THE DEPARTMENT OF
AGRICULTURE, FISHERIES & FOOD
AN ROINN TALMHAÍOCHTA, IASCAIGH & BIA

A strategy for improved pest control on Irish salmon farms

May 2008

Executive Summary

Marine finfish production in Ireland grew steadily throughout the 1990s; production in 2001 reached a high point of 24,000 tonnes but declined to 13,318 tonnes by 2006, due in some part to a lack of profitability and consequent liquidity in the sector. 2007 saw a small increase in production levels to 13,800 tonnes. The Minimum Import Price (MIP), a trade correction measure introduced by the European Union in 2005, has stabilised farmed salmon prices in a market which was being distorted by below-cost-selling in the European market. The MIP has provided the Irish industry with an opportunity to trade its way back to prosperity and to a position where it can once again increase output. The Irish industry acts as an important socio-economic driver in a number of rural and coastal communities by providing a source of local employment both full time and seasonal.

Farmed salmon is now the most commonly eaten fish in Europe, because of its year round availability and its versatility from a culinary perspective.

The ecto-parasitic sea louse, a tiny crustacean, is an economically significant pest of the farmed salmon industry worldwide. It is important, both from a farm management point of view and in the context of possible negative interactions with wild migratory salmonid populations, that this pest be tightly controlled. Accordingly, a mandatory national sea lice monitoring and control regime regime which features so-called ‘treatment-trigger-levels’ has been put in place, which aims to keep the level of infestation on marine salmon farms as low as possible. Achieving the desired level of control of this parasite has proved to be a challenging proposition in some areas in recent years

The pest has shown itself to be very resilient and it has the ability to rapidly develop resistance to the limited range of veterinary medicines that are available to treat it. Levels of infestation were successfully controlled, by and large, through the 1990s, but since 2002/2003 it has been more difficult for the salmon farmers, despite their best efforts, to achieve the very low levels of infestation required by the national control programme. The causes of this

difficulty are multifactorial and include: a succession of warm winter sea temperatures, resistance by the pest to the veterinary medicines, limited access to 'fallowing sites' for temporal and spatial separation of stocks and other complicating fish health problems.

The control of sea lice has been afforded a high priority by the State since 1991 and Irish salmon farms are the subject of a rigorous and transparent inspection regime carried out by the Marine Institute on behalf of the Government. This monitoring programme is backed up by mandatory licensing requirements imposed on fin-fish farmers through a protocol on management and control.

A Sea Lice Monitoring and Control Working Group was established by the then Department of Communications, Marine and Natural Resources in 2005, comprised of representatives of the Department, the Fisheries Boards, Marine Institute and an Bord Iascaigh Mhara to examine/review the systems and processes for controlling sea lice levels at marine finfish farms. The Group's deliberations were wholly inconclusive and it was unable to reach any consensus on the way forward at the time of the transfer of aquaculture licensing functions to the Department of Agriculture, Fisheries and Food. Since the establishment of the new Department of Fisheries, Agriculture and Food (DAFF) the Department and the Marine Institute have continued to work on the issue of enhanced sea lice control.

The following report outlines a comprehensive range of measures to provide for enhanced sea lice control.

The report makes the following recommendations:

1. *A joint DAFF/industry working group to be established to identify "break out" site options in areas which have persistent sea lice problems. These options would include the possibility of using redundant sites, to optimise fallowing and separation of generations.*

2. *Effective and appropriate use of chemical intervention to be reviewed to take ongoing account of changing environmental conditions, developing farming practices, sensitivity of lice to treatments and fish health issues.*

3. *The increased availability of well boat capacity coming on stream in the industry to be utilised for controlled bath treatments.*

4. *The optimisation of product rotation for strategic treatments should be given further consideration as a matter of urgency.*

5. *BIM and the Marine Institute to engage in intensive consultation with the fish farming industry, both with individual fish farmers and representative organisations, to ensure ongoing optimisation of management practices and to report back to the Minister within four months.*

6. *BIM and the Marine Institute to immediately establish a working group to report in three months on the potential of alternative treatment approaches and to set out the steps necessary to introduce these approaches.*

7. *A national implementation group to be established comprising appropriate representation from:*

The Coastal Zone Management, Veterinary and Seafood Policy Divisions of the Department of Agriculture, Fisheries and Food;
An Bord Iascaigh Mhara;
Marine Institute; and
Industry representatives.

The group is to provide the Minister, within ***six*** *months of it's establishment, with a full update of the actual situation on the ground, the progress made to reduce sea lice levels and the further steps required, if any, to redress the situation.*

8*.* *A New role for SBM (Single Bay Management) as a focus for management cells to manage sea lice control at a local and regional level reporting to the national implementation group.*

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Section 1: Background

1.1. Marine Finfish Aquaculture in Ireland

In the global context, aquaculture has grown significantly over recent decades, with annual growth of the order of 10% since 1990. It is the fastest growing area of food production. The industry is also characterised by ongoing diversification and innovation, including the cultivation of new species.

Salmon farming started in Ireland commercially in or around 1978. The first significant company was Curraun Fisheries Ltd (at the time a wholly owned subsidiary of Guinnesss Ireland Plc). There was a debate for a few years as to which species (Atlantic salmon or Rainbow trout) would be the more suitable for cultivation, with salmon winning out eventually as their survival at sea was better and they fetched a higher price. Roughly 350 tonnes of farmed salmon were produced in 1980 at a value of about €2.6million (prices were very high at that time as the fish were a rarity).

Since its initial trial development in the early 1970s, the Irish industry has grown to become a significant contributor to local economies. The Irish aquaculture industry provides fulltime and part time employment for some 2,000 people and had a value in 2007 of €131m. Production of farmed salmon in 2007was estimated at 13,800 tonnes. BIM estimated that 410 people were employed in finfish farming during 2005, of which 247 were full-time.

Irish output, however, is tiny by international standards. By way of comparison the two main world producers of farmed salmon, Norway and Chile, accounted for production of approximately 670,000 tonnes RWE[1] and approximately 660,000 tonnes RWE respectively, in 2006. Scotland the nearest salmon farming country had an output of about 150,000 tonnes RWE in 2006. Thus the Irish sector is less than one eleventh the size of its nearest neighbour and about one fiftieth the size of its main competitors.

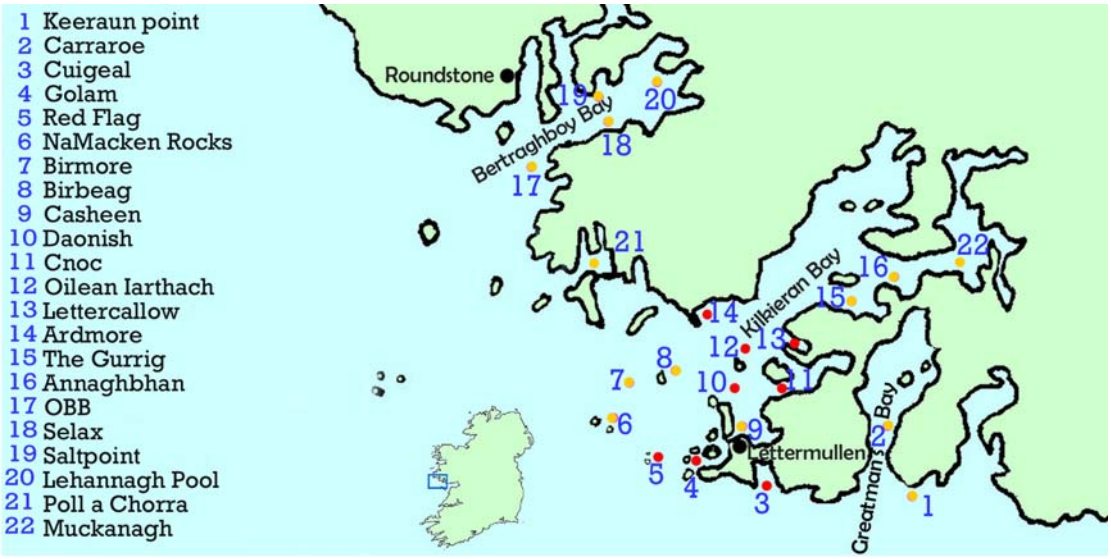
[1] Salmon production is given as Round Weight Equivalent – i.e. the harvest weight of the fish after is has been starved and bled.

There are three distinct regions in Ireland where marine salmonid farming is carried out, illustrated on the maps (courtesy of the Marine Institute)

below:

The West (Counties Mayo and Galway),

Salmon farm sites in south Connemara



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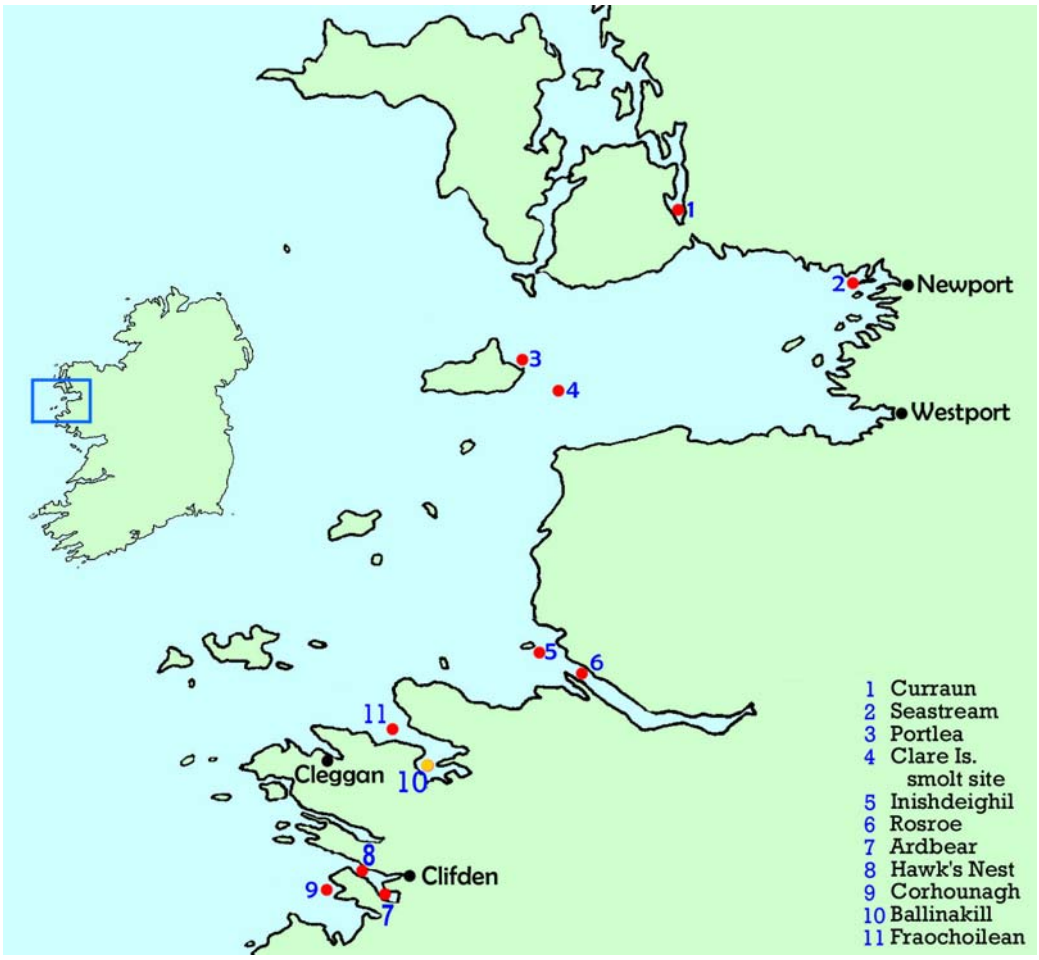
Salmon farm sites in Mayo and north Connemara



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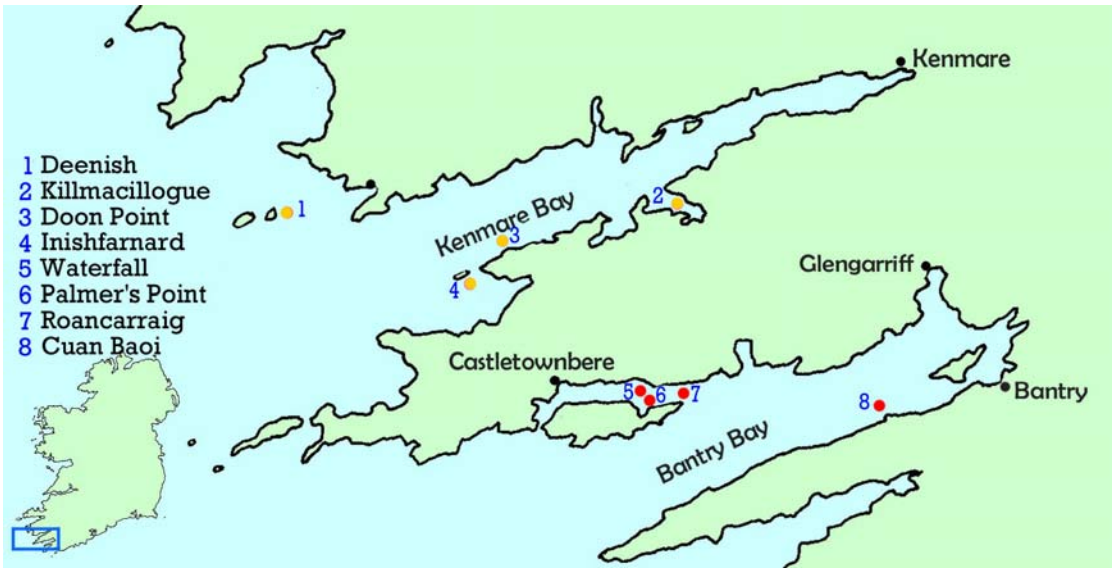
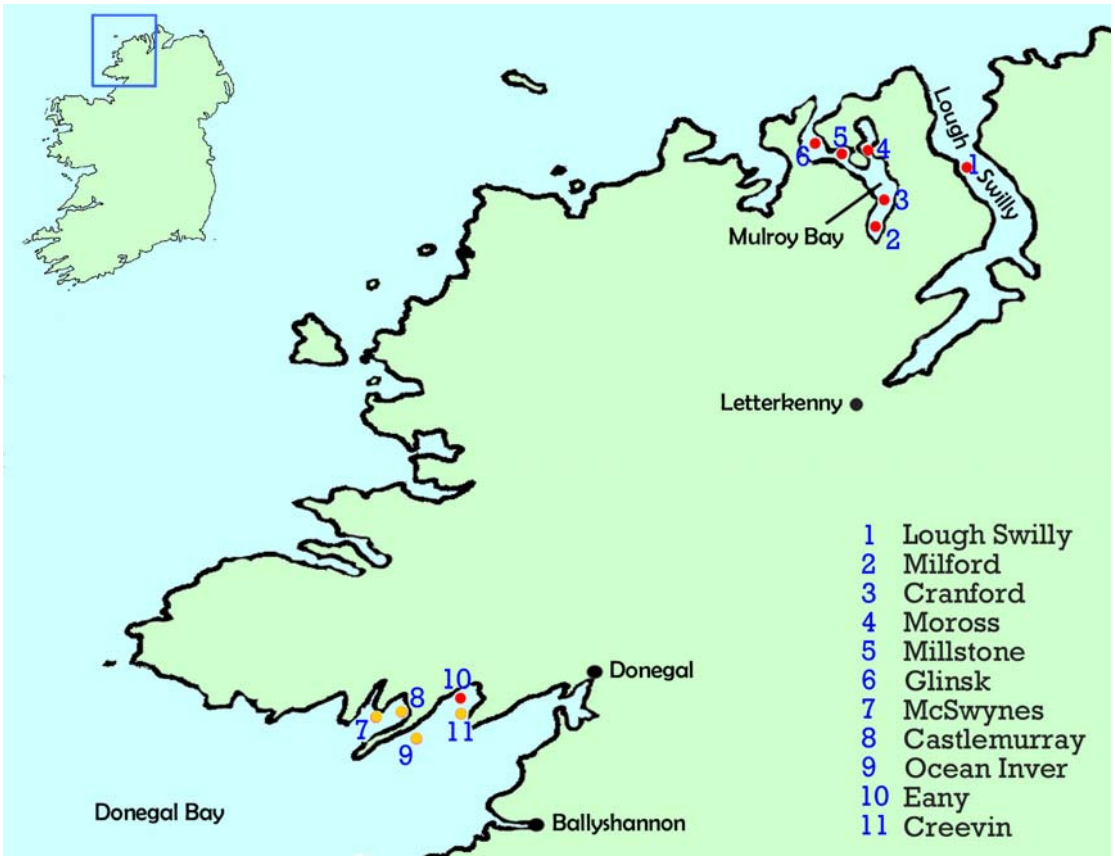
Salmon farm sites in the Southwest (Counties Cork and Kerry)



Salmon farm sites in the Northwest (Co. Donegal)



Sites used in 2006= ● red

Sites not used in 2006= ●orange

Finfish production in Ireland grew steadily throughout the 1990s; production in 2001 was as high as 24,000 tonnes but declined to c.12,000 tonnes by 2006[2]. The Cawley Report (*Steering a New Course – Strategy for a Restructured, Sustainable and Profitable Irish Seafood Industry 2007-2013*) identified market factors (salmon prices earlier this decade plummeted due to below cost selling) as the dominant cause for the decline. The European Union introduced Minimum Import Prices in 2005 and farmed salmon prices have stabilised significantly since then.

The Cawley Report also noted that sub-optimal stock performance due to fish health problems had also had a negative impact on the Irish industry. The report cites recent improvements in husbandry, stock breeding and feeding practices as the basis on which this issue is being addressed. The report acknowledges that in recent years the Irish industry has not been an attractive investment option, owing to the foregoing difficulties and also to shortcomings in the regulatory framework.

1.2 An Overview of the Challenges facing the industry

The biggest challenges facing the Irish salmon farming industry, as identified by the Cawley Report, revolve around the issues of public acceptance, proportionate regulation and the efficient control of pests and other fish health problems. At a national level, there is a concerted effort underway to streamline the regulatory arrangements and to engender a better understanding of the sector and its importance. At a local level, in many areas, the CLAMS process (Co-ordinated Local Aquaculture Management System) and the SBM (Single Bay Management) scheme approaches are being used to address these challenges.

Marine finfish farms are also perceived by anglers and wild fisheries interests to be problematic because of the proximity of some operations to river mouths and a concern over the possible impact on wild migratory salmonid fisheries. The Irish salmon farming industry has, for some time, expressed the need for

[2] Browne R, Deegan B, O'Carroll T, Norman M and Ó Cinnéide M. 2007. **Status of Irish Aquaculture 2006**. Merc Consultants

the provision of more sites for fallowing and separation of generations purposes. However, new applications have been slow to come forward in recent years, possibly due to the complex nature of the licensing process and uncertainties associated with the aquaculture licence appeals process. However, there are a number of underutilised licensed sites which are thought to hold significant break out potential for current operators. The use of these sites by existing operators to separate generations of fish and facilitate better management practices has begun to emerge.

1.3 What are Sea Lice?

Sea lice are a group of parasitic copepods found on fish world wide. There are two species of sea lice commonly found on cultured salmonids in marine conditions around the coast of Ireland, *Caligus elongatus* Nordmann, which infests over eighty different species of marine fish, and *Lepeophtheirus salmonis* Krøyer (the salmon louse), which infests only salmon, trout and closely related salmonid species. *L. salmonis*, the salmon louse, is the more serious parasite on salmon, both in terms of its prevalence and effects. It has been reported as a common ecto-parasite of both wild and farmed salmon at sea.

Returning wild salmon have been found to carry an average of 10 or more adult egg bearing females on their return to the Irish coastline from their feeding grounds in the Atlantic. Having evolved their relationship with salmon and trout over many millennia, the parasite is extremely well adapted to target its host species and it is ubiquitous to all the coastal waters around Ireland and indeed throughout the range of the Atlantic salmon.

Salmon, whether wild or cultured, go to sea from fresh water free of sea lice and only pick up the infestation after they enter the marine phase of their lives.

1.4 What effect do sea lice have?

Sea lice infestations can have commercially damaging effects on cultured salmon. They inflict damage to their hosts through their feeding activity on the outside of the host's body. Sea lice affect farmed salmon stock by damaging the integrity of the fish’s epithelium, which impairs its osmoregulatory ability

and leaves the fish open to secondary infections. The net effect of infestation, especially if it is left unchecked, is a reduced growth rate and an increased morbidity.

Sea lice and sea lice infestation of salmon have no implications for human health or seafood safety.

Section 2: Sea Lice Monitoring

2.1 Background

Monitoring of lice infestation levels on salmonid farms in Ireland was initiated in April/May 1991. This was in response to concerns that lice emanating from farmed salmonids might be implicated in the phenomenon of large numbers of sea trout returning to rivers in early summer in an emaciated state and with elevated lice numbers. Since April 1994, monitoring has been carried out in accordance with the recommendations of the Sea Trout Task Force and its successor body, the Sea Trout Management and Advisory Group.

The current national sea lice monitoring programme involves the inspection and sampling of each year class of fish at all fish farm sites 14 times per annum - twice per month during March, April and May and monthly for the remainder of the year except December-January. Only 1 inspection is carried out during this period.

In the early phases, the level of lice per fish that would trigger the need for treatment was set at a level of 2.0 lice per fish during the Spring period from March to May. These trigger levels have been tightened up over the years, however, as the monitoring and control programme has been developed and enhanced and incorporated into the existing Monitoring Protocol.

In 2000 this monitoring regime was formally adopted as one of a number of Monitoring Protocols to which all salmon farmers are required to adhere. The inspections are carried out directly by the Marine Institute (MI). This programme is applied at all marine finfish farms regardless of whether the licensee, through the terms and conditions of it's licence, is subject to the terms of the Protocol or not. The cooperation of the industry in this respect is noted. A copy of the Sea Lice Monitoring Protocol is attached at Appendix 1.

Lice levels are determined from the sampling process and measured against target levels set out in the protocol or in licences. The Spring period (March to May) targets are now set at very rigorous levels of 0.3 to 0.5 egg bearing (ovigerous) lice per fish. Outside of this a level of 2.0 egg bearing lice acts as the trigger for treatment. Where measurements at a farm exceed these target levels the MI issues a "Notice to Treat" to the licensee.

Results are reported to farms by the MI within five working days of the inspection together with appropriate advice. Monthly reports are compiled for each site of mean numbers of egg bearing lice and total mobile lice of each species. These reports are circulated to the farms, the Department, the Marine Institute, the Central Fisheries Board, the Regional Fisheries Boards, the Irish Salmon Growers Association, Save Our Seatrout and the Western Gamefishing Association. This ensures that real time information on the levels pertaining on farms is available to all interested parties. These reports are designed to give a clear, unambiguous measure of the infestation level at each site and to act as a basis for management decisions.

2.2 Purpose of Monitoring

The initial purpose of the monitoring in 1991 and 1992 was to obtain an objective assessment of infestation levels on farms and to investigate the nature of these infestations. The results of these investigations, first published in 1993, were used to develop a management strategy for effective sea lice control and subsequently to refine and further enhance the management strategy. The purpose of the national sea lice-monitoring plan since 1994 has been:

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

2.3 2007 Trends

Appendix 2 contains key information on sea lice infestation during 2007. The statistics in the tables are presented on a site by site and regional basis. For the purposes of this report the key issues to note are as follows:

2005 salmon

Only 4 sites (west & north—west) contained two sea winter salmon (i.e. salmon that had been at sea during winter 05/06 and winter 06/07) in 2007. Of these 4 sites, 3 sites had 100% of samples above the trigger levels on inspection. The number of such inspections is small however as these fish were harvested by March 2007 at the latest.

2006 salmon

South-West

- only 1 site (Roancarraig, Bantry Bay) was stocked
- all 6 samples in the critical spring period exceeded the treatment trigger levels
- sea-lice levels continued to increase during the critical period, notwithstanding the application of treatments

West

- there was a further reduction in the number of sites stocked in 2007 (11) compared with 2006 (18)
- of the 11 sites, on 4 sites 100% of the inspections in the critical period were above the trigger level, while one site was harvested out before the spring period
- of the remaining 6 sites, 4 sites had 50% or more of results of inspections above the trigger level in the spring period
- only one site was below the trigger level on all inspections in the spring period

- overall, outside the spring period, 35% of inspections showed results which were above the higher trigger level.

North-West

- 5 sites were stocked in 2007 compared with 6 in 2006
- the only site in Lough Swilly was below trigger levels on all inspections carried out during the spring period
- the 4 sites in Mulroy Bay exceeded trigger levels on 50% of inspections in the spring period
- despite higher trigger levels outside the spring period, taking the 5 sites together, there was the same incidence of exceeding the trigger levels outside the spring period as within the spring period
- the most significant feature in the north west was the continuing escalation in sea lice levels towards the end of 2007.

Monthly Mean Trends

The monthly mean sea lice figures show all 3 regions as exceeding the trigger levels throughout the spring period. Outside the spring period the experience varies but towards the latter half of 2007 both the West and north-West exhibited levels generally in excess of trigger levels.

Treatments

M.I. advise that all farms cooperate with regard to carrying out treatments on foot of notice to Treat. Notices are issued in all cases where trigger levels are exceeded. However, a key feature appears to be that re-infestation occurs relatively soon after treatment and this may raise issues as regards the efficacy of treatments and or the need for more coordination of treatments between adjacent cages and sites.

2.4 Annual Trends

L. *salmonis* ovigerous (egg-bearing) and mobile lice level trends for one-sea-winter salmon in the month of May from 1991 to 2007 are compared respectively in Figures 3 and 4 of the Marine Institute report at Appendix 2. (For ease of reference Figures 3 and 4 are reproduced hereunder.) The mean number of ovigerous lice per fish, and the mean number of mobile lice per fish are presented.

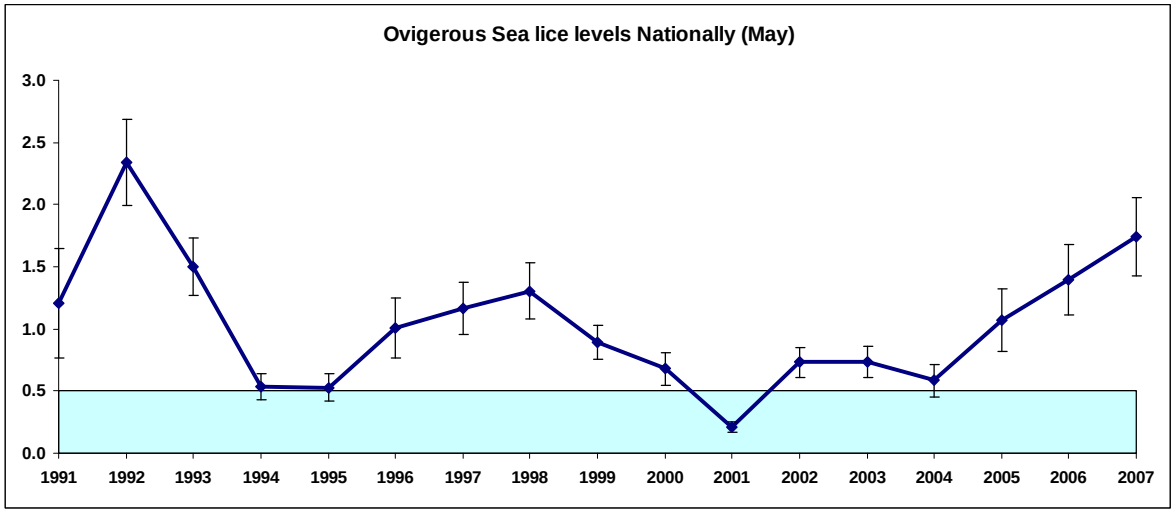


Figure 3. Annual trend (May mean) (SE) ovigerous *L. salmonis* on one-sea-winter salmon. (Blue shaded area represents the treatment trigger level during spring period.)

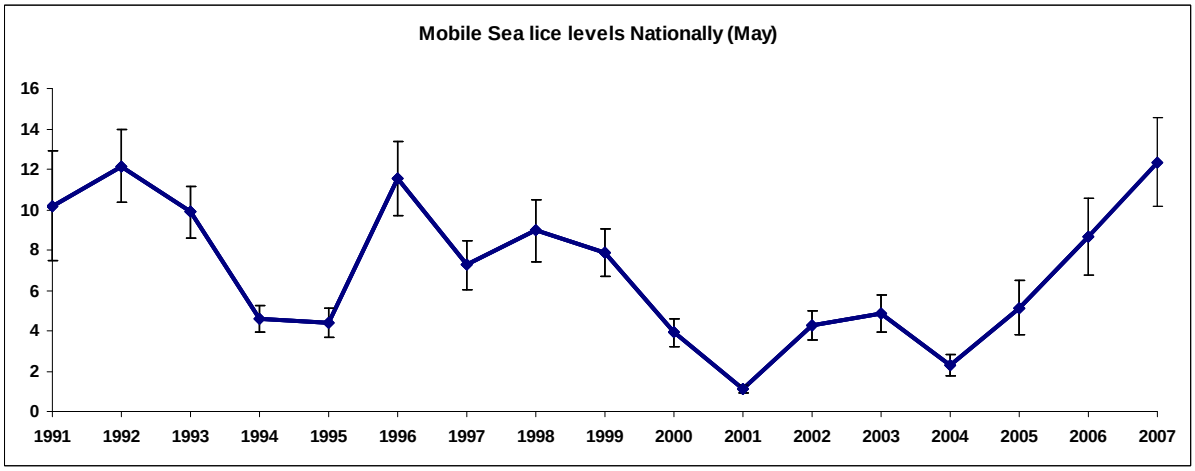


Figure 4. Annual trend (May mean) (SE) mobile *L. salmonis* on one-sea-winter salmon.

From 1998 to 2001 the levels decreased steadily for both ovigerous and total mobile lice. Mean ovigerous L. salmonis levels increased in 2002, remained steady in 2003 and show a slight decrease again in 2004.

In 2005 and 2006 levels increased and this trend continued in 2007. The mean ovigerous lice level for one sea winter salmon in 2007 is the second highest since monitoring commenced. Only 1992 is higher. Mean mobile levels increased from 2001 to 2002 and again from 2002 to 2003 but show a reduction in the 2004 figure. Levels increased in 2005 and again in 2006 and 2007. Mean mobile lice levels for one sea winter salmon in 2007 are the highest recorded to date.

The reasons for the increase are complex and have been outlined elsewhere but the trend underlines the necessity for a concerted effort to control lice infestations coming into the 2008 season.

Since 1991 the mean sea lice count for one sea winter salmon has only once (2001) been below the trigger level while in 1994/95 the count bordered on the trigger level.

While there are encouraging signs in the winter and early 2008 sealice inspection data, as a result of action by farms, March sea lice inspections resulted in a total of 11 sites being issued with notices to treat because they were above the trigger levels. This underscores the fact that it will take a concerted effort to achieve a sustained improvement in lice control in 2008. the Inspection results for March are appended (Appendix 3) to this Report.

2.5 Management Strategy

As a result of the experience gained over a number of years an integrated approach to sea lice control has been developed in Ireland. This management strategy was endorsed by the Sea Trout Task Force and subsequently, by the

Sea Trout Management and Advisory Group. This management strategy, which formed the basis for Single Bay Management (SBM) Agreements, relies on five principal components:

- *Separation of generations*
- *Annual fallowing of sites*
- *Early harvest of two sea-winter fish*
- *Targeted treatment regimes*
- *Agreed husbandry practices*

Together, these components are intended to reduce the development of infestations and to ensure the most effective treatment of developing infestations. They are intended to minimise lice levels whilst controlling reliance on, and reducing 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 the development of infestations. The early harvest of two sea winter fish removes a potential reservoir of lice infestation and the agreed practices and targeted treatments enhance the efficacy of treatment regimes. One important aspect of targeted treatments is the carrying out of autumn / winter treatments to reduce lice burdens to as close to zero as practicable on all fish, which are to be over-wintered. This ensures zero / near zero egg bearing lice in spring. This is the so called “critical period” for lice control. It is an important time as strategic control at this point can enhance lice control for the succeeding months by interrupting the cycle of infection before the warming water temperatures increase the speed of lice reproduction. It is also the most important period in terms of wild farmed interactions. The agreed husbandry practices cover a range of related fish health, quality and environmental issues in addition to those specifically related to lice control.

2.6 Trigger Levels for Treatment

The setting of appropriate treatment triggers is an integral part of implementing a targeted treatment regime. Treatment triggers during the spring period [March to May] are set close to zero in the range of from **0.3 to 0.5** egg bearing females per fish and are also informed by the numbers of

mobile lice on the fish. Where numbers of mobile lice are high, treatments are required even in the absence of egg bearing females.

Outside of the critical spring period, a level of **2.0** egg bearing lice acts as a trigger for treatments. This is only relaxed where fish are under harvest. Over the period since the initiation of SBM (Single Bay Management), treatment triggers have been progressively reduced from a starting point of 2.0 per fish during the spring period to the current levels which are **0.5** egg bearing lice per fish. 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 sea water temperatures are at a minimum and development rates of lice are reduced. This has the effect of tending to synchronise the development of lice larvae. A strategic treatment at this time can break the cycle of infection.

Ovigerous female 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 lice per fish ensures that treatments are carried out when a maximum of half of the fish examined have any ovigerous lice. This is the optimum time to interrupt lice development. Later in the year generations of lice are not as synchronised and intervention, at a lice level of 0.5 ovigerous lice per fish, by way of treatment is generally not justified. A level of 2.0 ovigerous lice per fish has been shown to be a pragmatic level at which intervention by way of treatment is advisable. Levels of total mobile lice or juvenile lice are important in advising fish health professionals in developing a lice control strategy. However, they are not of themselves appropriate measures upon which to trigger mandatory treatments.

2.7 Sampling Strategy

The Irish sampling strategy, which underpins the current monitoring programme, was developed through a consultation process with national and international experts in the field. It has been refined and modified as a result

of the recommendations of the Sea Trout Working Group, the Sea Trout Task Force and the Sea Trout Management and Advisory Group. The resulting programme meets both the exacting scientific requirements of a national monitoring programme and the diverse concerns of sectoral interests, as expressed through the various Ministerial committees and through direct representations. The rationale of the current sampling strategy is to:

- *Provide a robust and reliable objective measure of lice numbers on farmed fish*
- *Operate within a framework which is cost effective and capable of being carried out over the range of installations which are in use in offshore farming*
- *Take account of weather conditions, fish health issues, environmental effects and animal welfare considerations.*

Section 3: Co-ordinated Management Systems

3.1. Single Bay Management

On the basis of information gathered in surveys of lice infestation on salmon farms in 1991 and 1992, the Department of Marine put in place a new initiative in salmon farm management. This initiative, termed Single Bay Management, has been progressively introduced since then and has been shown to have a beneficial effect in lice control on farmed fish. It involves all of the farms in an area co-operating to develop an integrated management plan. Crucial elements in the success of this plan are identified as:

- *separation of generations;*
- *annual fallowing of sites;*
- *strategic application of chemotheraputants;*
- *good fish health management; and*
- *close co-operation between farms.*

3.2. CLAMS

In 1998 the Minister of State for Marine announced the setting up of a Co-ordinated Local Aquaculture Management System group (CLAMS). This concept of management is designed to facilitate the development of plans for individual bays incorporating and extending the concept of Single Bay Management. It will also be integrated with Coastal Zone Management policy and County Development Plans. Though CLAMS is integrated with these plans and the viewpoints of all interest groups are documented, the process is driven by the aquaculture producers working within the framework of national policy. BIM and the Marine Institute have been charged with the responsibility for developing the CLAMS framework at local level.

The CLAMS process is a non-statutory management system, which is anchored in the national marine policy and development programmes. It is envisaged that CLAMS will highlight issues in a bay and co-ordinate the industry and relevant bodies to deal with them. It is separate to the licensing process and is not intended to solve or take responsibility for all issues. The

concept focuses at local bay level while still taking on board relevant national policies. The object of this process is to formulate a management plan for the bay, which incorporates and extends the concepts of Single Bay Management to all farmed species.

CLAMS provides a concise description of the bay in terms of physical characteristics, history, aquaculture operations, future potential, problems, etc. It also allows various Codes of Practice to be customised and integrated to the aquaculture industry operating in the bay. In addition, it provides the framework from which a management and development plan for aquaculture in the bay can be drawn. Another important aspect is that this process acts as a focus group for the community. This will then provide an information channel from local to national level and vice versa. It is envisaged that this will provide a framework for addressing issues that affect or are affected by aquaculture activities and streamline the resolution of these situations.

3.3 Fallowing

Fallowing is a tool used to control the level of sea lice, benthic conditions and the spread of fish disease. To be effective it is dependent on a satisfactory length of time for fallowing and appropriate geographical separation between sites and/or synchronous fallowing of adjacent sites.

The Protocol on Fallowing essentially establishes the principle of fallowing and best practice in fallowing. All finfish farms **subject to the Protocol** are obliged to undertake appropriate fallowing for the control of disease and parasite problems (including sealice). Where there is more than one finfish farm in a particular bay the protocol requires licensees to pursue fallowing in the context of the Single Bay Management process. The Protocol specifies a minimum period of 30 continuous days for fallowing an individual site, although, in many cases, the conditions of a licence go beyond this in respect of particular locations. **Not all licences are subject to the Protocol on fallowing or, indeed, contain specific conditions on fallowing (a number of licences would predate the establishment of the Protocols).**

A key issue for licensed farms within their licensed areas is the lack of availability of sufficient sites to allow for effective fallowing. On a general level there is a balance to be met between a farm seeking to maximise its commercial return from the sites available to it while at the same time observing the requirement to fallow sites if single bay management, sea lice control and fish health management efforts are to be maximised. The balance between these potentially conflicting objectives has not assisted the sea lice control strategy.

The current situation whereby a large number of sites remain unstocked may afford the opportunity for a greater fallowing effort, largely through cooperation between licensees. In the medium term a more mandatory and enforcement approach to fallowing may be called for.

In this regard one of the recommendations of the Cawley Report should be noted viz:

> *"The DCMNR should support and facilitate the acquisition of fallowing sites for the salmon farming sector to assist with more effective sealice and disease control. Provision of these sites should not necessarily involve an increase in the permitted output of the industry, but should facilitate improved spatial and temporal stock management and reduced incidence of disease. This initiative, which could make a very valuable contribution to the national effort to control sealice numbers, should involve the applicants and the agents of DCMNR entering into detailed consultation on the location of proposed fallowing sites and agreeing binding stock rotation and fish health management protocols prior to the submission of applications for aquaculture licensing. The properly completed application, whose 'pro-bono' credentials should be made known to all of the statutory consultees, should then be processed as fast as possible through the system, without any compromise to the rigour and transparency of the Fisheries Amendment Act, 1997, but*

yielding a speedy outcome in terms of an appropriate licensing recommendation to the Minister to either grant or refuse the application."

Section 4: The Problem in Context

4.1 Best Practice

Over the last three seasons there has been a problem with lice control at a number of locations. In order to address this development a series of basic principles were developed as part of previous attempts to address the sea lice issue. These following 7 basic principles of best practice achieved a wide measure of agreement amongst all interested parties.

Seven Basic Principles

1) *Complete separation of Generations (sites to be one tidal excursion apart).*

2) *Each site to be fallowed annually, or at end of a production cycle, for one month (30 days) before re-stocking. All sites within one tidal excursion to be fallowed synchronously.*

3) *Annual synchronous "winter" lice treatment for all adjacent sites (one tidal excursion).*

4) *Planned rotation of sea lice treatments over the production cycle & adjacent sites to use the same product rotation.*

5) *Treatment triggers Spring Period 0.5 egg bearing females per fish, rest of year 2.0 egg bearing lice.*

6) *All above to be set out as part of formal signed SBM Agreement.*

7) *Where there is a persistent problem with sea lice control there is a need for an incremental series of actions up to and including mandatory treatments and sanctions where these are not effectively implemented.*

4.2 Causes of Current Difficulty

The potential causes/contributory factors which have led to the recent difficulties in maintaining good control of infestations can be summarised as follows:

- Poor farm management in carrying out lice control measures.
- Husbandry problems in administering lice treatments/poor inclusion rates for in-feed treatments.
- PD (pancreas disease) related issues (poor appetite and/or poor uptake of active ingredient in lice treatment) from diet
- Reduced sensitivity in sea lice populations to certain available treatments.
- Incomplete separation of generations leading to vertical transmission of lice.
- Additional lice treatments required by low trigger levels in protocols.

4.3 Potential Alternative Method of Treatment

There has certainly been an issue with inclusion rates for in-feed treatments. The effects of Pancreas Disease on appetite are well known (this has a direct effect on the up-take of in feed treatments) but there are other less well studied effects of the disease which may also impair the efficacy of in feed treatments. Taken together the above has undoubtedly had a significant impact on the efficacy of in feed lice treatments.

There is growing evidence that some populations of lice may be exhibiting reduced sensitivity to certain lice treatments. The loss of efficacy associated with in-feed treatments and the changes in farming practices, whereby cages have gotten larger and site locations have tended to be in more exposed areas, have made the problem of lice control more difficult. Using bath

treatments in these circumstances is problematic and often unsuccessful despite the best efforts of the grower.

The use of Very Large Live Fish Carriers (VLLFC) ships, also called well-boats, is now the option preferred of the industry, as these vessels can treat an entire cage at a time and can achieve very precise dose rates in a controlled environment. They are however expensive to charter and can be difficult to obtain, especially if there is a lot of demand for their services in their home countries as is currently the case.

The key issue appears to be access to well boats and how this is to be achieved would need very careful consideration from a Value for Money perspective as, e.g. purchasing a vessel could prove costly and perhaps may not be ideal for future needs. However, this is an issue that is being grasped by the industry and improved well-boat availability is coming on stream.

Health professionals have expressed concerns from time to time about additional treatments required to reduce lice levels, which were not having an adverse impact on the stock, to comply with trigger levels. This is especially a factor where fish health is already compromised due to other factors (*e.g.* PD, high temperatures etc). The need to carry out extra treatments is exacerbated where there is mixing of generations on the same or adjacent sites and/or integrated or strategic lice management is not the norm.

4.4 Review of lice control methods

Treatments Licensed in Ireland

Treatment	Purpose	Usage
SLICE	Emamectin Benzoate (in feed)	widely used
EXCIS	Cypermethrin (bath)	widely used
CALICIDE ECTOBAN	insect growth regulator Similar active ingredient (in feed)	no longer available available AR16 (special licence)
ALPHAMAX	Deltamethrin (bath)	available under special licence for use where other treatments are not effective or have limited efficacy.

Treatments Licensed or available elsewhere

Treatment	Purpose	Usage
Deltamethrin (*Alphamax*)	Bath	effective & widely used in Norway
Hi-cis Cypermethrin (*Betamax*)	Bath	as above
Salmosan (azamethiphos)	Bath	licensed in UK no longer available
Ivermectin	in-feed	licensed for other food animals in EU/Ireland

Other (alternative) lice "control" methods

Treatment	Usage
Wrasse	Used as a "cleaner fish" in several countries, including Ireland. Still used in Norway. Serious limitations to efficacy. Also issues with supply of wrasse, effects on wild populations and possible disease risks. May have limited application especially on post smolts in their first summer at sea.
Immuno-stimulants	e.g. Ecoboost (blend of aromatic herbs) feed additive, said to enhance ability of fish to withstand lice infection. May have part to play in integrated lice management plan. It is not of itself an effective way of controlling existing lice infestations.
Hydrogen Peroxide	Bath treatment. Issues with safety & practicality for treatments above 12^{o} C.

4.5 Solutions / Response Options

In seeking to address the current problems a number of approaches are required. In the short term it will be necessary to tackle the problem of severe infestations at certain sites, some of which may be experiencing reduced sensitivity to currently available medicines. This will have to be tackled on a bay by bay rather than a site by site or company basis to ensure that the extent of the management response is appropriate to the biological area of impact of the infective stages of the pest. In the short to medium term it will be necessary to review management practices to optimise lice control and to integrate it with overall health management, again on a bay by bay basis.

Three strategies are listed below which need to be addressed to ensure effective sea lice management on Irish salmon farms. Each of the strategies presents its own particular challenges, however as a suite of responses they provide the best way forward in the current circumstances.

A. Availability of a suite of novel lice treatments & methods (including VLLFC/wellboat)

- *For use on those sites where remedial action is urgently required.*
- *For use on sites where reduced sensitivity has been demonstrated or is suspected to traditional treatments.*
- *In particular, VLLFC are a key to effective use of bath treatments on exposed sites or those with large cages*

B. Full implementation of Site Management /Bay Management

- *Fallowing between generations*
- *Single Generation sites*
- *All in all out bay by bay strategies in specific cases*
- *Flexible and/or novel approach to use of currently licensed sites, including the species to be cultured at those sites.*

C. Enhanced role for SBM;- Integration of sea lice and health management protocols to include a bay management approach which is:

- *Defined by specific targets and goals.*
- *Goal led.*
- *Flexible and enforceable.*

Section 5: Conclusions

The solution most likely to have the best medium and long term results is a combination of all three response options set out in section 4.4. A flexible, inclusive approach can be achieved by continuing to adapt management practices at site and bay level to emerging trends in sea lice control.

In an effort to optimise management practices with regard to sea lice control at fish farms there have been a number of *ad hoc* initiatives including, the setting up of a small working group comprising Irish Salmon Growers Association and the Marine Institute. This group has met regularly over the last few months to improve co-ordination of efforts to achieve optimum benefit from the fish farmers control efforts. The enhancement of this approach through the formation of a management cell approach involving farmers, state agencies and DAFF at a local regional level would underpin a focussed SBM approach to addressing the ongoing management of sea lice control.

There appears to be an emerging consensus that “break-out” space is necessary to facilitate fallowing and separation of generations. This gives rise to a number of challenges including:

- *limited availability of space for new sites;*
- *access to existing licensed areas for fallowing purposes;*
- *environmental and other licensing constraints;*
- *potential objections from a variety of interested parties.*

Section 6. Recommendations and Action Plan

1. *A joint DAFF/industry working group to be established to identify "break out" site options in areas which have persistent sea lice problems. These options would include the possibility of using redundant sites, to optimise fallowing and separation of generations.*

In accordance with the Steering a New Course report, (Strategy for a Restructured, Sustainable and Profitable Irish Seafood Industry 2007-2013 (Cawley N, Murrin J and O'Bric R, 2006)) DAFF should "support and facilitate the acquisition of fallowing sites for the salmon farming sector to assist with more effective sea lice and disease control. Provision of these sites should not necessarily involve an increase in the permitted output of the industry, but should facilitate improved spatial and temporal stock management and reduced incidence of sea louse infestation and other diseases.

This initiative, which will make a very valuable contribution to the national effort to control sea lice numbers, should involve the applicants and the agents of DAFF entering into detailed consultation on the location of proposed fallowing sites and agreeing binding stock rotation and fish health management protocols prior to the submission of applications for an aquaculture licence." **It is very important that where break out space is made available it should be used by the industry for fallowing and separation of generations and not merely to enable an increase in output.**

2. *Effective and appropriate use of chemical intervention to be reviewed to take ongoing account of changing environmental conditions, developing farming practices, sensitivity of lice to treatments and fish health issues.*

In particular, the development of efficient protocols and mechanisms for the sourcing and use of well boats (VLLFCs) for controlled bath treatments and for the optimisation of product rotation for strategic treatments should be pursued by BIM in close consultation with the industry and the MI.

3. *The increased availability of well boat capacity coming on stream in the industry to be utilised for controlled bath treatments.*

4. *The optimisation of product rotation for strategic treatments should be given further consideration as a matter of urgency.*

5. *BIM and the Marine Institute to engage in intensive consultation with the fish farming industry, both with individual fish farmers and representative organisations, to ensure ongoing optimisation of management practices and to report back to the Minister within four months.*

6. *BIM and the Marine Institute to immediately establish a working group to report in three months on the potential of alternative treatment approaches and to set out the steps necessary to introduce these approaches.*

7. *A national implementation group to be established comprising appropriate representation from:*

- *The Coastal Zone Management, Veterinary and Seafood Policy Divisions of the Department of Agriculture, Fisheries and Food;*
- *An Bord Iascaigh Mhara;*
- *Marine Institute; and*
- *Industry representatives.*

*The group is to provide the Minister, within **six** months of it's establishment, with a full update of the actual situation on the ground, the progress made to reduce sea lice levels and the further steps required, if any, to redress the situation.*

8. A New role for SBM (Single Bay Management) as a focus for management cells to manage sea lice control at a local and regional level reporting to the national implementation group.

Efforts should be intensified to revitalise the single bay management approach and make it central to national policy for sea lice management.

In this regard it is proposed that a new feature of the strategy to enhance the control of sealice infestations on Irish salmon farms should be the creation of an integrated mandatory "real time" management regime, which will vigorously deal with failures to control sealice infestations on a case-by-case basis. One of the perceived shortcomings of the current arrangements is that they are not sufficiently proactive in dealing with situations where, despite attempts to treat, the sealice infestation is not brought adequately under control.

The rationale behind this new initiative is to bring all of the relevant State expertise to bear on problem situations in real time, actively engaging the affected farmer and ensuring that a high priority is given to dealing with the infestation by all concerned.

The regime is designed to bring progressively tougher actions to bear on the infestation to ensure the highest possible level of compliance.

The structure and *modus operandi* of this new more vigorous regime are set out below:

- Following established best practise for environmental management, a bay *management cell* approach will be taken to the problem of controlling sealice infestations on individual farms, where despite attempts to treat, the level of infestation has not been brought under control.

- Each bay where salmon farming takes place, will have a contingency *management cell* formed and available for immediate action. The cell shall consist of appropriate representation from the Marine Institute Sealice Monitoring Programme, Bord Iascaigh Mhara, an industry

representative from the *Single Bay Management Group* for the bay and a veterinary surgeon of record.

- The cell will be convened by the Marine Institute Sealice Monitoring Programme representative when a *"notice to treat"* has been issued to a farmer in the bay, followed by an inspection which determines that either the *"notice to treat"* was not acted upon, or that the attempted treatment did not prove successful.

- The cell will take into account *inter alia* such factors as the time of the year relative to the so called *critical period* and the spatial location of the affected farm in determining the relative urgency of its responses and the speed at which it ratchets up its responses.

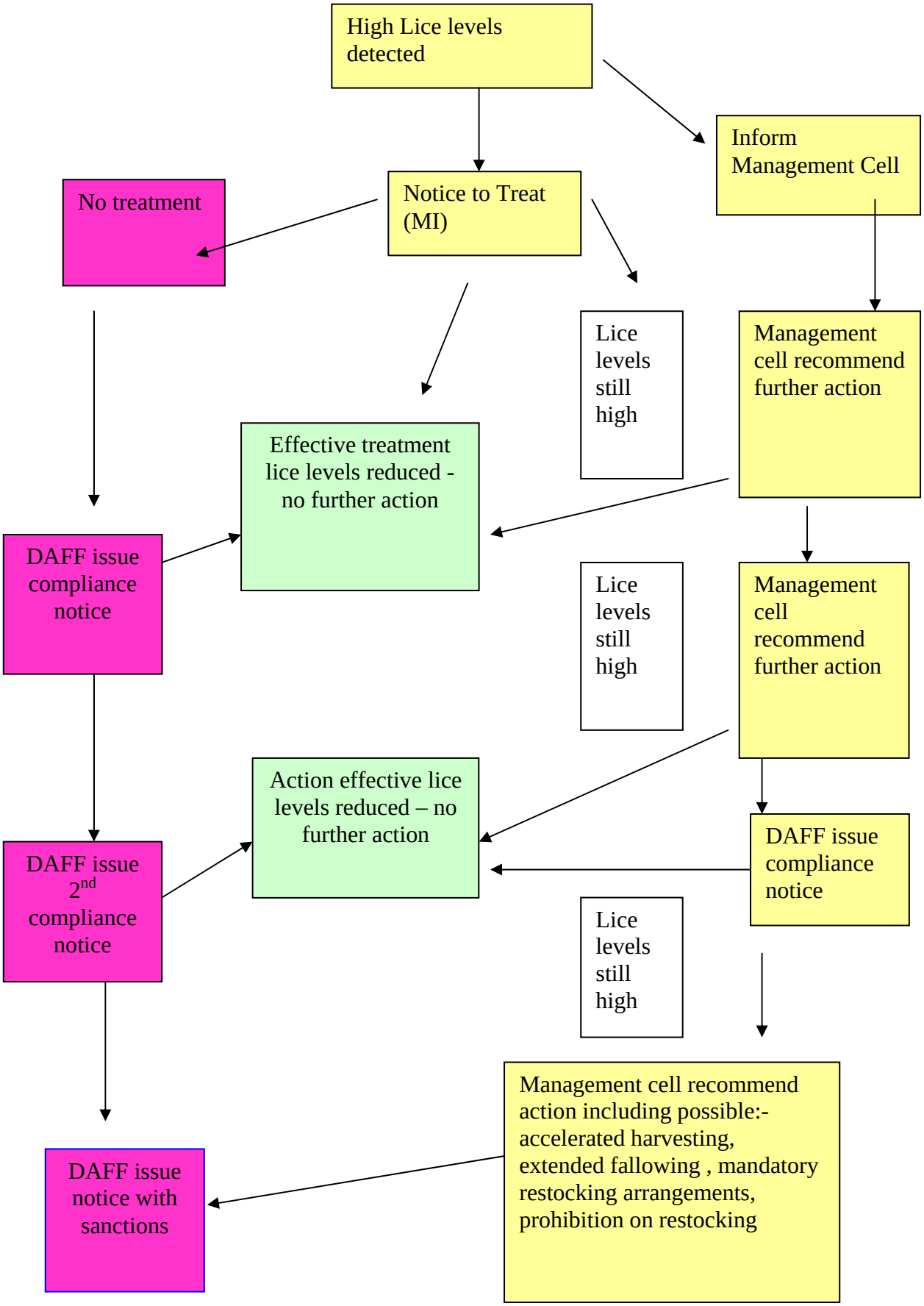
- The cell will attempt to convene within 72 hours of the meeting being called by the Marine Institute and it will meet with the farmer concerned, and review all pertinent data and facts. The MI representative shall act as the chair of the cell. The cell will then issue a recommendation for *further action*. The farmer concerned will be obliged to follow the *further action* recommendation of the sealice management cell, insofar as humanly possible.

- The *further action* recommendation from the cell shall be time specified and will be set down in writing and copied to the CZMD of the DAFF at the conclusion of the cell meeting or as soon as possible thereafter.

- Once the recommended course of action has been pursued, a further inspection will take place as soon as possible, and the results will be disseminated to the cell members. Depending on the relative success achieved, the cell may decide that no further action is required or that a further meeting and that a *further action* recommendation is needed. The subsequent *further action* recommendation of the cell shall also be mandatory and shall also be copied to the CZMD of the DAFF.

- Courses of action open to the cell for recommendation to the affected fish farmer, shall include selection of treatment medicine and the selection of treatment methodology. If after a number of attempts satisfactory control has not been achieved the cell may move to recommend accelerated harvesting, followed by extended fallowing post-harvesting. In exceptional circumstances the cell may also recommend mandatory restocking arrangements and/or an indefinite prohibition on restocking.

- The flow chart outlining the operation of the cell is set out below.


High Lice levels detected
Inform Management Cell
No treatment
Notice to Treat (MI)
Lice levels still high
Management cell recommend further action
Effective treatment lice levels reduced - no further action
DAFF issue compliance notice
Lice levels still high
Management cell recommend further action
Action effective lice levels reduced – no further action
DAFF issue 2nd compliance notice
DAFF issue compliance notice
Lice levels still high
Management cell recommend action including possible:- accelerated harvesting, extended fallowing , mandatory restocking arrangements, prohibition on restocking
DAFF issue notice with sanctions

Appendices

Department of the Marine and Natural Resources

Roinn na Mara agus Acmhainní Nádúrtha

Monitoring Protocol No. 3

for

Offshore Finfish Farms-
Sea Lice Monitoring and Control

(subject to revision from time to time)

11 May, 2000

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for
Offshore Finfish Farms -
Sea Lice Monitoring and Control

1. Monitoring Regime Required

All finfish farms are obliged to monitor for sealice on an ongoing basis and to take remedial action. This involves the inspection and sampling of each year class of fish at all fish farm sites fourteen times per annum, twice per month during March, April and May and monthly for the remainder of the year except December-January. Only one inspection is carried out during this period.

2. Purpose of Monitoring

The four purposes of the National Sea Lice-Monitoring Plan are:

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

3. Monitoring and Control Strategy

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

- Separation of generations
- Annual following 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 infestations and to ensure the most effective treatment of developing infestations. They minimise lice levels whilst controlling reliance on, and reducing use of, veterinary medicines. The separation of generations and annual following prevent the vertical transmission of infestations from one generation to the next, thus retarding the development of infestations. The early harvest of two sea winter fish removes a potential reservoir of lice infestation and the agreed practices and targeted treatments enhance the efficacy

of treatment regimes. One important aspect of targeted treatments is the carrying out of autumn / winter treatments to reduce lice burdens to as close to zero as practicable on all fish, which are to be over-wintered. This is fundamental to achieving zero / near zero egg bearing lice in spring. The agreed husbandry practices cover a range of related fish health, quality and environmental issues in addition to those specifically related to lice control.

4. Trigger Levels for Treatment

The setting of appropriate treatment triggers 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 from **0.3 to 0.5** egg bearing females per fish and are also informed by the numbers of mobile lice on the fish. Where numbers of mobile lice are high, treatments are triggered even in the absence of egg bearing females. Outside of the critical spring period, a level of **2.0** egg bearing lice acts as a trigger for treatments. This is only relaxed where fish are under harvest and with the agreement with the Department of Marine and Natural Resources or its agent.

Over the period since the initiation of SBM, treatment triggers have been progressively reduced from a starting point of 2.0 per fish during the spring period to the current levels which are the optimal sustainable at present. These trigger levels will be kept under review in the light of advances in lice control strategies. Triggered treatments are underpinned by follow up inspections and, where the Department or its agent considers it to be necessary, by sanctions. Sanctions employed include, peer review under the SBM process, conditional fish movement orders and accelerated harvests.

5. Synchronous Sea Lice Treatment and Control in Bays

All fish farms operating in a particular bay will be required to undertake appropriate synchronous sea lice treatment and control strategies through the Single Bay Management/CLAMS process. The Department of Marine and Natural Resources or its agent reserves the right to devise appropriate strategies for synchronous action by fish farms in any bay.

6. Sampling Strategy

The Irish sampling strategy methodology is designed to:

- Provide a robust and reliable objective measure of lice numbers on farmed fish
- Operate within a framework which is cost effective and capable of being carried out over the range of installations which are in use in offshore farming
- Take account of weather conditions, fish health issues, environmental effects and animal welfare considerations.

There are four key components to this sampling strategy: the sampling method, the sampling frequency, the sample size and reporting mechanisms.

6.2 Sampling Method

The full methodology is laid out in ***Appendix 1.*** It is essentially a non-destructive sampling method. Fish are removed at random from the cages and anaesthetised, to reduce stress and risk of injury. All adult and sub-adult mobile lice are then removed from the fish and retained for examination before the fish are allowed to recover and returned to the cage. Lice which become detached from the fish in the anaesthetic are collected and included in the lice count for the sample to ensure that lice numbers are not under reported. As it involves the handling of live animals and as there are animal welfare issues involved, the sampling process is subject to peer review and a licensing process. Strict limits are imposed on the number of fish which may be sampled and changes to these limits must be justified.

6.3 Frequency Sampling

The sampling frequency will fourteen inspections per year, plus any follow-up inspections required where instructions to reduce lice levels have been issued or such other frequency as may be determined by the Department or its agent.

6.4 Sample Size

The target number of fish sampled is sixty per inspection, comprising two samples of thirty fish. One sample is taken from a standard cage, inspected at each inspection, and one from a cage selected at random. Where there are difficulties in obtaining the full sample size, every effort will be made to obtain a minimum of ten fish in each sample. (This sample size is statistically robust and also takes into consideration the practicalities and animal welfare issues involved in carrying out the programme. The standard cage allows for the monitoring of within cage trends and the random cage acts as a spot check).

6.5 Reporting of Lice Monitoring

Monthly reports are compiled for each site of mean numbers of egg bearing lice and total mobile lice of each species. These reports are circulated to the farms, the Department of the Marine and Natural Resources, the Marine Institute, the Central Fisheries Board, the Regional Fisheries Boards, Save Our Sea Trout, the Western Gamefishing Association and the Irish Salmon Growers' Association. This ensures that detailed information on the levels pertaining on farms is available to all interested parties. These reports are designed to give a clear, unambiguous measure of the infestation level at each site and to act as a basis for management decisions.

APPENDIX 1.

Sampling Methodology

This protocol is followed in the carrying out of sea lice inspections on all salmon and rainbow trout farms.

Disinfection

Due to the real risk of transmitting disease from one site to the next the Disinfection Protocol should be rigidly adhered to.

It is especially important to ensure that your hands and protective clothing are kept clean and disinfected by washing with the Iodophor disinfectant provided. Disinfection of dirty clothing or equipment is not possible as the dirt reduces the effectiveness of the disinfectants.

Cages to be sampled

The standard cage (*i.e.* the selected cage which is sampled at each sampling session).

A random cage: To be selected by the inspector on the day. This cage may be nominated at the start of the inspection or on the morning of the inspection so that it can be left un-fed to facilitate the catching of fish. The inspector may, at his/her discretion, consult with the Fisheries Board's observer on the selection of the random cage.

Fish to he sampled

A sample of thirty fish is to be taken from a standard and random cage for each year class of fish on site.

Where there are only two cages of fish on site only one cage need be sampled.

Where fish are on starve for immediate harvest they need not be sampled.

Methods of Sampling

Fish may be caught by any of the following methods:

1. With a hand net (with or without the use of feed to attract fish).
2. By seining the cage.
3. By the use of a brailer.
4. By the use of a box net.
5. By pulling the net and removing fish using a net or brailer.
6. By use of a draw net.
7. By sampling fish being removed for harvesting.

Limitations to sampling

Sampling should not be attempted where weather conditions are such as to put the safety of personnel or the health of the fish at significant risk.

Where there is difficulty in obtaining a full sample of thirty fish every effort should be made to obtain a minimum of ten fish.

Where it is not possible to obtain a representative sample the sampling of damaged or moribund fish only should be avoided, as this will not give a representative measure of lice infestation levels within the cage and will skew the results for the site as a whole.

Difficulties in obtaining samples should be noted.

Registration of lice from fish sampled

All mobile stages of lice should be removed from the fish and placed in a bottle containing alcohol.

Attached stages may be removed, at the discretion of the inspector, for research purposes.

All lice remaining on the sampling tray or in the bin of anaesthetic should be collected and placed in a bottle containing alcohol and labelled “Bin”.

All sample bottles including the “Bin” bottle are to be placed in a plastic bag together with a waterproof label containing the following minimum information:

1. Date

2. Year Class of Fish
3. Site sampled
4. Number of fish sampled
5. Cage number

Inspection Forms

An inspection form should be completed for each inspection. The farm representative, the RFB observer and the inspector should sign the form.

Water Samples

A 30ml water sample should be taken at each inspection and preserved by the addition of 3-4 drops of Lugols Iodine.
This sample should be forwarded to the Phytoplankton section at the FRC at the earliest opportunity.

Disinfection Protocol for Sea Lice Inspections

1. All protective clothing, footwear, containers and equipment to be dipped/washed in iodophor (0.5%) on return to shore.
2. All observer from RFB's to be advised to disinfect before entering and on leaving Dip and/or wash all footwear and protective clothing in iodophor (0.5%) prior to leaving the shore base for the sea site.
3. All bins, containers and equipment to be dipped/washed in iodophor (0.5%) prior to leaving the shore base for the sea site.
4. All instruments and work surfaces to be washed in Virkon (2%) prior to use.
5. All observers from RFB's to be advised to disinfect before entering and on leaving site, as per above protocol.

APPENDIX 2

Key Facts about lice infestation during 2007

Dr David Jackson

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 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	Over outside	Total Samples	Total Over	% over in Spring	% over outside	% 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 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 19 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. 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.

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 2). Roancarraig (Silver King Seafoods Ltd), Bantry Bay, was the only site stocking 2006 fish in 2007.

Table2. Breakdown of inspections for 2006 fish on Southwest sites in 2007.

Company	Site	Samples in Spring	Over in Spring	Samples outside	Over outside	Total Samples	Total Over	% over in Spring	% over outside	% 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 3).

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

Company	Site	Samples in Spring	Over in Spring	Samples outside	Over outside	Total Samples	Total Over	% over in Spring	% over outside	% 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%
	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, 3 of which 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 the spring period.

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 10 out of 27 inspections (37%) in the Northwest region during the spring period and on 9 out of 25 inspections (36%) outside that period (see Table 4).

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

Company	Site	Samples in Spring	Over in Spring	Samples outside	Over outside	Total Samples	Total Over	% over in Spring	% over outside	% over total
Marine Harvest	**Millford**	3	1	2	0	5	1	33%	0%	20%
	Cranford A	6	3	2	2	8	5	50%	100%	63%
	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	10	25	9	52	19	37%	36%	37%

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 July. Millstone (Marine Harvest), Mulroy Bay, had elevated sea lice levels for December/January, March, May, June, September and November. Glinsk had elevated sea lice levels for 3 inspections in the spring period and again in October prior to harvesting.

Regional Monthly Means for one-sea-winter salmon

L. salmonis monthly mean figures for one-sea-winter salmon are shown in Figures 1 and 2 for each of the three regions. Regional monthly mean *L. salmonis* levels were in excess of treatment trigger levels in all 3 regions during the 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, July, 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.

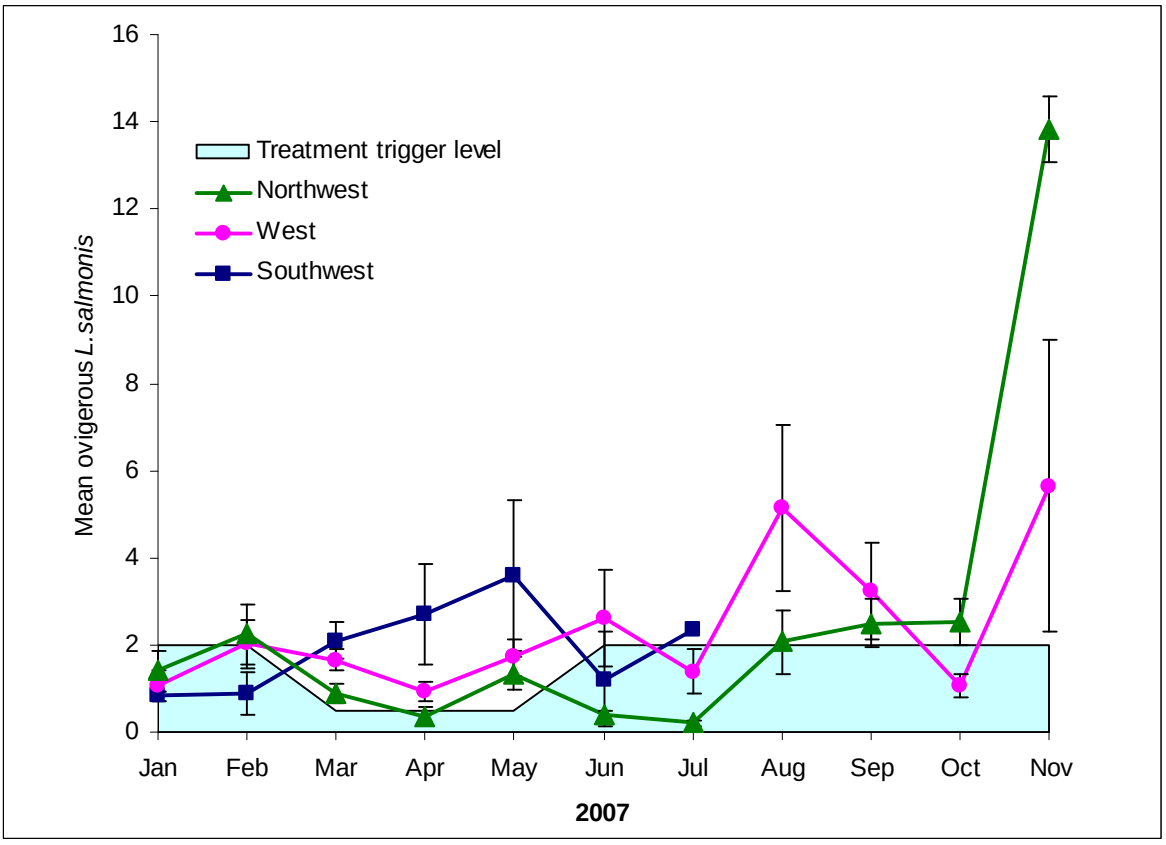

Figure 1. Mean (SE) ovigerous *L. salmonis* per month per region in 2007.

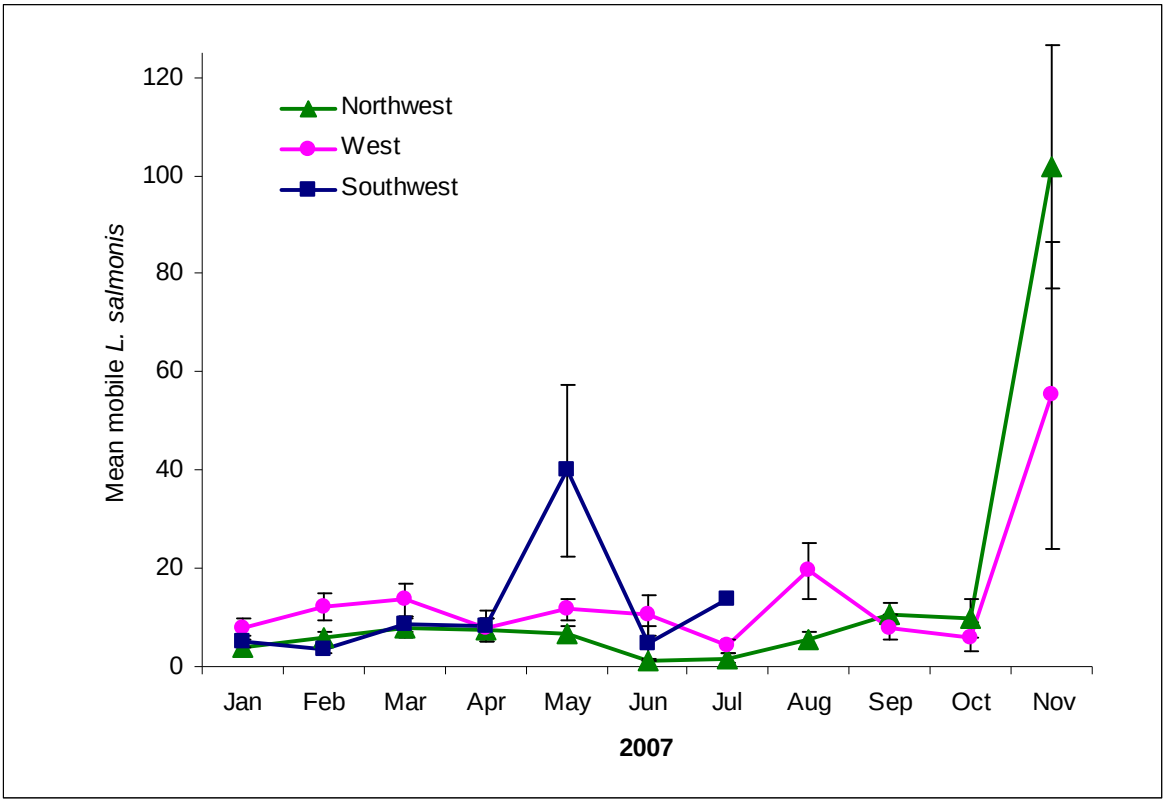

Figure 2. Mean (SE) mobile *L. salmonis* per month per region in 2007.

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 3 and 4 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.

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, with the exception of 2004. Levels in 2007 are at 1.74 ovigerous per fish, the highest since 1992 which reached 2.34 ovigerous per fish.

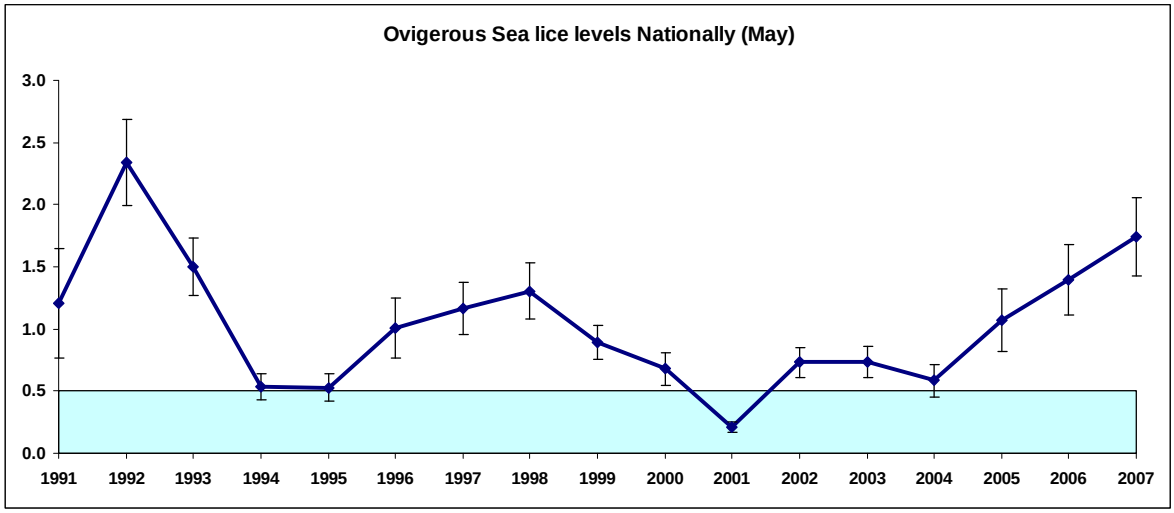

Figure 3. Annual trend (May mean) (SE) ovigerous *L. salmonis* on one-sea-winter salmon.

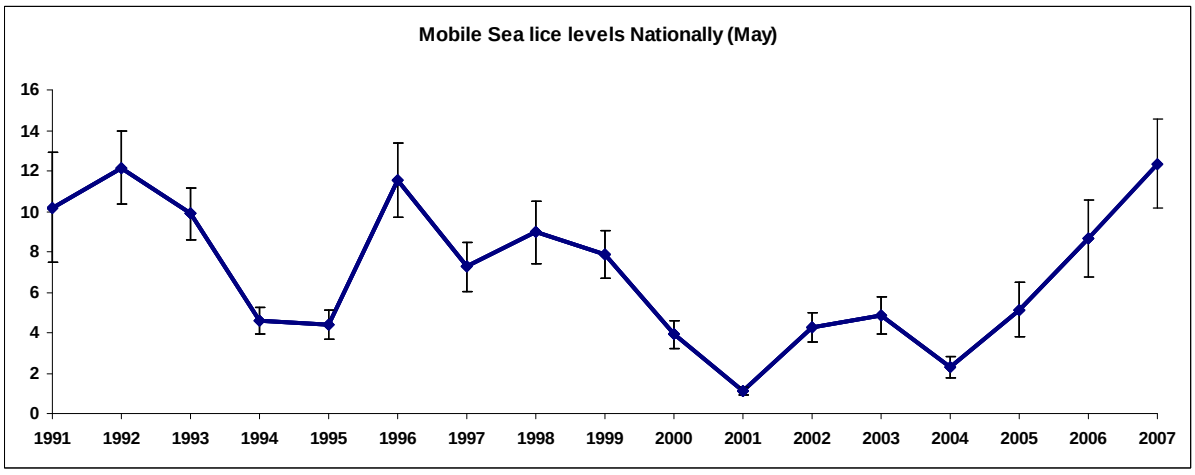

Figure 4. Annual trend (May mean) (SE) mobile *L. salmonis* on one-sea-winter salmon.

Mean mobile levels show a similar pattern with a steady increase from 2004 to their highest level on record in 2007 at 12.35 mobile sea lice per fish.

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. However in certain cases re-infestation from the surrounding environment has occurred quite quickly.

Appendix 3

Sea Lice Data for March 2008

		Date	*Lepeophtheirus salmonis* F + eggs	Total
BANTRY BAY				
FASTNET MUSSELS LTD				
Cuan				
Baoi				
	Atlantic salmon, 2008 S 1/2	04/03/2008	0.00	0.07
		18/03/2008	0.03	0.13
SILVER KING SEAFOODS LTD				
Roancarraig				
	Atlantic salmon, 2008 S 1/2	04/03/2008	0.00	0.04
		19/03/2008	0.00	0.00
JOHN POWER TROUT				
Waterfall				
	Rainbow trout 2007 (1)	04/03/2008	0.00	0.00
		19/03/2008	0.00	0.03
KILKIERAN BAY				
MUIRACHMHAINNI TEO				
Daonish				
	Atlantic salmon, 2007 S 1/2	06/03/2008	0.35	3.67
		19/03/2008	0.63	10.08
Golam				
	Atlantic salmon, 2008 S 1/2	05/03/2008	0.14	1.76
		20/03/2008	0.12	1.67
MUIR GHEAL TEO				
Cnoc				
	Atlantic salmon, 2007 S 1/2	13/03/2008	1.49	8.09
		27/03/2007	0.94	23.33
Ardmore				
	Atlantic salmon, 2007 S 1/2	13/03/2008	1.00	10.64

		27/03/2008	0.91	13.00
Lettercallow				
	Atlantic salmon, 2008 S 1/2	13/03/2008	0.02	0.12
		27/03/2008	0.00	0.55
The Gurrig				
	Atlantic salmon, 2008 S 1/2	05/03/2008	0.20	2.83
		20/03/2008	0.25	3.30

MANNIN BAY

MANNIN BAY SALMON CO LTD

Hawk's Nest

	Atlantic salmon, 2007		Moved to Corhounagh	

Corhounagh

	Atlantic salmon, 2007	18/03/2008	0.82	28.09
		27/03/2008	0.84	29.90

BALLINAKILL BAY

BIFAND LTD

Fraochoilean

	Atlantic salmon, 2007 S 1/2	04/03/2008	3.40	8.73
		25/03/2008	2.48	9.63
	Atlantic salmon, 2008 S 1/2	04/03/2008	0.00	0.35
		25/03/2008	0.00	0.68

MANNIN BAY SALMON CO LTD

Ballinakill

	Atlantic salmon, 2006	04/03/2008	4.78	11.89
		25/03/2008	7.88	40.38

KILLARY HARBOUR

CELTIC ATLANTIC SALMON (KILLARY) LTD

Rosroe

	Atlantic salmon, 2007	14/03/2008	0.39	1.75
	Atlantic salmon, 2007	28/03/2008	0.14	0.78

CLEW BAY

CLARE ISLAND SEAFARMS LTD

Seastream Inner

Atlantic salmon, 2006	06/03/2008	0.23	2.22
	20/03/2008	0.35	3.04

Portlea

Atlantic salmon, 2007	06/03/2008	2.31	6.57
	25/03/2008	0.49	1.50

BEALACRAGHER BAY

CURRAUN FISHERIES LTD

Curraun

Rainbow trout 2007 (2)	06/03/2008	0.06	0.35
	20/03/2008	0.04	0.36
Rainbow trout 2007 (3)	06/03/2008	0.04	0.41
	20/03/2008	0.00	0.07

DONEGAL BAY

EANY FISH PRODUCTS LTD

Inver Bay

Rainbow trout 2007 (2)	14/03/2008	0.00	0.13
	27/03/2008	0.00	0.21
Rainbow trout 2007 (3)	14/03/2008	0.00	0.16
	27/03/2008	0.05	0.80

MARINE HARVEST

McSwyne's Bay

Atlantic salmon, 2007	14/03/2008	0.05	2.77
	27/03/2008	0.75	3.06

Ocean Inver

Atlantic salmon, 2008			
S1/2	14/03/2008	0.00	0.04
	27/03/2008	0.00	0.03

MULROY BAY

MARINE HARVEST

Moross 1

Atlantic salmon, 2007	04/03/2008	0.14	5.05
	19/03/2008	0.25	7.70

Millstone

Atlantic salmon, 2006		Harvested Out	
Atlantic salmon, 2007 S 1/2	04/03/2008	0.00	4.48
	19/03/2008	0.05	3.09

LOUGH SWILLY

MARINE HARVEST

Lough Swilly

Atlantic salmon, 2006		Harvested Out	
Atlantic salmon, 2007 S 1/2	04/03/2008	0.25	10.77
	19/03/2008	1.09	13.45