

National Survey of Sea Lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2009

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SALMONIS KRØYER AND *CALIGUS ELONGATUS* NORDMANN)
ON FISH FARMS IN IRELAND – 2009**

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INTRODUCTION

One of the greatest challenges facing Irish fin fish farming is the ectoparasite - sea lice. Sea lice are found on many species of fish worldwide. The main species of concern in Ireland are *Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann. Of the two species found on farmed Atlantic salmon *Salmo salar* and rainbow trout *Oncorhynchus mykiss* in Ireland, *C. elongatus* parasitises over 80 different species of marine fish (Kabata, 1979), while *L. salmonis* infests only salmonids. *L. salmonis* is regarded as the more damaging parasite of the two species and occurs most frequently on farmed Atlantic salmon and rainbow trout (Jackson and Minchin, 1992; Jackson *et al.*, 2005). Sea lice are a cause of concern to the fish farmer due to reduced growth and damage to the fish through scale loss and subsequent secondary infections (Wooten *et al.*, 1982). Skin damage can also lead to reduced marketability.

The damage caused by these parasites is primarily mechanical, carried out during the course of attachment and feeding (Kabata, 1974; Brandal *et al.*, 1976; Jones *et al.*, 1990). Inflammation and hyperplasia was recorded in Atlantic salmon after infections with *L. salmonis* (Jones *et al.*, 1990; Jonsdottir *et al.*, 1992; Nolan *et al.*, 2000). Increases in stress hormones caused by sea lice infestations are thought to increase the susceptibility of fish to infectious diseases (MacKinnon, 1998). Severe erosion around the head caused by heavy infestations of *L. salmonis* has been recorded previously (Pike, 1989; Berland, 1993). Heavy infestations takes place around the head because of the rich supply of mucus secreted by mucous-cell lined ducts in that region (Nolan *et al.*, 1999). In experimental and field investigations carried out in Norway, heavy infestation was found to cause fish mortalities (Finstad *et al.*, 2000).

L. salmonis has a direct life-cycle (i.e. a single host) with ten stages (Figure 1). Following hatching from paired egg-strings, two free-living nauplii stages are dispersed into the plankton. These stages are followed by a copepodid stage where attachment to the host takes place. The copepodid then moults through four attached chalimus stages before becoming a mobile pre-adult male or female. There are two pre-adult stages followed by the fully mature adult phase. The adult female can produce a number of batches of paired egg-strings, which in turn hatch into the water column to give rise to the next generation (Kabata, 1979; Schram, 1993).

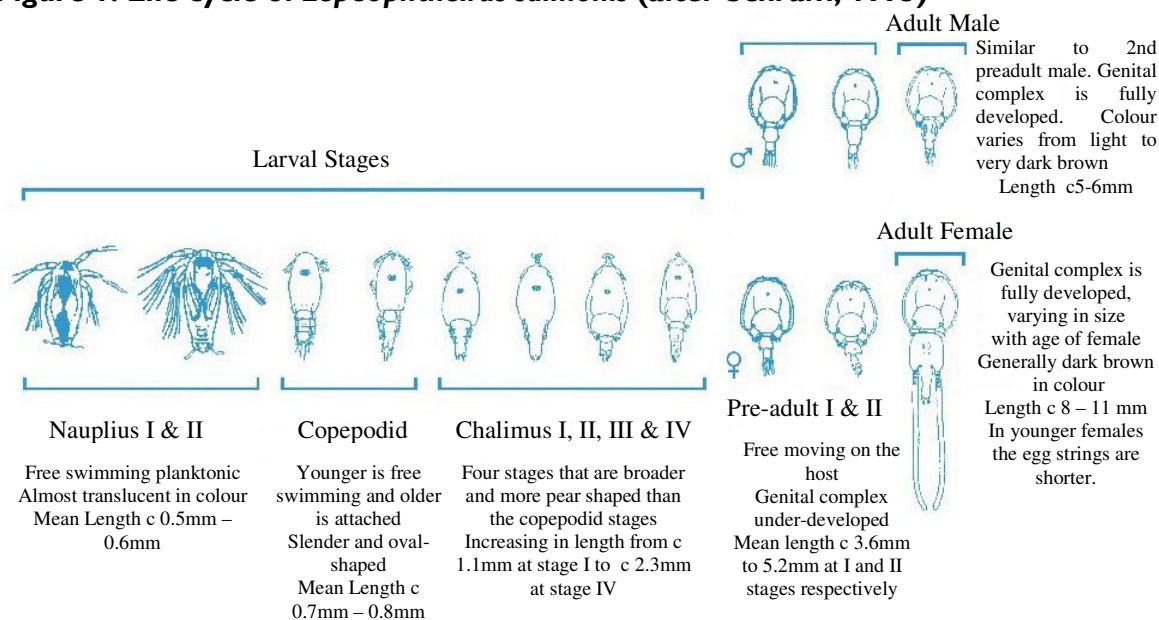
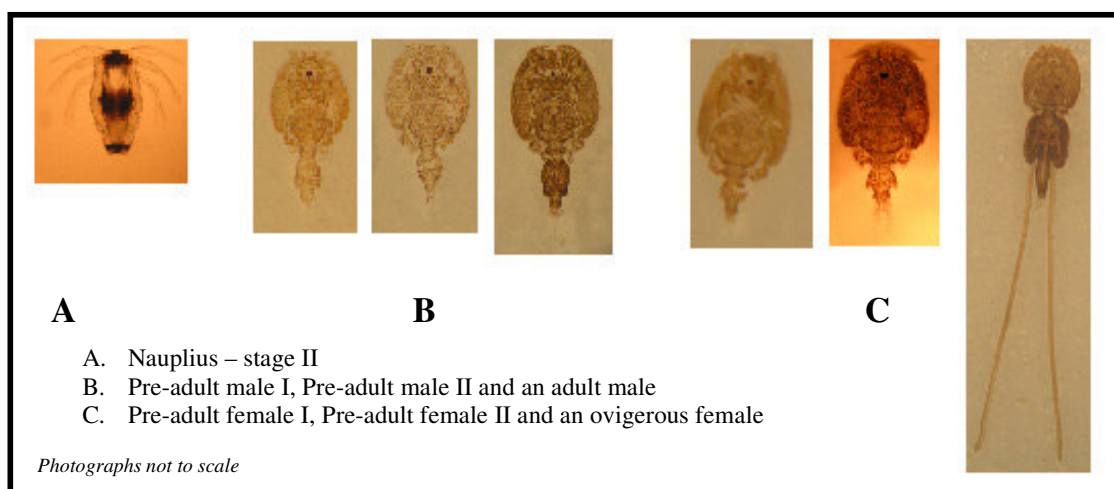
Figure 1. Life cycle of *Lepeophtheirus salmonis* (after Schram, 1993)

Diagram not to scale

Examples of nauplius, pre-adult and adult male & ovigerous female *L. salmonis* are shown in Figure 2. The mean length for an adult female is 8mm-11mm and an adult male is 5mm-6mm (Schram, 1993).

Figure 2. Photographs of stages of *L. salmonis*.

Photographs not to scale

The fact that *C. elongatus* is not as host specific as *L. salmonis* (Kabata, 1979) and that these hosts migrate widely is thought to account for the highly variable levels on farmed salmonids at different times of the year. *C. elongatus* is smaller in size than *L. salmonis* and averages approximately 6-8mm in length (Hogans & Trudeau, 1989).

In 1991, the then Department of the Marine (DOM), instigated a Sea Lice Monitoring Programme for finfish farms in Ireland (Jackson & Minchin, 1993). In 1993 monitoring was expanded nationwide (Jackson *et al.*, 2002; Jackson *et al.*, 2005). In May 2000 the protocol for sea lice monitoring was formally published (Monitoring Protocol No.3 for Offshore Finfish Farms – Sea Lice Monitoring and Control) by the then Department of Marine and Natural Resources (DMNR).

In May 2008 the Department of Agriculture, Fisheries and Food (DAFF) published “A strategy for the improved pest control on Irish salmon farms”. The strategy outlines a comprehensive range of measures to provide for enhanced sea lice control and was developed by a joint DAFF, Marine Institute and Bord Iascaigh Mhara (BIM) workgroup in response to difficulties experienced by farms in achieving the very low levels of infestation required by the national control programme. These measures draw on the ongoing Single Bay Management process and, through a comprehensive action plan and list of recommendations, seek to advance the suite of tools necessary for improved sea lice control on farms.

The purpose of the national sea lice monitoring programme is:

- ♦ To provide an objective measurement of infestation levels on farms.
- ♦ To investigate the nature of infestations.
- ♦ To provide management information to drive the implementation of control and management strategies.
- ♦ To facilitate further development and refinement of this strategy.

The sea lice control and management strategy has five principal components:

- Separation of generations.
- Annual fallowing of sites.
- Early harvest of two-sea-winter fish.
- Targeted treatment regimes, including synchronous treatments.
- Agreed husbandry practises.

Together, these components combine to reduce the development of sea lice infestations and to ensure the most effective treatment of sea lice challenges. They minimise sea lice levels whilst lessening reliance on, and reducing the use of, veterinary medicines. Separation of generations and annual fallowing prevent the vertical transmission of infestations from one generation to the next thus retarding the population's development. The early harvest of two-sea-winter fish removes a potential reservoir of sea lice, while

the agreed husbandry practises and targeted treatments enhance the efficacy of treatment regimes. One important aspect of targeted treatments is carrying out of synchronized autumn / winter treatments to reduce sea lice burdens to as close to zero as practicable on all fish which are to be over-wintered. This is fundamental to achieving near zero egg-bearing sea lice in spring. The agreed husbandry practises cover a range of related fish health, quality and environmental issues in addition to those specifically related to sea lice control. The Single Bay Management programme (SBM) serves to facilitate this and provides a forum for exchange of information between farmers.

In late winter and early spring seawater temperatures are at a minimum and the development rates of sea lice are reduced. These temperatures tend to synchronise the development of sea lice larvae. A strategic treatment at this time can break the cycle of infection. Ovigerous female sea lice are those which produce the infective larvae and treatments are timed to remove adult females before they can release larvae. Setting the treatment trigger at 0.5 ovigerous sea lice per fish in spring ensures that treatments are carried out when a maximum of half of the fish examined have one ovigerous sea lice. This is an optimum time to interrupt sea lice development. Later in the year, the development of new generations are not as synchronized and automatic intervention at a sea lice level of 0.5 ovigerous by way of treatment is not justified. A level of 2.0 ovigerous sea lice per fish has been shown to be a pragmatic level at which intervention by way of treatment is advisable. Levels of mobile sea lice or juvenile sea lice are important in advising fish health professionals in developing a sea lice control strategy. However, they are not of themselves appropriate measures upon which to trigger mandatory treatments.

The setting of appropriate treatment trigger levels is an integral part of implementing a targeted treatment regime. Treatment triggers during the spring period are set close to zero in the range of 0.3 to 0.5 egg bearing female *L. salmonis* per fish and are also informed by the numbers of mobile sea lice present on the fish.

Over the period since the initiation of Single Bay Management, treatment trigger levels have been progressively reduced from a starting point of 2.0 ovigerous female *L. salmonis* per fish during the spring period to the current levels. Outside of the spring period, a level of 2.0 ovigerous female *L. salmonis* per fish acts as a trigger for treatments. Where the number of mobile sea lice is high, treatments are triggered even in the absence of egg bearing females.

Results of the monitoring programme are sent to the relevant farm within 5-10 days of the inspection. A monthly report of results is circulated to relevant parties and the data is published annually (O'Donohoe et al., 2003-2009; McCarney et al., 2002; Copley et al., 2001).

Table I shows a list of the animal medicines and other remedies available to assist in the control of sea lice.

Table I. Options available to assist in the control of sea lice on Atlantic salmon.

Compound	Trade Name	Licensing status	Delivery Method	Group	Mode of action	Stages targeted	Withdrawal period
Animal medicines							
Azamethiphos	Salmosan®	AR-16	Bath	Organo-phosphate	Interferes with nerve transmission by blocking acetylcholinesterase at synapse.	Adults, Preadults	24 hours
Cypermethrin	Excis®	Full MA	Bath	Pyrethroid	Interferes with nerve transmission by blocking sodium channels in nerve cells	Adults, Preadults, Chalimus III-IV	24 hours
Deltamethrin	AMX® Alpha Max®	Full MA	Bath	Pyrethroid	Interferes with nerve transmission by blocking sodium channels in nerve cells	Adults, Preadults. Chalimus unknown	5 degree days
Emamectin benzoate	Slice®	Full MA	In-feed	Avermectin	Interferes with neurotransmission disrupting nerve cells causing paralysis and death. Effective at 3- 15°C. Protects fish for up to 11 weeks post treatment.	All stages	Zero
Teflubenzuron	Ektobann®	AR-16	In-feed	Insect Growth Regulator	Inhibits chitin synthesis preventing moulting and growth. Limited efficacy beyond medication period. Not authorized for use below 9°C	Moulting stages - Chalimus, Preadults only	7 days
Teflubenzuron	Calicide®	Full MA	In-feed	Insect Growth Regulator	Inhibits chitin synthesis preventing moulting and growth. Limited efficacy beyond medication period. Not authorized for use below 9°C	Moulting stages - Chalimus, Preadults only	45 degree days
Disinfectants							
Hydrogen peroxide			Bath	Oxidizer	Formation of gas bubbles on and within the sea lice.	Adults, Preadults	
Immuno-stimulants& Food supplements							
	Bio-mos®		In-feed	Extract from yeast wall	Increases mucus production		
	Ecoboost®		In-feed	Blend of aromatic herbs	Immuno-stimulant		
	Ergosan®		In-feed	Seaweed extract	Immuno-stimulant		
Others							
Bioemitters Wrasse			In cage In cage		Electromagnetic signal Cleaner fish. Issues with wrasse availability and efficacy	Adults, Preadults	

MA - marketing authorisation.

All AR16 licences are exceptional authorisations.

METHODOLOGY

Farmed stocks of salmonids in Ireland are visited on 14 occasions throughout the year to monitor sea lice for species, life stage and quantity. Follow-up inspections may be carried out where required. Sea lice inspections take place monthly, with two inspections taking place each month during March, April and May; referred to as the spring period. One inspection is carried out for the December-January period. At each inspection two samples are taken for each generation of fish on site, a sample from a standard cage, which is sampled at each subsequent inspection, and a sample from a random cage, which is selected on the day of the inspection. Thirty fish are examined for each sample by anaesthetising using tricaine methane sulphonate (MS222) in seawater. The seawater is sieved for any detached lice at the end of each sample. Each fish is examined individually for all mobile lice. Lice are removed and placed in a bottle containing 70% ethanol, one sample bottle per fish. In the laboratory the species, quantity and life stage of the sea lice are determined and recorded. The mean number of sea lice per fish is calculated by adding the number of sea lice taken from each fish with the number of detached lice from the sieved seawater then dividing by the number of fish examined.

Results presented are mean ovigerous sea lice levels and mean mobile sea lice levels for *L. salmonis* and *C. elongatus*. Total mobile levels estimate successful infestation levels. Ovigerous sea lice levels estimate breeding female populations. The information gathered aims to evaluate the level of sea lice on the fish and to inform the farmer on a control strategy, by advising treatment if necessary. Effective parasite control is characterised by a drop in sea lice levels on the subsequent inspection.

In 2009, salmonid farms were producing 6 different stocks of fish, namely: 2007 rainbow trout, *Oncorhynchus mykiss* (Walbaum) (rainbow trout first inspected in 2007); 2008 rainbow trout (rainbow trout first inspected in 2008); 2009 rainbow trout (rainbow trout first inspected in 2009); 2007 Atlantic salmon, *Salmo salar* L. (two-sea-winter salmon), 2008 Atlantic salmon (one-sea-winter salmon) and 2009 Atlantic salmon (smolts).

There are three distinct regions in Ireland where salmonid farming is carried out; the West (Counties Mayo and Galway), the Northwest (Co. Donegal) and the Southwest (Counties Cork and Kerry). These regions are geographically separate from each other with distances between regions of c.160 km from Northwest to West and c.200 km from West to Southwest. In 2009 a total number of 25 sites were inspected around Ireland, see figures 3-5.

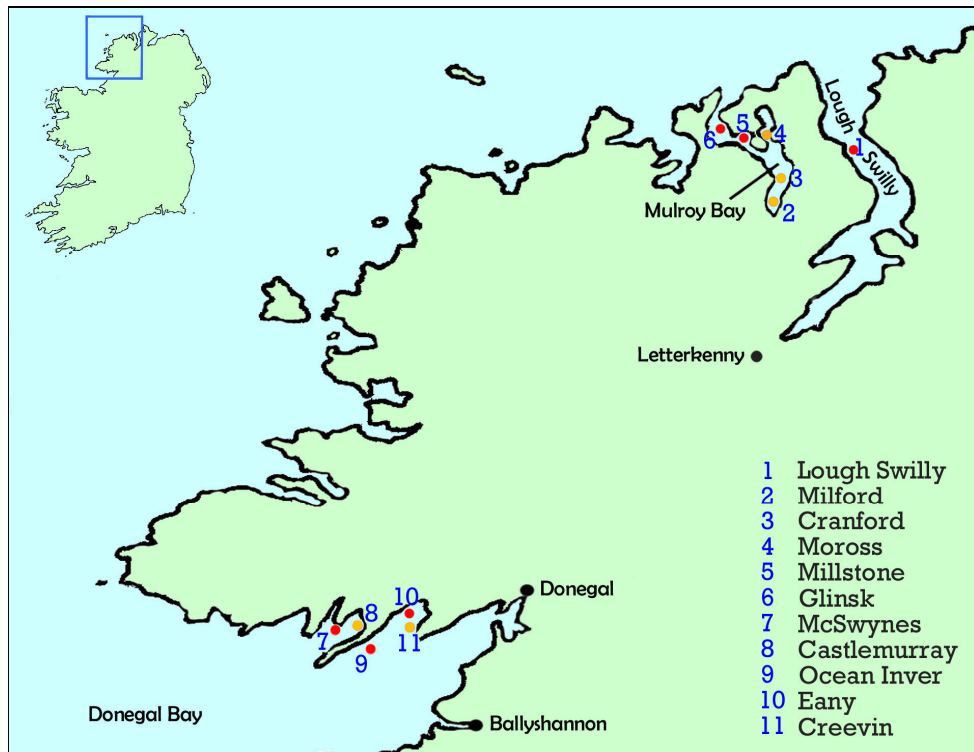


Figure 3. Fish farm sites in the Northwestern region.

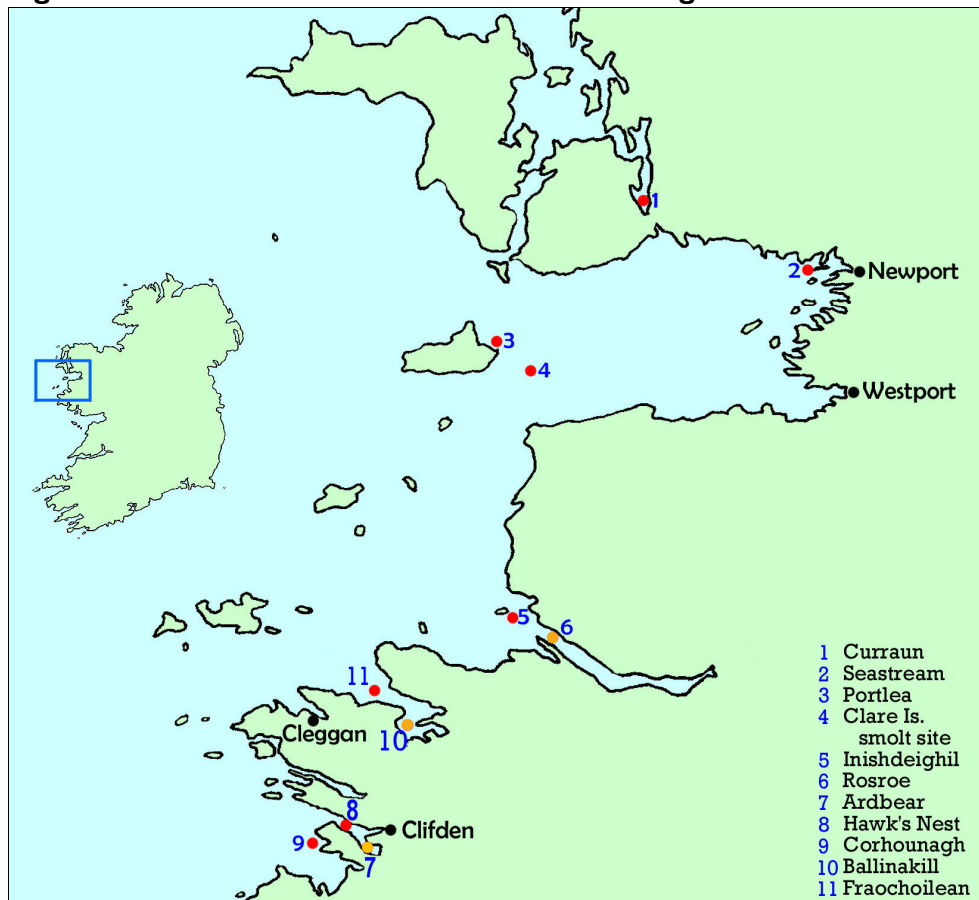


Figure 4a. Fish farm sites in the Western region (Mayo & N. Connemara).

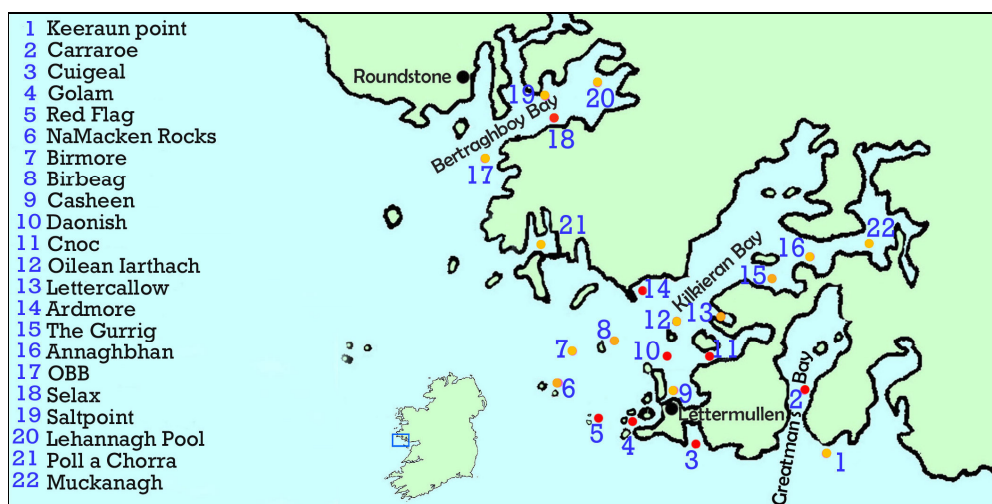


Figure 4b. Fish farm sites in the Western region (S. Connemara).

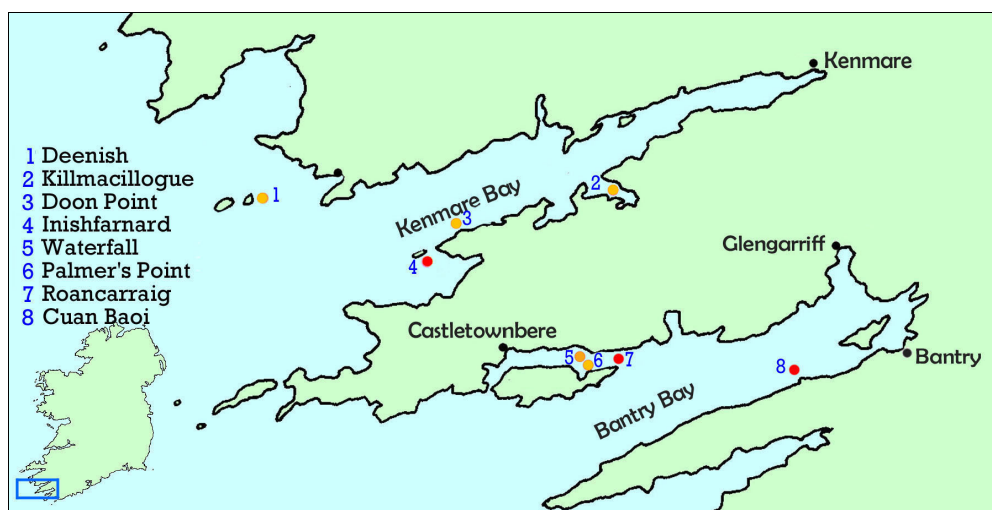


Figure 5. Fish farm sites in the Southwestern region.

- Sites stocked in 2009
- Sites fallow in 2009

Statistical tests were carried out using Kruskal-Wallis analysis and a Post-hoc LSD (least squared distance).

RESULTS

In 2009 there were 25 active salmonid sites and 304 sea lice inspections were carried out on these sites. Over 77% of Atlantic salmon samples and 93% of rainbow trout samples were below the treatment trigger levels (TTLs) as outlined in the Monitoring Protocol No.3 for Offshore Finfish Farms – Sea Lice Monitoring and Control, Department of Marine and Natural Resources (2000). For salmon smolts 89% of inspections were below the TTLs, for one-sea-winter salmon 69% of inspections were below TTLs and 76% of inspections to two-sea-winter salmon were below TTLs.

Full results of inspections for all sites for each month are given in Appendix I.

Atlantic salmon 2007 (two-sea-winter salmon)

At the beginning of 2009, two-sea-winter salmon were stocked in 4 sites: Seastream Inner (Clare Island Seafarms Ltd.), Clew Bay; McSwyne's (Ocean Farm Ltd), Donegal Bay; and Millstone & Glinsk, Mulroy Bay (Marine Harvest). Table 2 contains the number of inspections per site and total number of inspections exceeding the treatment trigger levels.

Table 2. National breakdown of inspections for 2007 salmon on fish farm sites in 2009.

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Clare Island Seafarms Ltd.	Seastream Inner	1	1	2	0	3	1	100%	0%	33%
West		1	1	2	0	3	1	100%	0%	33%
Ocean Farm Ltd.	McSwyne's	0	0	1	0	1	0	0%	0%	0%
Marine Harvest	Glinsk	4	0	1	0	5	0	0%	0%	0%
	Millstone	6	3	2	0	8	3	50%	0%	38%
Northwest	Totals	10	3	4	0	14	3	30%	0%	21%
National Totals		11	4	6	0	17	4	36%	0%	24%

A total of 17 visits were undertaken to these sites before harvesting was completed, with 24% of inspections exceeding treatment trigger levels.

Atlantic salmon 2008 (one-sea-winter salmon)

One-sea-winter salmon were stocked in a total of 16 sites in 11 bays in 2009. One hundred and thirty-three visits were undertaken to this generation of fish. Four sites, in 4 bays, continued to stock one-sea-winter salmon in November 2009.

Ovigerous *L. salmonis* levels greater than the treatment trigger level were recorded in a total of 41 inspections (31%) on one-sea-winter fish (see Table 3). Within the critical spring period, sea lice levels were in excess of 0.5 ovigerous females per fish on 24

inspections (33%) and outside of the spring period 17 inspections (28%) were in excess of 2.0 ovigerous female *L. salmonis* per fish.

Table 3. National breakdown of inspections for 2008 salmon on all fish farm sites in 2009.

	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
National Totals	72	24	61	17	133	41	33%	28%	31%

C. elongatus levels were recorded at numbers greater than 10 per fish on two inspections in March and remained very low on all other sites stocking 2008 salmon.

Southwestern Region

In the Southwest there were no *L. salmonis* levels greater than the treatment trigger levels recorded (see Table 4).

Table 4. Breakdown of inspections for 2008 salmon for Southwestern sites in 2009.

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Murphy's Irish Seafood Ltd	Cuan Baoi	6	0	2	0	8	0	0%	0%	0%
Silver King Seafoods Ltd	Roanearraig	6	0	3	0	9	0	0%	0%	0%
	Inishfarnard	6	0	8	0	14	0	0%	0%	0%
Southwest	Totals	18	0	13	0	31	0	0%	0%	0%

Western Region

In the West, *L. salmonis* infestation levels greater than the treatment trigger were recorded on 22 out of 36 inspections (61%) in the spring period and on 15 out of 34 inspections (44%) outside the spring period (see Table 5).

Table 5. Breakdown of inspections for 2008 salmon on Western sites in 2009.

Company		Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Muirachmhainni Teo	Daonish	6	6	3	2	9	8	100%	67%	89%
Muir Gheal Teo	Cnoc	6	6	2	1	8	7	100%	50%	88%
	Ardmore	0	0	1	0	1	0	0%	0%	0%
Eisc Ui Flathartha Teo	Ardmore	6	3	6	4	12	7	50%	67%	58%
Mannin Bay Salmon Co Ltd	Corhounagh	5	2	6	4	11	6	40%	67%	55%
	Hawk's nest	1	1	2	0	3	1	100%	0%	33%
Bifand Ltd	Fraochoilean	6	2	5	2	11	4	33%	40%	36%
Celtic Atlantic (Killary) Ltd	Inishdeighil	0	0	1	1	1	1	0%	100%	100%
Clare Island Seafarms Ltd.	Portlea	6	2	6	1	12	3	33%	17%	25%
	Seastream Inner	0	0	2	0	2	0	0%	0%	0%
West	Totals	36	22	34	15	70	37	61%	44%	53%

Levels at Daonish (Muirachmhainni Teo), Kilkieran Bay, were in excess of treatment trigger levels for all 6 inspections in the spring period and 2 of the 3 inspections outside the spring period.

Cnoc (Muir Gheal Teo.), Kilkieran Bay, were above treatment trigger levels for all 6 of the spring inspections and 1 of the 2 inspections outside spring.

Ardmore, (Eisc Ui Flathartha Teo), Kilkieran Bay, was above treatment trigger levels for 3 of the 6 spring inspections and 4 of the 6 inspections outside the spring period.

At Corhounagh (Mannin Bay Salmon Co. Ltd.), Mannin Bay, *L. salmonis* exceeded treatment trigger levels for 2 of the 5 inspections in the spring and for 4 of the 6 inspections outside the spring.

Fraochoilean (Bifand Ltd.), Ballinakill Bay, exceeded treatment trigger levels for 2 of the 6 spring inspections in the spring and 2 of the 5 inspections outside the spring period.

Sea lice levels at Portlea (Clare Island Seafarms Ltd.) in Clew Bay, were in excess of treatment trigger levels for 2 of the 6 inspections in spring and 1 of the 6 inspections outside the spring period.

Northwestern Region

The treatment trigger levels were exceeded on 2 out of 18 inspections (11%) in the Northwest during the spring period and on 2 out of 14 inspections (14%) outside that period (see Table 6).

Table 6. Breakdown of inspections for 2008 salmon on Northwestern sites in 2009.

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Ocean Farm Ltd.	Ocean Inver	6	1	4	0	10	1	17%	0%	10%
Marine Harvest	Glinsk	6	1	2	0	8	1	17%	0%	13%
	Millstone	0	0	1	0	1	0	0%	0%	0%
	Lough Swilly	6	0	7	2	13	2	0%	29%	15%
Northwest	Totals	18	2	14	2	32	4	11%	14%	13%

Atlantic salmon 2009 (Smolts)

A total of 107 visits were made to 14 sites stocking Atlantic salmon 2009 SI and S½ smolts during the year 2009. *L. salmonis* levels were below the treatment trigger level of 0.5 ovigerous female lice per fish for all of the 42 inspections in the spring period. Outside of this period, levels exceeded 2.0 ovigerous female lice per fish on 12 of the 65 inspections (see Table 7).

Table 7. National breakdown of inspections for 2009 salmon on fish farm sites in 2009.

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Murphy's Irish Seafood Ltd	Cuan Baoi	6	0	8	0	14	0	0%	0%	0%
Silver King Seafoods Ltd	Roanarraig	6	0	8	0	14	0	0%	0%	0%
Southwest	Totals	12	0	16	0	28	0	0%	0%	0%
Muirachmhainni Teo	Carraroe	6	0	7	3	13	3	0%	43%	23%
	Cuigeal	3	0	4	3	7	3	0%	75%	43%
	Golam	6	0	2	0	8	0	0%	0%	0%
	Red Flag	0	0	3	1	3	1	0%	33%	33%
	Daonish	0	0	2	2	2	2	0%	100%	100%
Muir Gheal Teo	Cnoc	0	0	3	1	3	1	0%	33%	33%
Comhlucht Bradain Chonamara Teo	Sealax	6	0	8	1	14	1	0%	13%	7%
Mannin Bay Salmon Co Ltd	Hawk's nest	2	0	6	0	8	0	0%	0%	0%
Bifand Ltd	Fraochoilean	0	0	2	1	2	1	0%	50%	50%
Clare Island Seafarms Ltd.	C.I. smolt site	3	0	5	0	8	0	0%	0%	0%
	Portlea	0	0	1	0	1	0	0%	0%	0%
West	Totals	26	0	43	12	69	12	0%	28%	17%
Ocean Farm Ltd.	McSwyne's	4	0	6	0	10	0	0%	0%	0%
Northwest	Totals	4	0	6	0	10	0	0%	0%	0%
National Totals		42	0	65	12	107	12	0%	18%	11%

C. elongatus levels remained low throughout the year on 2009 smolts.

Rainbow trout

In 2009 there was 3 year-classes of rainbow trout (2007, 2008 and 2009 rainbow trout) stocked between 2 sites, in 2 bays (Table 8). There was one inspection carried out on 2007 rainbow trout before harvesting which was below treatment trigger levels. A total of 23 inspections were carried out on the 2008 rainbow trout stock, *L. salmonis* levels reached treatment trigger levels on 2 of these inspections. Twenty-three inspections were carried out on the 2009 rainbow trout, stocked in Bealacragher Bay and Donegal Bay, one of these inspections was above treatment trigger levels.

Table 8. National breakdown of inspections for all Rainbow trout on fish farm sites in 2009.

Rainbow Trout 2007 stocked in 2009

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Eany Fish Products Ltd	Eany	0	0	1	0	1	0	0%	0%	0%
Northwest	Totals	0	0	1	0	1	0	0%	0%	0%
National Totals		0	0	1	0	1	0	0%	0%	0%

Rainbow Trout 2008 stocked in 2009

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Curraun Fisheries Ltd	Curraun	6	0	7	2	13	2	0%	29%	15%
West		6	0	7	2	13	2	0%	29%	15%
Eany Fish Products Ltd	Eany	6	0	4	0	10	0	0%	0%	0%
Northwest	Totals	6	0	4	0	10	0	0%	0%	0%
National Totals		12	0	11	2	23	2	0%	18%	9%

Rainbow Trout 2009 stocked in 2009

Company	Site	Samples in Spring	Over in Spring	Samples outside Spring	Over outside Spring	Total Samples	Total Over	% over in Spring	% over outside Spring	% over total
Curraun Fisheries Ltd	Curraun	3	0	6	1	9	1	0%	17%	11%
West		3	0	6	1	9	1	0%	17%	11%
Eany Fish Products Ltd	Eany	6	0	8	0	14	0	0%	0%	0%
Northwest	Totals	6	0	8	0	14	0	0%	0%	0%
National Totals		9	0	14	1	23	1	0%	7%	4%

C. elongatus levels remained low throughout the year on rainbow trout.

One-sea-winter salmon monthly trend

Mean ovigerous and mean mobile *L. salmonis* and *C. elongatus* levels for each bay are shown in Table 9 for one-sea-winter salmon throughout the year. Monthly ovigerous *L. salmonis* levels were greater than the treatment trigger level of 0.5 ovigerous sea lice per fish on 7 of the 28 occasions during the spring period on a bay basis. These occurred in Kilkieran Bay (3), Mannin Bay (1), Clifden Bay (1), Donegal Bay (1) and Clew Bay (1). On 14 out of 52 inspections, outside of the spring period, mean ovigerous levels of 2.0 ovigerous females per fish or greater were recorded. These occurred in Kilkieran Bay (4), Mannin Bay (4), Lough Swilly (2), Ballinakill Harbour (2), Killary Harbour (1) and Clew Bay (1).

Mean mobile levels per bay in excess of 10 *L. salmonis* per fish were recorded on 19 occasions and 6 of these instances had means of greater than 20 mobile lice per fish. The maximum level recorded was 38.37 mobile sea lice per fish in Kilkieran Bay in July.

Table 9. Mean ovigerous and mean mobile *Lepeophtheirus salmonis* and *Caligus elongatus* per month, for one- sea-winter salmon for each bay inspected in the year 2009.Mean ovigerous *L. salmonis*

	Dec-Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Bantry Bay	0.04	0.02	0.03	0.07	0.30	0.71	HO				
Kenmare Bay	0.00	0.02	0.01	0.00	0.00	0.00	0.10	0.08	0.32	0.45	1.29
Kilkieran Bay	1.73	0.67	2.19	1.00	1.32	10.31	10.47	10.97	6.39	HO	
Mannin Bay			0.11	0.22	1.73	0.67	0.87	2.46	6.04	6.17	3.30
Clifden Bay	0.07	0.65	0.92	TO							
Ballinakill Bay	1.60	2.49	0.36	0.40	0.35	1.30	0.32	12.53	HO		
Killary Harbour	2.96	TO									
Clew Bay	0.08	0.33	0.37	0.28	1.30	0.35	0.61	4.17	0.17	0.82	0.34
Donegal Bay	0.35	0.88	0.02	0.54	0.04	0.22	0.35	HO			
Mulroy Bay	0.34	TO	0.06	0.05	0.80	0.82	HO				
Lough Swilly		0.33	0.15	0.11	0.12	0.07	0.16	0.05	0.99	2.10	2.99

Mean mobile *L. salmonis*

	Dec-Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Bantry Bay	0.09	0.09	0.10	0.38	0.87	1.12	HO				
Kenmare Bay	0.09	0.02	0.01	0.01	0.03	0.05	0.27	0.27	0.77	1.76	2.62
Kilkieran Bay	7.38	18.63	16.90	7.60	21.86	25.97	38.37	19.06	11.96	HO	
Mannin Bay			0.69	8.17	6.81	1.42	1.52	10.36	27.66	11.39	10.23
Clifden Bay	1.89	1.75	3.33	TO							
Ballinakill Bay	22.28	7.47	2.81	5.39	2.17	2.57	7.65	25.97	HO		
Killary Harbour	12.87	TO									
Clew Bay	0.44	2.35	3.62	5.52	4.14	1.47	1.47	11.36	0.70	2.82	0.83
Donegal Bay	2.20	15.69	0.53	2.24	0.10	0.25	1.26	HO			
Mulroy Bay	7.47		0.18	0.97	6.23	10.68	HO				
Lough Swilly		1.68	0.62	1.29	2.17	0.55	0.78	0.99	7.60	12.99	11.71

Mean ovigerous *C. elongatus*

	Dec-Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Bantry Bay	0.14	0.18	2.17	1.24	1.33	1.21	HO				
Kenmare Bay	2.52	0.00	0.09	0.01	0.59	0.28	0.90	0.34	0.35	0.33	0.11
Kilkieran Bay	0.00	0.05	0.10	0.02	0.43	0.51	0.02	0.00	0.00	HO	
Mannin Bay			0.13	0.02	0.15	0.07	0.05	0.25	0.00	0.00	0.00
Clifden Bay	0.05	0.10	0.21	TO							
Ballinakill Bay	0.07	0.10	0.01	0.00	0.08	0.07	0.16	1.03	HO		
Killary Harbour	0.20	TO									
Clew Bay	0.00	0.19	0.40	0.84	0.04	0.42	1.41	0.00	0.00	0.09	0.00
Donegal Bay	0.02	0.04	0.02	0.14	0.02	0.00	0.04	HO			
Mulroy Bay	0.22		0.00	0.03	0.16	0.71	HO				
Lough Swilly		0.05	0.06	0.13	0.06	0.02	0.72	0.00	0.00	0.02	0.00

Mean mobile *C. elongatus*

	Dec-Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Bantry Bay	0.56	2.53	6.12	2.54	3.40	4.18	HO				
Kenmare Bay	7.18	0.00	0.20	0.05	1.02	0.55	2.71	0.54	0.58	0.58	0.27
Kilkieran Bay	0.03	0.18	0.17	0.05	0.88	0.97	0.06	0.00	0.00	HO	
Mannin Bay			0.13	0.07	0.48	0.23	0.15	0.32	0.02	0.02	0.02
Clifden Bay	0.07	0.10	0.37	TO							
Ballinakill Bay	0.10	0.16	0.04	0.00	0.15	0.23	0.55	1.77	HO		
Killary Harbour	0.24	TO									
Clew Bay	0.04	0.28	0.57	1.09	0.15	0.82	3.20	0.07	0.00	0.12	0.03
Donegal Bay	0.04	0.10	0.11	0.26	0.04	0.00	0.04	HO			
Mulroy Bay	0.79		0.00	0.13	0.34	1.15	HO				
Lough Swilly		0.05	0.07	0.23	0.14	0.09	1.59	0.00	0.00	0.03	0.00

HO = Harvested out TO = Transferred out

Regional monthly means for one-sea-winter salmon

L. salmonis monthly mean figures for one-sea-winter salmon regionally are shown in Figures 6 and 7. In 2009 the ovigerous mean levels did not reach treatment trigger levels at all in the Southwest. Regional mean ovigerous *L. salmonis* levels were in excess of treatment trigger levels for all three spring months in 2009 in the West and also from June to October. The Northwest mean levels were above treatment trigger levels in October and November. The Northwest mean levels were above treatment trigger levels in October and November.

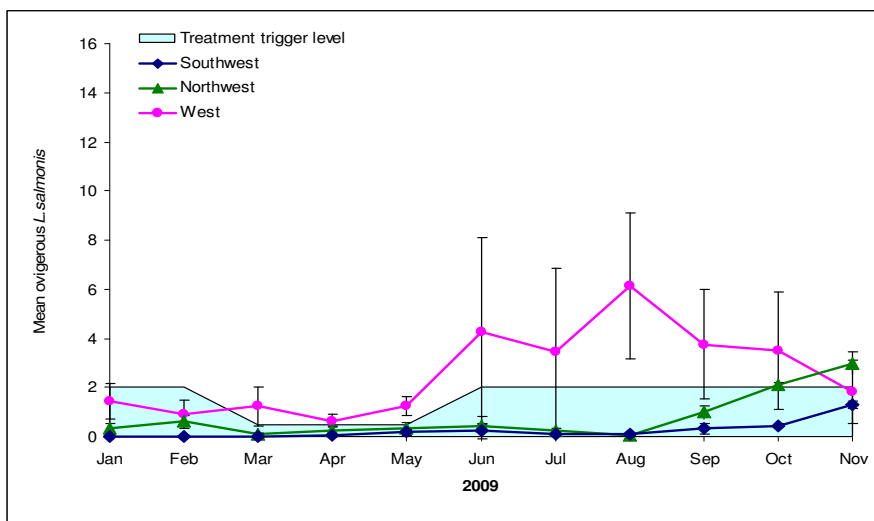


Figure 6. Mean (SE) ovigerous *L. salmonis* per month per region in 2009 on one-sea-winter fish.

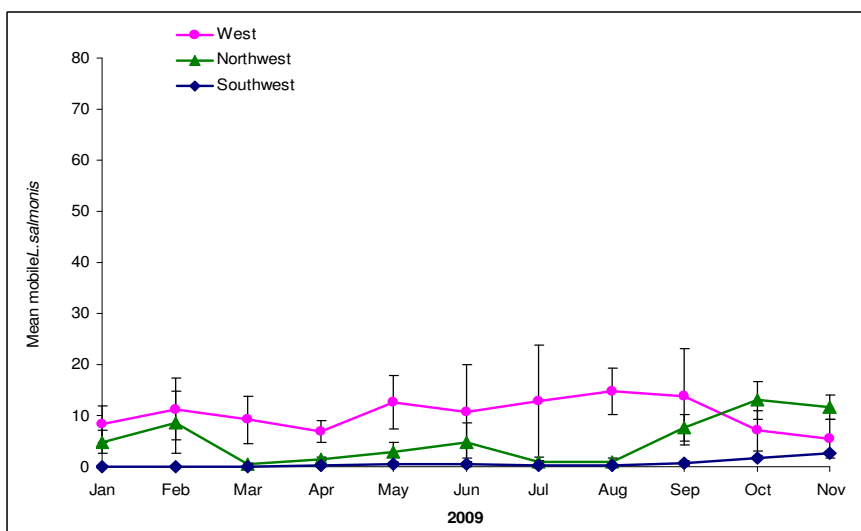


Figure 7. Mean (SE) mobile *L. salmonis* per month per region in 2009 on one-sea-winter fish.

Total mobile *L. salmonis* levels exceeded 10 sea lice per fish in February, May, June, July, August and September in the West region. In the Northwest total mobile levels exceeded 10 mobile sea lice per fish in October and November.

Annual trends

The annual trends of *L. salmonis* ovigerous and mobile sea lice levels are compared in Figures 8 and 9 for one-sea-winter salmon in the month of May from 1991 to 2009. The mean number of ovigerous and mobile *L. salmonis* per fish are presented.

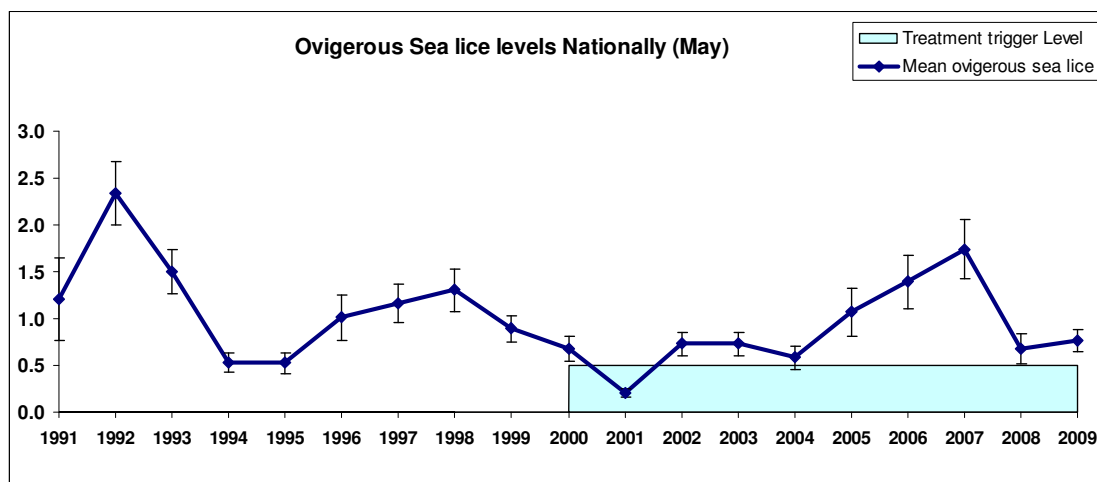


Figure 8. Annual trend (May mean) (SE) ovigerous *L. salmonis* on one-sea-winter salmon.

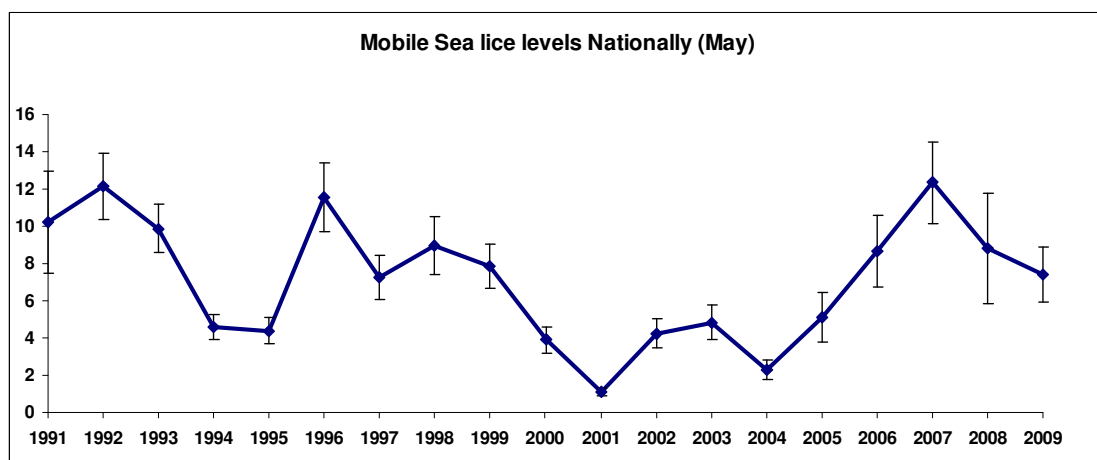


Figure 9. Annual trend (May mean) (SE) mobile *L. salmonis* on one-sea-winter salmon.

Mean ovigerous *L. salmonis* levels in 2009 are similar to 2008 with a slight increase from 0.68 to 0.77 ovigerous *L. salmonis* per fish (no significant difference, $p=0.0136$). Both 2009 and 2008 are significantly different from the 2007 mean.

DISCUSSION

Nationally, when comparing smolt stocks from 2009 with those from 2008 we see that 89% of inspections were below the treatment trigger levels (TTLs) in 2009, compared with 91% in 2008; 69% of inspections on one-sea-winter salmon were below TTLs compared to 57% in 2008; and 76% of inspections of two-sea-winter salmon were below treatment trigger levels compared to 53% in 2008. These changes represent an improvement in sea lice control on both one-sea-winter and two-sea-winter salmon stocks.

Sea lice levels on one-sea-winter salmon during the spring period were below treatment trigger levels for 39% of inspections in the West, 89% in the Northwest and 100% in the Southwest. This compares with 46% in the West and 62% in the Northwest in 2008. There were no one-sea-winter fish stocked in the Southwest in 2008. The levels for the rest of the year show that 56% of inspections are below TTLs in the West, 86% in the Northwest and 100% in the Southwest. These compare to 48% below in the West and 79% below in the Northwest in 2008 for one-sea-winter salmon. Levels in excess of 10 *L. salmonis* per fish on one-sea-winter fish were recorded on 32 occasions, 12 of these with means of greater than 20 mobile *L. salmonis* per fish. For one-sea-winter salmon the highest mean sea lice level recorded was 38.37 *L. salmonis* per fish, this compares to 118.11 mobile sea lice per fish in 2008 and 142.50 mobile sea lice per fish in 2007.

Sea lice inspections exceeding the treatment trigger levels on two-sea-winter salmon decreased nationally from 47% in 2008 to 24% in 2009.

The regional ovigerous *L. salmonis* mean monthly trend on one-sea-winter salmon showed an improvement on 2008 levels, with the Southwest being below TTLs for the whole period. The Northwest also maintained levels below TTLs for most of the year with mean levels exceeding TTLs in October and November. Ovigerous levels in the West were over TTLs for most of the year, barring January, February and November. Regional mean total *L. salmonis* levels are lower than 2008, mean numbers did not exceed 15 *L. salmonis* per fish compared to a peak of 41 *L. salmonis* per fish in 2008.

The May mean *L. salmonis* annual trend graphs of one-sea-winter fish (figures 8 & 9) show that a reduction in infestation levels was seen from 2007 to 2008 and this was maintained in 2009 with improvements in control across a broad range of sites. Ovigerous *L. salmonis* levels were similar to 2008 and mobile sea lice levels continued a decreasing trend.

The management cell process, outlined in the DAFF strategy, was trialled for sites in Connemara during 2009, the first full year of operation of the new pest management measure. The management cell approach was invoked four times in 2009. As part of the review of the impact of the new management strategy the Marine Institute held consultations with all licenced operators to assess the effectiveness of the new approach. In those bays where there was not a detailed medium term plan in place for sea lice management or where that plan was not implemented, sea lice numbers were more likely to breach protocol limits. Poor logistics and planning for the execution of complicated bath treatments were also identified as key factors in certain instances.

Two husbandry related issues which had a major impact at a number of locations were the practice of protracted or partial harvests on production sites and the absence of effective separation of generations and fallowing. Where a lack of fallowing and/or separation of generations occurred at the same time as prolonged harvesting the effects on lice control were compounded.

In examining those sites and bays which showed good or improved lice control in 2009 there were a number of husbandry factors identified which underpinned good control. These were complete separation of generations (often in separate bays) with a minimum fallow period, of 1 month, prior to restocking and the removal of harvest fish from grower sites to separate harvest locations to facilitate best practice in the management of both grower fish and harvest fish and sea lice control.

In conclusion, the key factors having a positive influence on the effectiveness of lice control in 2009 can be summarised as follows:

- Having a detailed management plan in place for sea lice control.
- Planning regular and appropriate treatments.
- Having carefully pre-planned logistics for each treatment operation.
- Avoidance of partial or incomplete treatments of a site.
- Carrying out weekly on-farm assessment of sea lice levels (by way of count or visual assessment) to fine tune the treatment regime.
- Keeping complete separation of generations in bays.
- Having at least one month fallow between stocking sites.
- Carrying out harvest remote from the grower sites.

GLOSSARY

<i>Grower:</i>	A fish which has been at sea for one complete year or longer.
<i>Hyperplasia</i>	Enlargement caused by an abnormal increase in the number of cells in an organ or tissue.
<i>Mobile lice:</i>	All sea lice that are mobile – male and female (pre-adult and adult stages) sea lice that have developed beyond the attached larval stages.
<i>Ovigerous lice:</i>	An egg bearing adult female sea lice.
<i>Random (Ran.) Cage:</i>	A cage which is selected by the inspector on the day of inspection.
<i>Standard (Std.) Cage:</i>	The selected cage which is sampled at each inspection.
<i>S1 Smolt:</i>	This pertains to a stage in the life cycle of the salmon when it changes from being a freshwater fish to a seawater fish, a process known as smoltification. These fish are transported to the saltwater environment in the spring, which is approximately 15 months after they were hatched.
<i>S1/2 Smolt:</i>	These fish are exposed to manipulated photoperiods to hasten the onset of smoltification. Hence an S1/2 smolt is ready to go to sea during the Autumn/Winter, approximately 11 months after hatching. Also known as S0 (S zero) smolts.
<i>SE:</i>	Standard error (error bars in the graphs) is the standard error of the mean of a sample from a population with a normal distribution, which is equal to the standard deviation of the normal distribution divided by the square root of the sample size.

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APPENDIX I. Mean sea lice levels on salmonid farms in 2009.

	Date	<i>Lepeophtheirus salmonis</i>		<i>Caligus elongatus</i>	
		F + eggs	Total	F + eggs	Total
BANTRY BAY					
MURPHYS IRISH SEAFOOD LTD					
Cuan Baoi					
Atlantic salmon, 2008 S 1/2	11/12/08	0.11	0.26	0.26	1.00
	04/02/09	0.05	0.11	0.47	7.05
	12/03/09	0.00	0.13	4.67	12.00
	25/03/09	0.00	0.00	3.31	10.23
	08/04/09	0.07	0.30	1.33	2.19
	24/04/09	0.07	0.31	0.93	2.00
	13/05/09	0.13	0.38	0.75	1.19
	20/05/09	0.19	0.56	3.44	9.93
Harvested Out					
Atlantic salmon, 2009 S 1/2	11/12/08	0.00	0.00	0.06	0.17
	04/02/09	0.00	0.07	0.00	0.07
	12/03/09	0.00	0.00	0.04	0.07
	25/03/09	0.00	0.00	0.00	0.07
	08/04/09	0.00	0.00	0.03	0.10
	24/04/09	0.00	0.00	0.00	0.00
	13/05/09	0.00	0.00	0.10	0.20
	20/05/09	0.00	0.00	0.97	1.93
	10/06/09	0.00	0.13	0.43	1.37
	23/07/09	0.00	0.05	0.04	0.19
	12/08/09	0.02	0.02	0.07	0.15
	09/09/09	0.05	0.05	0.10	0.24
	07/10/09	0.00	0.05	0.29	0.45
	10/11/09	0.05	0.35	1.19	2.80
SILVER KING SEAFOODS LTD					
Roanearraig					
Atlantic salmon, 2008 S 1/2	11/12/08	0.00	0.00	0.09	0.34
	03/02/09	0.00	0.08	0.04	0.28
	12/03/09	0.05	0.12	1.12	4.08
	26/03/09	0.03	0.11	1.39	3.16
	08/04/09	0.07	0.34	1.52	3.25
	23/04/09	0.08	0.49	1.07	2.28
	12/05/09	0.27	1.01	0.70	1.66
	20/05/09	0.46	1.13	1.19	2.99
	11/06/09	0.71	1.12	1.21	4.18
Harvested out					

Atlantic salmon, 2009 S 1/2	11/12/08	0.00	0.09	1.62	3.95
	03/02/09	0.00	0.02	0.06	0.24
	12/03/09	0.00	0.00	0.05	0.49
	26/03/09	0.00	0.04	0.11	0.56
	08/04/09	0.00	0.02	0.96	2.71
	23/04/09	0.00	0.22	2.04	3.80
	12/05/09	0.00	0.11	1.32	2.35
	20/05/09	0.02	0.11	2.34	4.00
	11/06/09	0.06	0.13	0.80	2.48
	23/07/09	0.06	0.18	1.06	2.23
	13/08/09	0.00	0.00	0.08	0.18
	10/09/09	0.12	0.18	0.33	0.62
	08/10/09	0.02	0.06	0.16	0.24
	10/11/09	0.04	0.35	0.10	0.29

KENMARE BAY

SILVER KING SEAFOODS LTD

Inishfarnard

Atlantic salmon, 2008	10/12/08	0.00	0.09	2.52	7.18
	03/02/09	0.02	0.02	0.00	0.00
	12/03/09	0.02	0.02	0.07	0.14
	26/03/09	0.00	0.00	0.12	0.27
	08/04/09	0.00	0.02	0.02	0.07
	23/04/09	0.00	0.00	0.00	0.04
	12/05/09	0.00	0.00	0.23	0.33
	19/05/09	0.00	0.05	0.95	1.71
	11/06/09	0.00	0.05	0.28	0.55
	23/07/09	0.10	0.27	0.90	2.71
	13/08/09	0.08	0.27	0.34	0.54
	10/09/09	0.32	0.77	0.35	0.58
	08/10/09	0.45	1.76	0.33	0.58
	10/11/09	1.29	2.62	0.11	0.27

GREATMAN'S BAY**MUIR GHEAL TEO****Carraroe**

Atlantic salmon, 2009	12/02/09	0.00	0.00	0.00	0.00
	06/03/09	0.00	1.29	0.00	0.00
	24/03/09	0.00	0.88	0.03	0.07
	03/04/09	0.00	2.27	0.10	0.22
	16/04/09	0.02	1.95	0.16	0.27
	12/05/09	0.00	0.27	0.02	0.05
	19/05/09	0.00	0.20	0.00	0.00
	16/06/09	0.03	0.25	0.02	0.02
	14/07/09	0.56	1.92	0.27	0.41
	24/08/09	3.39	16.77	0.00	0.02
	09/09/09	1.39	8.50	0.00	0.00
	07/10/09	3.78	14.43	0.02	0.02
	30/11/09	9.93	21.23	0.00	0.07

MUIRACHMHAINNI TEO**Cuigeal**

Atlantic salmon, 2009 S 1/2	21/04/09	0.16	4.62	0.21	0.31
	11/05/09	0.32	3.59	0.55	1.63
	21/05/09	0.34	7.00	1.50	2.60
	10/06/09	0.88	4.83	1.70	3.08
	22/07/09	2.73	12.23	0.00	0.04
	20/08/09	3.87	11.21	0.00	0.02
	18/09/09	2.54	5.13	0.00	0.00

Transferred to Daonish

KILKIERAN BAY**MUIRACHMHAINNI TEO****Golam**

Atlantic salmon, 2009 S 1/2	13/01/09	0.08	3.28	0.02	0.02
	11/02/09	0.36	2.88	0.05	0.06
	06/03/09	0.07	1.77	0.09	0.10
	24/03/09	0.00	1.87	0.02	0.04
	03/04/09	0.00	1.34	0.12	0.15
	21/04/09	0.00	2.31	0.00	0.13
	11/05/09	0.03	1.70	0.08	0.10
	21/05/09	0.10	5.86	0.32	0.50

Transferred to Red Flag & Cuigeal

Red Flag

Atlantic salmon, 2009 S 1/2	10/06/09	0.10	2.08	0.02	0.02
	23/07/09	1.78	17.51	0.00	0.14
	25/08/09	5.95	27.98	0.07	0.25

Transferred to Cnoc

Daonish

Atlantic salmon, 2008 S 1/2	17/12/08	3.49	11.36	0.00	0.09
	11/02/09	0.29	13.34	0.02	0.09
	10/03/09	1.21	21.98	0.10	0.17
	31/03/09	0.99	7.58	0.05	0.13
	09/04/09	0.96	5.91	0.06	0.10
	30/04/09	0.78	13.82	0.00	0.00
	15/05/09	0.71	20.19	0.52	1.09
	22/05/09	0.70	19.28	0.49	0.97
	24/06/09	4.27	7.80	0.00	0.00

Harvested out

Atlantic salmon, 2009 S 1/2	28/10/09	15.43	67.00	0.64	0.79
	20/11/09	11.06	50.34	0.00	0.08

MUIR GHEAL TEO**Cnoc**

Atlantic salmon, 2008 S 1/2	13/01/09	2.19	10.28	0.00	0.00
	12/02/09	0.87	17.78	0.00	0.05
	12/03/09	2.01	29.51	0.00	0.00
	31/03/09	3.13	16.56	0.04	0.06
	09/04/09	1.65	6.44	0.00	0.00
	30/04/09	1.26	5.48	0.00	0.00
	15/05/09	1.34	24.11	0.14	0.28
	22/05/09	1.24	17.07	0.11	0.14

Harvested out

Atlantic salmon, 2009 S 1/2	11/09/09	1.98	4.84	0.00	0.00
	09/10/09	0.87	10.79	0.00	0.00
	20/11/09	4.60	27.91	0.00	0.00

Ardmore

Atlantic salmon, 2008 S 1/2	03/12/08	1.22	3.52	0.00	0.05
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Harvested Out

EISC UI FLATHARTHA TEO**Ardmore**

Atlantic salmon, 2008	21/01/09	0.03	4.35	0.00	0.00
	12/02/09	0.84	24.78	0.13	0.40
	11/03/09	4.50	16.45	0.36	0.56
	31/03/09	0.37	1.58	0.10	0.11
	17/04/09	0.40	8.44	0.04	0.17
	29/04/09	0.24	5.44	0.00	0.22
	19/05/09	1.49	23.40	0.96	1.84
	26/05/09	2.60	20.63	0.16	0.55
	23/06/09	13.34	35.05	0.77	1.45
	17/07/09	10.47	38.37	0.02	0.06
	28/08/09	10.97	19.06	0.00	0.00
	11/09/09	6.39	11.96	0.00	0.00

Harvested out

BERTRAGHBOY BAY**COMHLUCHT BRADAIN CHONAMARA TEO****Sealax**

Atlantic salmon, 2009 S 1/2	03/12/08	0.00	3.02	0.00	0.06
	07/01/09	0.11	0.41	0.02	0.03
	21/01/09	0.00	0.03	0.00	0.04
	11/02/09	0.00	0.14	0.02	0.02
	03/03/09	0.00	0.27	0.04	0.05
	20/03/09	0.00	0.33	0.07	0.12
	03/04/09	0.00	0.19	0.15	0.15
	16/04/09	0.00	0.48	0.10	0.13
	12/05/09	0.02	0.83	0.22	0.40
	26/05/09	0.02	0.17	0.08	0.17
	12/06/09	0.00	0.10	0.00	0.03
	08/07/09	0.03	0.38	0.16	0.17
	19/08/09	0.79	4.36	0.00	0.02
	23/09/09	2.60	5.78	0.00	0.02

Transferred to Fraochoilean

MANNIN BAY**MANNIN BAY SALMON CO LTD****Corhounagh**

Atlantic salmon, 2008	23/03/09	0.11	0.69	0.13	0.13
	08/04/09	0.17	8.55	0.04	0.05
	24/04/09	0.28	7.80	0.00	0.09
	14/05/09	2.01	6.85	0.24	0.66
	28/05/09	1.46	6.78	0.06	0.30
	25/06/09	0.67	1.42	0.07	0.23
	02/07/09	0.87	1.52	0.05	0.15
	07/08/09	2.46	10.36	0.25	0.32
	17/09/09	6.04	27.66	0.00	0.00
	08/10/09	6.17	11.39	0.00	0.02
	17/11/09	3.30	10.23	0.00	0.02

CLIFDEN BAY**MANNIN BAY SALMON CO LTD****Hawk's Nest**

Atlantic salmon, 2008	08/01/09	0.07	1.89	0.05	0.07
	12/02/09	0.65	1.75	0.10	0.10
	06/03/09	0.92	3.33	0.21	0.37

Transferred to Corhounagh

Atlantic salmon, 2009	14/05/09	0.00	0.24	0.00	0.02
	28/05/09	0.00	0.01	0.00	0.01
	25/06/09	0.00	0.04	0.00	0.04
	02/07/09	0.00	0.06	0.00	0.03
	06/08/09	0.00	0.15	0.05	0.06
	17/09/09	0.22	0.59	0.00	0.00
	08/10/09	1.84	16.51	0.00	0.00
	16/11/09	0.45	1.82	0.00	0.00

BALLINAKILL HARBOUR**BIFAND LTD****Fraochoilean**

Atlantic salmon, 2008 S 1/2	08/01/09	1.60	22.28	0.07	0.10
	12/02/09	2.49	7.47	0.10	0.16
	10/03/09	0.25	0.55	0.00	0.00
	24/03/09	0.46	5.08	0.02	0.09
	09/04/09	0.17	6.86	0.00	0.00
	23/04/09	0.64	3.91	0.00	0.00
	15/05/09	0.58	2.85	0.06	0.17
	26/05/09	0.12	1.49	0.10	0.13
	19/06/09	1.30	2.57	0.07	0.23
	16/07/09	0.32	7.65	0.16	0.55
	07/08/09	12.53	25.97	1.03	1.77

Harvested out

Atlantic salmon, 2009 S 1/2	19/10/09	3.09	8.98	0.00	0.00
	16/11/09	1.69	22.35	0.06	0.07

KILLARY HARBOUR**CELTIC ATLANTIC SALMON (KILLARY) LTD****Inishdeighil**

Atlantic salmon, 2008	11/12/08	2.96	12.87	0.20	0.24
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Transferred to Ardmore

CLEW BAY**CLARE ISLAND SEAFARMS LTD****Clare Island Smolt Site**

Atlantic salmon, 2009	20/04/09	0.00	1.57	0.02	0.06
	14/05/09	0.00	1.06	0.00	0.04
	26/05/09	0.00	0.66	0.02	0.06
	10/06/09	0.00	0.26	0.00	0.02
	07/07/09	0.00	0.18	0.11	0.16
	21/08/09	0.37	1.47	0.84	1.45
	29/09/09	0.35	3.76	0.44	0.75
	16/10/09	0.59	3.53	0.14	0.27

Transferred to Portlea

Portlea

Atlantic salmon, 2008	03/12/08	0.08	0.44	0.00	0.04
	13/02/09	0.33	2.35	0.19	0.28
	10/03/09	0.32	1.71	0.22	0.27
	30/03/09	0.42	5.52	0.59	0.87
	08/04/09	0.31	6.36	1.08	1.43
	20/04/09	0.25	4.69	0.60	0.75
	14/05/09	1.81	6.00	0.00	0.00
	26/05/09	0.79	2.27	0.09	0.30
	10/06/09	0.35	1.47	0.42	0.82
	07/07/09	0.61	1.47	1.41	3.20
	21/08/09	4.17	11.36	0.00	0.07
	29/09/09	0.17	0.70	0.00	0.00

Transferred to Seastream Inner

Atlantic salmon, 2009	30/11/09	1.18	4.35	0.00	0.02
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Seastream Inner

Atlantic salmon, 2007	11/12/08	0.32	0.75	0.00	0.02
	04/02/09	0.19	16.52	0.03	0.03
	13/03/09	2.93	4.52	0.11	0.11

Harvested out

Atlantic salmon, 2008	16/10/09	0.82	2.82	0.09	0.12
	30/11/09	0.34	0.83	0.00	0.03

BEALACRAGHER BAY**CURRAUN FISHERIES LTD****Curraun**

Rainbow trout 2007 (3)	Harvested out				
Rainbow trout 2008 (1)	02/12/08	1.67	10.89	0.00	0.04
	13/02/09	0.10	3.03	0.00	0.00
	09/03/09	0.07	3.33	0.00	0.00
	30/03/09	0.00	3.13	0.00	0.00
	Harvested out				
Rainbow trout 2008 (2)	02/12/08	0.06	5.94	0.00	0.06
	04/02/09	0.32	1.42	0.00	0.00
	09/03/09	0.00	2.21	0.00	0.00
	30/03/09	0.17	2.33	0.00	0.00
	06/04/09	0.00	0.61	0.00	0.00
	24/04/09	0.04	1.04	0.00	0.02
	14/05/09	0.00	0.98	0.00	0.00
	26/05/09	0.15	3.88	0.00	0.00
	16/06/09	0.08	0.30	0.00	0.00
	17/07/09	0.90	2.60	0.00	0.00
	31/08/09	6.37	20.10	0.00	0.00
	28/09/09	4.57	10.37	0.00	0.00
	Harvested out				
Rainbow trout 2009 (1)	24/04/09	0.00	0.65	0.00	0.00
	14/05/09	0.00	0.57	0.00	0.00
	26/05/09	0.00	0.40	0.00	0.00
	16/06/09	0.00	0.13	0.00	0.00
	17/07/09	0.17	0.97	0.00	0.00
	31/08/09	0.60	4.07	0.00	0.00
	28/09/09	3.43	18.53	0.00	0.00
	28/10/09	0.13	1.13	0.00	0.00
	10/11/09	0.06	10.74	0.00	0.00
Rainbow trout 2009 (2)	28/10/09	0.00	0.63	0.00	0.00
	10/11/09	0.00	4.87	0.00	0.00

DONEGAL BAY**EANY FISH PRODUCTS LTD****Inver Bay**

Rainbow trout 2007 (3)	10/12/08	1.46	15.14	0.11	0.14
		Harvested out			
Rainbow trout 2008 (1)	10/12/08	0.22	5.11	0.07	0.12
	03/02/09	0.03	2.12	0.00	0.00
	04/03/09	0.12	1.00	0.02	0.02
	19/03/09	0.10	1.28	0.00	0.00
	02/04/09	0.09	0.62	0.02	0.09
	21/04/09	0.04	0.24	0.00	0.06
	14/05/09	0.05	0.32	0.02	0.02
	27/05/09	0.03	1.25	0.04	0.10
	25/06/09	0.13	0.33	0.03	0.07
	14/07/09	0.04	0.78	0.17	0.17
		Harvested out			
Rainbow trout 2009 (1)	10/12/08	0.00	0.82	0.00	0.00
	03/02/09	0.02	0.27	0.00	0.00
	04/03/09	0.00	0.22	0.00	0.00
	19/03/09	0.03	0.35	0.00	0.03
	02/04/09	0.00	0.04	0.00	0.00
	21/04/09	0.04	0.09	0.00	0.00
	14/05/09	0.00	0.02	0.00	0.00
	27/05/09	0.00	0.49	0.00	0.02
	25/06/09	0.00	0.04	0.04	0.07
	14/07/09	0.00	0.24	0.02	0.03
	06/08/09	0.13	0.44	0.00	0.00
	17/09/09	0.10	0.49	0.00	0.00
	07/10/09	0.04	0.12	0.00	0.00
	10/11/09	0.02	0.07	0.00	0.00
Rainbow trout 2009 (2)	06/08/09	0.00	0.03	0.04	0.04
	17/09/09	0.02	0.17	0.00	0.00
	07/10/09	0.02	0.36	0.00	0.00
	10/11/09	0.00	0.13	0.00	0.00

OCEAN FARM LTD**McSwyne's Bay**

Atlantic salmon, 2007	10/12/08	1.88	3.43	0.00	0.00
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Transferred to Glinsk and Millstone

Atlantic salmon, 2009	02/04/09	0.00	0.00	0.00	0.00
	21/04/09	0.00	0.08	0.00	0.00
	05/05/09	0.00	0.05	0.00	0.00
	27/05/09	0.00	0.22	0.00	0.00
	25/06/09	0.00	0.00	0.02	0.09
	14/07/09	0.00	0.00	0.13	0.13
	06/08/09	0.00	0.00	0.04	0.04
	17/09/09	0.00	0.00	0.02	0.02
	07/10/09	0.02	0.02	0.00	0.00
	10/11/09	0.02	0.06	0.00	0.00

Ocean Inver

Atlantic salmon, 2008 S1/2	10/12/08	0.35	2.20	0.02	0.04
	03/02/09	0.88	15.69	0.04	0.10
	04/03/09	0.00	0.04	0.02	0.04
	19/03/09	0.03	1.02	0.03	0.19
	02/04/09	0.05	1.78	0.14	0.29
	21/04/09	1.04	2.70	0.14	0.24
	14/05/09	0.07	0.11	0.02	0.02
	27/05/09	0.02	0.10	0.02	0.05
	25/06/09	0.22	0.25	0.00	0.00
	14/07/09	0.35	1.26	0.04	0.04

Harvested out

MULROY BAY**MARINE HARVEST****Glinsk**

Atlantic salmon, 2008	10/12/08	0.34	7.47	0.22	0.79
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Transferred to Lough Swilly

Atlantic salmon, 2008 SI/2	04/03/09	0.04	0.04	0.00	0.00
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	20/03/09	0.09	0.32	0.00	0.00
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	07/04/09	0.02	0.61	0.04	0.12
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	21/04/09	0.09	1.32	0.02	0.14
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	05/05/09	0.32	9.21	0.14	0.42
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	21/05/09	1.29	3.26	0.18	0.27
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	16/06/09	1.09	11.68	1.00	1.41
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Transferred to Millstone

Atlantic salmon, 2007	04/02/09	0.16	2.47	0.02	0.02
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	04/03/09	0.00	0.12	0.00	0.04
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	20/03/09	0.02	0.62	0.00	0.00
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	07/04/09	0.35	2.03	0.14	0.32
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	21/04/09	0.36	4.00	0.15	0.38
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Transferred to Millstone

Millstone

Atlantic salmon, 2007	10/12/08	0.96	24.25	0.21	0.61
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	04/02/09	0.00	0.12	0.00	0.00
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	04/03/09	0.00	0.36	0.02	0.02
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	20/03/09	0.58	1.97	0.07	0.15
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	07/04/09	0.24	0.59	0.05	0.05
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	21/04/09	0.30	2.85	0.10	0.35
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	05/05/09	0.59	8.64	0.33	0.70
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	21/05/09	1.47	5.41	0.18	0.21
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Harvested out

Atlantic salmon, 2008 SI/2	16/06/09	0.59	7.78	0.16	0.45
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On starve for harvest (Harvesting site)

LOUGH SWILLY

MARINE HARVEST

Lough Swilly

Atlantic salmon, 2008	04/02/09	0.33	1.68	0.05	0.05
	04/03/09	0.23	1.01	0.07	0.09
	20/03/09	0.07	0.24	0.06	0.06
	07/04/09	0.10	1.22	0.10	0.20
	21/04/09	0.12	1.36	0.16	0.26
	05/05/09	0.25	4.30	0.12	0.28
	21/05/09	0.00	0.04	0.00	0.00
	16/06/09	0.07	0.55	0.02	0.09
	07/07/09	0.16	0.78	0.72	1.59
	06/08/09	0.05	0.99	0.00	0.00
	29/09/09	0.99	7.60	0.00	0.00
	16/10/09	2.10	12.99	0.02	0.03
	18/11/09	2.99	11.71	0.00	0.00

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