Irish Fisheries Bulletin

No. 31 2008

National Survey of Sea Lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2007

Pauline O'Donohoe

Frank Kane

Suzanne Kelly

Pat Nixon

Ayesha Power

Oisín Naughton

Dave Jackson

Marine Institute
Foras na Mara

NATIONAL SURVEY OF SEA LICE (*LEPEOPHTHEIRUS SALMONIS* KRØYER AND *CALIGUS ELONGATUS* NORDMANN) ON FISH FARMS IN IRELAND – 2007

February 2008

Pauline O'Donohoe, Frank Kane, Suzanne Kelly,
Pat Nixon, Ayesha Power, Oisín Naughton
and Dave Jackson.

Aquaculture Section,
Aquaculture and Catchment Management Services,
Marine Institute,
Rinville,
Oranmore,
Co. Galway.

Table of Contents

INTRODUCTION

Farming of salmonids in Irish seas in 2006 produced approximately 12,000 tonnes and was worth over €55 million (Browne *et al*, 2007). One of the greatest challenges facing Irish fish farming is sea lice. Sea lice are ectoparasites which occur on many fish worldwide. The two main species of concern are *Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann. The damaging effects of sea lice infestation occur in a variety of ways, namely: reduction in growth; reduction of marketability; and loss of scales -which leaves the fish open to secondary infections (Wooten *et al*., 1982). Of the two species of sea lice found on cultured salmonids in Ireland, *C. elongatus* parasitises over 80 different types of marine fish, while *L. salmonis* infests only salmon and other salmonids. *L. salmonis* is regarded as the more serious parasite of the two species and has been found to occur most frequently on farmed Atlantic salmon (Jackson and Minchin, 1992; Jackson *et al*., 2005).

Most of the damage caused by these parasites is thought to be mechanical, carried out during the course of attachment and feeding (Kabata, 1974; Brandal *et al*., 1976; Jones *et al*., 1990). Inflammation and hyperplasia (enlargement caused by an abnormal increase in the number of cells in an organ or tissue) have been recorded in Atlantic salmon in response to 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 occur here 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) that comprises of 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 and this is 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)

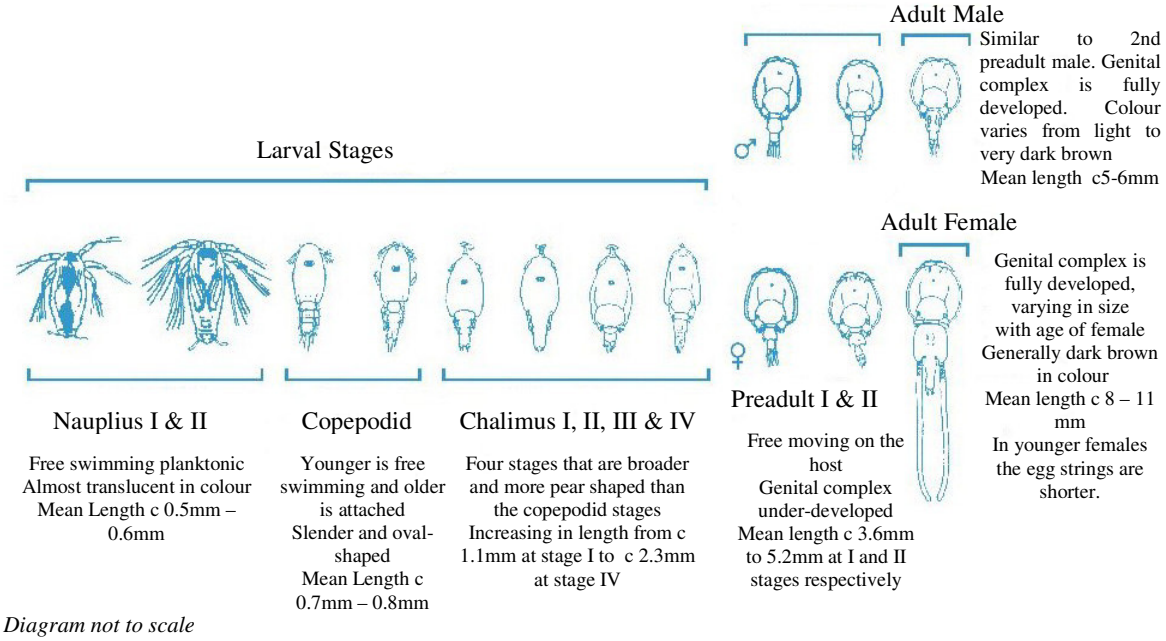
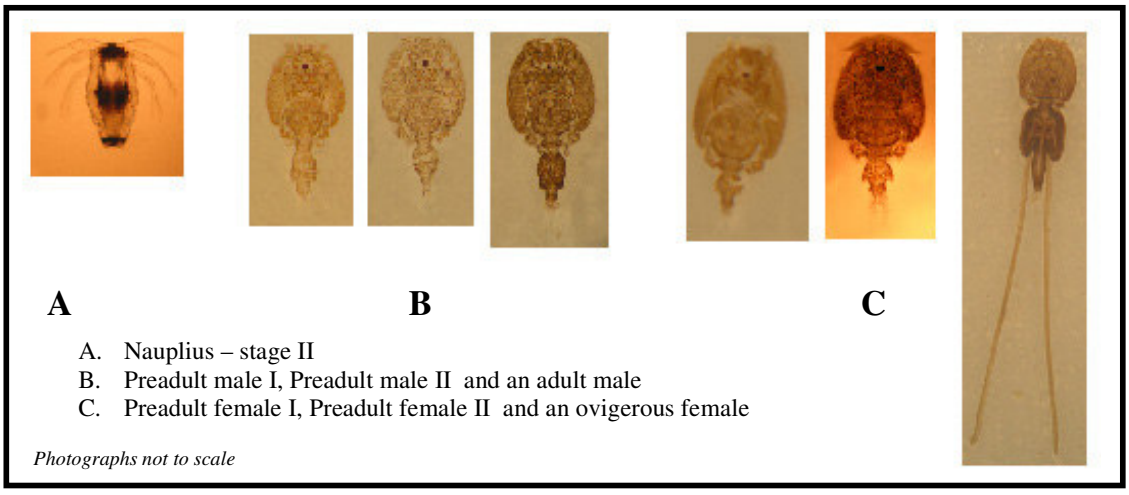


Diagram not to scale

Examples of nauplius, preadult 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*.



A. Nauplius – stage II
B. Preadult male I, Preadult male II and an adult male
C. Preadult female I, Preadult female II and an ovigerous female

Photographs not to scale

C. elongatus is not as host specific as *L. salmonis* and parasitises a range of marine fish (Kabata, 1979). This, combined with the migrating patterns of their hosts, 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 instigated a Sea lice Monitoring Programme for finfish farms in Ireland, in 1993 it became a nationwide programme. 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).

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 the 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 practices.

Together, these components work 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 controlling reliance on, and reducing the use of, veterinary medicines. The separation of generations and annual fallowing prevent the vertical transmission of infestations from one generation to the next, thus retarding their development. The early harvest of two-sea-winter fish removes a potential reservoir of sea lice and the agreed practices and targeted treatments enhance the efficacy of treatment regimes. One important aspect of targeted treatments is the 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 and relevant management practices between farmers.

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. Where numbers of mobile sea lice are high, treatments are triggered even in the absence of egg bearing females. Outside of the spring period, a level of 2.0 ovigerous female *L. salmonis* per fish acts as a trigger for treatments. Over the period since the initiation of Single Bay Management, treatment triggers 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. Triggered treatments are underpinned by follow up inspections and, where necessary, by sanctions. Sanctions employed include: peer review under the SBM process; conditional fish movement orders; and accelerated harvests.

In late winter and early spring the sea water temperatures are at a minimum and 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 any ovigerous sea lice. This is the 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.

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 interested parties and the data is published annually (O'Donohoe *et al.*, 2007; O'Donohoe *et al.*, 2006; O'Donohoe *et al.*, 2005; O'Donohoe *et al.*, 2004; O'Donohoe *et al.*, 2003; McCarney *et al.*, 2002; Copley *et al.*, 2001)

Treatments are administered to fish either as in-feed treatments or bath treatments. Currently, there are four licensed sea lice treatments in Ireland. Two of these, CALICIDE® also available as EKTOBANN®, and SLICE®, are in-feed and the remaining two, EXCIS® and ALPHAMAX® are topical treatments. CALICIDE® and EKTOBANN® contain teflubenzuron which acts as a chiton synthesis inhibitor that interferes with the cuticle

formation of the louse. It is effective against the moulting stages of the life cycle and it has a 7 day withdrawal period. SLICE® contains emamectin benzoate, which interferes with the peripheral nervous system of the louse causing paralysis or death. It is effective against all stages of the life cycle and withdrawal period is zero. The topical treatment EXCIS® contains cypermethrin, which also affects the nervous system of the louse. It is effective against all stages of the life cycle and has a 24 hour withdrawal period. ALPHAMAX® contains deltamethrin which acts on the nervous system of the louse. It affects adults and pre-adults (it's efficacy against the chalimus stages is unknown) and has a 3 day withdrawal period.

Other methods currently in use or being trialed to control sea lice include:

Hydrogen Peroxide is a bleaching and oxidising agent. When used as a disinfectant, it is effective against sea lice. It works by the formation of gas bubbles both within and without the louse. It is believed to be effective against both adult and pre-adult stages. There is no withdrawal period.

Ecoboost®, a blend of aromatic herbs, is incorporated into the feed. It is said to boost the immune system and this enhances the ability of fish to withstand sea lice infestation.

Bioemitters® use bioenergetic technology to emit a low power highly programmed and specific electromagnetic signal into the salmon cage. These are on trial in Ireland at present with varying results.

Ergosan® is an algine based immunomodulator. It is formulated from seaweed extracts and it enhances the fish's immune response. It is used particularly for non-specific disease or stress-related problems and is being trialed on farms in Ireland at present.

Bio-mos® is currently being trialed on some farms, it is a prophylactic treatment aimed at the reduction of stress, improvement of fish health status, optimization of performance and improvement of disease resistance, gut morphology and efficiency. Bio-mos® is derived from the outer cell wall of a specific strain of yeast.

Wrasse are used as a 'cleaner fish' in several countries. There are limitations to efficacy and also issues with supply, effects on wild populations and possible disease risks. They may have limited application especially on post smolts in their first summer at sea.

METHODOLOGY

All stocks of salmonids on all farms in Ireland are visited on 14 occasions throughout the year when present. Sea lice are monitored 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 them in a container of sea water. The sea water is sieved for any 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% alcohol, one 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 from the sieved sea water, 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 successful breeding female populations. The information gathered aims to evaluate the levels 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 lice levels on the subsequent inspection.

In the year 2007, salmonid farms had 6 different stocks of fish. These were: 2006 rainbow trout, *Oncorhynchus mykiss* (Walbaum) (rainbow trout first inspected in 2006); 2007 rainbow trout (rainbow trout first inspected in 2007); 2005 Atlantic salmon, *Salmo salar* L. (two-sea-winter salmon); 2006 Atlantic salmon (one-sea-winter salmon), 2007 Atlantic salmon (smolts) and Atlantic salmon 2008 $S^1/_2$ (early smolts stocked at the end of 2007).

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 the year 2007 a total number of 30 sites were inspected around Ireland, Figures 3-5.

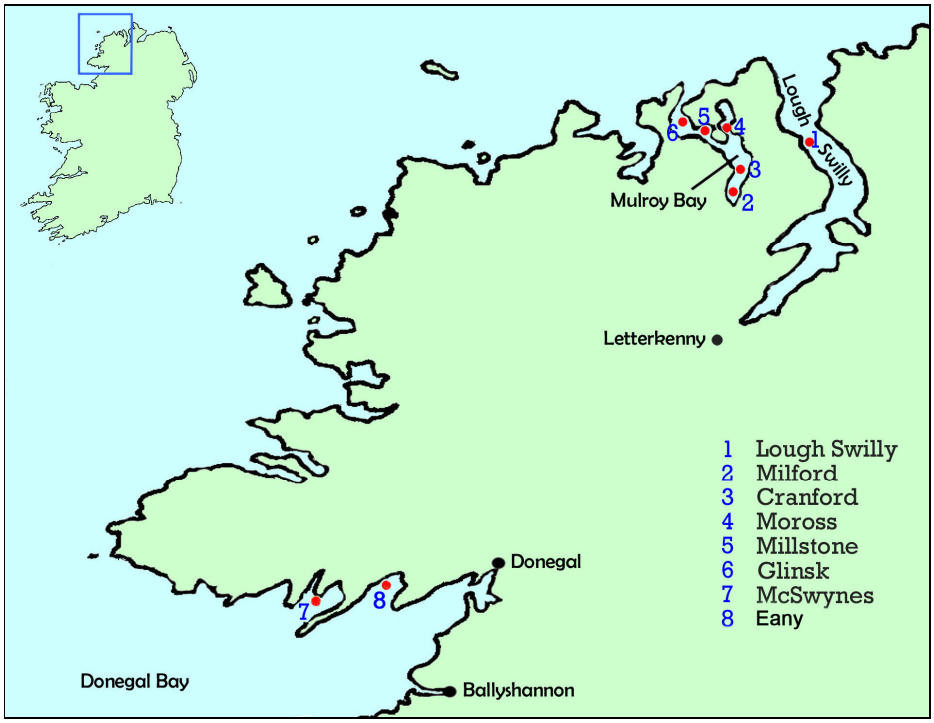


Figure 3. Locations of fish farm sites in Northwest region.

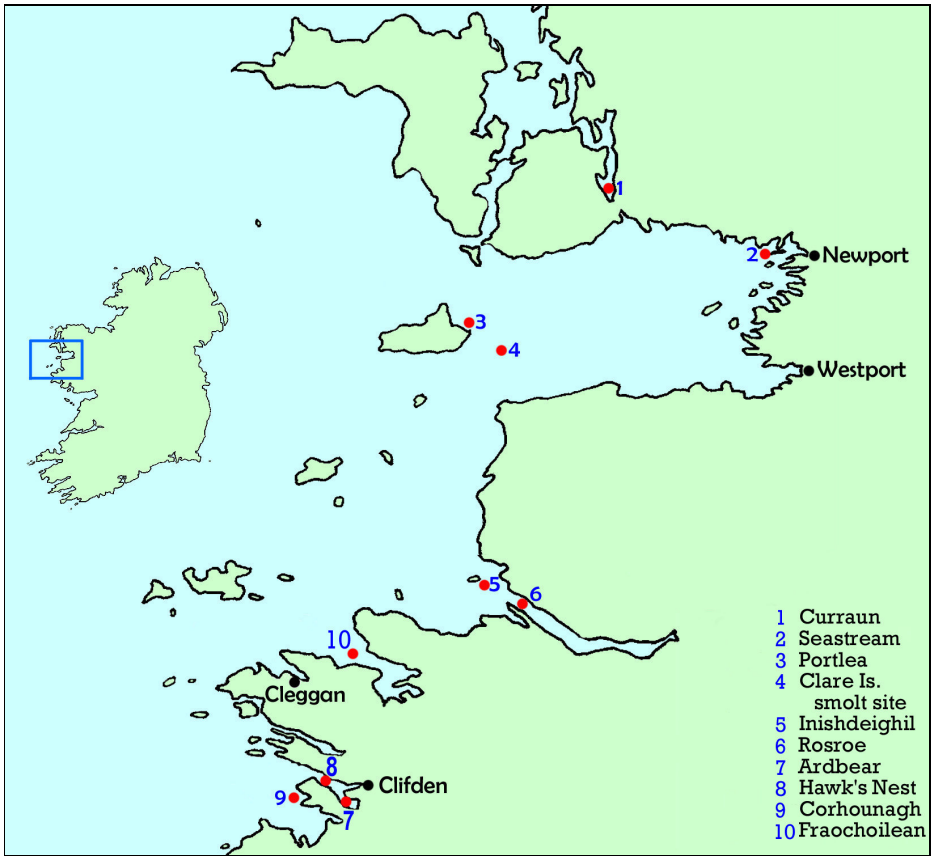


Figure 4a. Locations of fish farm sites in the West region (Clew Bay / Connemara).

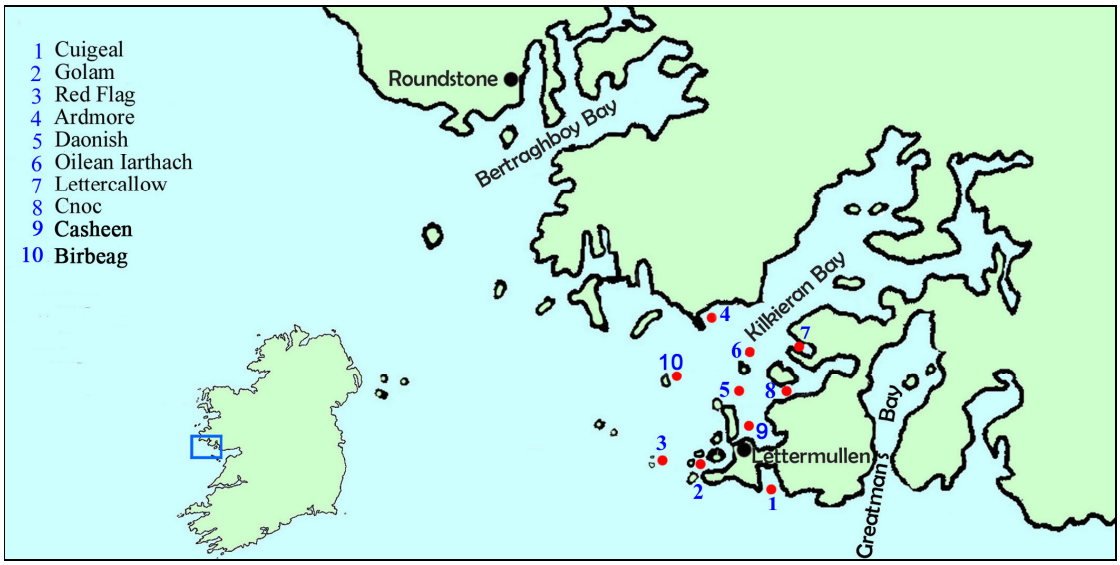


Figure 4b. Locations of fish farm sites in the West region (Connemara).

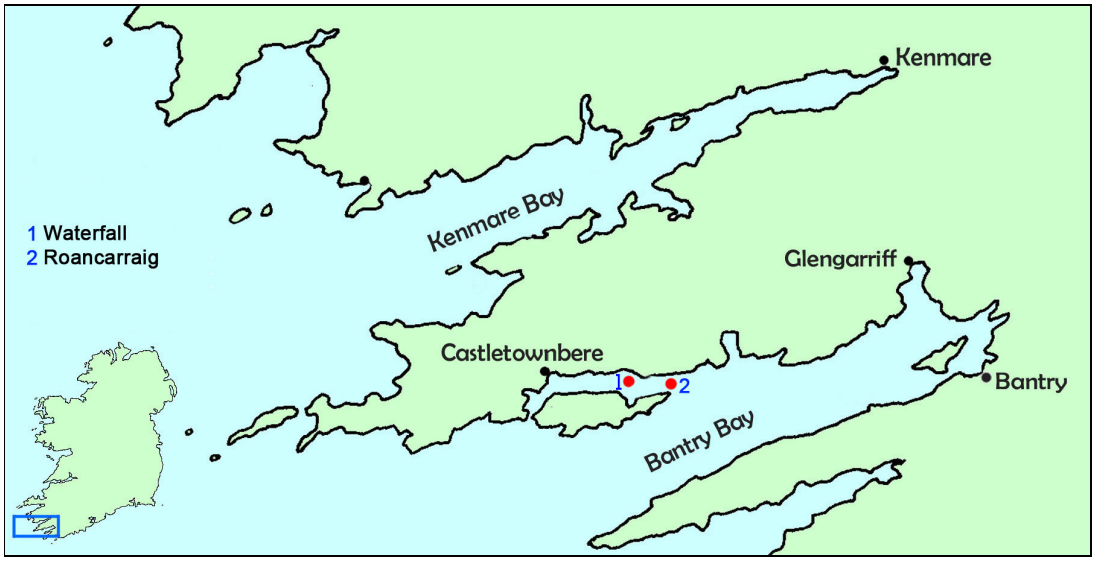


Figure 5. Locations of fish farm sites in the Southwest region.

RESULTS

Atlantic salmon 2005 (two-sea-winter salmon)

At the beginning of 2007, two-sea-winter salmon were still being stocked on 4 sites: Corhounagh (Mannin Bay Salmon Ltd.); Seastream Inner (Clare Island Seafarms Ltd.); Millstone (Marine Harvest); and Lough Swilly (Marine Harvest). Table 1 contains the number of inspections per site and total number of inspections exceeding the treatment trigger.

Table 1. National breakdown of inspections for 2005 fish on fish farm sites in 2007.

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
Mannin Bay Salmon Co Ltd	**Corhounagh**	0	0	1	1	1	1	-	100%	100%
Clare Island Seafarms Ltd.	**Seastream Inner**	2	0	2	0	4	0	0%	0%	0%
Southwest	**Totals**	2	0	3	1	5	1	0%	33%	20%
Marine Harvest	**Millstone**	3	3	0	0	3	3	100%	-	100%
	Lough Swilly	0	0	1	1	1	1	-	100%	100%
Northwest	**Totals**	3	3	1	1	4	4	100%	100%	100%
National Totals		5	3	4	2	9	5	60%	50%	56%

A total of 9 visits were undertaken to these sites before harvesting was completed, with 55.56% of inspections exceeding treatment trigger levels.

Atlantic salmon 2006 (one-sea-winter salmon)

One-sea-winter salmon were stocked in a total of 17 sites in 9 bays in 2007. One hundred and fifty-six visits were undertaken to this generation of fish. Five sites, in 4 bays, continued to stock one-sea-winter salmon in November 2007.

Ovigerous *L. salmonis* levels greater than the treatment trigger level were recorded in a total of 75 inspections (48%) on one-sea-winter fish (see Table 2). Within the critical spring period, sea lice levels were in excess of 0.5 ovigerous females per fish on 50 inspections (60%) and outside of the spring period 25 inspections (35%) were in excess of 2.0 ovigerous female sea lice per fish.

Table 2. National breakdown of inspections for 2006 fish on fish farm sites in 2007.

	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	84	50	72	25	156	75	60%	35%	48%

C. elongatus levels were consistently recorded at a low level throughout the year, with the exception in the Southwest in January where numbers reached 13.65 mobile *C. elongatus* per fish.

Southwest Region

In the Southwest region, all of the 6 inspections in the spring period (March to May) were in excess of treatment trigger levels and 1 of the 4 inspections outside the spring period exceeded the treatment trigger levels (see Table 3). Roancarraig (Silver King Seafoods Ltd), Bantry Bay, was the only site stocking 2006 fish in 2007.

Table 3. Breakdown of inspections for 2006 fish on Southwest sites in 2007.

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
Silver King (Beara Atlantic) Ltd	**Roancarraig**	6	6	4	1	10	7	100%	25%	70%
Southwest	**Totals**	6	6	4	1	10	7	100%	25%	70%

West Region

In the West region, sea lice infestation levels greater than the treatment trigger were recorded on 34 out of 51 inspections (67%) in the spring period and on 15 out of 43 inspections (35%) outside the spring period (see Table 4).

Table 4. Breakdown of inspections for 2006 fish on West sites in 2007.

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
Muirachmhainni Teo	**Cuigeal**	0	0	1	0	1	0	-	0%	0%
	Casheen	5	3	1	0	6	3	60%	0%	50%
	Daonish	6	3	3	0	9	3	50%	0%	33%
Muir Gheal Teo	**Cnoc**	6	5	3	2	9	7	83%	67%	78%
Eisc Ui Flathartha Teo	**Ardmore**	6	6	5	4	11	10	100%	80%	91%
Mannin Bay Salmon Co Ltd	**Corhounagh**	4	4	6	4	10	8	100%	67%	80%
	Hawk's nest	2	2	2	1	4	3	100%	50%	75%
Bifand Ltd	**Fraochoilean**	6	6	4	2	10	8	100%	50%	80%
Celtic Atlantic Salmon (Killary) Co ltd	**Rosroe**	6	2	4	0	10	2	33%	0%	20%
Clare Island Seafarms Ltd	**Seastream Inner**	4	0	6	1	10	1	0%	17%	10%
	Portlea	6	3	8	1	14	4	50%	13%	29%
West	**Totals**	51	34	43	15	94	49	67%	35%	52%

Levels at Daonish (Muirachmhainni Teo), Kilkieran Bay, were in excess of treatment trigger levels for 3 out of 6 inspections in the spring period and none of the 3 inspections outside the spring period. At Casheen (Muirachmhainni Teo), Kilkieran Bay, there were 5 inspections in the spring, 3 of which were over treatment trigger levels.

Cnoc (Muir Gheal Teo.), Kilkieran Bay, were above treatment trigger levels for 5 of the 6 spring inspections and 2 of the 3 inspections outside spring.

Ardmore, (Eisc Ui Flathartha Teo), Kilkieran Bay, were above treatment trigger levels for all of the 6 spring inspections and 4 of the 5 inspections outside the spring period.

At Corhounagh (Mannin Bay Salmon Co. Ltd.), Mannin Bay, sea lice exceeded treatment trigger levels for all 4 inspections in the spring and for 4 of the 6 inspections outside the

spring. Both inspections at Hawk's Nest in the spring were in excess of treatment trigger levels and for 1 of the 2 inspections outside spring.

Fraochoilean (Bifand Ltd.), Ballinakill Bay, exceeded treatment trigger levels for all 6 spring inspections and 2 of the 4 inspections outside the spring period.

Sea lice levels at Portlea (Clare Island Seafarms Ltd), Clew Bay, were in excess of treatment trigger levels for 3 of the 6 inspections in spring and 1 of the 8 inspections outside the spring period.

Northwest Region

The treatment trigger levels were exceeded on 11 out of 27 inspections (41%) in the Northwest region during the spring period and on 9 out of 25 inspections (36%) outside that period (see Table 5).

Table 5. Breakdown of inspections for 2006 fish on Northwest sites in 2007.

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
Marine Harvest	**Millford**	3	1	2	0	5	1	33%	0%	20%
	Cranford A	6	4	2	2	8	6	67%	100%	75%
	Millstone	6	3	8	3	14	6	50%	38%	43%
	Glinsk	6	3	7	1	13	4	50%	14%	31%
	Lough Swilly	6	0	6	3	12	3	0%	50%	25%
Northwest	**Totals**	27	11	25	9	52	20	41%	36%	38%

Cranford A (Marine Harvest), Mulroy Bay, had sea lice levels in excess of treatment trigger levels in December/January, February, March, and April. The fish were harvested out in June. Millstone (Marine Harvest), Mulroy Bay, had elevated sea lice levels for December/January, March, May, September and November. Glinsk had elevated sea lice levels for 3 inspections in the spring period and again in October prior to harvesting.

Atlantic salmon 2007 (Smolts)

A total of 133 visits were undertaken at 20 sites stocking S1 and S½ smolts during the year 2007. *L. salmonis* levels were maintained below the treatment trigger level of 0.5 ovigerous female lice per fish for all of the 49 inspections in the spring period. Outside of this period levels exceeded 2.0 ovigerous female lice per fish on 4 of the 84 inspections (see Table 6).

Table 6. National breakdown of inspections for 2007 fish on fish farm sites in 2007.

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
Silver King (Beara Atlantic) Ltd	**Roancarraig**	5	0	6	0	11	0	0%	0%	0%
Southwest	**Totals**	5	0	6	0	11	0	0%	0%	0%
Muirachmhainni Teo	**Cuigeal**	1	0	3	0	4	0	0%	0%	0%
	Daonish	0	0	3	0	3	0	-	0%	0%
	Golam	5	0	2	0	7	0	0%	0%	0%
	Red Flag	1	0	4	1	5	1	0%	25%	20%
Muir Gheal Teo	**Cnoc**	0	0	1	0	1	0	-	0%	0%
	Lettercallow	6	0	2	0	8	0	0%	0%	0%
	Oilean Iarthach	2	0	5	0	7	0	0%	0%	0%
	Birbeag	1	0	5	0	6	0	0%	0%	0%
	Ardmore	0	0	1	0	1	0	-	0%	0%
Mannin Bay Salmon Co Ltd	**Hawk's nest**	2	0	6	2	8	2	0%	33%	25%
	Ardbear	6	0	3	0	9	0	0%	0%	0%
Bifand Ltd	**Fraochoilean**	0	0	5	0	5	0	-	0%	0%
Celtic Atlantic Salmon (Killary) Co ltd	**Rosroe**	2	0	6	0	8	0	0%	0%	0%
	Inishdeighil	2	0	6	0	8	0	0%	0%	0%
Clare Island Seafarms Ltd.	**C.I. smolt site**	4	0	6	0	10	0	0%	0%	0%
West	**Totals**	32	0	58	3	90	3	0%	5%	3%
Marine Harvest	**McSwyne's Bay**	5	0	6	0	11	0	0%	0%	0%
	Cranford A	6	0	3	0	9	0	0%	0%	0%
	Moross I	1	0	6	0	7	0	0%	0%	0%
	Millstone	0	0	5	1	5	1	-	20%	20%
Northwest	**Totals**	12	0	20	1	32	1	0%	5%	3%
National Totals		49	0	84	4	133	4	0%	5%	3%

C. elongatus levels remained low throughout the year on 2007 smolts.

Atlantic salmon 2008 S$^{1}/_{2}$ (Smolts)

There were 3 inspections carried out to this stock in November 2007 directly after they were inputted to sea. All inspections recorded numbers below the treatment trigger levels.

Rainbow trout

In 2007 there were 2006 rainbow trout and 2007 rainbow trout stocked between 3 sites, in 3 regions. There were a total of 25 inspections carried out on the 2006 rainbow trout. Sea lice levels did not reach treatment trigger levels except for 1 inspection in June.

Twenty-nine inspections were carried out on the 2007 rainbow trout, stocked in Bantry Bay, Bealacragher Bay and Donegal Bay. All, except one of these inspections, were below treatment trigger levels.

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

Sampling record

Two site inspections were missed due to technical difficulties in 2007.

All the mean values for each farm visit can be seen in Appendix 1.

One-sea-winter salmon monthly trend

Mean ovigerous and mean mobile *L. salmonis* and *C. elongatus* levels for each bay are shown in Table 7 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 17 of the 24 occasions during the spring period on a bay basis. These occurred in Bantry Bay (3), Kilkieran Bay (3), Mannin Bay (3), Ballinakill Bay (3), Killary Harbour (2), Mulroy Bay (2) and Clew Bay (1). On 19 occasions outside of the spring period, mean ovigerous levels of 2.0 ovigerous females per fish or greater were recorded. These occurred in Mannin Bay (5), Mulroy Bay (4), Lough Swilly (3), Kilkieran Bay (3), Ballinakill Bay (2), Bantry Bay (1) and Clew Bay (1).

Table 7. Mean ovigerous and mean mobile *L. salmonis* and *C. elongatus* per month for one-sea-winter salmon for each bay inspected in the year 2007.

Mean ovigerous *L. salmonis*

	Dec/Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*
Bantry Bay	0.82	0.87	2.09	2.69	3.59	1.22	2.33	HO			
Greatman's Bay	0.10	TO									
Kilkieran Bay	0.78	1.94	1.32	1.08	2.57	5.48	5.00	15.79	HO		
Mannin Bay	1.64	5.35	1.43	2.34	1.02	0.40	2.60	5.78	6.07	1.63	12.31
Ballinakill Bay	3.67	2.42	2.28	1.10	4.64	1.97	0.87	HO			
Killary Harbour	0.02	0.09	2.38	0.57	0.10	0.07	0.24	HO			
Clew Bay	0.32	0.73	1.57	0.10	0.36	0.90	0.59	2.14	1.82	0.71	1.19
Mulroy Bay	1.40	2.24	1.07	0.48	1.69	0.36	0.14	0.68	3.02	2.36	13.24
Lough Swilly		TI	0.07	0.00	0.30	0.45	0.33	3.93	1.82	2.87	14.40

Mean mobile *L. salmonis*

	Dec/Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*
Bantry Bay	5.20	3.70	8.62	8.25	39.95	4.73	13.93	HO			
Greatman's Bay	10.07	TO									
Kilkieran Bay	6.72	9.75	15.71	10.00	14.32	24.13	10.37	46.11	HO		
Mannin Bay	9.06	34.44	9.61	14.07	17.68	0.55	5.32	23.75	14.52	12.78	125.01
Ballinakill Bay	20.71	7.66	26.79	13.81	23.37	6.27	11.00	HO			
Killary Harbour	0.22	10.44	3.95	2.77	0.68	0.72	1.96	HO			
Clew Bay	2.72	6.32	7.53	1.31	5.40	1.15	1.37	10.80	4.73	1.39	8.74
Mulroy Bay	3.77	5.83	9.20	9.37	8.69	0.94	0.32	3.90	7.15	4.44	61.22
Lough Swilly		TI	2.22	0.73	1.26	1.90	4.54	7.94	15.48	20.62	142.50

Mean ovigerous *C. elongatus*

	Dec/Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*
Bantry Bay	7.55	0.23	0.40	0.69	1.82	0.72	1.40	HO			
Greatman's Bay	0.10	TO									
Kilkieran Bay	0.01	0.04	0.01	0.00	0.06	0.21	0.00	0.16	HO		
Mannin Bay	0.00	0.12	0.00	0.08	0.03	0.00	0.02	0.04	0.00	0.00	0.11
Ballinakill Bay	0.23	0.00	0.02	0.00	0.02	0.00	0.03	HO			
Killary Harbour	0.00	0.04	0.01	0.03	0.01	0.11	0.00	HO			
Clew Bay	0.17	0.62	0.74	0.01	0.09	0.11	0.58	0.31	0.22	0.00	0.11
Mulroy Bay	0.00	0.02	0.00	0.04	0.14	0.03	0.01	0.03	0.03	0.00	0.00
Lough Swilly		TI	0.00	0.00	0.08	0.05	0.13	0.21	0.03	0.28	4.75

Mean mobile *C. elongatus*

	Dec/Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*
Bantry Bay	13.65	0.57	0.68	2.14	3.60	1.84	7.27	HO			
Greatman's Bay	0.21	TO									
Kilkieran Bay	0.02	0.13	0.02	0.03	0.11	0.43	0.00	0.32	HO		
Mannin Bay	0.02	0.15	0.00	0.19	0.10	0.00	0.04	0.08	0.00	0.08	0.23
Ballinakill Bay	0.38	0.00	0.10	0.00	0.21	0.10	0.03	HO			
Killary Harbour	0.00	0.11	0.02	0.03	0.03	0.46	0.09	HO			
Clew Bay	0.37	0.93	1.20	0.04	0.22	0.18	1.41	0.52	0.32	0.00	0.23
Mulroy Bay	0.00	0.05	0.01	0.08	0.37	0.04	0.04	0.08	0.06	0.01	0.00
Lough Swilly		TI	0.03	0.02	0.12	0.09	0.27	0.38	0.07	0.38	7.25

HO = Harvested out
TI = Transferred in
TO = Transferred out

Mean mobile levels in excess of 10 *L. salmonis* per fish were recorded on 26 occasions and 12 of these had means of greater than 20 mobile lice per fish. Four of these were over 40 mobile sea lice per fish with 2 exceeding 100 mobile sea lice per fish, in Mannin Bay and Lough Swilly in November. The highest level recorded was 142.50 mobile sea lice per fish. This compares to a maximum of 85.93 mobile sea lice per fish in 2006.

Regional Monthly Means for one-sea-winter salmon

L. salmonis monthly mean figures for one-sea-winter salmon are shown in Figures 6 and 7 for each of the three regions. Regional monthly mean *L. salmonis* levels were in excess of treatment trigger levels in all 3 regions for all 3 spring months in 2007 with the exception of the Northwest in April. The Southwest exceeded treatment trigger levels again in July prior to harvest. In the West monthly mean ovigerous levels were in excess of treatment trigger levels outside of the spring period in February, June, August, September and November. In the Northwest monthly mean ovigerous levels exceeded the treatment trigger levels in February and again from August to November inclusive outside of the spring period.

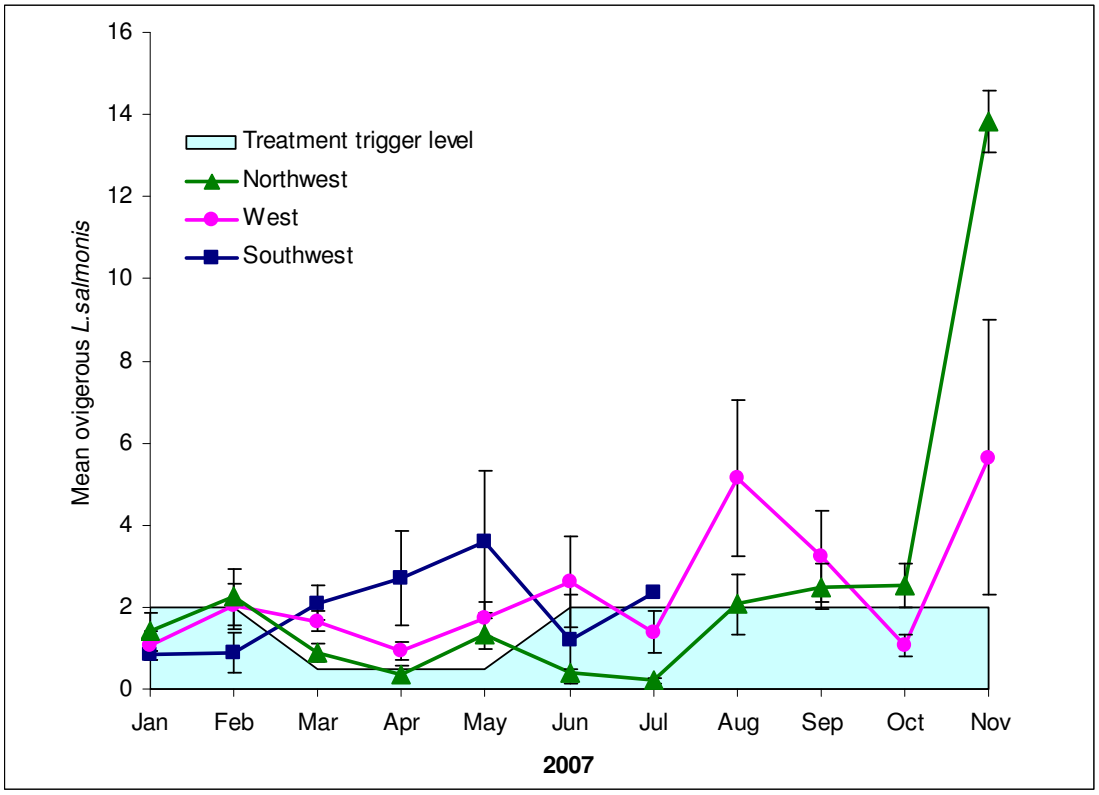


Figure 6. Mean (SE) ovigerous *L. salmonis* per month per region in 2007.

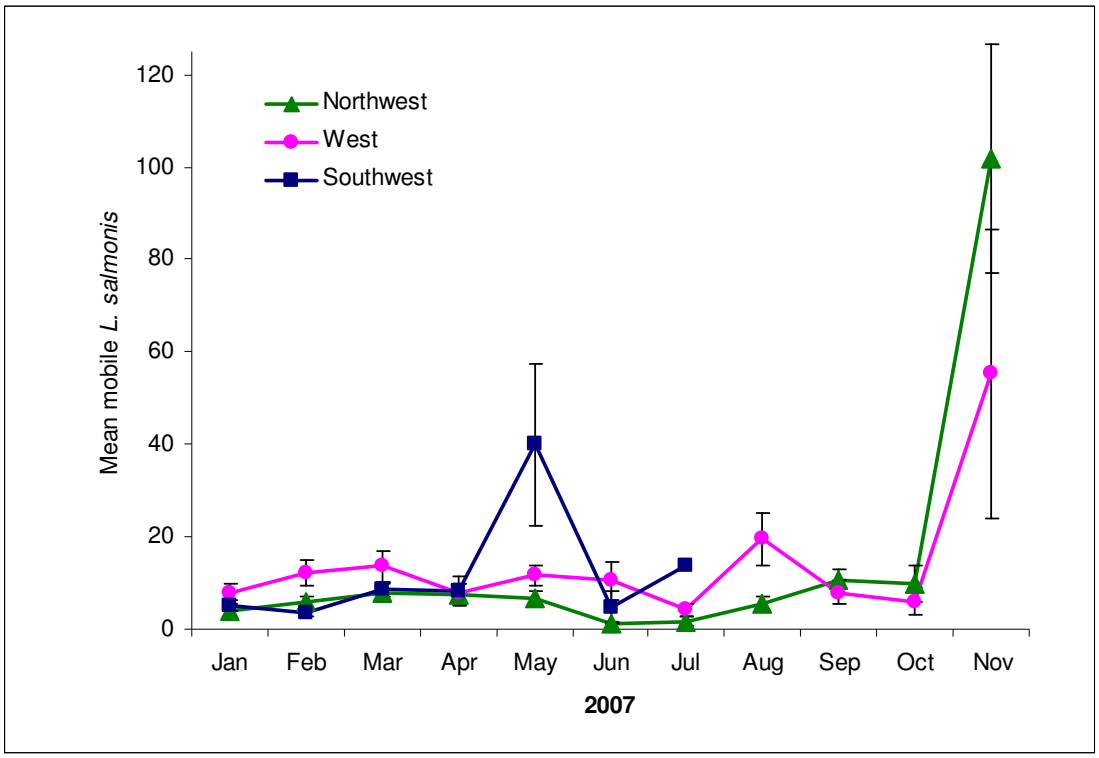


Figure 7. Mean (SE) mobile *L. salmonis* per month per region in 2007.

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

Annual trends

L. salmonis ovigerous and mobile level trends are compared in Figures 8 and 9 for one-sea-winter salmon in the month of May from 1991 to 2007. The mean number of ovigerous sea lice per fish and the mean number of mobile sea lice per fish are presented.

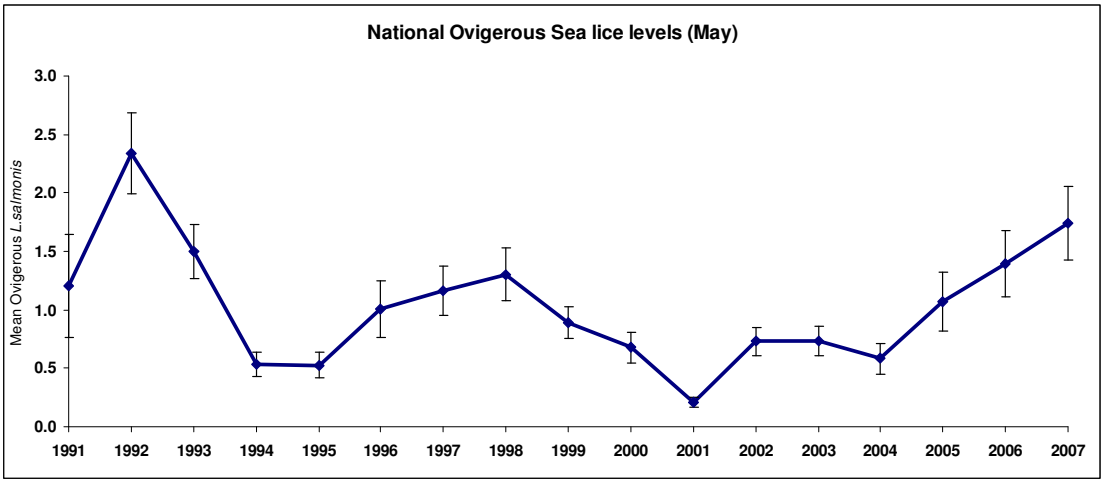


Figure 8. Annual trend (May mean) (SE) ovigerous *L. salmonis* on one-sea-winter salmon.

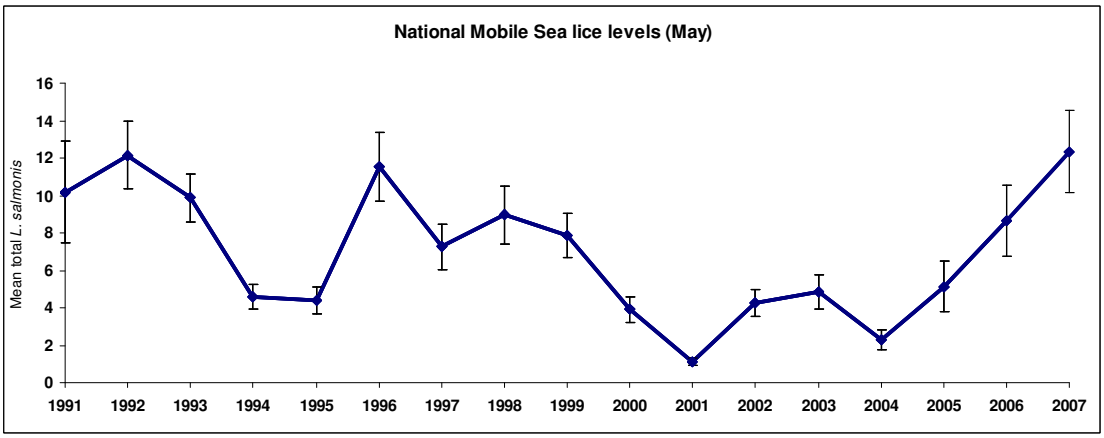


Figure 9. Annual trend (May mean) (SE) mobile *L. salmonis* on one-sea-winter salmon.

Sea lice levels were at their lowest on record in 2001 for both ovigerous and total mobile lice. Mean ovigerous *L. salmonis* levels have increased steadily since 2004. Levels in 2007 are at 1.74 ovigerous per fish, the highest since 1992 which reached 2.34 ovigerous per fish.

Mean mobile levels show a similar pattern with the lowest levels recorded in 2001. There has been an increase in mobile sea lice levels from 2004 to 2007, which are the highest on record at 12.35 mobile sea lice per fish.

DISCUSSION

In 2007, of the 355 sea lice inspections carried out on salmonids, 72% of Atlantic salmon samples and 96.3% of rainbow trout samples were below the treatment trigger levels outlined in DCMNR protocols. In the smolt stock, 97% of inspections did not exceed the treatment trigger levels, 51.9% of inspections on one-sea-winter salmon were below the treatment trigger levels and 44.4% of inspections on two-sea-winter salmon were below treatment trigger levels.

On one-sea-winter salmon sea lice levels exceeded treatment trigger levels for 70% of inspections in the Southwest, for 52.1% of inspections in the West and for 36.5% of inspections in the Northwest. During the spring period 100%, 66.7% and 37% of inspections exceeded the treatment trigger in the Southwest, West and Northwest respectively. The monthly trend of sea lice levels on one-sea-winter salmon show that in the Southwest, sea lice levels were in excess of treatment trigger levels for the whole spring period. Despite high mobile levels in May, control was achieved in June and levels rose again in July prior to harvest. Mean sea lice levels in the West region on one-sea-winter salmon were elevated for the spring period, again in June, August, September and also in November. In the Northwest, sea lice levels were elevated twice in spring, with control being achieved over the summer months. Levels steadily increased from July to October, with a large increase observed in the November inspection.

In 2007, regional mean sea lice levels on one-sea-winter salmon, for all regions, were in excess of treatment trigger levels for the entire spring period, barring the Northwest in April. Levels held steady for most of the year but reached regional peaks of 101.86 total mobile *L. salmonis* per fish in November in the Northwest and 55.24 total mobile *L. salmonis* per fish in the West.

Of the 9 inspections carried out on two-sea-winter fish, between Dec/Jan 07 and the last inspection in May, prior to completion of harvest, the maximum regional level reached was 87.16 mobile sea lice per fish in the West and 35.86 mobile sea lice per fish in the Northwest, compared to 12.74 mobile sea lice per fish and 62.04 mobile sea lice per fish respectively in 2006.

Out of a total of 355 inspections of all stocks, sea lice numbers greater than a mean of 10 *L. salmonis* per fish were recorded on 69 inspections in 2007 compared with 55 out of 317 inspections in 2006. Means greater than 20 *L. salmonis* per fish were recorded on 29 of these inspections, an increase from 26 in 2006 (O'Donohoe *et al*., 2006). Sea lice are

known to cause damage to fish at these levels (Wooten *et al*., 1982). The maximum level recorded for an individual site was 142.5 mobile *L. salmonis* per fish in 2007, compared to 85.93 in 2006.

Comparing the May mean annual trend *L. salmonis* graphs of one-sea-winter fish (figures 8 & 9) it shows that there was an increase in both the May mean ovigerous levels and May mean mobile levels nationally. The mean ovigerous level is the highest since 1992 and the mobile is the highest since inspections began.

It is noticeable in the trends that higher sea lice levels often occur prior to harvest. Factors contributing to this are that some or all cages on site are being left untreated in expectation of harvest. If harvest is delayed for any reason, such as market trends or weather events, then sea lice levels can rise very quickly in these cages. Not treating the entire site at the same time can result in a residual sea lice population, which can re-infest other cages and makes clearing sea lice populations problematic. Sea lice can also be subjected to sub-lethal doses of chemotherapeutants. Staggering the treatment of cages on a site can have the same effect and leads to the re-infestation of previously treated cages, from those yet untreated. Treating all sites in a bay synchronously is important to negate this effect and to help achieve near zero levels in the bay, as outlined in SBM principals.

Optimally using all available sites in an area to keep generations of fish separate is a key tool in breaking the life cycle of the sea lice and keeping infestations under control so as to avoid cross infection of younger fish from older stocks. Having sufficient and appropriate sites available to cater for separation of generations and fallowing is important and this has been raised as an issue by the industry frequently. Fallowing also serves to break the life cycle of the sea lice, as can be seen in Lough Swilly (Marine Harvest) this year where the site was fallow early in the spring, control of sea lice was achieved until the autumn (Appendix 1). However in certain cases re-infestation from the surrounding environment has occurred quite quickly. Inclusion of brood stock sites in bay management plans, specifically in fallowing and separation of generations, is vital in keeping potential reservoirs of sea lice to a minimum.

It is generally agreed that the most effective method of administering a bath treatment is the use of a well boat. In a well boat there is total control over water volume and concentration of chemotherapeutant. Due to the limited availability in Ireland, it may not always be possible to implement well boat treatments when required. Having an alternative sea lice treatment plan is critical as sea lice populations can increase and

become difficult to manage when sea temperatures allow. All discarded water from harvesting or treatment events should be disposed of properly to avoid returning the moribund sea lice to the sea to recover and re-infest fish, or for ovigerous females to release their eggs into the water column.

Complicating factors in controlling sea lice in 2007 were: disease; plankton blooms and ineffective treatments. PD was present on many sites in 2007, this causes difficulties when treating fish for sea lice. The reduced appetite renders in-feed treatments unsuitable and poor health adds complications to bath treatments. Plankton blooms damage fish and fish-gills and this renders bath treatments more difficult to carry out as the health of the fish is already compromised.

A variety of treatments were used throughout the country in 2007 with varying results. There were cases where treatment effort did not achieve full clearance of the sea lice and multiple treatments were required. Combinations of two treatments proved effective at some sites. Achieving near zero sea lice proved very difficult on occasions and this led to population recovery being more rapid and hence, the need for more frequent treatments. It is suspected that there may be reduced sensitivity in some sea lice populations to certain chemotherapeutants.

The industry has trialled other novel approaches to combat sea lice by incorporating alternative treatments, such as Bioemitters® and Bio-mos®, with varying results.

Warmer sea temperatures have been a complicating factor in the management of sea lice. Increases in water temperature leads to an acceleration in the life cycle of the sea louse and also an increase in reproductive output (Hogans and Trudeau, 1989). In the last number of years mean monthly sea temperatures have been steadily climbing with the average sea temperature in 2006 being 1.38°C higher than the 30 year mean (worked from source data from Met Éireann - www.met.ie).

GLOSSARY

Ovigerous lice:	An egg bearing adult female sea lice.
Mobile lice:	All lice that are mobile – male and female (pre-adult and adult stages) sea lice that have developed beyond the attached larval stages.
Standard (Std.) Cage:	The selected cage which is sampled at each inspection.
Random (Ran.) Cage:	A cage which is selected by the inspector on the day of inspection.
S1 Smolt:	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.
S1/2 Smolt:	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.
Grower:	A fish which has been at sea for one complete year or longer
Rainbow Trout (1), (2):	Trout can be stocked at any stage during the year. The number refers to the earliest stocked fish on site and so forth.
SE:	Standard error (error bars in the graphs)- the standard error of the mean of a sample from a population with a normal distribution is equal to the standard deviation of the normal distribution divided by the square root of the sample size.

REFERENCES

Berland, B. 1993. Salmon lice on wild salmon (*Salmo salar* L.) in western Norway. *In:* Boxshall, G. A. & Defaye, D. (eds), *Pathogens of wild and farmed fish: sea lice*, pp. 179-187. Ellis Horwood Ltd., West Sussex, United Kingdom.

Brandal, P. O., Egidius, E. & I. Romslo. 1976. Host blood: A major food component for the parasitic copepod *Lepeophtheirus salmonis* Kröyer, 1838 (Crustacea: Caligidae). *Norwegian Journal of Zoology,* **24:** 341-343.

Browne, R., Deegan, B., O'Carroll, T., Norman, M., & M. O'Cinneide. 2007.Status of Irish Aquaculture 2006. Marine Institute Report.

Copley, L., McCarney, P., Jackson, D., Hasset, D., Kennedy, S., & C. Nulty. 2001. The occurrence of Sea lice (*Lepeophtheirus salmonis* Krøyer) on Farmed Salmon in Ireland(1995 to 2000). *Marine Resource Series, No. 17. Marine Institute*.

Department of Communications, the Marine and Natural Resources. 2000. Monitoring Protocol No. 3: Offshore finfish farms — sea lice monitoring and control.

Finstad, B., Bjorn, P. A., Grimnes, A. & N.A. Hvidsten. 2000. Laboratory and field investigations of salmon lice [*Lepeophtheirus salmonis* (Krøyer)] infestation on Atlantic salmon (*Salmo salar* L.) post-smolts. *Aquaculture Research*, **31:** 795-803.

Hogans, W. E. & D. J. Trudeau. 1989. Preliminary studies on the biology of sea lice, *Caligus elongatus*, *Caligus curtus* and *Lepeophtheirus salmonis* (Copepoda: Caligoida) parasitic on cage-cultured salmonids in the Lower Bay of Fundy. *Canadian Technical Report of Fisheries and Aquatic Sciences*, **No. 1715:** 14 pp.

Jackson, D., Copley, L., Kane, F., Naughton, O., Kennedy, S., & P. O'Donohoe. 2005. Thirteen years of monitoring sea lice in farmed salmonids. *In 'Long-term monitoring; Why, What, Where, When & How?'* Edited by John Solbé*, Proceedings of 'The importance of long-term monitoring of the environment' conference. Sherkin Island Marine Station, Ireland.* pp 92-105.

Jackson, D. & D. Minchin. 1992. Aspects of the reproductive output of two caligid copepod species on cultivated salmon. *Invertebrate Reproductive Development*, **22:** 87-90.

Jones, M. W., Sommerville, C. & J. Bron. 1990. The histopathology associated with the juvenile stages of *Lepeophtheirus salmonis* on the Atlantic salmon, *Salmo salar* L. *Journal of Fish Diseases*, **13:** 303-310.

Jonsdottir, H., Bron, J. E., Wootten, R. & J. F. Turnbull. 1992. The histopathology associated with the pre-adult and adult stages of *Lepeophtheirus salmonis* on the Atlantic salmon, *Salmo salar* L. *Journal of Fish Diseases*, **15:** 521-527.

Kabata, Z. 1974. Mouth and mode of feeding of Caligidae (Copepoda), parasites of fishes, as determined by light and scanning electron microscopy. *Journal of the Fisheries Research Board of Canada*, **31 (10):** 1583-1588.

Kabata, Z. 1979. *Parasitic Copepoda of British Fishes*. The Ray Society, London.

MacKinnon, B. M. 1998. Host factors important in sea lice infections. *ICES Journal of Marine Science*, **55:** 188-192.

McCarney, P., Copley, L., Kennedy, S., Nulty, C. & D. Jackson. 2002. National Survey of Sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2001. *Fisheries Leaflet 181, Marine Institute*.

Nolan, D. T., Reilly, P. & S. E. Wendelaar Bonga. 1999. Infection with low numbers of the sea louse *Lepeophtheirus salmonis* (Krøyer) induces stress-related effects in post-smolt Atlantic salmon (*Salmo salar* L.). *Canadian Journal of Fisheries and Aquatic Science,* **56:** 947-959.

Nolan, D. T., Ruane, N. M., van der Heijden, Y., Quabius, E. S., Costelloe, J. & S. E. Wendelaar Bonga. 2000. Juvenile *Lepeophtheirus salmonis* (Krøyer) affect the skin and gills of rainbow trout *Oncorhynchus mykiss* (Walbaum) and the host response to a handling procedure. *Aquaculture Research*, **31:** 823-833.

O'Donohoe, P., Kennedy, S., Kane, F., Naughton, O., Nixon, P., Power, A. & D. Jackson. 2007. National Survey of Sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2006. *Irish Fisheries Bulletin No 28, Marine Institute*.

O'Donohoe, P., Kennedy, S., Kane, F., Naughton, O., Nixon, P., Power, A. & D. Jackson. 2006. National Survey of Sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2005. *Irish Fisheries Bulletin No 24, Marine Institute*.

O'Donohoe, P., Kennedy, S., Kane, F., Naughton, O., Tierney, D. & D. Jackson. 2005. National Survey of Sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2004. *Irish Fisheries Bulletin No 22, Marine Institute*.

O'Donohoe, P., Kennedy, S., Kane, F., Naughton, O., Tierney, D., Copley, L. & D. Jackson. 2004. National Survey of Sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2003. *Fisheries Leaflet 184, Marine Institute*.

O'Donohoe, P., Kennedy, S., Copley, L., Kane, F., Naughton, O. & D. Jackson. 2003. National Survey of Sea lice (*Lepeophtheirus salmonis* Krøyer and *Caligus elongatus* Nordmann) on Fish Farms in Ireland - 2002. *Fisheries Leaflet 183, Marine Institute*.

Pike, A. W. 1989. Sea lice - major pathogens of farmed Atlantic salmon. *Parasitology Today*, **5:** 291-297.

Schram, T. A. 1993. Supplementary descriptions of the developmental stages of *Lepeophtheirus salmonis* (Krøyer, 1837) (Copepoda: Caligidae). *In:* Boxshall, G. A. & Defaye, D. (eds), *Pathogens of wild and farmed fish: sea lice*, pp. 30-47. Ellis Horwood Ltd., West Sussex, United Kingdom.

Wooten, R., Smith, J. W. & E. A. Needham. 1982. Aspects of the biology of the parasitic copepods *Lepeophtheirus salmonis* and *Caligus elongatus* on farmed salmonids, and their treatment. *Proceedings of the Royal Society of Edinburgh,* **81B**: 185-197.

APPENDIX 1. Mean sea lice levels on salmonid farms in 2007.

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
BANTRY BAY					
SILVER KING SEAFOODS LTD					
Roancarraig					
Atlantic salmon, 2006 S1/2	25/01/07	0.82	5.20	7.55	13.65
	14/02/07	0.87	3.70	0.23	0.57
	07/03/07	2.78	11.83	0.72	1.27
	21/03/07	1.96	6.66	0.32	0.42
	04/04/07	0.10	0.33	0.05	0.10
	17/04/07	0.06	3.44	0.17	1.56
	02/05/07	0.10	41.20	2.80	6.40
	16/05/07	6.62	86.23	4.08	7.15
	20/06/07	2.30	8.35	1.10	3.15
		Harvested out			
Atlantic salmon, 2006	25/01/07	Sampled Atlantic Salmon 06 S1/2			
	14/02/07	Sampled Atlantic Salmon 06 S1/2			
	07/03/07	1.33	6.50	0.08	0.33
	21/03/07	Sampled Atlantic Salmon 06 S1/2			
	04/04/07	4.74	11.64	1.39	3.35
	17/04/07	3.83	14.22	0.44	2.33
	02/05/07	1.18	2.47	0.00	0.00
	16/05/07	6.45	29.90	0.41	0.83
	20/06/07	0.13	1.10	0.33	0.53
	11/07/07	2.33	13.93	1.40	7.27
		Harvested out			
Atlantic salmon, 2007	14/02/07	0.00	0.21	0.07	0.21
	March (1)	Not sampled due to technical difficulties			
	21/03/07	0.00	0.68	0.21	0.71
	04/04/07	0.00	1.68	0.21	1.82
	17/04/07	0.00	2.21	0.64	1.54
	02/05/07	0.00	0.35	0.00	0.00
	16/05/07	0.00	0.10	0.00	0.03
	20/06/07	0.00	0.07	0.11	0.39
	11/07/07	0.17	1.57	0.53	1.37
	16/08/07	0.97	6.87	2.30	3.27
	September	Not sampled due to technical difficulties			
	04/10/07	0.40	0.80	0.00	0.00
	06/11/07	0.00	0.00	0.03	0.07

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
JOHN POWER LTD					
Waterfall					
Rainbow trout 2006 (1)	25/01/07	0.31	1.60	3.30	4.67
	14/02/07	0.08	0.88	0.21	0.38
	07/03/07	0.00	0.02	0.00	0.00
	21/03/07	0.00	0.02	0.03	0.04
	04/04/07	0.00	0.04	0.04	0.04
	17/04/07	0.00	0.02	0.00	0.05
	02/05/07	0.00	1.23	0.02	0.05
	16/05/07	0.16	8.19	0.04	0.21
	20/06/07	2.23	5.55	0.02	0.72
	11/07/07	0.83	1.88	0.13	0.27
		Harvested out			
Rainbow trout 2007 (1)	06/11/07	0.05	0.30	0.35	0.40
GREATMAN'S BAY					
MUIRACHMHAINNI TEO					
Cuigeal					
Atlantic salmon, 2006	06/12/06	0.10	10.07	0.10	0.21
		Fish transferred to Casheen			
Atlantic salmon, 2007 S 1/2	16/05/07	0.06	0.90	0.04	0.05
	07/06/07	0.03	1.18	0.26	0.28
	03/07/07	0.04	1.07	0.09	0.24
	14/08/07	0.46	1.64	0.04	0.09
		Fish transferred to Daonish			
KILKIERAN BAY					
MUIRACHMHAINNI TEO					
Casheen					
Atlantic salmon, 2006	20/02/07	0.29	4.33	0.00	0.17
	08/03/07	0.83	4.83	0.03	0.03
	30/03/07	0.78	61.30	0.00	0.04
	03/04/07	0.00	6.94	0.00	0.00
	17/04/07	0.38	19.48	0.00	0.00
	04/05/07	3.25	47.36	0.11	0.14
		Fish transferred to Daonish			

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
Daonish					
Atlantic salmon, 2006 S 1/2	06/12/06	0.22	1.07	0.03	0.05
	20/02/07	0.30	2.20	0.01	0.04
	08/03/07	0.27	8.55	0.00	0.05
	30/03/07	0.37	4.12	0.00	0.00
	03/04/07	0.49	2.99	0.00	0.02
	17/04/07	0.56	7.82	0.00	0.02
	04/05/07	1.33	32.93	0.32	0.60
	22/05/07	2.15	4.73	0.00	0.00
	11/06/07	0.36	1.11	0.00	0.00
		Harvested out			
Atlantic salmon, 2006	22/05/07	3.66	7.86	0.07	0.07
	11/06/07	1.00	13.13	0.00	0.10
		Harvested out			
Atlantic salmon, 2007 S 1/2	21/09/07	0.75	2.04	0.09	0.24
	24/10/07	0.84	2.98	0.00	0.00
	06/11/07	1.22	12.17	0.00	0.00
Golam					
Atlantic salmon, 2007 S 1/2	14/12/06	0.21	3.92	0.05	0.08
	06/02/07	0.00	0.60	0.03	0.03
	08/03/07	0.03	3.58	0.02	0.02
	22/03/07	0.00	3.12	0.04	0.06
	06/04/07	0.00	1.16	0.05	0.11
	17/04/07	0.00	0.82	0.02	0.08
	02/05/07	0.07	3.94	0.31	0.43
		Fish transferred to Cuigeal & Red Flag			
Atlantic salmon, 2008 S 1/2	22/11/07	0.00	2.91	0.00	0.02
Red Flag					
Atlantic salmon, 2007 S 1/2	16/05/07	0.06	1.04	0.23	0.27
	07/06/07	0.37	6.94	0.71	1.08
	03/07/07	0.45	1.83	0.00	0.06
	14/08/07	0.61	3.19	0.00	0.00
	21/09/07	2.40	9.89	0.00	0.00
		Fish transferred to Daonish			

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
MUIR GHEAL TEO					
Cnoc					
Atlantic salmon, 2006 S 1/2	05/12/06	0.26	4.27	0.00	0.00
	06/02/07	5.77	27.40	0.17	0.40
	07/03/07	1.78	4.23	0.04	0.04
	30/03/07	2.05	41.49	0.00	0.02
	12/04/07	0.29	2.29	0.00	0.02
	24/04/07	1.20	13.80	0.00	0.03
	22/05/07	4.61	10.99	0.00	0.00
	31/05/07	4.70	10.01	0.00	0.00
	20/06/07	9.04	40.10	0.06	0.26
		Harvested out			
Atlantic salmon, 2007 S 1/2	27/11/07	1.04	7.21	0.00	0.02
Lettercallow					
Atlantic salmon, 2007 S 1/2	05/12/06	0.00	0.50	0.00	0.00
	06/02/07	0.00	0.20	0.00	0.00
	07/03/07	0.00	3.38	0.00	0.02
	30/03/07	0.00	1.23	0.00	0.00
	12/04/07	0.00	0.00	0.00	0.00
	24/04/07	0.00	0.27	0.00	0.00
	14/05/07	0.05	1.45	0.03	0.05
	29/05/07	0.03	0.99	0.00	0.00
		Fish transferred to Oilean Iarthach & Birbeag			
Atlantic salmon, 2008 S 1/2	27/11/07	0.02	0.58	0.00	0.00
Oilean Iarthach					
Atlantic salmon, 2007 S 1/2	14/05/07	0.12	8.83	0.02	0.37
	29/05/07	0.37	6.56	0.00	0.02
	13/06/07	1.12	8.12	0.03	0.03
	18/07/07	0.11	0.64	0.02	0.02
	17/08/07	0.97	2.68	0.00	0.04
	07/09/07	0.52	5.90	0.00	0.02
	02/10/07	0.99	2.78	0.00	0.00
		Fish transferred to Cnoc			
Birbeag					
Atlantic salmon, 2007 S 1/2	29/05/07	0.07	1.44	0.00	0.02
	13/06/07	0.56	10.60	0.08	0.22
	18/07/07	1.70	5.80	0.00	0.00
	17/08/07	1.67	12.35	0.07	0.22
	07/09/07	0.73	3.62	0.00	0.00
	02/10/07	1.17	7.05	0.11	0.28
		Fish transferred to Cnoc & Ardmore			

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
Ardmore					
Atlantic salmon, 2007 S 1/2	23/11/07	1.54	13.89	0.00	0.00
EISC UI FLATHARTHA TEO					
Ardmore					
Atlantic salmon, 2006	05/12/06	1.87	14.83	0.00	0.00
	20/02/07	2.20	9.95	0.00	0.04
	02/03/07	1.93	5.62	0.00	0.00
	13/03/07	2.33	7.84	0.00	0.03
	11/04/07	2.28	19.35	0.02	0.10
	27/04/07	2.56	10.55	0.00	0.00
	08/05/07	0.74	3.15	0.00	0.03
	29/05/07	0.84	6.05	0.00	0.00
	28/06/07	6.73	25.16	0.56	0.99
	31/07/07	5.00	10.37	0.00	0.00
	21/08/07	15.79	46.11	0.16	0.32
		Harvested out			
MANNIN BAY					
MANNIN BAY SALMON CO LTD					
Corhounagh					
Atlantic salmon, 2005	19/12/06	24.04	87.16	2.24	3.48
		Harvested Out			
Atlantic salmon, 2006	13/04/07	0.59	4.37	0.00	0.00
	25/04/07	4.10	23.77	0.16	0.39
	17/05/07	0.65	30.00	0.05	0.19
	28/05/07	1.39	5.36	0.02	0.02
	15/06/07	0.40	0.55	0.00	0.00
	18/07/07	2.60	5.32	0.02	0.04
	16/08/07	5.78	23.75	0.04	0.08
	28/09/07	6.07	14.52	0.00	0.00
	22/10/07	1.63	12.78	0.00	0.08
	16/11/07	12.31	125.01	0.11	0.23
Hawk's Nest					
Atlantic salmon, 2006	05/12/06	1.64	9.06	0.00	0.02
	07/02/07	5.35	34.44	0.12	0.15
	02/03/07	1.01	2.86	0.00	0.00
	21/03/07	1.85	16.37	0.00	0.00
		Fish transferred to Corhounagh			
Atlantic salmon, 2007	10/05/07	0.00	0.06	0.00	0.00
	28/05/07	0.00	0.02	0.00	0.00
	15/06/07	0.02	0.33	0.00	0.02

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
	18/07/07	0.02	0.61	0.07	0.07
	23/08/07	1.60	5.96	0.18	0.28
	28/09/07	6.02	19.23	0.00	0.00
	22/10/07	3.06	9.63	0.03	0.05
	16/11/07	0.59	12.67	0.00	0.00
Ardbear					
Atlantic salmon, 2007 S 1/2	05/12/06	0.00	7.53	0.00	0.00
	02/02/07	0.02	5.55	0.00	0.00
	02/03/07	0.49	11.52	0.00	0.00
	21/03/07	0.00	0.05	0.00	0.00
	13/04/07	0.00	5.80	0.00	0.00
	25/04/07	0.00	0.18	0.00	0.00
	10/05/07	0.00	0.58	0.00	0.00
	28/05/07	0.04	0.59	0.00	0.02
	15/06/07	0.02	0.25	0.00	0.02
		Fish transferred to Fraochoilean			

BALLINAKILL BAY

BIFAND LTD

Fraochoilean

Atlantic salmon, 2006 S 1/2	19/12/06	3.67	20.71	0.23	0.38
	07/02/07	2.42	7.66	0.00	0.00
	09/03/07	3.45	50.26	0.02	0.17
	27/03/07	1.11	3.33	0.02	0.03
	10/04/07	1.68	25.58	0.00	0.00
	26/04/07	0.52	2.05	0.00	0.00
	08/05/07	0.92	19.22	0.02	0.09
	22/05/07	12.07	31.67	0.02	0.47
	14/06/07	1.97	6.27	0.00	0.10
	26/07/07	0.87	11.00	0.03	0.03
		Harvested out			
Atlantic salmon, 2007 S 1/2	19/07/07	0.13	5.45	0.40	1.08
	23/08/07	0.58	5.45	0.02	0.07
	25/09/07	0.06	0.49	0.00	0.00
	22/10/07	0.38	3.75	0.00	0.00
	21/11/07	1.14	3.77	0.03	0.06
Atlantic salmon, 2008 S 1/2	21/11/07	0.00	0.93	0.00	0.00

		Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
			F + eggs	Total	F + eggs	Total
KILLARY HARBOUR						
CELTIC ATLANTIC SALMON (KILLARY) LTD						
Rosroe						
	Atlantic salmon, 2006	08/01/07	0.02	0.22	0.00	0.00
		05/02/07	0.09	10.44	0.04	0.11
		12/03/07	4.57	7.29	0.00	0.00
		30/03/07	0.19	0.62	0.02	0.03
		13/04/07	1.12	5.22	0.06	0.06
		30/04/07	0.02	0.33	0.00	0.00
		10/05/07	0.19	0.82	0.02	0.05
		25/05/07	0.02	0.55	0.00	0.00
		22/06/07	0.07	0.72	0.11	0.46
		24/07/07	0.24	1.96	0.00	0.09
			Harvested out			
	Atlantic salmon, 2007	10/05/07	0.00	1.34	0.00	0.00
		25/05/07	0.00	0.24	0.00	0.00
		22/06/07	0.00	0.00	0.00	0.00
		24/07/07	0.00	0.50	0.00	0.00
		24/08/07	0.19	2.45	0.00	0.03
		21/09/07	0.65	1.88	0.00	0.00
		26/10/07	0.97	6.28	0.00	0.00
		29/11/07	0.63	2.22	0.00	0.00
Inishdeighil						
	Atlantic salmon, 2007	10/05/07	0.00	0.08	0.00	0.00
		25/05/07	0.00	0.12	0.00	0.00
		22/06/07	0.00	0.05	0.00	0.00
		24/07/07	0.00	0.69	0.00	0.00
		24/08/07	0.10	0.90	0.00	0.00
		21/09/07	0.13	1.09	0.00	0.00
		26/10/07	0.14	0.69	0.02	0.04
		29/11/07	0.06	1.84	0.02	0.02
CLEW BAY						
CLARE ISLAND SEAFARMS LTD						
Seastream Inner						
	Atlantic salmon, 2005	16/01/07	0.64	1.06	0.00	0.00
		12/02/07	0.94	12.07	0.98	2.02
		01/03/07	0.10	1.59	0.03	0.62
		22/03/07	0.21	17.31	0.83	2.03
			Harvested out			

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
Atlantic salmon, 2006	05/04/07	0.21	0.41	0.00	0.00
	19/04/07	0.15	1.30	0.00	0.00
	03/05/07	0.00	0.02	0.02	0.02
	15/05/07	0.07	0.67	0.00	0.00
	06/06/07	0.35	0.60	0.07	0.10
	10/07/07	0.22	0.95	0.14	0.18
	13/08/07	2.98	19.64	0.60	0.99
	12/09/07	0.11	0.47	0.07	0.10
	24/10/07	0.23	0.43	0.00	0.00
	15/11/07	0.30	5.27	0.27	0.60
Portlea					
Atlantic salmon, 2006	16/01/07	0.32	2.72	0.17	0.37
	12/02/07	0.73	6.32	0.62	0.93
	01/03/07	1.30	6.93	0.44	0.81
	22/03/07	1.84	8.14	1.04	1.59
	05/04/07	0.05	0.25	0.00	0.00
	19/04/07	0.00	3.28	0.04	0.10
	04/05/07	0.14	18.05	0.32	0.80
	15/05/07	1.22	2.85	0.04	0.07
	06/06/07	1.45	1.69	0.16	0.27
	10/07/07	0.96	1.80	1.03	2.65
	13/08/07	1.29	1.96	0.03	0.05
	13/09/07	3.53	9.00	0.37	0.54
	24/10/07	0.95	1.87	0.00	0.00
	15/11/07	1.64	10.47	0.04	0.05
Clare Island smolt site					
Atlantic salmon, 2007	05/04/07	0.00	0.50	0.00	0.00
	19/04/07	0.00	1.69	0.00	0.12
	04/05/07	0.02	2.44	0.02	0.07
	15/05/07	0.06	1.17	0.00	0.00
	06/06/07	0.00	0.13	0.00	0.03
	10/07/07	0.00	0.55	0.03	0.10
	13/08/07	0.57	2.66	0.70	1.04
	13/09/07	0.32	1.70	0.17	0.35
	24/10/07	0.05	11.07	0.05	0.10
	15/11/07	1.50	5.66	0.00	0.00

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
BEALACRAGHER BAY					
CURRAUN FISHERIES LTD					
Curraun					
Rainbow trout 2006 (1)		Harvested out			
Rainbow trout 2006 (2)	17/01/07	0.33	2.13	0.00	0.00
	13/02/07	0.13	0.53	0.00	0.00
	01/03/07	0.00	0.17	0.00	0.00
	22/03/07	0.00	0.07	0.00	0.00
	04/04/07	0.03	0.03	0.00	0.00
	20/04/07	0.00	0.17	0.00	0.00
	03/05/07	0.22	0.50	0.00	0.00
	16/05/07	0.34	1.66	0.00	0.03
	07/06/07	1.00	4.60	0.03	0.07
	11/07/07	1.43	4.17	0.00	0.00
	14/08/07	0.09	1.50	0.00	0.00
		Harvested out			
Rainbow trout 2007 (1)	17/01/07	0.00	1.33	0.00	0.00
	13/02/07	0.00	0.03	0.00	0.00
	01/03/07	0.00	0.03	0.00	0.00
	22/03/07	0.00	0.00	0.00	0.00
	04/04/07	0.00	0.00	0.00	0.00
	20/04/07	0.00	0.21	0.00	0.00
	03/05/07	0.00	0.12	0.00	0.00
	16/05/07	0.06	0.22	0.00	0.00
	07/06/07	0.25	3.19	0.00	0.00
	11/07/07	0.26	1.67	0.00	0.00
	14/08/07	0.13	0.83	0.00	0.00
	12/09/07	0.47	2.00	0.00	0.00
	25/10/07	3.41	10.93	0.00	0.00
		Harvested out			
Rainbow trout 2007 (2)	20/04/07	0.00	0.17	0.00	0.00
	03/05/07	0.00	0.03	0.00	0.00
	16/05/07	0.00	0.10	0.00	0.00
	07/06/07	0.00	0.40	0.00	0.00
	11/07/07	0.00	0.12	0.00	0.00
	14/08/07	0.02	0.21	0.00	0.00
	12/09/07	0.23	1.54	0.03	0.03
	25/10/07	1.73	4.97	0.00	0.00
	15/11/07	0.96	4.46	0.00	0.00
Rainbow trout 2007 (3)	15/11/07	0.08	4.36	0.00	0.00

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
DONEGAL BAY					
EANY FISH PRODUCTS LTD					
Inver Bay					
Rainbow trout 2006 (2)	23/01/07	0.15	0.55	0.02	0.02
	13/02/07	0.04	0.19	0.04	0.04
	01/03/07	0.07	0.27	0.00	0.03
	26/03/07	0.03	0.25	0.00	0.06
		Harvested out			
Rainbow trout 2007 (1)	23/01/07	0.00	0.21	0.00	0.00
	13/02/07	0.00	0.02	0.00	0.00
	01/03/07	0.02	0.03	0.00	0.00
	26/03/07	0.00	0.02	0.03	0.07
	10/04/07	0.00	0.00	0.00	0.00
	24/04/07	0.00	0.00	0.00	0.00
	09/05/07	0.00	0.04	0.00	0.00
	23/05/07	0.00	0.00	0.00	0.00
	22/06/07	0.00	0.00	0.05	0.08
	24/07/07	0.00	0.00	0.02	0.02
	09/08/07	0.07	0.58	0.30	0.60
	26/09/07	0.17	1.37	0.03	0.03
	09/10/07	0.73	3.13	0.03	0.20
	14/11/07	1.19	12.19	0.13	0.13
Rainbow trout 2007 (2)	22/06/07	0.00	0.02	0.13	0.15
	24/07/07	0.00	0.00	0.02	0.05
	09/08/07	0.00	0.05	0.43	0.60
	26/09/07	0.03	1.19	0.07	0.08
	09/10/07	0.22	1.23	0.03	0.03
	14/11/07	1.27	13.67	0.17	0.17
Rainbow trout 2007 (3)	14/11/07	0.06	1.61	0.00	0.00
MARINE HARVEST					
McSwyne's Bay					
Atlantic salmon, 2007	26/03/07	0.00	0.00	0.00	0.00
	10/04/07	0.00	0.00	0.00	0.00
	24/04/07	0.00	0.00	0.00	0.02
	09/05/07	0.00	0.00	0.00	0.00
	23/05/07	0.00	0.00	0.00	0.00
	22/06/07	0.00	0.00	0.04	0.10
	24/07/07	0.00	0.00	0.17	0.17
	09/08/07	0.00	0.00	0.16	0.22
	26/09/07	0.00	0.21	0.04	0.09
	09/10/07	0.02	0.04	0.02	0.10
	14/11/07	0.02	0.30	0.15	0.26

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
MULROY BAY					
MARINE HARVEST					
Milford					
Atlantic salmon, 2006	06/12/06	0.28	0.54	0.00	0.00
	13/02/07	0.38	1.20	0.00	0.00
	08/03/07	0.54	3.75	0.00	0.00
	21/03/07	0.49	1.55	0.00	0.00
	12/04/07	0.07	1.43	0.00	0.00
		Fish transferred to Millstone			
Cranford A					
Atlantic salmon, 2006 S 1/2	06/12/06	2.68	8.47	0.00	0.00
	13/02/07	5.18	11.39	0.02	0.04
	07/03/07	2.46	11.21	0.00	0.00
	21/03/07	2.57	13.23	0.03	0.05
	11/04/07	2.45	25.63	0.02	0.04
	24/04/07	0.39	4.94	0.07	0.08
	09/05/07	0.50	5.43	0.05	0.14
	24/05/07	0.12	0.68	0.00	0.02
		Harvested out			
Atlantic salmon, 2007 S 1/2	06/12/06	0.04	2.65	0.00	0.02
	13/02/07	0.03	1.43	0.00	0.00
	07/03/07	0.00	3.97	0.00	0.00
	21/03/07	0.00	0.81	0.00	0.02
	11/04/07	0.02	2.71	0.00	0.02
	24/04/07	0.07	9.21	0.02	0.07
	09/05/07	0.00	0.28	0.03	0.03
	24/05/07	0.00	0.28	0.11	0.18
	20/06/07	0.19	2.19	0.09	0.09
		Fish transferred to Millstone			
Moross I					
Atlantic salmon, 2007	23/05/07	0.00	0.10	0.00	0.00
	19/06/07	0.00	0.82	0.00	0.00
	10/07/07	0.00	0.09	0.00	0.00
	08/08/07	0.08	0.60	0.00	0.02
	06/09/07	1.53	13.83	0.04	0.08
	02/10/07	0.02	1.46	0.03	0.05
	20/11/07	0.91	5.62	0.00	0.00

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
Millstone					
Atlantic salmon, 2005		Fish transferred from broodstock site			
	24/04/07	1.22	32.19	0.00	0.15
	09/05/07	2.62	13.77	0.04	0.19
	23/05/07	2.70	14.97	0.30	0.93
		Harvested out			
Atlantic salmon, 2006 S 1/2	06/12/06	2.22	5.07	0.00	0.00
	12/02/07	1.67	5.16	0.02	0.05
	08/03/07	1.50	27.32	0.00	0.02
	22/03/07	0.03	2.00	0.00	0.00
	11/04/07	0.13	1.97	0.00	0.03
	24/04/07	0.33	30.67	0.13	0.20
	09/05/07	4.67	16.78	0.15	0.26
	23/05/07	3.96	19.32	0.25	0.86
	19/06/07	0.69	1.48	0.00	0.03
		Harvested out			
Atlantic salmon, 2006	22/03/07	0.07	1.23	0.00	0.00
	11/04/07	0.03	1.47	0.00	0.00
	24/04/07	0.10	12.30	0.03	0.20
	09/05/07	2.65	11.31	0.15	0.27
	23/05/07	2.30	12.33	0.20	0.50
	19/06/07	0.00	0.92	0.11	0.14
	10/07/07	0.08	0.30	0.02	0.04
	08/08/07	0.69	5.51	0.05	0.16
	06/09/07	4.27	10.36	0.02	0.07
	02/10/07	1.49	2.40	0.00	0.02
	20/11/07	13.24	61.22	0.00	0.00
Atlantic salmon, 2007 S 1/2	10/07/07	0.04	0.42	0.05	0.07
	08/08/07	0.32	3.16	0.00	0.02
	06/09/07	0.79	2.28	0.07	0.09
	02/10/07	0.47	1.41	0.10	0.12
	20/11/07	6.48	27.75	0.00	0.03

	Date	*Lepeophtheirus salmonis*		*Caligus elongatus*	
		F + eggs	Total	F + eggs	Total
Glinsk					
Atlantic salmon, 2006	06/12/06	0.42	0.99	0.00	0.00
	12/02/07	1.75	5.59	0.03	0.10
	07/03/07	0.92	13.46	0.00	0.00
	22/03/07	0.02	1.44	0.00	0.03
	11/04/07	0.02	1.55	0.02	0.02
	24/04/07	0.15	8.82	0.08	0.18
	09/05/07	1.62	8.92	0.05	0.12
	23/05/07	1.15	7.24	0.39	0.99
	19/06/07	0.37	0.69	0.00	0.00
	11/07/07	0.20	0.33	0.00	0.04
	08/08/07	0.67	2.30	0.00	0.00
	06/09/07	1.77	3.95	0.03	0.05
	02/10/07	3.24	6.49	0.00	0.00
		Harvested out			
LOUGH SWILLY					
MARINE HARVEST					
Atlantic salmon, 2005	06/12/06	35.86	77.64	0.00	0.00
		Harvested out			
Atlantic salmon, 2006 S1/2	19/06/07	0.33	2.00	0.07	0.07
	10/07/07	0.12	3.74	0.06	0.24
	08/08/07	5.52	13.00	0.28	0.64
	06/09/07	1.00	12.67	0.00	0.00
		Harvested out			
Atlantic salmon, 2006	07/03/07	0.03	1.29	0.00	0.01
	21/03/07	0.12	3.15	0.00	0.00
	12/04/07	0.00	0.20	0.00	0.00
	24/04/07	0.00	1.25	0.00	0.05
	10/05/07	0.40	1.30	0.02	0.02
	23/05/07	0.21	1.22	0.15	0.215
	19/06/07	0.57	1.80	0.03	0.10
	10/07/07	0.53	5.33	0.20	0.30
	08/08/07	3.14	5.42	0.18	0.25
	06/09/07	2.23	16.89	0.05	0.11
	02/10/07	2.87	20.62	0.28	0.38
	28/11/07	14.40	142.50	4.75	7.25

www.marine.ie

ISSN 1649-5055

www.marine.ie

HEADQUARTERS & LABORATORIES

MARINE INSTITUTE
Rinville
Oranmore
Co. Galway
Tel: +353 91 387 200
Fax: +353 91 387 201
Email: Institute.mail@marine.ie

MARINE INSTITUTE REGIONAL OFFICES

MARINE INSTITUTE
80 Harcourt Street
Dublin 2
Tel: +353 1 4766500
Fax: +353 1 4784988

MARINE INSTITUTE
Furnace
Newport
Co. Mayo
Tel: +353 98 42300
Fax: +353 98 42340