small number of samples

This is perhaps the main concern regarding any interpretation of results. Some samples are of very few fish (e.g. River Carron sub-sample of sea trout <26cm in length). There were few samples taken at distances of over 30km from the nearest salmon farm / nearest salmon farm in the second year of the production cycle. An obvious solution to this problem, is to carry out additional sampling at sites at intermediate distances from salmon farms, and / for a West of Scotland wide analyses, to include the results of samples from a much wider area (e.g. data sets from Lochaber, Argyll and Western Isles).

4.4.2 Sea lice epizootics in Wester Ross in 2007 and 2008

Lice epizootics affecting sea trout were recorded in both 2007 and 2008 within the WRFT area.

2007

In 2007 lice counts on fish taken by rod and line in the pool above the track bridge of the River Kanaird indicated that lice had been at or close to epizootic levels; though many of the fish in the rod sample had lost their lice.

Lice infection of sea trout in the Dundonnell fyke net exceeded epizootic levels in 2007.

Lice infection of sea trout exceeded ‘epizootic’ levels for samples in the River Ewe. Very heavily infected ‘early returned’ sea trout were taken in the River Ewe in May 2007, and the lower pools of the River Ewe. Lice levels were lower on samples taken in June and July, but scarring ‘black spots and dorsal fin erosion’ often indicated higher levels of lice infection of many of the fish. Few clean fresh run sea trout were taken by rod anglers in the River Ewe in August and September 2007.

In 2007, sea trout post-smolts with very high numbers of lice (>several hundred chalimus lice) were reported from Loch Torridon by Rafell *et al* (2007). However, these samples were not available for the analyses presented above.

Sea trout with scarring along the back typical of epizootic sea lice infection were also seen under bridges at Flowerdale(Charleston) in June 2007 and in the pool beneath the River Shiel road bridge(Loch Duich).

2008

Lice epizootics affecting sea trout were recorded in Loch Kanaird, Loch Carron and Loch Long, but not Loch Ewe and Loch Gairloch.

4.4.3 Sea lice epizootics and salmon farm production cycles

The analyses presented in part 4.3 indicate that total abundance of sea lice and levels of chalimus lice tended to be highest at sites closest to salmon farms in the second year of their production cycle, and lowest at sites furthest away from salmon farms in the second year of their production cycle. In contrast, levels of pre-adult and adult lice showed no trend.

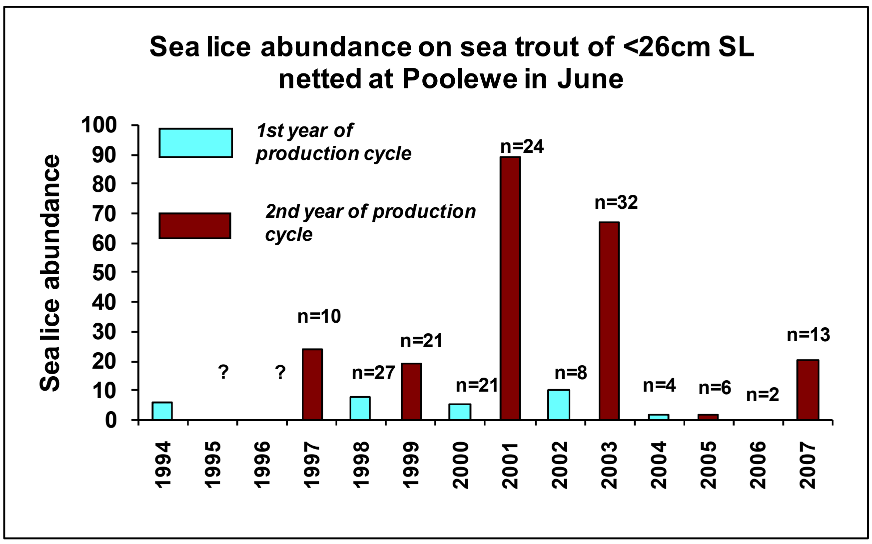
These results are in agreement with the hypothesis that salmon farms in the second year of the production cycle are the primary source of infective sea lice larvae for wild sea trout in nearby areas. This hypothesis could be more usefully tested with larger data sets, and in future with a more clearly targeted sampling programme.

There were some anomalies. In 2008, the lice abundance on many of the sea trout taken in the Dundonnell fyke net were high despite there being no active fish farm in the preceding four months within 25km of the netting site. Dundonnell fyke net results are discussed further below.

Loch Ewe

Sea trout with high levels of lice infection were reported from the mouth of the River Ewe nearby from the early 1990s (see Figure 4.18). Over an eleven year period until 2007, WRFT sampled sea trout at the mouth of the River Ewe using a gill net. The net was set to fish and supervised for an hour over high tide for up to 20 days in the month as a means of monitoring sea lice on post-smolt sea trout. The objective was to catch up to 30 'post-smolts' (fish of less than 26cm in length) during the month. As soon as fish were caught, they were removed from the net, anaesthetised, measured and inspected for sea lice. Although not the most efficient means of obtaining samples, the method was considered to be as consistent as any other so far as being able to compare catches and lice abundance from one year to the next on wild fish.

Figure 4.18 Sea lice abundance on sea trout of < 26cm taken using a gill net at Poolewe in June by WRFT



Lice levels were highest during alternate years, except 2005. Sea lice epizootics were recorded in 2001 and 2003, with an average of over 30 lice per fish. In May 2007, early-returned finnock carrying over 100 lice were taken in the River Ewe nearby, using rod and line; and subsequent gill net catches also indicated elevated lice levels, though not quite so high as in 2003. In 2008, lice levels on sea trout taken in the sweep net at Boor bay in May and July were very low as reported above; however for reasons discussed in 4.4.1 this data is not directly comparable to the Poolewe gill net data.

In Loch Ewe, two salmon farms ('Naast' and 'Aultbea') were established in 1987 and remained in production until 2004. Production cycles were synchronised. In 2005, production was transferred to a one larger farm ('Isle of Ewe').

Note that in intervening years, lice abundance never exceeded 10 on post-smolt sea trout during the month of June. This level can be considered as a background level for post-smolt sea trout in June in Loch Ewe (c. Lochaber data in Box 4.1).

Little Loch Broom

In Little Loch Broom, a salmon farm was established by Ardessie in 1986. The farm was operated by Ardessie Salmon until the year 2000, then from 2004 to 2007 by Marine Harvest. In 2004, production commenced at a larger farm at Stattic Point nearby. This farm operated for only one production cycle until 2005.

In April 1997 Ardessie Salmon Ltd. and the WRFT initiated the Ardessie Sea Lice Project with the aim of monitoring sea lice infestations on farm salmon and sea trout in Little Loch Broom, and investigating the relationship between the two (Butler, 2000). Fortnightly counts were taken on the salmon farm throughout the year, and lice counts were taken on early returning sea trout in the Dundonnell estuary in the critical May/June period. To determine the 'background' levels of lice on larger sea trout, fish were also sampled at the mouth of the Kildonan Burn on the northern shore of the loch in the spring.

To catch early-returning, lice-infested sea trout a fyke net was set in the estuary, facing downstream. This was flooded at high tide, and enabled a full count of lice on fish before they had reached freshwater. Only post-smolt sea trout (smolts which have just entered the sea) were considered in the annual comparisons, although heavily-liced adult sea trout were also caught.

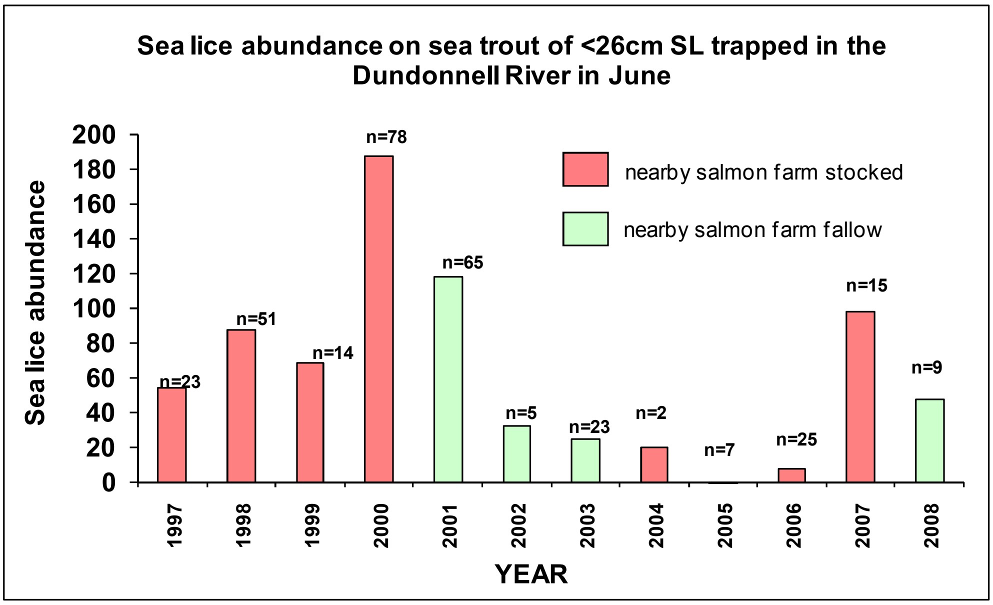
Annually, average lice burdens exceeded the potentially lethal level of 30 (Figure 4.19) and in every year except 1997, the vast majority of fish had more than this threshold. Moribund, heavily-lice infested fish were found in the Sea Pools in 1997, 1998 and 2000. The project concluded that 'ovigerous lice levels on farm salmon were low each spring, and similar to those on sea trout. However, because of the greater number of farm salmon, up to 95% of the larvae produced in the loch probably emanated from the farm. Furthermore 'Levels of ovigerous lice on the farm should be reduced to zero during the period march to June in order to minimise the risk of infection to Dundonnell post-smolt sea trout.'(*ibid*).

Between the years 2001 to 2003. The Ardessie salmon farm was fallow from July 2000. However, in June 2001 levels of lice infection on post-smolt sea trout at the mouth of the

Dundonnell River were again very high, prompting the local fish farm interests to question the conclusions of the Ardessie project. If 95% of the sea lice on sea trout in Little Loch Broom were of Ardessie salmon farm origin in year 1997 to 2000, how could lice levels be so high in 2001 when the farm was fallow? An explanation was offered that in 2001, sea trout had probably become infected by lice from farms outwith Little Loch Broom (Butler, *pers comm* 2002). The next nearest farms were at Summer Isles (23 km from the mouth of the Dundonnell River as the fish swims) and in Loch Kanaird (26 km away), and Loch Broom (35 km away).

In the following years (2002 – 2006), recorded lice levels on sea trout fell to their lowest levels on record. In 2004 production of farmed salmon commenced at the Stattic Point farm by Marine Harvest, with biomass consent of 1400 tonnes. Production recommenced at Ardessie, now leased to Marine Harvest with increased biomass consent of 662 tonnes. Despite an 8 fold increase in the biomass of farmed salmon within the loch in 2005, only seven post-smolt sea trout were taken in the fyke net, with the lowest levels of lice on record. This improvement reflected reduced levels of lice infection recorded in Loch Ewe and Loch Torridon in 2005 – see below.

Figure 4.19 Sea lice abundance on sea trout of <26cm caught in a fyke net at the mouth of the Dundonnell River in June in relation to production at nearby salmon farms (1997 – 2008).



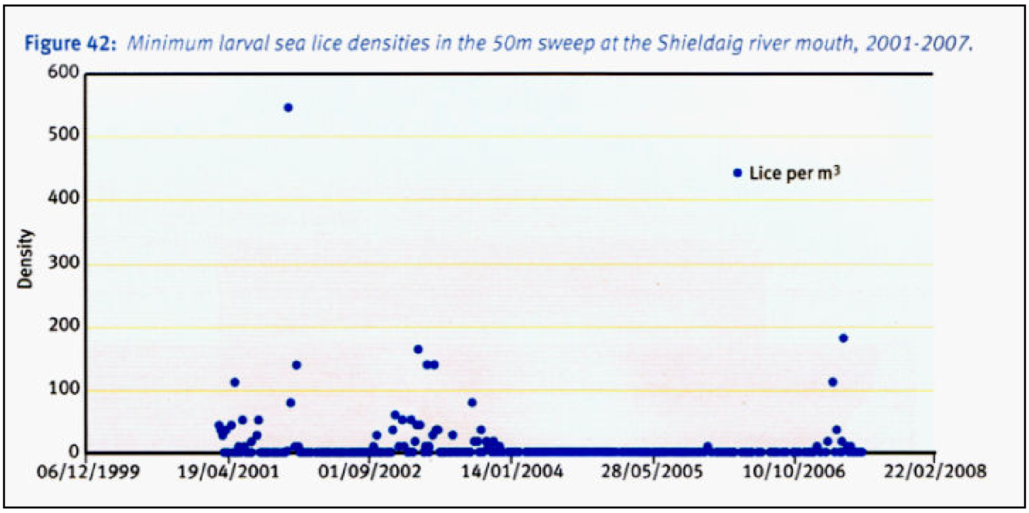
There was a general sense of optimism after the 2005 season, that with the use of the new in-feed medicine, emamectin benzoate (trade name SLICE), the sea lice problem had been solved. 2005 was also the second year of the fish farm production cycle in Loch Ewe and Loch Torridon. Heavily infested sea trout were scarce or absent at monitoring sites in these lochs. Marine survival of Shieldaig sea trout in Loch Torridon was the highest on record (Raffell, *et al* 2007).

The relatively high lice abundance in 2008 despite the nearby fish farm being inactive, again highlights Little Loch broom as a sensitive one for sea lice. It is not clear whether lice become concentrated within Little Loch Broom from areas beyond, or whether sea trout migrate into the loch from other areas where they have become infected (e.g. Loch Kanaird).

Loch Torridon

Studies by government scientists at the Fisheries Research Services (FRS) field station by Loch Torridon have provided further insights into the relationship between salmon farming, lice occurrence, and sea trout. There were 4 (formerly 5) active salmon farms in Loch Torridon during the period 2002-2006 and fish farm production cycles were synchronised. Plankton trawls have generally recorded higher levels of lice *nauplius* and *copipodid* stages in the water column during odd years (2001, 2003, 2007; but not 2005), correlating with the second year of the production cycle on nearby farms (Figure 4.20).

Figure 4.20 Minumum larval sea lice densities in sweep net samples taken at and around the Shieldaig river mouth, 2001 – 2007 (reproduced from Raffell et al, 2007)



The Shieldaig trap also enables an assessment to be made of the survival of sea trout in the marine environment. Until 2004, the rates of survival of sea trout were 5% or less except for wild finnock in 2002. Then, in 2005, a second year of the production cycle, over 14% of wild sea trout smolts survived, the previous highest rate of survival on record (*were any of these fish treated with product EX?). In 2006, marine survival peaked with over 35% of wild sea trout smolts and 7% stocked smolts survived to return to the trap as finnock. However, a sea lice epizootic affecting wild sea trout occurred in May and June 2007; some fish had over 400 lice; lice numbers were often so large that accurate counts could not be made in the field (reported by Raffell *et al* 2007).Tagging studies showed that some fish spent as little as four or five days at sea before returning to the Shieldaig system. Subsequently, just over 20 finnock returned to the trap, all were of stocked origin; respective rates of marine survival for tagged fish were less than 2% for both wild and stocked fish [D. Hay, *pers comm.*].

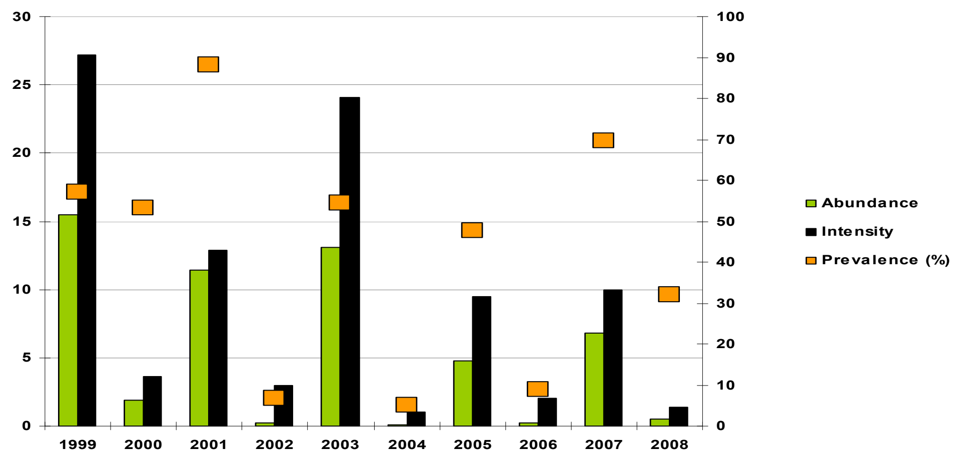
Loch Linnhe

Outwith the WRFT area, data from sea lice monitoring in Loch Linnhe also shows good-year bad-year cyclicity correlating with the salmon farm production cycle within the AMA area (Box4.1).

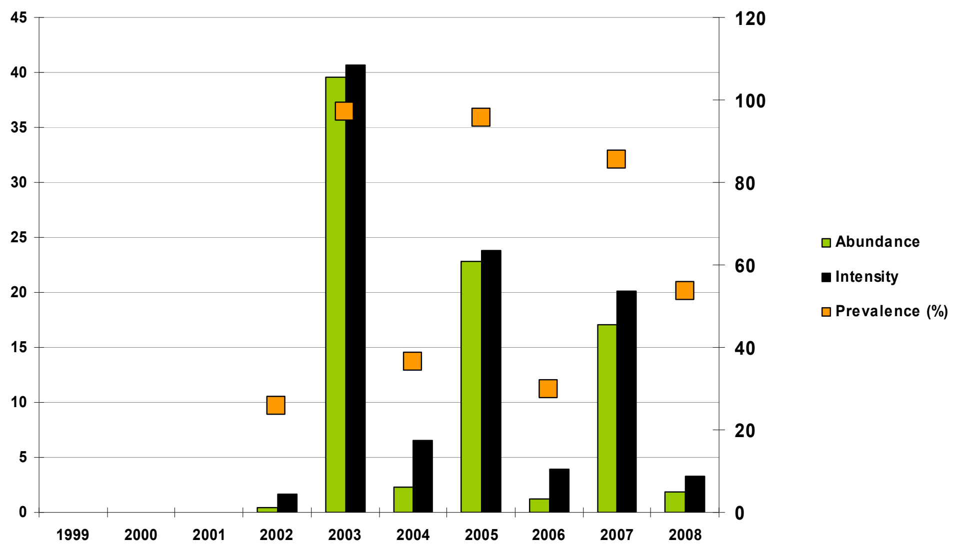
Box 4.1 Summary of Loch Linnhe Lice Data (reproduced with permission of LFT Biologist)

Lochaber Fisheries Trust has collected data on lice levels on wild sea trout post smolts from two sites on upper Loch Linnhe: Kinlocheil (NM978790) and Camus na Gaul (NN095751). Marine Harvest operate two farms in upper Loch Linnhe above the Corran Narrows: Gorsten (NN060705) and Ardgour (NN015645). A third farm in Loch Eil (NM990780) closed in 2005. The three farms were on synchronous production cycles and their second year of production coincides with high lice burdens on wild post smolts in 1999, 2001, 2003, 2005 and 2007.

Kinlocheil (sea lice levels on wild post-smolt sea trout from upper Loch Linnhe).



Camus na Gaul



Perhaps most closely comparable to the analyses presented here is that of Gargan *et al* 2003. Using a much larger data set, they were able to demonstrate that levels of chalimus lice were much higher at samples sites within 30km of the nearest salmon farm than at distances further away than this (Figure 4.21).

Figure 4.21 In Ireland, high numbers of chalimus lice were found on sea trout within 30km of the nearest fish farm, but not on sea trout caught further than 30km (reproduced from Gargan et al, 2003)

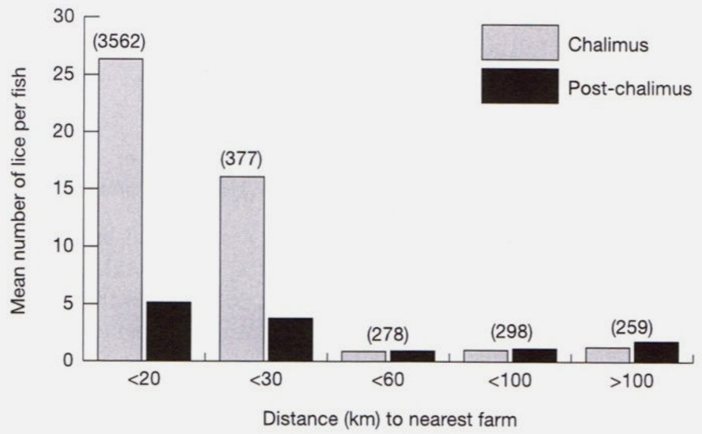


Fig. 10.3 Mean number of lice juveniles (chalimus) and adults (post-chalimus) infesting sea trout smolts in relation to distance categories to the nearest farm. Number of fish in each category is given in parentheses.

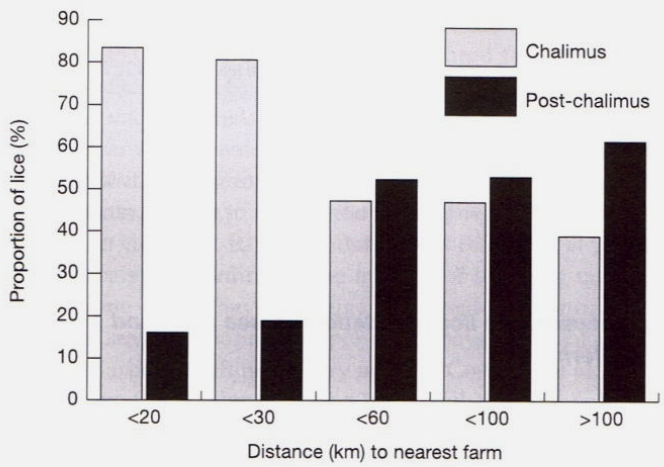


Fig. 10.4 Proportion of chalimus in the lice population infesting sea trout as a function of distance to the nearest farm.

5. Conclusions

- *Within the WRFT area, sea lice infection levels of sea trout reached 'epizootic' levels in Loch Kanaird in 2008, Little Loch Broom in 2007, Loch Ewe in 2007, (Loch Torridon in 2007), Loch Carron in 2008 and Loch Loch (by Loch Duich) in 2008. Observations suggested that lice epizootics also occurred in Loch Kanaird in 2007 (rod sample data), and Loch Duich in 2007.*

- *However, lice levels on sea trout were not uniformly high within the WRFT area especially in 2008. Samples of sea trout from Loch Ewe had low sea lice abundance in 2008. Sea trout with low levels of sea trout in good condition were caught in the River Ewe in August 2008.*

- *Levels of chalimus lice on sea trout tended to be highest at sites nearest salmon farms in the second year of their production cycle, though the small sample size probably means that no firm conclusion can be reached without additional data. In contrast, there was no clear trend in the numbers of pre-adult and adult lice with distance from salmon farms.*

- *Levels of chalimus lice infection of sea trout were generally greatly reduced at distances over 20km from the nearest salmon farm in the second year of the production cycle.*

- *Lice levels were highest on samples taken from river estuary sites.*

- *Sweep net sampling at beach sites in Loch Ewe (Boor Bay) and Loch Gairloch (Kerry bay) were less productive with fewer fish caught, and at Boor bay*

- *All methods of sampling caught fish with more than 100 lice and fish with less than 10 sea lice.*

- *Lice epizootics may have been exacerbated in 2008 by unusually warm, dry sunny weather. Bright, sunny conditions with low rainfall are typical of April and May in Wester Ross.*

- *This study also hints that some areas are naturally more prone to sea lice epizootics than others (e.g. Little Loch Broom).*

- *Catch returns at the FRS Shieldaig trap in 2007 support the hypothesis that a majority sea trout which become very heavily infected do not survive.*

- *Sea lice data collected in the WRFT area in 2007 and 2008 is consistent with the hypothesis that salmon farms in the second year of the production cycle are the primary source of sea lice which infect sea trout within the area.*

6. Recommendations

- *With the inclusion of additional existing data sets and more complex testing, a clearer understanding of patterns of infection could be developed for sea lice infection of wild sea trout in 2007 and 2008 for the WRFT area. More usefully, the study should address patterns of infection across the west of Scotland.*

- *From 2009, additional monitoring sites within the WRFT area particularly at sites further than 20km from the nearest salmon farm in the second year of the production cycle would provide further clarification of contemporary relationships between sea lice infection of sea trout and salmon farming cycle in local waters.*

- *A GIS mapping system could be developed to analyse sea lice abundance and infection pressures on both wild fish and farmed fish in the west of Scotland to inform management at both the local and regional scale. Fisheries trust biologists, FRS biologists and RDOs should work together to develop such a system. The SFCC may be able to provide support.*

- *From samples which do not fit a general pattern (e.g. samples with mean abundance of L. salmonis chalimus stage lice >30 more than 30km from a salmon farm in second year of production cycle; or samples with mean abundance of L. salmonis chalimus stage lice <30 within 10km of a salmon farm in the second year of the production cycle), it may be possible to identify areas which are 'naturally' more prone or less prone to sea lice epizootics.*

- *This study further highlights the need for additional measures to be taken to reduce the production of larval sea lice further on salmon farms particularly in the second year of their production cycle in all areas if populations of wild sea trout are to recover.*

- *Because of the numbers of salmon present on salmon farms within the area, this will invariably mean reducing on-farm ovigerous lice levels to much less than the recommended 0.5 ovigerous lice per fish during the period February – June as stated in the Code of Good Practice.*

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Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (1).

									Caligus	*Lepeophtheirus salmonis*				Scars and damage			km from active salmon fm	
Location	Date	Method	Riv/Est/Bea	id	sal/st	length (mm)	weight (g)	condition	total	Chalimus	Pre-ad&ad	Ov female	Total Ls	Dorsal	Spots	Predator	km to sal fm	km to 2nd year
Ewe	15-May-07	Rod	River		Sea trout	278				15	0	0	15	2		0	8	8
Ewe	15-May-07	Rod	River		Sea trout	269				372	2	0	374	2		0	8	8
Ewe	15-May-07	Rod	River		Sea trout	150				0	0	0	0	0		0	8	8
Ewe	15-May-07	Rod	River		Sea trout	180				0	0	0	0	0		0	8	8
Ewe	15-May-07	Rod	River		Sea trout	237				92	44	0	136	2		0	8	8
Ewe	15-May-07	Rod	River		Sea trout	270				176	2	0	178	1		0	8	8
Ewe	15-May-07	Rod	River		Sea trout	330				256	0	0	256	3		0	8	8
Ewe	17-May-07	Rod	River		Sea trout	230				80	12	0	92	1		0	8	8
Ewe	17-May-07	Rod	River		Sea trout	230				60	82	0	142	1		0	8	8
Ewe	17-May-07	Rod	River		Sea trout	197				30	0	0	30	0		0	8	8
Ewe	17-May-07	Rod	River		Sea trout	213				154	0	0	154	0		0	8	8
Ewe	23-May-07	Rod	River	TO823	Sea trout	194				18	60	0	78	1		0	8	8
Ewe	23-May-07	Rod	River	T0824	Sea trout	256				45	0	0	45	1		0	8	8
Ewe	23-May-07	Rod	River	T0825	Sea trout	284	236	1.03		110	4	0	114	2		0	8	8
Ewe	23-May-07	Rod	River	T0826	Sea trout	287	212	0.90		19	15	0	34	1.5		0	8	8
Ewe	23-May-07	Rod	River	T0827	Sea trout	292	246	0.99		150	8	0	158	1		0	8	8
Ewe	23-May-07	Rod	River	T0828	Sea trout	285	239	1.03		34	12	0	50	1		0	8	8
Ewe	23-May-07	Rod	River	T0829	Sea trout	289	238	0.99		57	14	0	71	1		0	8	8
Ewe	23-May-07	Rod	River	T0830	Sea trout	170	46	0.94		0	2	0	2	0		0	8	8
Ewe	23-May-07	Rod	River	T0831	Sea trout	210	91	0.98		90	1	0	91	1.5		0	8	8
Ewe	23-May-07	Rod	River	T0832	Sea trout	277	212	1.00		134	0	0	134	1.5		0	8	8
Ewe	23-May-07	Rod	River	T0833	Sea trout	292	243	0.98		15	0	0	15	1		0	8	8
Ewe	23-May-07	Rod	River	T0834	Sea trout	285	205	0.89		145	13	0	158	1		0	8	8
Ewe	23-May-07	Rod	River	T0835	Sea trout	297	248	0.95		10	0	0	10	1		1	8	8
Ewe	23-May-07	Rod	River	T0836	Sea trout	180	55	0.94		57	1	0	57	1		1	8	8
Ewe	23-May-07	Rod	River	T0837	Sea trout	241	122	0.87		97	0	0	98	1		0	8	8
Ewe	23-May-07	Rod	River	T0838	Sea trout	260	132	0.75		77	0	0	77	1		1	8	8
Ewe	23-May-07	Rod	River	T0839	Sea trout	170				0	0	0	0	1		1	8	8
Ewe	29-May-07	Gill net	Estuary	T0851	Sea trout	228				50	14	0	64	1		0	8	8
Ewe	29-May-07	Gill net	Estuary	T0852	Sea trout	280				33	7	0	40	1		0	8	8
Ewe	29-May-07	Gill net	Estuary	T0853	Sea trout	210				1	4	0	5	1		0	8	8
Ewe	29-May-07	Gill net	Estuary	T0854	Sea trout	235				3	14	0	17	1		0	8	8
Ewe	04-Jun-07	Gill net	Estuary	T0855	Sea trout	315				50	13	2	65	1		0	8	8
Dundonnell	07-Jun-07	Fyke	River		Sea trout	185				70	12	0	82	1		0	5	5
Ewe	07-Jun-07	Gill net	Estuary	T0856	Sea trout	140				0	0	0	0	0		0	8	8
Ewe	08-Jun-07	Gill net	Estuary	T0857	Sea trout	220				24	0	0	24	0		0	8	8
Ewe	08-Jun-07	Gill net	Estuary	T0858	Sea trout	210				14	1	0	15	0		0	8	8
Ewe	08-Jun-07	Gill net	Estuary	T0859	Sea trout	285				75	6	1	82	2		0	8	8
Dundonnell	11-Jun-07	Fyke	River		Sea trout	180				0	1	0	1	1			5	5
Dundonnell	11-Jun-07	Fyke	River		Sea trout	220				0	2	0	2	1		1	5	5
Ewe	11-Jun-07	Gill net	Estuary	T0860	Sea trout	308				45	4	0	49	2		0	8	8
Ewe	11-Jun-07	Gill net	Estuary	T0861	Sea trout	212				3	17	0	20	1		0	8	8

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 2)

Ewe	11-Jun-07	Gill net	Estuary	T0862	Sea trout	207				9	1	0	10	1		0	8	8
Ewe	12-Jun-07	Gill net	Estuary	T0863	Sea trout	173				13	2	0	15	0		0	8	8
Dundonnell	13-Jun-07	Fyke	River		Sea trout	140				0	0	0	0				5	5
Dundonnell	13-Jun-07	Fyke	River		Sea trout	230				300	0	0	300				5	5
Dundonnell	14-Jun-07	Fyke	River		Sea trout	290				0	0	0	0				5	5
Dundonnell	14-Jun-07	Fyke	River		Sea trout	190				0	30	0	30	2			5	5
Ewe	14-Jun-07	Gill net	Estuary	T0864	Sea trout	198				17	11	2	30	3		0	8	8
Ewe	14-Jun-07	Rod	River	T0841	Sea trout	210				15	18	0	33	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0842	Sea trout	280				54	16	0	70	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0843	Sea trout	210				1	4	0	5	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0844	Sea trout	235				3	14	0	17	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0845	Sea trout	230				9	4	0	13	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0846	Sea trout	220				6	11	0	17	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0847	Sea trout	205				9	5	0	14	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0848	Sea trout	275				32	6	2	40	1		N	8	8
Ewe	14-Jun-07	Rod	River	T0849	Sea trout	270				30	6	0	36	2		N	8	8
Ewe	14-Jun-07	Rod	River	T0850	Sea trout	290				0	1	0	1	0		Y	8	8
Ewe	14-Jun-07	Rod	River	T0840	Sea trout	188				1	0	0	1	1.5		Y	8	8
Ewe	14-Jun-07	Rod	River	T0831	Sea trout	205				0	0	0	0	0		Y	8	8
Ewe	14-Jun-07	Rod	River	T0900	Sea trout	291				0	1	0	1	1		N	8	8
Dundonnell	15-Jun-07	Fyke	River		Sea trout	190				0	0	0	0				5	5
Ewe	16-Jun-07	Gill net	Estuary	T0865	Sea trout	208				21	16	0	37	1		0	8	8
Ewe	16-Jun-07	Gill net	Estuary	T0866	Sea trout	224				15	4	0	19	1		0	8	8
Ewe	18-Jun-07	Gill net	Estuary	T0867	Sea trout	301				96	1	0	97	1.5		0	8	8
Ewe	18-Jun-07	Gill net	Estuary	T0868	Sea trout	240				12	0	0	12	2		N	8	8
Ewe	18-Jun-07	Gill net	Estuary	T0869	Sea trout	215				14	2	0	16	2		0	8	8
Ewe	18-Jun-07	Gill net	Estuary	T0870	Sea trout	197				2	1	0	2	1		0	8	8
Dundonnell	19-Jun-07	Fyke	River		Sea trout	160				2	3	0	5				5	5
Dundonnell	19-Jun-07	Fyke	River		Sea trout	320				30	10	0	40	2			5	5
Dundonnell	19-Jun-07	Fyke	River		Sea trout	350				25	10	1	36	2			5	5
Dundonnell	20-Jun-07	Fyke	River		Sea trout	210				80	40		120	2		0	5	5
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	206	98	1.12		32	24	0	56	1		Y	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	229	128	1.07		52	14	0	66	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	189	79	1.17		16	28	0	44	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	200	93	1.16		18	7	0	25	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	206	83	0.95		0	8	0	8	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	199	91	1.15		12	18	0	30	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	315	315	1.01		30	26	0	56	3		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	235	150	1.16		5	4	0	9	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	235	138	1.06		34	10	0	44	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	200	98	1.23		42	15	0	59	1		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	190	77	1.12		5	1	0	6	0		N	8	8
Ewe	20-Jun-07	Rod	River	no dna	Sea trout	196	80	1.06		0	2	0	2	0		N	8	8

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 3)

Ewe	20-Jun-07	Rod	River	no dna	Sea trout	163	49	1.13		23	6	0	29	1	N		8	8
Dundonnell	22-Jun-07	Fyke	River		Sea trout	210				120	21		141	3		0	5	5
Dundonnell	22-Jun-07	Fyke	River		Sea trout	240				120	14	1	135	1			5	5
Dundonnell	22-Jun-07	Fyke	River		Sea trout	240				120	15	1	136	1			5	5
Dundonnell	22-Jun-07	Fyke	River		Sea trout	170				0	6		6	1			5	5
Dundonnell	22-Jun-07	Fyke	River		Sea trout	200				0	6		6			1	5	5
Dundonnell	22-Jun-07	Fyke	River		Sea trout	250				0	1		1				5	5
Dundonnell	23-Jun-07	Fyke	River		Sea trout	200				70	12	0	82	1			5	5
Ewe	26-Jun-07	Gill net	Estuary	T0871	Sea trout	290				0	0	0	0	2		1	8	8
Ewe	26-Jun-07	Rod	River	T0897	Sea trout	200				12	9	0	21	1	bird		8	8
Ewe	26-Jun-07	Rod	River	no dna	Sea trout	198				32	33	0	65	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0899	Sea trout	221				35	55	5	95	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0896	Sea trout	235				17	13	1	31	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0895	Sea trout	240				10	10	0	20	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0894	Sea trout	189				8	11	0	19	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0893	Sea trout	212				6	3	0	9	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0892	Sea trout	195				43	23	0	66	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0891	Sea trout	250				0	3	0	3	2	N		8	8
Ewe	26-Jun-07	Rod	River	T0890	Sea trout	200				8	10	0	18	1	N		8	8
Ewe	26-Jun-07	Rod	River	T0889	Sea trout	212				20	26	0	46	0	N		8	8
Ewe	26-Jun-07	Rod	River	T0898	Sea trout	205				6	11	0	17	0	N		8	8
Dundonnell	27-Jun-07	Fyke	River		Sea trout	210				6	1		7				5	5
Ewe	27-Jun-07	Gill net	Estuary	T0872	Sea trout	212				36	9	1	46	1		0	8	8
Ewe	27-Jun-07	Gill net	Estuary	T0873	Sea trout	196				12	9	0	21	0		0	8	8
Kanaird	28-Jun-07	Rod	River		Sea trout	**215**				0	2	0	**2**	**1**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**228**				9	0	0	**9**	**1**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**380**				0	0	0	**0**	**2**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**232**				0	0	0	**0**	**0.5**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**218**				7	2	0	**9**	**1**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**213**				0	1	0	**1**	**0.5**		1	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**199**				0	2	0	**2**	**1**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**220**				90	9	0	**99**	**1.5**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**184**				40	0	0	**40**	**1**		0	5	13
Kanaird	28-Jun-07	Rod	River		Sea trout	**233**				170	10	0	**180**	**2.5**		0	5	13
Ewe	30-Jun-07	Gill net	Estuary	T0874	Sea trout	311				96	5	0	101	1		0	8	8
Ewe	04-Jul-07	Rod	River	Z0014	Sea trout	216				6	2	0	8	1	Y		8	8
Ewe	04-Jul-07	Rod	River	Z0015	Sea trout	221				14	11	1	26	1	N		8	8
Ewe	04-Jul-07	Rod	River	Z0016	Sea trout	222				0	0	0	0	1	N		8	8
Ewe	04-Jul-07	Rod	River	Z0017	Sea trout	232				0	1	0	1	1	N		8	8
Ewe	04-Jul-07	Rod	River	Z0018	Sea trout	215				47	14	0	61	1	Y		8	8
Ewe	04-Jul-07	Rod	River	Z0019	Sea trout	190				41	23	0	64	1			8	8
Ewe	04-Jul-07	Rod	River	Z0020	Sea trout	194				0	1	0	1	1	N		8	8
Ewe	04-Jul-07	Rod	River	Z0021	Sea trout	216				27	5	0	32	1	N		8	8
Ewe	04-Jul-07	Rod	River	Z0022	Sea trout	225				2	0	0	2	1	BIRD		8	8

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 4)

Ewe	04-Jul-07	Rod	River	Z0023	Sea trout	222				0	2	0	2	1		N	8	8
Ewe	04-Jul-07	Rod	River	Z0024	Sea trout	202				0	0	0	0	1		N	8	8
Ewe	04-Jul-07	Rod	River	Z0025	Sea trout	227				0	0	0	0	1		N	8	8
Ewe	04-Jul-07	Rod	River	Z0026	Sea trout	210				0	1	0	1	1		N	8	8
Ewe	19-Jul-07	Rod	River	SO233	Sea trout	231				7	20	0	27	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO234	Sea trout	233				34	26	2	50	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO235	Sea trout	245				91	12	0	103	2		n	8	8
Ewe	19-Jul-07	Rod	River	SO236	Sea trout	250				62	17	0	79	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO237	Sea trout	204				23	4	0	27	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO238	Sea trout	227				0	0	0	0	0		n	8	8
Ewe	19-Jul-07	Rod	River	SO239	Sea trout	256				0	7	0	7	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO240	Sea trout	233				11	12	3	26	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO241	Sea trout	231	123	1.00		17	48	0	65	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO242	Sea trout	232	138	1.11		1	4	0	5	1		n	8	8
Ewe	19-Jul-07	Rod	River	SO243	Sea trout	236	140	1.07		20	22	0	42	1		y	8	8
Ewe	19-Jul-07	Rod	River	SO244	Sea trout	261	193	1.09		13	24	0	37	1		y	8	8
Ewe	03-Aug-07	Rod	River		Sea trout	198				0	0	0	0	0		N	8	8
Ewe	03-Aug-07	Rod	River		Sea trout	250				0	0	0	0	1		N	8	8
Ewe	03-Aug-07	Rod	River		Sea trout	273				0	0	0	0	1		N	8	8
Ewe	03-Aug-07	Rod	River		Sea trout	248				0	0	0	0	1		N	8	8
Ewe	03-Aug-07	Rod	River		Sea trout	233				0	0	0	0	0.5		N	8	8
L. Loch Broom	2-May-08	Sweep	Beach		Sea trout	165	50	1.11		0	0	0	0				28	28
Kanaird	8-May-08	Sweep	Estuary		Sea trout	162	42	0.99	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	183	60	0.98	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	194	72	0.99	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	164	47	1.07	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	181	62	1.05	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	165	45	1.00	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	351	400	0.92	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	173	53	1.02	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	159	44	1.09	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	180	54	0.93	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	154	41	1.12	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	119	19	1.13	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	151	38	1.10	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	142	31	1.08	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	150	35	1.04	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	143	31	1.06	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	155	43	1.15	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	154	45	1.23	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	151	42	1.22	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	191	74	1.06	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	165	54	1.20	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	150	41	1.21	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	177	63	1.14	0	0	0	0	0				4	4

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 5)

Kanaird	8-May-08	Sweep	Estuary		Sea trout	139	35	1.30	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	170	55	1.12	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	160	43	1.05	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	145	33	1.08	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	164	56	1.27	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	162	56	1.32	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	158	54	1.37	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	115	27	1.78	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	225	100	0.88	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	165	62	1.38	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	156	54	1.42	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	142	32	1.12	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	182	78	1.29	0	0	0	0	0				4	4
Kanaird	8-May-08	Sweep	Estuary		Sea trout	190	77	1.12	0	0	0	0	0				4	4
River Carron	12-May-08	Sweep	Estuary	23N	Sea trout	403	681	1.04	0	0	3	0	3	0			8	8
River Carron	12-May-08	Sweep	Estuary	24N	Sea trout	331	362	1.00	0	33	10	0	43	0		1	8	8
River Carron	12-May-08	Sweep	Estuary	25N	Sea trout	343	232	0.57	0	107	15	0	122	1.5			8	8
River Carron	12-May-08	Sweep	Estuary	26N	Sea trout	386	631	1.10	2	0	7	0	7	0		1	8	8
River Carron	12-May-08	Sweep	Estuary	27N	Sea trout	318	348	1.08	0	8	4	0	12	0			8	8
River Carron	12-May-08	Sweep	Estuary	28N	Sea trout	332	386	1.05	0	4	7	0	11	0			8	8
River Carron	12-May-08	Sweep	Estuary	not tagged	Sea trout	130	20	0.91	0	26	15	0	41	1			8	8
Kerry Bay	20-May-08	Sweep	Beach		Sea trout	370	417	0.82		10	7	0	17	1		0	30	30
Kerry Bay	20-May-08	Sweep	Beach		Sea trout	285	224	0.97		3	16	0	19	2		0	30	30
Kerry Bay	20-May-08	Sweep	Beach		Sea trout	318	328	1.02		2	16	1	19	1		1	30	30
Kerry Bay	20-May-08	Sweep	Beach		Sea trout	320	334	1.02		2	14	0	16	1		0	30	30
River Carron	22-May-08	Sweep	Estuary	not tagged	Sea trout	206			0	500	13	0	513	2			8	8
River Carron	22-May-08	Sweep	Estuary	not tagged	Sea trout	170			0	93	25	0	118	1			8	8
River Carron	22-May-08	Sweep	Estuary	N03	Sea trout	438			0	85	9	0	94	1			8	8
River Carron	22-May-08	Sweep	Estuary	N04	Sea trout	387			0	0	2	0	2	0.5			8	8
River Carron	22-May-08	Sweep	Estuary	N05	Sea trout	398			0	0	0	0	0	0			8	8
River Carron	22-May-08	Sweep	Estuary	N06	Sea trout	327			0	12	11	0	23	0			8	8
River Carron	22-May-08	Sweep	Estuary	N07	Sea trout	315			0	77	58	0	135	2			8	8
River Carron	22-May-08	Sweep	Estuary	N08	Sea trout	353			0	0	7	0	7	0			8	8
River Carron	22-May-08	Sweep	Estuary	N09	Sea trout	327			3	3	8	0	11	0			8	8
River Carron	22-May-08	Sweep	Estuary	N10	Sea trout	304			1	0	3	0	3	0			8	8
River Carron	22-May-08	Sweep	Estuary	N11	Sea trout	337			2	0	3	0	3	0			8	8
River Carron	22-May-08	Sweep	Estuary	N12	Sea trout	385			0	0	4	0	4	0			8	8
River Carron	22-May-08	Sweep	Estuary	N13	Sea trout	350			0	23	21	0	44	2		1	8	8
River Carron	22-May-08	Sweep	Estuary	N14	Sea trout	247			0	52	45	1	98	3			8	8
River Carron	22-May-08	Sweep	Estuary	N15	Sea trout	401			0	0	5	1	6	0			8	8
Kanaird	22-May-08	Sweep	Estuary		Sea trout	245	135	0.92	0	150	0	0	150				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	298	298	1.13	0	60	2	0	62				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	294	243	0.96	0	60	0	0	60				4	4

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 6

Kanaird	22-May-08	Sweep	Estuary		Sea trout	311	259	0.86	0	18	1	0	19				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	195	73	0.98	0	80	0	0	80				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	309	323	1.09	0	60	0	0	60				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	378	453	0.84	0	100	1	0	101				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	317	328	1.03	0	70	0	0	70				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	390	701	1.18	0	35	0	0	35				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	385	535	0.94	0	50	1	0	51				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	210	96	1.04	0	46	0	0	46				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	271	203	1.02	0	60	0	0	60				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	298	209	0.79	0	50	0	0	50				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	218	110	1.06	0	50	1	0	51				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	210	87	0.94	0	70	0	0	70				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	301	278	1.02	0	60	7	0	67				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	250	153	0.98	0	70	3	0	73				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	265	201	1.08	0	40	0	0	40				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	224	113	1.01	0	60	0	0	60				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	260	192	1.09	0	80	0	0	80				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	304	255	0.91	0	10	0	0	10				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	360	383	0.82	0	20	9	0	29				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	225	126	1.11	0	10	0	0	10				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	265	96	0.52	0	56	0	0	56				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	272	185	0.92	0	50	0	0	50				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	225	120	1.05	0	3	0	0	3				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	258	174	1.01	0	0	0	0	0				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	300	271	1.00	0	120	7	0	127				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	260	148	0.84	0	3	0	0	3				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	275	217	1.04	0	0	0	0	0				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	255	161	0.97	0	50	0	0	50				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	315	305	0.98	0	60	0	0	60				4	4
Kanaird	22-May-08	Sweep	Estuary		Sea trout	261	192	1.08	0	30	0	0	30				4	4
Kanaird	22-May-08	Sweep	Estuary		Salmon	163	51	1.18	0	60	0	0	60				4	4
Kanaird	22-May-08	Sweep	Estuary		Salmon	184	63	1.01	0	15	1	0	16				4	4
Kanaird	22-May-08	Sweep	Estuary		Salmon	180	53	0.91	0	40	0	0	40				4	4
Kanaird	22-May-08	Sweep	Estuary		Salmon	158	49	1.24	0	40	0	0	40				4	4
Kanaird	22-May-08	Sweep	Estuary		Salmon	186	57	0.89	0	70	0	0	70				4	4
Kanaird	22-May-08	Sweep	Estuary		Salmon	150	43	1.27	0	15	0	0	15				4	4
Loch Long	23-May-08	Sweep	Estuary	19M	Sea trout	395	620	1.01	4	60	47	1	108	1	1		12	12
Boor Bay	28-May-08	Sweep	Beach	20N	Sea trout	172	60	1.18		3	0	0	3	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	221	110	1.02		5	0	0	5	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	156	45	1.19		3	0	0	3	0			8	34
Boor Bay	28-May-08	Sweep	Beach	21N	Sea trout	239	145	1.06		3	4	0	7	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	180	60	1.03		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	210	90	0.97		2	4	0	6	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	170	48	0.98		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	229	129	1.07		3	0	0	3	0			8	34

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 7)

Boor Bay	28-May-08	Sweep	Beach		Sea trout	176	70	1.28		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	174	54	1.03		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	160	48	1.17		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	151	37	1.07		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	186	65	1.01		0	1	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	203	77	0.92		2	1	0	3	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	190	76	1.11		4	0	0	4	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	195	80	1.08		3	0	0	3	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	187	61	0.93		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	188	50	0.75		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	173	56	1.08		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	182	55	0.91		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	235	149	1.15		2	3	0	5	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	164	44	1.00		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	160	41	1.00		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	191	60	0.86		1	2	0	3	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	153	34	0.95		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	194	69	0.95		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	155	40	1.07		0	1	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	172	63	1.24		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	193	75	1.04		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	172	50	0.98		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	185	59	0.93		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	172	58	1.14		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	163	45	1.04		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	163	44	1.02		2	1	0	3	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	170	45	0.92		2	0	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	167	45	0.97		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	141	29	1.03		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	196	69	0.92		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	152	30	0.85		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	165	47	1.05		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	200	87	1.09		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	194	83	1.14		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	189	68	1.01		1	0	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	186	60	0.93		0	2	0	2	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	193	70	0.97		0	1	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	183	59	0.96		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	217	102	1.00		2	2	0	4	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	196	67	0.89		0	0	0	0	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	173	55	1.06		0	1	0	1	0			8	34
Boor Bay	28-May-08	Sweep	Beach		Sea trout	158	37	0.94		0	0	0	0	0			8	34
L. Loch Broom	30-May-08	Sweep	Beach		Sea trout	309	323	1.09		0	22	1	23				28	28
L. Loch Broom	30-May-08	Sweep	Beach		Sea trout	307	300	1.04		0	23	0	23				28	28
Loch Long	05-Jun-08	Sweep	Estuary	Nt	Sea trout	204	80	0.94	0	49	25	0	74	1	1		12	12

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 8)

Loch Long	05-Jun-08	Sweep	Estuary	Nt	Sea trout	165	46	1.02	0	53	47	0	100	0	1		12	12
Loch Long	05-Jun-08	Sweep	Estuary	Nt	Sea trout	115	19	1.25	0	3	1	0	4	1	1		12	12
Loch Long	05-Jun-08	Sweep	Estuary	Nt	Sea trout	171	53	1.06	0	60	28	0	88	1	1		12	12
Kanaird	6-Jun-08	Sweep	Estuary	M34	Salmon	760			0	300	12	92	404				4	4
Kanaird	6-Jun-08	Sweep	Estuary	M36	Salmon	520			0	925	26	50	1001				4	4
Kanaird	6-Jun-08	Sweep	Estuary	M37	Salmon	720			0	350	7	40	397				4	4
Kanaird	6-Jun-08	Sweep	Estuary	M35	Salmon	720			0	430	11	50	491				4	4
Dundonnell	07-Jun-08	Fyke	Estuary		Sea trout	260				50	40	0	90	3			28	28
Dundonnell	07-Jun-08	Fyke	Estuary		Sea trout	200				30	32	1	63	0			28	28
Dundonnell	07-Jun-08	Fyke	Estuary		Sea trout	140				0	0	0	0	0			28	28
Dundonnell	07-Jun-08	Fyke	Estuary		Sea trout	130				2	0	0	2	0			28	28
Dundonnell	11-Jun-08	Fyke	Estuary		Sea trout	295	258	1.00		57	3	0	60	0		0	28	28
Dundonnell	12-Jun-08	Fyke	Estuary		Sea trout	240	94	0.68		100	2	0	102	2		0	28	28
Dundonnell	13-Jun-08	Fyke	Estuary		Sea trout	145	26	0.85		0	0	0	0	0		1	28	28
Kerry Bay	13-Jun-08	Sweep	Beach		Sea trout	180	50	0.86		0	0	0	0	0		0	30	30
Kerry Bay	13-Jun-08	Sweep	Beach		Sea trout	188	68	1.02		0	4	1	5	0		0	30	30
Kerry Bay	13-Jun-08	Sweep	Beach		Sea trout	155	45	1.21		0	4	0	4	0		0	30	30
Kerry Bay	13-Jun-08	Sweep	Beach		Sea trout	157	44	1.14		0	0	0	0	0		1	30	30
Dundonnell	17-Jun-08	Fyke	Estuary		Sea trout	190	74	1.08		35	5	0	40	1		0	28	28
Dundonnell	18-Jun-08	Fyke	Estuary		Sea trout	185	72	1.14		20	9	1	30	0		0	28	28
Dundonnell	19-Jun-08	Fyke	Estuary		Sea trout	175				55	12	0	67	0		1	28	28
Dundonnell	19-Jun-08	Fyke	Estuary		Sea trout	180				40	9	0	49	0		0	28	28
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	190	61	0.89	0	46	40	0	86				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	184	69	1.11	0	6	5	0	11				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	197	89	1.16	0	4	20	0	24				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	254	175	1.07	0	15	5	0	20				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	181	57	0.96	0	0	0	0	0				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	346	396	0.96	0	6	3	0	9				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Sea trout	170	50	1.02	0	30	30	0	60				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Salmon	153	38	1.06	0	0	8	2	10				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Salmon	151	32	0.93	0	0	1	0	1				4	4
Kanaird	19-Jun-08	Sweep	Estuary		Salmon	175	51	0.95	0	0	0	30	30				4	4
Dundonnell	20-Jun-08	Fyke	Estuary		Sea trout	205	90	1.04		10	40	10	60	3		1	28	28
Kerry Bay	24-Jun-08	Sweep	Beach		Sea trout	320	410	1.25		6	80	7	93	1		0	30	30
Kerry Bay	24-Jun-08	Sweep	Beach		Sea trout	185	69	1.09		0	3	0	3	0		0	30	30
Kerry Bay	24-Jun-08	Sweep	Beach		Sea trout	320	376	1.15		11	4	7	22	0.5		0	30	30
Kerry Bay	24-Jun-08	Sweep	Beach		Sea trout	206	104	1.19		6	0	0	6	0		0	30	30
Kerry Bay	24-Jun-08	Sweep	Beach		Sea trout	181	63	1.06		3	0	0	3	0		0	30	30
Kerry Bay	24-Jun-08	Sweep	Beach		Sea trout	361	550	1.17		6	28	6	40	1		0	30	30
Dundonnell	26-Jun-08	Fyke	Estuary		Sea trout	215	102	1.03		20	9	0	29	0		0	28	28
Dundonnell	30-Jun-08	Fyke	Estuary		Sea trout	275				7	120	0	127	0		1	28	28
Dundonnell	01-Jul-08	Fyke	Estuary		Sea trout	280	248	1.13		3	14	0	17	0		1	28	28
Dundonnell	02-Jul-08	Fyke	Estuary		Sea trout	175	60	1.12		4	29	0	33	1		1	28	28
Dundonnell	02-Jul-08	Fyke	Estuary		Sea trout	270	202	1.03		2	14	0	16	1		0	28	28
Dundonnell	03-Jul-08	Fyke	Estuary		Sea trout	265	228	1.23		20	34	0	54	0			28	28

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 9)

Dundonnell	03-Jul-08	Fyke	Estuary		Sea trout	215	114	1.15		29	14	4	47	0			28	28
Boor Bay	03-Jul-08	Sweep	Beach		Sea trout	172	50	0.98		0	0	0	0	0		0	8	34
Boor Bay	03-Jul-08	Sweep	Beach		Sea trout	167	55	1.18		2	2	1	5	0		0	8	34
Boor Bay	03-Jul-08	Sweep	Beach		Sea trout	226	137	1.19		1	0	3	4	0		1	8	34
Boor Bay	03-Jul-08	Sweep	Beach		Sea trout	200	96	1.20		0	4	0	4	0		0	8	34
Boor Bay	03-Jul-08	Sweep	Beach		Sea trout	153	38	1.06		3	0	0	3	0		0	8	34
Loch Long	04-Jul-08	Sweep	Estuary	Nt	Sea trout	196	77	1.02	0	2	0	0	2	1	1		12	12
Loch Long	04-Jul-08	Sweep	Estuary	M28	Sea trout	270	207	1.05	0	0	2	0	2	0	1		12	12
Dundonnell	04-Jul-08	Fyke	Estuary		Sea trout	250	156	1.00		23	56	0	79	0.5		0	28	28
River Carron	08-Jul-08	Sweep	Estuary		Sea trout	179	67	1.17	1	0	0	0	0	0			8	8
River Carron	08-Jul-08	Sweep	Estuary		Sea trout	187	72	1.10	0	0	0	0	0	0			8	8
River Carron	08-Jul-08	Sweep	Estuary		Sea trout	211	104	1.11	0	0	0	0	0	0			8	8
River Carron	08-Jul-08	Sweep	Estuary		Sea trout	176	55	1.01	0	0	0	0	0	0			8	8
River Carron	08-Jul-08	Sweep	Estuary		Sea trout	430	911	1.15	0	7	46	2	55	3			8	8
River Carron	08-Jul-08	Sweep	Estuary		Sea trout	320	347	1.06	0	0	0	0	0	1.5			8	8
Ewe	10-Jul-08	Rod	River	35N	Sea trout	255	187	1.13	0	15	14	0	29	0		0	8	34
Ewe	10-Jul-08	Rod	River		Sea trout	237	152	1.14	0	6	12	0	18	0		0	8	34
Ewe	10-Jul-08	Rod	River		Sea trout	220	124	1.16	0	6	3	0	9	1		0	8	34
Ewe	10-Jul-08	Rod	River		Sea trout	257	210	1.24	0	51	45	0	96	0.5		0	8	34
Ewe	10-Jul-08	Rod	River		Sea trout	227	134	1.15	0	9	5	0	14	0.5		1	8	34
Ewe	10-Jul-08	Rod	River	36N	Sea trout	312	365	1.20	0	29	20	0	49	1		1	8	34
Ewe	10-Jul-08	Rod	River	37N	Sea trout	267	262	1.38	0	55	38	1	94	1		0	8	34
Ewe	10-Jul-08	Rod	River	38N	Sea trout	332	451	1.23	0	5	13	0	18	1.5		0	8	34
Boor Bay	17-Jul-08	Sweep	Beach		Sea trout	177	63	1.14		2	0	0	2	0		0	8	34
Boor Bay	17-Jul-08	Sweep	Beach		Sea trout	200	94	1.18	1	1	0	0	1	0		1	8	34
Boor Bay	17-Jul-08	Sweep	Beach		Sea trout	225	138	1.21	0	0	3	1	4	0		1	8	34
Boor Bay	17-Jul-08	Sweep	Beach		Sea trout	196	104	1.38	0	0	1	1	2	0		0	8	34
Ewe	22-Jul-08	Rod	River		Sea trout	255	195	1.18	0	0	1	0	1	0		0	8	34
Ewe	22-Jul-08	Rod	River	80H	Sea trout	297	282	1.08	0	0	10	0	10	0.5		0	8	34
Ewe	22-Jul-08	Rod	River		Sea trout	267	238	1.25	0	3	13	0	16	0		0	8	34
Ewe	22-Jul-08	Rod	River		Sea trout	230	142	1.17	0	4	2	0	6	0		0	8	34
Ewe	22-Jul-08	Rod	River		Sea trout	263	238	1.31	0	0	2	0	2	0		0	8	34
Ewe	22-Jul-08	Rod	River	81H	Sea trout	314	380	1.23	0	0	1	0	1	0.5		1	8	34
Ewe	22-Jul-08	Rod	River	82H	Sea trout	395	715	1.16	0	0	0	0	0	0		1	8	34
Ewe	22-Jul-08	Rod	River	83H	Sea trout	360	570	1.22	0	1	9	0	10	1		1	8	34
Ewe	22-Jul-08	Rod	River		Sea trout	250	175	1.12	0	9	2	0	11	0.5		0	8	34
Ewe	22-Jul-08	Rod	River		Sea trout	261	180	1.01	0	0	3	0	3	0		0	8	34
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	212	112	1.18	0	0	0	0	0	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	227	138	1.18	0	0	0	0	0	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	195	70	0.94	0	0	0	0	0	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	239	142	1.04	0	0	1	0	1	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	206	91	1.04	1	4	0	0	4	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	186	60	0.93	0	0	0	0	0	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	202	90	1.09	1	0	0	0	0	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	191	70	1.00	0	2	0	0	2	0			8	8

Appendix 1: Results of sea lice monitoring in 2007 and 2008: the full data set (continued - 10)

River Carron	23-Jul-08	Sweep	Estuary		Sea trout	149	38	1.15	0	0	1	0	1	0			8	8
River Carron	23-Jul-08	Sweep	Estuary		Sea trout	402	766	1.18	0	59	0	0	59	0			8	8
Kanaird	25-Jul-08	Sweep	Estuary		Sea trout	266	229	1.22	0	40	6	0	46				4	4
Kanaird	25-Jul-08	Sweep	Estuary		Sea trout	246	160	1.07	0	0	0	0	0				4	4
Kanaird	25-Jul-08	Sweep	Estuary		Sea trout	460	1144	1.18	0	15	33	0	48				4	4
Kanaird	25-Jul-08	Sweep	Estuary		Sea trout	335	466	1.24	0	0	12	0	12				4	4
Kerry Bay	27-Jul-08	Sweep	Beach		Sea trout	202	95	1.15		5	3	0	8	0		0	30	30
Boor Bay	29-Jul-08	Sweep	Beach		Sea trout	232	137	1.10	0	0	4	1	5	0		0	8	34
Boor Bay	07-Aug-08	Sweep	Beach		Sea trout	223	115	1.04	0	0	0	1	1	0		0	8	34
Boor Bay	07-Aug-08	Sweep	Beach		Sea trout	198	90	1.16	0	0	3	0	3	0		0	8	34
Boor Bay	07-Aug-08	Sweep	Beach		Sea trout	199	78	0.99	0	0	0	0	0	0		0	8	34
Ewe	07-Aug-08	Rod	River		Sea trout	260	198	1.13	0	0	0	0	0	0		0	8	34
Kerry Bay	12-Aug-08	Sweep	Beach		Sea trout	228	127	1.07		36	16	0	52	1		0	30	30
Kerry Bay	12-Aug-08	Sweep	Beach		Sea trout	212	95	1.00		19	9	0	28	0		0	30	30
Boor Bay	18-Aug-08	Sweep	Beach		Sea trout	238	140	1.04	0	5	2	0	7	0		1	8	34
Boor Bay	18-Aug-08	Sweep	Beach		Sea trout	223	127	1.15	0	5	3	1	9	0		0	8	34
Lochcarron	29-Aug-08	Sweep	Beach		Sea trout	172			0	0	0	0	0	1			7	7