



## **Reported sea lice treatment chemical residues in Scottish sea lochs**

**Guy Linley-Adams**  
**Solicitor to the Salmon & Trout Association Aquaculture Campaign**  
[guy@linley-adams.co.uk](mailto:guy@linley-adams.co.uk)

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## Executive Summary

1. Information and data used to compile this report was obtained by the Salmon & Trout Association (S&TA) from the Scottish Environment Protection Agency (SEPA) pursuant to the EC Directive on Public Access to Environmental Information (2003/4/EC) as implemented in Scotland by the Environmental Information (Scotland) Regulations 2004.
2. The in-feed treatment Slice (emamectin benzoate) is widely used in the Scottish salmon farming industry for the control of sea lice parasites on the farmed fish.
3. Emamectin benzoate is highly toxic to marine crustacea.
4. The typical licence held by fish-farmers under the Controlled Activities Regulations requires farm operators to report to SEPA the results of self-monitoring of sea-bed residues of certain sea lice treatments, including emamectin benzoate.
5. In response to a specific request for information made to SEPA to identify fish farms that have failed to provide benthic or sea lice treatment residue data, SEPA provided the S&TA with a list of 91 incidences covering the period of 2005 to 2010 where such data had not been submitted. In those 91 incidences, 72 related to the failure to report emamectin benzoate residue data.
6. The self-monitoring data submitted by fish-farm operators reveals that over the five year period, 2005 to 2010, 237 replicate samples taken at 61 different fish farms were above Environmental Quality Standards as set by SEPA to protect marine flora and fauna.
7. SEPA has published annual screening survey reports giving the results of marine sediment sampling undertaken each year by SEPA itself at a very small sample of fish farm locations between 2003 and 2006. After the request for information made by the S&TA in 2011, SEPA has subsequently published sediment survey reports covering the samples taken in 2008 and 2009. The sediment survey reports covering 2010 and 2011 are yet to be published.
8. SEPA screening survey reports, covering the samples taken from 2003 to 2006, indicated further breaches of Environmental Quality Standards.
9. SEPA screening surveys, covering 2003 to 2006, suggested some evidence of the possible illegal use of unlicensed sea lice treatments by fish-farmers, with between 10% of sites in 2003, up to 57% of sites in 2004 showing detections of chemicals unlicensed for sea lice treatment.
10. Unlike SEPA's screening survey reports, covering 2003 to 2006, SEPA's sediment survey reports, covering 2008 and 2009 and published in 2011, declined to highlight whether any chemicals unlicensed for use as sea lice treatments were detected and downplay the link previously discussed in the earlier screening surveys between any residues found and nearby fish farming activity.

11. Both the number of fish-farm sites associated with either the screening or sediment surveys and the number of sample sites has fallen over through the period 2003 to 2009, indicating that audit monitoring of benthic residues of sea lice treatment chemicals by SEPA has reduced significantly.
12. Over the same period, the overall tonnage of emamectin benzoate used by the Scottish farming industry has increased dramatically.
13. The current expansion of the Scottish salmon and farming industry and its reliance on using chemicals such as emamectin benzoate to control sea lice on farmed fish calls into question the long term sustainability of the system open-cage fish farming and provides further support for the early relocation of those existing fish-farms in sensitive locations and a move towards closed containment production of farmed salmon over the medium term.

## Sources of Information

Much of the information and data used to compile this report has been obtained pursuant to the EC Directive on Public Access to Environmental Information (2003/4/EC) as implemented in Scotland by the Environmental Information (Scotland) Regulations 2004.

Acting on behalf of the Salmon & Trout Association (S&TA), a request for information was made by the author to SEPA on 25<sup>th</sup> March 2011. SEPA's Initial Response was given on 27<sup>th</sup> April 2011, with a Final Response on 26<sup>th</sup> May 2011. A Formal Review was requested from SEPA on 24<sup>th</sup> June 2011 and the Review was conducted on 26<sup>th</sup> July 2011.

In addition, prior to the request, SEPA had published annual Screening Surveys<sup>1 2 3 4</sup> on its website. These Screening Surveys were carried out by SEPA in the years 2003 to 2006 looking at chemicals used in sea-louse treatments in sediments adjacent to fish farms, giving the results of the annual audit monitoring conducted as a check on self-monitoring of such residues by the fish-farmers themselves.

In response to S&TA's request on 24<sup>th</sup> June 2011 for a Formal Review of its Initial Response to the request for information, SEPA informed S&TA that no annual screening survey was conducted in 2007 "due to a disease outbreak"<sup>5</sup>, that the 2008 and 2009 would be "finalised shortly" and that the 2010 survey "is likely to be published on our website in late 2011"<sup>6</sup>. It has yet to be published.

Reports covering 2008<sup>7</sup> and 2009<sup>8</sup> (hereinafter referred to as the Sediment Surveys) were belatedly published in October 2011 but have a markedly different emphasis to the earlier Screening Surveys, downplaying the link between the residues found in the marine sediments sampled to the fish farms present at or near to the sampling sites. Despite this, it is patent that the chemicals analysed are licenced sea lice treatments (or unlicensed sea lice treatments, unlawfully used, in the case of ivermectin) and the sample sites are very closely associated with fish-farms.

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<sup>1</sup> SEPA (2004) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms Results of Screening Surveys During 2003 Report TR-040430JBT 30<sup>th</sup> April 2004

<sup>2</sup> SEPA (2005) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms Results of Screening Surveys During 2004 Report TR-050202JBT 2<sup>nd</sup> February 2005

<sup>3</sup> SEPA (2006) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms Results of Screening Surveys During 2005 Report TR-060830JBT 30<sup>th</sup> August 2006

<sup>4</sup> SEPA (2007) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms Results of Screening Surveys During 2006 Report TR-070807JBT 7<sup>th</sup> August 2007

<sup>5</sup> SEPA Formal Review of information request made on behalf of S&TA, 26<sup>th</sup> July 2011

<sup>6</sup> Email from SEPA to Guy Linley-Adams, Solicitor to S&TA, 15<sup>th</sup> June 2011

<sup>7</sup> SEPA (2011) The Occurrence of Chemical Residues in Sediments in Loch Kanaird, Summer Isles, Loch Fyne, Portree Bay, Loch Slapin and Loch na Keal 2008 Survey. Report TR110810\_JT, 26 September 2011

<sup>8</sup> SEPA (2011) The Occurrence of Chemical Residues in Sediments in Loch Linnhe, Loch Ewe and Loch Nevis 2009 Survey. Report TR110811\_JT, 26 September 2011

## Sea-lice chemical residues

It is now widely accepted by almost all fisheries scientists that raised levels of sea lice emanating from salmon farms are a significant threat to wild salmonid populations<sup>9</sup>, causing death in emigrating salmon and sea trout smolts or 'early returning behaviour' whereby sea trout (both smolts and older fish) in poor condition return early to freshwater to shed their load of lice (which drop off in freshwater)<sup>10</sup>.

Wild salmonid fish, in the first days or weeks after they transfer to sea water, enter bays and sea lochs containing salmon farms that produce an abundance of juvenile sea lice some orders of magnitude above natural background levels. The effect on wild sea-trout has been well-documented<sup>11</sup>, including in relation to the collapse of the Loch Ewe / Loch Maree sea-trout population<sup>12</sup> and a similar impact is believed to occur in Atlantic salmon.

Recent research in Ireland has reinforced the conclusion that "sea lice-induced mortality on adult Atlantic salmon returns [in Ireland] can be significant, and that sea lice larvae emanating from farmed salmon may influence individual survivorship and population conservation status of wild salmon...."<sup>13</sup>.

What is perhaps less well discussed is the concern as to the effects of long-term and repeat exposure of the wider marine environment, and particularly marine fauna, to chemicals deliberately designed to be toxic to marine species (sea lice) and deliberately (in the case of bath-type treatments) or knowingly (in the case of in-feed products) released after use from the fish-farms. Sea-bed marine fauna, both directly below and beyond salmon-farm cages, can be affected by residues of the chemicals used in sea-lice treatments.

The most commonly-used chemicals are emamectin benzoate (Slice), cypermethrin (Excis), deltamethrin (Alphamax) and azamethiphos (Salmosan). These chemicals are used across the majority of marine salmon-farms in Scotland to limit the numbers of parasitic sea lice on the farmed fish, but this report necessarily concentrates largely on the residues of the in-feed treatment, Slice (emamectin benzoate), as this is where most data exists by virtue of its greater propensity to accumulate in marine sediment than the bath type treatments, where the release is directly to the water column<sup>14</sup>.

Slice is administered in feed to salmon and so will reach the wider environment through uneaten feed and also excreted in faeces by farmed fish. It is highly toxic to crustacea<sup>15</sup>.

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<sup>9</sup> Costello M J (2009) How sea lice from salmon farms may cause wild salmonid declines in Europe and North America and be a threat to fishes elsewhere. Proc R Soc B 2009 276, 3385-3394

<sup>10</sup> FRS (2007) Seventh Annual Report of the Shieldaig Sea Trout Project

<sup>11</sup> SJ Middlemas, JA Raffell, DW Hay, M Hatton-Ellis and J D Armstrong (2010) Temporal and spatial patterns of sea lice levels on sea trout in western Scotland in relation to fishfarm production cycles Biol. Lett. 23 August 2010 vol. 6 no. 4 548-551

<sup>12</sup> Butler JRA, Walker AF. 2006. Characteristics of the sea trout *Salmo trutta* L. stock collapse in the River Ewe (Wester Ross, Scotland) in 1988-2001. In: Sea Trout: Biology, Conservation and Management, pp. 45-59 (eds N.J. Milner & G.S. Harris). Blackwell Publishing Ltd., Oxford, UK.

<sup>13</sup> P.G. Gargan, G. Forde, N. Hazon, D.J.F. Russell, and C.D. Todd (2012) Evidence for sea lice-induced marine mortality of Atlantic salmon (*Salmo salar*) in western Ireland from experimental releases of ranched smolts treated with emamectin benzoate Can. J. Fish. Aquat. Sci. Vol. 69, 2012

<sup>14</sup> [www.thefishsite.com/articles/9/slice-for-the-control-of-sealice](http://www.thefishsite.com/articles/9/slice-for-the-control-of-sealice)

<sup>15</sup> Willis K J and Ling N (2003) The toxicity of emamectin benzoate, an aquaculture pesticide, to planktonic marine copepods. Aquaculture 221 (289-297)

Marine crustacea include some commercially important marine animals such as lobster, crab, prawns and shrimps. Indeed, all the various therapeutic agents used to kill sea lice on fish farms are a particular threat to crustaceans. Sea-lice are themselves copepod crustaceans.

## Environmental Quality Standards

In 1999, SEPA conducted a risk assessment of emamectin benzoate which indicated that the farmed fish will absorb 90% of emamectin benzoate fed to them while 10% will be immediately excreted in the faeces<sup>16</sup>. The potential impact on the marine environment will, therefore, either be as a result of indirect input from excreted material or the direct input from waste feed<sup>17</sup>.

The maximum concentration of emamectin benzoate on the sea-bed is predicted to occur 118 days post-treatment<sup>18</sup>.

Following the SEPA risk assessment, in 2000, the Veterinary Medicines Directorate issued a Marketing Authorisation for the treatment of sea lice in salmon aquaculture using Slice (emamectin benzoate).

The environmental impact of emamectin benzoate, like other pesticides, is controlled by reference to an Environmental Quality Standard (EQS). SEPA states that it “limits the use of in-feed anti-parasitic chemicals by predicting the quantity that may be discharged from a fish farm site that does not result in a sediment concentration in excess of the EQS”<sup>19</sup>.

In relation to fish-farms, SEPA expects and permits some localised impact within the immediate vicinity of a fish-farm, in what it terms the Allowable Zone of Effect (AZE). The default inner AZE is the area under the cages and out to 25m beyond the cages in any direction<sup>20</sup>. As well as having an inner AZE, each fish farm has a ‘far field’ AZE. The far-field AZE is typically the area outside the cages, plus a 100m margin. Between the inner AZE and 100m of the cages, the far-field EQS may be breached.

[Note that an AZE may be changed where a farm has submitted an application to SEPA for a farm-specific AZE taking into account the particular characteristics (wind, tide, depth etc) of a site].

The EQS for emamectin benzoate (Slice) is set at 0.763 microgrammes per kg outside the inner AZE<sup>21</sup>, but with a trigger value of 7.63 microgrammes per kg to “gauge the

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<sup>16</sup> SEPA (1999) Emamectin Benzoate, An Environmental Risk Assessment , 23pp.

<sup>17</sup> P Walsham and L Webster (2004) Determination of the semi-synthetic avermectin, emamectin benzoate, by liquid chromatography – atmospheric pressure chemical ionisation mass spectrometry (LC-APCI-MS) in sediment from Loch Sunart and Loch Kishorn Fisheries Research Services Contract Report No 01/04

<sup>18</sup> SEPA (2005a) Regulation and monitoring of marine cage fish farming in Scotland. Marine Fish Farming Manual (Annex 7). Monitoring.

<sup>19</sup> SEPA (2006) In-feed consent limits at dispersive sites – v 3 dated 24<sup>th</sup> November 2006

<sup>20</sup> SEPA (2006) In-feed consent limits at dispersive sites – v 3 dated 24<sup>th</sup> November 2006

<sup>21</sup> SEPA (1999) Emamectin benzoate use in Marine Fish Farms: An Environmental Risk Assessment. SEPA Board Paper 65/99

need to monitor sediment re-worker fauna populations...within the inner AZE" (ie out to 25m from the cages)<sup>22</sup>.

It is instructive to note that some years later, in 2002, a Review and Synthesis of the Environmental Impacts of Aquaculture, produced for the Scottish Executive commented that "there is relatively little information available on the toxicity of the chemical to marine benthic invertebrates in particular, and little is known about the potential long-term impacts of this chemical in the marine environment"<sup>23</sup>. In 2005, Environment Canada (part of the Canadian Government) also noted substantial knowledge gaps for data on chronic (as opposed to acute) toxicity and ecologically relevant effects other than mortality, endocrine disruption effects (eg altered moulting and reproduction in lobsters exposed to emamectin benzoate) and toxicity data for benthic meiofauna such as nematodes which are potentially sensitive and ecologically important indicator species<sup>24</sup>.

The Environmental Quality Standard for emamectin benzoate, set by SEPA in 1999, remains in force.

### **The potential for an impact on marine shellfish**

There is understandable concern that emamectin benzoate used in sea-lice treatments may negatively impact upon crabs, lobsters and prawns. The agent is designed to kill crustacean sea-lice on fish and is known to be released into the wider environment in significant quantities as an inevitable consequence of its use as a sea lice treatment.

If wild marine crustaceans are exposed to significant concentrations, this has the potential to have an impact upon populations and the livelihoods of coastal shellfishermen.

There are some anecdotal reports of an impact of sea lice treatment chemicals on wild shellfish. For example, dead and dying *Nephrops* (aka Norway lobster, Dublin Bay prawn, langoustine or scampi) were reported in creels in Loch Shell following sea-lice treatments carried out at fish farms in 2010<sup>25</sup>.

Verifiable scientific evidence of such impacts is, of course, virtually impossible for shellfishermen to bring forward or to demonstrate due to the costly nature of the sampling and subsequent analytical chemistry required and the reluctance of some fish-farmers to provide dates and details of sea-lice treatments carried out on specific farms.

As such, shellfishermen can only rely on SEPA to police and monitor the use and emission of emamectin benzoate to the sea loch environment.

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<sup>22</sup> SEPA (2005) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms: Results of Screening Surveys During 2004 Report TR050202JBT February 2005 at page 2

<sup>23</sup> Scottish Executive (2002) Review and Synthesis of the Environmental Impact of Aquaculture, Chapter 3

<sup>24</sup> Environment Canada (2005) Use of Emamectin Benzoate in the Canadian Finfish Aquaculture Industry. A review of Environmental Fate and Effects

<sup>25</sup> Letter dated 18<sup>th</sup> November 2010 to SEPA from Loch Shell creel fisherman

## **Self-monitoring by fish-farms; failure to provide benthic surveys and sea-lice treatment residue data**

To enable SEPA to keep a check on both benthic fauna and enrichment from waste food and faeces, as well as the degree to which marine sediments are impacted by sea-lice chemicals, under the terms of a typical Controlled Activities Regulations (CAR) licence, fish-farmers are required to undertake self-monitoring in accordance with a protocol and to submit both benthic biological and chemical analyses of sea-bed sediments as well as analyses of sea-lice residues.

In response to a specific request made on behalf of the S&TA for SEPA to identify any fish farms that had failed to provide benthic or sea-lice treatment residues data, SEPA provided<sup>26</sup> the list at Table 1 listing 91 incidences of fish-farms over the period 2005 to 2010 where the benthic or residue data has been due but not submitted in accordance with the conditions of their CAR authorisations from SEPA.

Explaining some of the failures, SEPA confirmed that “some farms may have used Slice but not completed the associated seabed sampling and associated sample analysis, some farms may have completed the sampling but have not submitted monitoring results for example because the analysis has not been completed or results have not been received by the company concerned...fish farmers have at times had difficulties finding laboratories within Scotland or indeed the UK with the ability to undertake the required analysis to the required standard”<sup>27</sup>.

The failure of fish-farmers to report monitoring data, for whatever reason, must make it difficult for SEPA to be certain that unacceptable residues of sea-lice treatments are not building up in the affected sea-lochs.

Table 1 below shows 72 cases of fish farms failing to report Slice residue data as required by SEPA, representing about 16% of fishfarms. There are approximately 450 marine salmon fish farms in Scotland.

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<sup>26</sup> SEPA letter to Guy Linley-Adams 21<sup>st</sup> July 2011, with attached spreadsheet

<sup>27</sup> Email from SEPA to Guy Linley-Adams 15<sup>th</sup> June 2011



**Table 1**

**Fish farms reported by SEPA over the period 2005 to 2010 as having failed to provide the benthic or residue data in accordance with the conditions of their CAR authorizations**

<b>Company</b>	<b>Site name</b>	<b>Location</b>	<b>Year monitoring due but not submitted</b>	<b>Survey type</b>
The Scottish Salmon Company Ltd	Aird Ardheslaig, Loch Shieldaig	Loch Torridon	2010	Slice residues
Loch Duart Ltd	Eilean Ard / Site 3 (CE = site 2 /	Loch Laxford	2010	Slice residues
The Scottish Salmon Company Ltd	Ardvourlie, Lewis	Loch Seaforth	2007	Slice residues
North Uist Fisheries	Baigh Chlann Neill, Grimsay	Loch Grimsay	2010	Benthic
Thompson Bros Salmon	Basta Voe, North West Site	Basta Voe	2010	Benthic
North Atlantic Salmon	Brandy Ayre	Easter Sound	2007	Benthic
Scottish Sea Farms Ltd	Bellister	Dury Voe	2009	Slice residues
Scottish Sea Farms Ltd	Brei Geo Inshore	Sandsound	2007	Benthic
Lakeland Unst Ltd	Site 3, South Head of Mula	Bluemull Sound	2009	Benthic
Hjaltland Seafarms Ltd	Boatsroom Voe	Boatsroom Voe	2010	Slice residues
Scottish Sea Farms Ltd	East of Bruna Ness	Lang Sound	2008	Slice residues
Northern Isles Salmon Ltd	Bunya Sand	Mid Yell Voe	2008	Slice residues
Marine Harvest (Scotland) Ltd	Bunavoneader (inner), Harris /	West Loch Tarbet	2007	Slice residues
Hjaltland Seafarms Ltd	West of Burwick	West of Scalloway	2010	Slice residues
Loch Duart Ltd	Site 5, Calbha Beag (CE site 3)	Calbha Bay	2010	Slice residues
Hjaltland Seafarms Ltd	North of Papa, W of Scalloway	The Deeps	2010	Slice residues
Dales Voe Salmon Ltd	Dales Voe, Lerwick	Dales Voe, Lerwick	2010	Slice residues
The Scottish Salmon Company Ltd	Druimyeon Bay (new site)	Gigha	2010	Slice residues
Loch Duart Ltd	Loch Droighniche	Eddrachillis Bay	2006	Slice residues
Loch Duart Ltd	Eilean a Mhadaidh / site 2 (CE =	Loch Laxford	2008	Slice residues
Scottish Sea Farms Ltd	Eilean Fada Mhor, Summer Isles	Fada Mhor	2010	Slice residues
Scottish Sea Farms Ltd	East of Hildasay	Hildasay	2008	Benthic
Scottish Sea Farms Ltd	East of Hildasay	Hildasay	2008	Slice residues
Scottish Sea Farms Ltd	East of Hildasay	Hildasay	2007	Calicide residues
Marine Harvest (Scotland) Ltd	Eilean Haey	Loch Skipport	2007	Slice residues
Marine Harvest (Scotland) Ltd	Eishort	Loch Eishort	2007	slice residues

Hjaltland Seafarms Ltd	East of Langa	Atlantic Ocean	2009	Benthic
Hjaltland Seafarms Ltd	East of Langa	Atlantic Ocean	2010	Slice residues
Lakeland Marine Farms Ltd	Eilean Grianain	Kilbrannan Sound	2010	Slice residues
Hjaltland Seafarms Ltd	East of Merry Holm	West Burra Firth	2008	Slice residues
Hjaltland Seafarms Ltd	Easter Score Holm, S. Foraness	The Deeps	2010	Slice residues
The Scottish Salmon Company Ltd	Scallastle Bay South East	Sound of Mull	2009	Slice residues
Lakeland Marine Farms Ltd	Port na Moine, Site 2, North	Loch Craignish	2010	Slice residues
Scottish Sea Farms Ltd	Creran A	Loch Creran	2010	Slice residues
Scottish Sea Farms Ltd	Fishnish A	Sound of Mull	2009	Calicide residues
Scottish Sea Farms Ltd	Tuath (Rubha na Gall)	Loch Tuath	2010	Slice residues
Kames Fish Farming	Kames Bay	Loch Melfort	2009	Benthic
Lakeland Marine Farms Ltd	Port nan Seannag (Lunga)	East Coast Lunga	2009	Slice residues
Lakeland Marine Farms Ltd	Bagh Dail nan Ceann South	Craignish Peninsula	2010	Slice residues
Lakeland Marine Farms Ltd	Bagh Dail nan Ceann North	Craignish Peninsula	2010	Slice residues
Scottish Sea Farms Ltd	Fishnish B	Sound of Mull	2009	Calicide residues
Loch Duart Ltd	Foindle East / Site 1 (CE = site 3	Loch Laxford	2010	Slice residues
Marine Harvest (Scotland) Ltd	Geo Beag, Harris	West Loch Tarbet	2010	Slice residues
The Scottish Salmon Company Ltd	Gravir Inner	Loch Odhairn	2010	Slice residues
West Minch Salmon Ltd	Loch Grosebay	Loch Grosebay	2009	Slice residues
Northern Aquaculture Ltd	Geo of Valladale / Urafirth	Urafirth	2010	Slice residues
Scottish Sea Farms Ltd	Holms Geo, Site 3	Clift Sound	2010	Slice residues
Northern Aquaculture Ltd	Hamar Sound	Hamar Voe	2010	Slice residues
Scottish Sea Farms Ltd	Kempie Bay	Loch Eriboll	2008	Slice residues
West Minch Salmon Ltd	Petersport South/Loch Kilerivagh	Loch a Laip	2008	Slice residues
Hebridean Salmon Company Ltd	Kyles Little Bernera, West	Loch Roag	2007	Slice residues
Marine Harvest (Scotland) Ltd	Laga Bay	Loch Sunart	2006	Slice residues
Lewis Salmon Ltd	Arbhair	Loch Leurbost	2010	Slice residues
Scottish Sea Farms Ltd	Lippie Geo, Site 2	Clift Sound	2010	Slice residues
North Atlantic Salmon	Skewart Holm (Linga site)	Brindister Voe	2009	Slice residues
Wester Ross Fisheries Ltd	Site A, Ardesie	Little Loch Broom	2007	Slice residues
Nafc	Lea of Trondra	Clift Sound	2010	Slice residues
Northern Isles Salmon Ltd	Lyrawa Bay, Hoy	Rysa Sound, SF	2009	Visual
Marine Harvest (Scotland) Ltd	Marulaig Bay	The Minch	2010	Slice residues
Scottish Sea Farms Ltd	Tanera 1, Minch/East Bay	Summer Isles	2010	Slice residues
The Scottish Salmon Company Ltd	Mid Strome	Loch Carron	2009	Slice residues
Hjaltland Seafarms Ltd	North Havra	Weisdale Voe	2010	Slice residues

The Scottish Salmon Company Ltd	Gravir Outer	Loch Odhairn	2010	Slice residues
Loch Duart Ltd	Oldany Island	Eddrachillis Bay	2010	Slice residues
Hjaltland Seafarms Ltd	Olnafirth South	Olnafirth	2010	Slice residues
Hjaltland Seafarms Ltd	Papa, East Head of Scalloway	Atlantic Ocean	2010	Slice residues
Northern Isles Salmon Ltd	Pegal Bay, Hoy	Rysa Sound, SF	2010	Visual
The Scottish Salmon Company Ltd	Sgeir Mhor	Portree Bay	2008	Slice residues
Scottish Sea Farms Ltd	Pobie Sukka (Site A)	Ronas Voe	2010	Slice residues
Scottish Sea Farms Ltd	Crying Taing (Site B)	Ronas Voe	2010	Slice residues
Marine Harvest (Scotland) Ltd	Rossay, Harris	East Loch Tarbert	2007	Slice residues
Hjaltland Seafarms Ltd	Setterness West - Poseidon Site	Off Lunnansess	2010	Slice residues
Marine Harvest (Scotland) Ltd	Loch Skipport (outer), Ornish	Loch Skipport	2007	Slice residues
Kames Fish Farming	Loch Slapin	Loch Slapin	2010	Slice residues
Mjm Salmon Ltd	Slocka (Site C)	Ronas Voe	2009	Benthic
Mjm Salmon Ltd	Slocka (Site C)	Ronas Voe	2010	Slice residues
West Minch Salmon Ltd	Loch Stockinish, Harris	Loch Stockinish	2009	Slice residues
Hjaltland Seafarms Ltd	Taing of Railsborough	Cat Firth	2010	Slice residues
Scottish Sea Farms Ltd	Tanera 2	Summer Isles	2010	Slice residues
Scottish Sea Farms Ltd	Teisti Geo	Clift Sound	2010	Slice residues
West Minch Salmon Ltd	Uiskevagh	Loch Uiskevagh	2008	Slice residues
Northern Isles Salmon Ltd	Wick of Vatsetter	South Sound, Yell	2009	Benthic
Northern Isles Salmon Ltd	Wick of Vatsetter	South Sound, Yell	2009	Slice residues
Scottish Sea Farms Ltd	Vidlin North	Vidlin Voe	2009	Benthic
Scottish Sea Farms Ltd	Site 3, Loura Voe	Dury Voe	2008	Slice residues
Marine Harvest (Scotland) Ltd	West Loch Bracadale (Bharcasaig)	Loch Bracadale	2007	Slice residues
Scottish Sea Farms Ltd	North of Hoy	Weisdale Voe	2008	Benthic
Scottish Sea Farms Ltd	North of Hoy	Weisdale Voe	2007	Calicide residues
Scottish Sea Farms Ltd	North of Hoy	Weisdale Voe	2008	Slice residues
Scottish Sea Farms Ltd	Flotta	Mouth of Weisdale Voe	2007	Calicide residues
Hjaltland Seafarms Ltd	North Voe, Whalsay	North Voe, Linga Sound	2010	Slice residues

## **Breaches of Environmental Quality Standards (EQS) shown by self-monitoring provided by fish-farmers**

Where fish-farms have submitted data as required by their CAR licences, there is some cause for concern.

Table 2 shows sample failures as against EQS standards for Slice (emamectin benzoate) over the period 2005 to 2010 at a variety of distances from fish-farm cages, including directly under cages, at a distance of 25m, at 100m and at 150m.

Over the period 2005 - 2010, 237 samples taken at 61 different fish-farms failed EQS limits. 61 fish farms represent approximately 13% of all marine cage fish-farms.

Of these, 84 samples taken at 28 different fish-farms were over the inner field EQS and 153 samples taken at 43 different fish-farms at 100m or beyond were over the outer field EQS.

It is of note that the Minister, Stewart Stevenson, in an Answer to a Parliamentary Question in December 2011 stated that “should an EQS ...for sea louse chemicals be breached following the use and discharge of the substances to treat sea lice at fish farms, SEPA would take various steps to rectify the situation - for example, through a variation of licence conditions limiting the further release of these substances until residue levels reduced to below those identified safe levels”<sup>28</sup>.

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<sup>28</sup> Scottish Parliament Written Answer 14<sup>th</sup> December 2011 given by Stewart Stevenson

**Table 2**

**Sample failures as against EQS standards for Slice (emamectin benzoate) over the period 2005 to 2010 at a variety of distances from fish-farm cages.**

Farm	Company	Sample date	Samples exceeding EQS of 7.63 microgram / kg at cages	Samples exceeding EQS of 0.763 microgram / kg at 100 metres from cages	Samples exceeding EQS of 0.763 microgram / kg at 150 metres from cages
Allt a Chois/ North Shore Site 3	Scottish Sea Farms Limited	14/06/2006	10.89		
Allt a Chois/ North Shore Site 3	Scottish Sea Farms Limited	15/07/2005	10.59, 12.7, 9.05		
An Camus	Marine Harvest	11/11/2007	8.66, 7.87, 10.05		
Achintraid site 1 Loch Kishorn	Scottish Sea Farms Limited	24/07/2007		7.23, 4.39, 5.11	
Kenmore bay (Loch a Chracaich)	The Scottish Salmon Company	03/06/2009	9.57		
Ardgour	Marine Harvest	01/09/2003		1.25, 1.28, 1.57	
Ardintigh Bay Site C	Scottish Sea Farms Limited	10/10/2006	13.47, 8.07, 10.23		
Ardnish	Marine Harvest	25/05/2005	9.93		
Ardintoul Bay	Marine Harvest	20/04/2010		1.48, 1.07, 0.96	
Ardintoul Bay	Marine Harvest	26/03/2008		1.64, 1.71, 1.45	
Brei Geo Offshore	Scottish Sea Farms Limited	07/12/2005			1.16, 0.9, 0.94
Brei Geo Offshore	Scottish Sea Farms Limited	07/12/2005			0.81, 1.30, 0.91
Camus Glas	Marine Harvest	08/10/2008		1.49, 1.43, 1.36	
Camus Glas	Marine Harvest	15/07/2010		2.37, 2.18, 2.20	
Camus Glas	Marine Harvest	11/11/2009		1.07, 1.01	
Camas an Leim	Marine Harvest	06/10/2009		1.01, 1.2, 1.00	
Site 7 North Calba Bay	Loch Duart Limited	04/02/2010	56.87, 42.38		
Site 6 East Rubh a Mhucard	Loch Duart Limited	04/02/2010	13.13, 9.71		
Duich NW	Marine Harvest	03/08/2008		2.2, 2.9, 2.8	

Duich SE	Marine Harvest	03/08/2008		2.3, 2, 1.8
Eilean Fada Mhor (Summer Isles)	Scottish Sea Farms Limited	20/06/2007	8.16, 10.17, 8.11	
Erisort, North Shore	Marine Harvest	08/03/2010		1.4, 1.62, 1.14
St Molios	The Scottish Salmon Company	22/03/2010		1.58, 1.09, 0.82
St Molios	The Scottish Salmon Company	14/10/2008	95.74, 13.03, 12.44	4.64, 4.64, 4.64
Meall Mhor	The Scottish Salmon Company	18/01/2011		1.14, 0.93, 1.5
Shuna, Sound of Shuna	Scottish Sea Farms Limited	13/08/2009		1.39, 2.2, 1.91
Shuna, Sound of Shuna	Scottish Sea Farms Limited	27/07/2007	16.83, 22.39, 17.77	
Creran B	Scottish Sea Farms Limited	23/07/2009		1.54, 2.12, 3.09
Spelve A (Balure)	Scottish Sea Farms Limited	20/04/2009	37.02, 56.89, 43.45	1.46
Spelve B (Camas na Crann)	Scottish Sea Farms Limited	24/02/2009	63.8, 66.5	16, 1.13, 1.5
Spelve B (Camas na Crann)	Scottish Sea Farms Limited	06/07/2005	13.1, 9.82, 10.5	
Fishnish A	Scottish Sea Farms Limited	05/06/2006		1.69, 2.47, 1.43
Fishnish A	Scottish Sea Farms Limited	08/09/2008	24.06, 33.4, 21.38	1.81, 1.98, 1.67
Oban Bay (Ardentraive, Kerrera A)	Scottish Sea Farms Limited	09/12/2009		0.82
Oban Bay (Ardentraive, Kerrera A)	Scottish Sea Farms Limited	28/06/2007	7.83	
Port na Moralachd (Lismore A)	Scottish Sea Farms Limited	14/06/2007	9.18, 9.2, 9.71	
Dubh Sgeir (Lismore B)	Scottish Sea Farms Limited	14/06/2007	12.59, 9.3, 9.9	
Achnacroish/Walters/Lismore East	Scottish Sea Farms Limited	01/07/2005	11.16, 9.72, 9.14	
Bagh Dail na Ceann North	Lakeland Marine Farms	27/08/2006		1.47
Port na Cro	Lakeland Marine Farms	18/07/2007		2.97, 3.89, 3.27
Fishnish B	Scottish Sea Farms Limited	08/09/2008		1.68, 1.76, 1.24
Strondoir Bay	The Scottish Salmon Company	28/01/2009	20.06, 16.93, 13.55	
Bloody Bay	Scottish Sea Farms Limited	10/12/2007		2.45, 2.79, 3.68
East Tarbert Bay	The Scottish Salmon Company	14/08/2007		0.8, 1.4, 0.8
Fiunary	Scottish Sea Farms Limited	09/06/2006		1.42, 1.68, 1.55
Glencripesdale	Marine Harvest	10/08/2008		1.44, 1.22, 1.38
Glencripesdale	Marine Harvest	14/07/2010		3.07, 1.2, 2.49
Geo Beag Harris	Marine Harvest	07/03/2007		1.58, 1.74

Gorsten, Ardgour, Fort William	Marine Harvest	25/05/2005			1.06, 1.06
Gorsten, Ardgour, Fort William	Marine Harvest	14/05/2009		1.85, 3.07	
Gorsten, Ardgour, Fort William	Marine Harvest	21/03/2007	9.13, 8.20, 9.26	4.2, 3.87, 8.82	
Gorsten, Ardgour, Fort William	Marine Harvest	27/08/2009	16.46, 13.8, 14.97	2.58, 2.33, 2.35	
Gorsten North, Ardgour	Marine Harvest	08/05/2007		8.95 2.99, 2.75, 3.07	
Gousam Island	The Scottish Salmon Company	22/05/2008		8.1	
Greinham Island Lewis	The Scottish Salmon Company	22/05/2008		1.3, 1.35, 0.92	
Hogan	Hoganess Salmon Limited	20/11/2009	8.9, 9.8		
Invasion Bay	Marine Harvest	13/07/2010		3.04, 1.8, 2.14	
Invasion Bay	Marine Harvest	31/05/2006	10.38, 8.53		
Isle of Ewe	Marine Harvest	13/04/2007	16.3, 16.97, 18.22	2.46, 2.61, 1.59	
Kyles Vuia East	The Scottish Salmon Company	22/05/2008		1.12, 1.15, 2.08	
Linga (South of Linga)	Hjaltland Seafarms Limited	02/09/2009	8.9, 7.8		
Maaruig Harris	The Scottish Salmon Company	22/05/2008	14.95, 9.66		
North Nesting Site 2 (Grunna Voe)	Scottish Sea Farms Limited	28/07/2010		1.23, 3.71, 2.74	
Noster South C Harris	Marine Harvest	29/07/2010		2.29, 1.82, 2.24	
Noster South C Harris	Marine Harvest	23/06/2009		1.68, 1.80, 1.45	
Sgeir Bhuidhe Pecam Bay 3	Marine Harvest	16/09/2009		0.97, 1.13	
Portnalong Loch Harport	Marine Harvest	02/02/2010		2.04, 1.66, 2.82	
Portnalong Loch Harport	Marine Harvest	27/09/2006	10.77, 9.0, 12.51		1.76, 2.12, 2.06
Portnalong Loch Harport	Marine Harvest	21/04/2008	20.44, 20.96, 19.04	4.76, 4.82, 5.04	
Scotasay Harris	Marine Harvest	31/05/2007		2.12, 2.16	
Loch Seaforth North B Harris	Marine Harvest	23/06/2009		1.84, 1.68, 1.49	
Trouts Ness, Seli Voe	Scottish Sea Farms Limited	03/03/2008		21.75	1.97
Setterness West -Posiedon Site	Hjaltland Seafarms Limited	30/05/2008		1.11, 1.46, 0.86	
South Ford, S Uist	Loch Duart Limited	12/06/2007	7.93, 9.62		
Loch Shell (Outer) Lemreway	Marine Harvest	28/07/2010		1.39	
Mid Loch Shell /Pairc -West (A &...)	Marine Harvest	05/03/2010		1.45, 1.11, 1.26	
Mid Loch Shell /Pairc -West (A &...)	Marine Harvest	29/11/2005		8.04	1.06

mid Loch Shell /Pairc -East (C &...)	Marine Harvest	29/11/2005			4.71
mid Loch Shell / Pairc -East (C &...)	Marine Harvest	05/03/2010		2.05, 2.14, 2.49	
Stoull / Nevis B	Scottish Sea Farms Limited	10/10/2006			2.76
Tanera 2	Scottish Sea Farms Limited	20/06/2007	15.24, 13.54, 13.97		
Vuia Beg Lewis	The Scottish Salmon Company	22/05/2008	16.56, 17.10, 9.29	1.4, 1.33	



### Breaches of EQS in SEPA sampling of marine sediments near fish-farms

Not all monitoring of sea lice treatment residues is carried out by the fish-farms themselves. Some sea-bed monitoring is undertaken by SEPA itself covering a very small sample of the 450 or so salmon fish-farms.

SEPA has published Screening Survey reports between 2003 and 2006, each described as “part of an on-going surveillance monitoring programme to regulate the use chemicals for the treatment of sea lice in the marine fish farming industry”<sup>29</sup>.

In 2003, SEPA detected exceedances of 25m EQS values at 50% of the fish farms it sampled (10 out of the 20 fish farm sites it sampled), with some samples almost up to 3 times the EQS. The fish-farm locations where the EQS was breached in SEPA sampling between 2003 and 2009 are shown in Table 3.

**Table 3**

#### Breaches of EQS in SEPA sampling between 2003 and 2009

Farm	Year	Samples exceeding EQS of 7.63 microgrammes / kg at cages
South Keava	2003	19.1
Portnalong	2003	14.3
Kyles Vuia East	2003	27.9
Gribun	2003	9.98
Creran A	2003	10.2
Port na Moine	2003	12.0
Charlotte Bay	2003	14.0
Shuna Castle Bay	2003	10.3
Camas an Eilean	2003	8.41
Loch Diabaig	2003	19.2
Loch Spelve A	2005	14.8
Summer Isles Site 1	2008	10.0
Loch Linnhe North Site 1	2009	8.03 and 44.0
Loch Linnhe North Site 2	2009	12.5
Loch Linnhe South Site 1	2009	8.03

Of course, the exceedances shown by SEPA monitoring are only a tiny snapshot of the overall picture, with the overwhelming majority of fish-farms sediments never being sampled by SEPA at all over the 2003 to 2009 period.

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<sup>29</sup> 2003 report

## Apparent illegal use of unlicensed sea lice treatments

SEPA's own monitoring has also revealed some evidence of the possible illegal use of unlicensed sea-lice treatments by fish-farmers.

In 2004, SEPA reported that its own sampling at 20 fishfarm sites in 2003 had shown that ivermectin (a chemical related to emamectin but not licensed for use in salmon farming) was found in benthic samples near Kyles Vuia East and Loch Diabaig fishfarms. While SEPA stated that "it is not possible to conclusively attribute the source of residues found in marine sediments to fish farms located in the vicinity", SEPA did consider that follow up action was necessary to attempt to establish evidence of possible unauthorised use of ivermectin as a sea lice treatment. SEPA noted that unauthorised treatments are "often cheaper, very often because they have not been subject to the rigorous assessment that is a prerequisite for authorization both by the VMD [Veterinary Medicines Directorate] and SEPA...". SEPA concluded that "there are indications that industry practice is moving on to use only authorized compounds"<sup>30</sup>.

In 2005, SEPA reported that its own sampling at 23 fishfarm sites in 2004 had shown that ivermectin (a chemical not licensed for use in salmon farming) was found in benthic samples near Pobie Sukka and North of Hoy fishfarms and that cypermethrin was also detected at all 23 sites, 11 of which were not licensed for its use. Again, SEPA stated that "it is not possible to conclusively attribute the source of residues found in marine sediments to fish farms located in the vicinity", but did consider that follow up action was necessary to attempt to establish evidence of possible unauthorised use of ivermectin as a sea lice treatment. Again, SEPA noted that unauthorised treatments are "often cheaper, very often because they have not been subject to the rigorous assessment that is a prerequisite for authorization both by the VMD [Veterinary Medicines Directorate] and SEPA...". As in 2004, SEPA concluded that "there are indications that industry practice is moving on to use only authorized compounds"<sup>31</sup>.

In 2006, SEPA reported that its equivalent 2005 survey of 33 fishfarm sites [not the same sites as surveyed in 2003 or 2004], had shown that at 7 of the sites, there were indications of the presence of compounds (in this case, cypermethrin, teflubenzuron, emamectin benzoate and ivermectin) unlicensed for use on these fish farms<sup>32</sup>: These were the sample sites at Tanera Mhor (ivermectin), Baigh au Sgairbh (emamectin benzoate), Rodel (teflubenzuron), Kirkiebost (teflubenzuron), Ardchattan Bay (teflubenzuron), Loch Riddon (cypermethrin) and Camas Bruaich (cypermethrin). As it had in 2004 and 2005, SEPA again concluded in 2006 that "there are indications that industry practice is moving on to use only authorized compounds".

In 2007, SEPA reported that its equivalent 2006 survey of 15 fishfarm sites [not the same sites as surveyed in 2003, 2004 or 2005] had shown that at 3 of the sites (Pegal

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<sup>30</sup> SEPA (2004) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms: Results of Screening Surveys During 2003 Report TR040430JBT April 2004.

<sup>31</sup> SEPA (2005) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms: Results of Screening Surveys During 2004 Report TR050202JBT February 2005

<sup>32</sup> SEPA(2006) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms: Results of Screening Surveys During 2005 Report TR060830JBT August 2006

Bay, Puldrite Bay and Eday), there were indications of the presence of compounds (in this case, emamectin benzoate) unlicensed for use on these fish farms<sup>33</sup>.

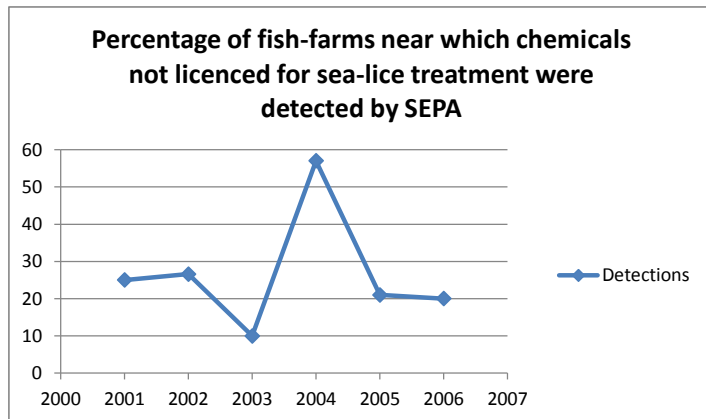
As it had in 2004, 2005 and 2006, SEPA again concluded in 2007 that “there are indications that industry practice is moving on to use only authorized compounds”. However, as shown in Table 4 and Graph 1, the percentage of unlicensed detections has shown no discernible trend, and in 2006 still remained at 1/5<sup>th</sup> of fishfarm sites sampled.

**Table 4**

**Percentage of fish-farms near which chemicals not licensed for sea-lice treatment were detected by SEPA**

Year	%
2001	25
2002	26.6
2003	10
2004	57
2005	21
2006	20

**Graph 1**



That unlicensed use of pesticides to treat sea-lice has been suspected in Scottish salmon farming is made clear not only by the Screening Survey results 2003 – 2006, but also by SEPA itself in guidance issued on the use of Alphamax in 2007 which states that "it is possible that less scrupulous fish farmers may seek to use deltamethrin before it is

<sup>33</sup> SEPA (2007) The Occurrence of Chemicals Used in Sea Louse Treatments in Sediments Adjacent to Marine Fish Farms: Results of Screening Surveys During 2006 Report TR070807JBT August 2007

fully authorized in the UK". SEPA goes on to list deltamethrin-containing pesticides formulations used in other agricultural applications (eg for use on cattle or plant crops) and gives guidance to SEPA staff on evidence-gathering in relation to such illegal use<sup>34</sup>.

Unlike the Screening Surveys from 2003 to 2006, SEPA's Sediment Surveys for 2008 and 2009 declined to highlight whether any chemicals were detected that were unlicensed for use as sea-lice treatments at nearby fish-farms, reflecting the altered emphasis of the reports. The 2008 and 2009 Sediment Surveys were no longer being characterised by SEPA as being related to marine fish farms but were now "part of an on-going surveillance programme to measure the presence of certain chemicals in marine sediment", although the sampling was still all associated with fish-farms and the chemical analysed are all sea-lice treatment chemicals (other than ivermectin which is believed to have been used unlawfully as a sea-lice treatment and had been detected near fish-farms in each one of the 2003 to 2005 surveys).

Although SEPA stated in both the 2008 and 2009 Sediment Surveys that "we need to focus further monitoring efforts to learn more about the likely sources of some of these chemicals"<sup>35</sup>, it highlighted possible alternative sources for various chemicals residues found:

Teflubenzuron – "also used as a crop protection insecticide, for example the product Nomolt © used to treat whiteflies in tomato crops"

Diflubenzuron – "also present in a range of insecticide products used in forestry/crop protection eg the product Dimilin ©"

Ivermectin – "in medicines commonly used to treat agricultural livestock for a wide range of pests, including helminth worms, insects and other arthropod parasites. It is also used in certain treatments for companion animals eg the product Xeno © is used for the treatment of lice in pet rabbits"

Emamectin benzoate – "used in insecticides to deal with cockroach and other insect infestations as well as to treat certain infestations in trees and food crops (such as lettuce and broccoli)"

In the 2008 and 2009 reports, SEPA states that "the present set of sample points chosen for the surveillance programme do not in themselves facilitate identification of the source or the type of activity from which they have arisen"<sup>36</sup> a marked change from views expressed in the 2002-2006 reports.

Whether this is evidence of better behaviour by fish-farmers is not clear, but there appears to be no credible evidence that these residues are in some way linked to pet rabbits, cockroach infestation or lettuce, broccoli and tomato-growing on the west coast of Scotland.

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<sup>34</sup> SEPA (2007) Interim guidance on the Sea Lice Treatment Alphamax (active ingredient Deltamethrin) 17<sup>th</sup> August 2007

<sup>35</sup> SEPA(2001) Marine sediment chemical levels low says new report Press Release 10<sup>th</sup> October 2011

<sup>36</sup> SEPA (2011) The Occurrence of Chemical Residues in Sediments in Loch Kanaird, Summer Isles, Loch Fyne, Portree Bay, Loch Slapin and Loch na Keal 2008 Survey. Report TR110810\_JT, 26 September 2011

## Reduced SEPA audit monitoring for sea-lice treatment residues

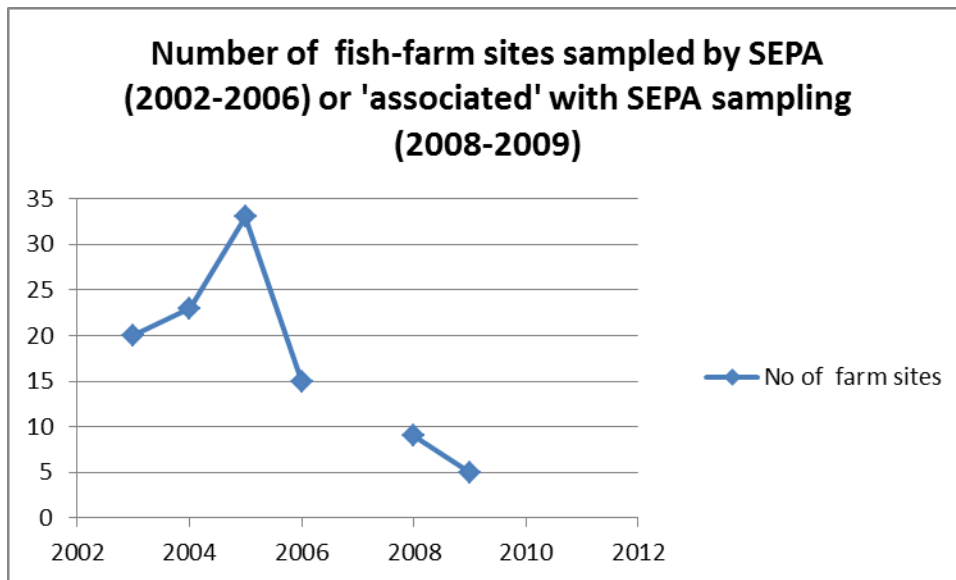
Despite the clear evidence of a problem shown by the 2003 to 2006 Screening Surveys, over the time period of the Screening Surveys (2003 to 2006) and the Sediment Surveys (2008 to 2009), as shown in Table 5 and Graph 2, there is a clear downward trend in the number of fish-farm sites sampled and samples sites.

**Table 5**

### Number of fish-farm sites sampled by SEPA (2002-2006) or 'associated' with SEPA sampling (2008-2009)

Year	No of lochs / fishfarms sampled	No of sample sites
2003	20 fish farm sites	26 (20 fish farm, 6 reference)
2004	23 fish farm sites	34 (23 fish farm, 10 ref, 1 other)
2005	33 fish farm sites	51 (33 fish farm, 18 reference)
2006	15 fish farm sites	24 (15 fish farm, 9 reference)
2007	No audit monitoring undertaken in 2007	
2008	6 sea lochs / 9 'associated' fish farms	15
2009	3 sea lochs / 5 'associated' fish farms	9

**Graph 2**



This steeply downward trend in the degree of audit monitoring would perhaps be justified if nothing untoward was being found by the earlier surveys, but as this is patently not the case, this reduced effort must call into question the ability of SEPA properly to police self-monitoring for sea lice residues by the fish-farming industry.

Figures obtained by the BBC in 2011 suggest that the use of Slice is increasing dramatically in recent years, which may well result in an increased number of EQS failures in more recent sampling (the 2010 and 2011 audit monitoring reports are yet to be published by SEPA).

The tonnage of Slice used in Scottish fishfarms has increased from 28.6 tonnes in 2005 to 51.8 tonnes in 2009, shown in Table 6

**Table 6**

**Tonnage of Slice used in Scottish fish farms**

	2005	2006	2007	2008	2009
Tonnage	28.6	22.1	61.8	63.5	51.8

The likely trajectory for the use of Slice appears to be upwards. In some areas of Scotland, resistance against or tolerance to Slice has been reported. In 2009, a general lowered efficacy of Slice was suggested throughout the industry, which has resulted in reduced time intervals between treatments<sup>37</sup>.

With reduced efficacy of the other 'bath-type' sea-lice treatments also reported and the industry increasing in size, there would appear to be every likelihood of an overall increase in sea-bed residues of Slice in 2011 and 2012. What the impact of this will be on marine fauna, especially shellfish, is not clear.

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<sup>37</sup> EWOS Integrated Sea lice Programme – Feed as A Tool in the Management of Sea lice (2009) EWOS Spotlight

## **Glossary**

Alphamax – a deltamethrin-based used to treat sea-lice; a synthetic pyrethroid

Controlled Activities Regulations - the Water Environment (Controlled Activities) (Scotland) Regulations 2011, drawn under the Water Environment and Water Services (Scotland) Act 2003.

Excis - a cypermethrin-based used to treat sea-lice; a synthetic pyrethroid

Fish Health Inspectorate – appointed by Scottish Ministers as inspectors of aquaculture businesses and part of Marine Scotland Science

Salmosan - an azamethiphos-based used to treat sea-lice; an organophosphate

Sea-lice – external parasites of salmonids, grazing on the skin of the fish. Two types - *Lepeophtheirus salmonis* (sometimes called 'Leps') and *Caligus elongatus*.

Slice – an in-feed sea-lice treatment containing the avermectin, emamectin benzoate

Veterinary Medicines Directorate – UK Government agency responsible for the safe and effective use of veterinary medicinal products in the UK