Dangerous Substance Usage in Finfish Aquaculture

Report prepared by the Marine Institute for SWRBD

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Summary

Over recent years the finfish aquaculture sector has contracted in Ireland. The bulk of this sector is accounted for by marine salmon production. A number of substances are used in finfish farming that may give rise to discharges to the aquatic environment.

Substances discharged from finfish aquaculture locations

The main medicinal treatments used in finfish aquaculture by volume (active ingredient) are antibiotics, especially oxytetracycline, although the pattern of medicinal use in finfish aquaculture changes frequently. The sea lice treatments currently used are Slice (active ingredient emamectin benzoate), Excis (cypermethrin) and Ektobann (teflubenzuron) and Alphamax (deltamethrin). While the greatest overall quantity of sea lice treatment product used from 2004-2006 was Slice, there is a relatively low proportion of active ingredient. Overall use of sea lice treatments as volume active ingredient during the 2004-2006 period were:

Teflubenzuron > Emamectin > Cypermethrin > Deltamethrin

However, that hides the changing usage pattern over the 3 years with teflubenzuron only becoming available in 2006 and deltamethrin in 2005. The use of cypermethrin has greatly diminished as it has become less effective. In 2006 the estimated quantities of sea lice active ingredient were:

Teflubenzuron(177kg)>> Emamectin(6.4kg) > Deltamethrin(3.26L) >> Cypermethrin(0.04L)

Other treatments and substances used include the anti-fungicide bronopol, the anaesthetic tricaine methane sulphonate and disinfectants.

Other substances discharged by fish farms include nitrogen, phosphorus and organic carbon associated with fish waste and feed. Antifoulants and feed are also a source of copper and zinc. A total load for feed derived zinc discharge is estimated at approximately 966kg in 2005.

The extent of finfish aquaculture in Ireland

The most recent information from DCMNR indicates 45 marine sites licenced for finfish aquaculture and 69 freshwater site licences. There are considerably less active sites and the Marine Institute fish health database lists 60 finfish aquaculture sites of which 27 are marine sites.

Aquaculture: Medicine regulation and monitoring

This report includes information on the authorisation process for medicines for use in aquaculture and also on related monitoring programmes. Work is underway to develop an approach for regulating chemical use and discharge from finfish aquaculture in Ireland.

1. Introduction

1.1 Scope of the report

This report was prepared by Evin McGovern, Marine Institute on foot of a request by the South Western River Basin District (SWRBD). The report covers the following agreed areas

- Review of dangerous substances relevant to aquaculture
- A list of licences for fish farms and an indication of which are believed to be currently active
- Assessment of total quantities of relevant treatments prescribed for 2004- 2006
- A short overview of the regulatory system

Information presented in chapters 3, 4, and 5.1 was compiled by Hamish Rodgers, Vet-Aqua International. The figures used in these sections have been sourced from Vet-Aqua International, which is the veterinary practice that provides veterinary services to the majority (90 – 95%) of the finfish farms in Ireland and its sister company, Atlantic Veterinary Services Ltd., which is a Department of Agriculture authorised wholesaler for animal remedies. There are other agricultural suppliers of disinfectants for fish farms in Ireland and in the absence of exact figures for the supply of these to fish farms estimates have been supplied based on the treatments considered to have been undertaken by the farms. Any estimates used are based on the knowledge of the treatment or cleaning frequency on the fish farms. Fish vaccines are not included in this report.

The information contained in this report provides a current “snapshot”. However, the pattern of medicine use changes continually as new products or alternatives (e.g. vaccines) become available and other treatments become less effective. The pattern of medicine usage will also vary as new diseases emerge or as old diseases change their pattern of virulence.

1.2 Finfish Aquaculture in Ireland

The finfish aquaculture sector in Ireland predominantly produces Atlantic Salmon (*Salmo salar*). Rainbow trout (*Oncorhynchus mykiss*) accounts for a much smaller part of the sector and both freshwater and sea reared trout are produced.

For salmon and sea-reared trout the cycle commences in freshwater hatcheries and initial rearing occurs in freshwater before transfer to sea. Table 1 shows the production statistics for 2003 - 2005. Production has been falling since a peak in 2001 (Total volume in 2001: 25,082 tonnes of which 23,312 was salmon).

Table 1: Aquaculture production in 2003 –2005 (Tonnes)[1]

	2003	***2004***	***2005***
Salmon	16,347	14,067	13,764
Sea Reared Trout	370	282	717
Freshwater trout	1,081	889	897
Others	40	25	6
Total	17,838	15,263	15,384

Note, that as well as hatcheries rearing fish for intensive aquaculture production there are also freshwater hatcheries and facilities rearing fish for angling and for stocking of wild fisheries. These are not covered in this report.

1.3 Chemicals usage in aquaculture

Use of chemicals in finfish aquaculture can be grouped as follows:

a. Medicinal treatments (these may be bath or in-feed treatments)
b. Antifoulants used on equipment (nets, cages)

[1] Parsons. A, (2005) Status of Irish Aquaculture 2004& Browne, R. (2006). Status of Irish Aqauculture (2006). Reports produced by MI Galway, BIM and Taighde Mara Teo.

c. Anaesthetics
d. Feed additives (e.g. zinc, dyes)
e. Others (e.g. Disinfectants, detergents)

Other substances are discharged in fish waste or uneaten feed, for example

f. nutrients associated with waste,
g. contaminants associated with feed.

The primary medicinal treatments used in aquaculture are

- Antibacterial agents
- Antifungal agents
- Antiparasitic treatments (e.g. Sea lice treatments)

1.3.1 Medicines/ veterinary treatments:

A detailed review of the use of veterinary treatments is given in chapters 3 and 4. The increased use of vaccines has reduced the use of antibiotics in this sector although the use varies as different issues arise and as disease patterns vary.

Under the National Sea Lice Management Programme, measures are taken to control the levels of sea lice in farmed salmon and mitigate against possible impacts on wild sea trout stocks. An important element of the management strategy is targeted treatment regimes, included synchronous treatments.

In accordance with the residues directive (Dir. 96/23/EC), monitoring is carried out by the Marine Institute, on behalf of DCMNR, to support consumer protection (food safety), ensure proper use of medicines (e.g. adherence to withdrawal periods), and control use of illegal substances. Use of Malachite Green (MG) in freshwater has been detected in the past but, following increased surveillance and industry awareness, the results of the MI's monitoring programme suggest this

practice has ceased. As MG is not a veterinary treatment it may not be used even under the cascade principle (see Chapter 5.2).

There is some uncertainty as to whether or not antibiotics and disinfectants should be considered as biocides under Directive 76/464. Antibiotic are not included in the exhaustive list of biocide products in Directive 98/8 and are not specifically mentioned in List I or II of Directive 76/464. It is also worth taking note that SEPA have not set EQSs for antibiotics used in aquaculture.

1.3.2 Feed additives & contaminants:

Zinc is added to feeds to prevent cataracts in fish and therefore finfish aquaculture is a source of zinc through uneaten feed and fish waste. The Scottish Environmental Protection Agency (SEPA) have published a method for fish farms to estimate the emissions of zinc from marine fish farms calculated from the quantity of feed used[2]. This assumes 23% is emitted to the environment (3% loss through uneaten feed and 20% through excreta).

Applying this formula and assuming a feed conversion ratio of 1.25:1 to production statistics (table 1) to calculate total feed quantities used, it is estimated of the total load of feed derived zinc discharged in 2005 from Irish finfish aquaculture was approximately 966kg.

Feed is also a potential source of other additives and contaminants. Organochlorine compounds such as PCBs, have been detected in the fish oil/fish meal used in feed. In a study undertaken in 2001/2, SEPA[3] found levels of PCBs in sediments collected in areas close to marine fish farm cages in the concentration range 0.45 to 34.3 µg/kg. The report indicated that the majority of sites would be considered “slightly

[2] SEPA (2004) Scottish Pollution research Inventory, Marine Fish Farm Emission Calcualtion consultation Part 2. 24 November 2004.
[3] SEPA (2005). The Occurrence of Polychlorinated Biphenyls in Sediments Adjacent to Marine Fish Farms: Results of Screening Surveys During 2001 & 2002. Report TR- 030905_LJS. November 2005.

contaminated" but below "probable biological effects" levels.

Improvements in feed formulation and in fish farm practices have led to improved feed conversion ratios and reduced feed loss.

1.3.3 **Antifoulants***:* Use of Tributyltin (TBT) has not been permitted on aquaculture installations for over 20 years. Where antifoulants are used to prevent fouling of cages they are usually, copper based. Zinc may also be an active ingredient in some products. Antifoulants are not always used and mechanical cleaning of nets/equipment is often preferred.

2. Overview of fish farm licences in Ireland

The fish farming industry has undergone substantial rationalisation in recent years. While a record of extant licences is maintained by DCMNR, this does not reflect the true number of active sites. A list of current marine finfish aquaculture licences is attached as Annex 1 and a recent list of freshwater site licences is given in Annex 2. Table 2 gives an indicative list of actual sites in operation, including marine and freshwater. This is based on best information available to the Marine Institute (Marine Institute fish health database). However, this information is likely to date rapidly as the sector is subject to constant change. Currently 60 sites are listed of which 27 are marine sites. In total 39 companies are listed.

Table 2: Indicative List of current active sites (Marine Institute database Mar 2006)

License No.	Company Name	Site Name	Water Type	County
?	Douglas Valley	Douglas Valley	Fresh	Cork
097/579	Celtic Atlantic Salmon	Rosroe	Marine	Galway
177	Gaelic Seafoods (Ireland) Ltd	Casheen Bay	Marine	Galway
178	Muir Gheal Teo	Oilean Iarrach	Marine	Galway
180	Mannin Bay Salmon Ltd	Hawks Nest	Marine	Galway
181	Eisc Ui Fhlatharta Teo	Ardmore	Marine	Galway
214	Iasc Mhuicineach Teo	Camus Bay	Fresh	Galway
236	Feirm Mara Oilean Acla Teoranta	Achill	Fresh	Mayo
39140	Comhlacht Forbartha Toin-Re-Gaoith Teoranta	Goatesbridge	Fresh	Kilkenny
277	Clare Island Seafarms Ltd	Portlea, Clare Island	Marine	Clare
283	Blue Springs	Boyle	Fresh	Roscommon
299	Silverking Seafoods Ltd.	Dinish	Marine	Cork
321	Cuan Baoi Fisheries Ltd	Bantry Bay A	Fresh	Cork
321/497	Cuan Baoi Fisheries Ltd	Bantry Bay	Marine	Cork
336	Celtic Fisheries Ltd.	Lough Allen	Fresh	Leitrim
349	Cuigeal Teo	Carraroe 1	Marine	Galway
349	Cuigeal Teo	Carraroe 2	Marine	Galway
40	John Power	Bearhaven, Ahabeg/ Roancarraig	Marine	Cork
40	John Power	Bearhaven, Palmers Point	Marine	Cork
425	St. Killians Harvest Ltd	Doon Point, kenmare River	Fresh	Kerry
484	Silverking Seafoods Ltd.	Bantry Bay	Fresh	Cork
484	Silverking Seafoods Ltd.	Bantry Bay(A)	Marine	Cork
588	Eisc Ui Fhlatharta Teo	Ardmore Bay	Marine	Galway
627	Muirachmhainni Teo	Redflag	Marine	Galway
641	Clare Island Seafarms Ltd	Clew Bay	Fresh	Mayo
643	Celtic Atlantic Salmon	Inishdeighil	Marine	Galway
645	Muirachmhainni Teo	Golam	Marine	Galway
646/673	Muirachmhainni Teo	Kilkieran Bay	Marine	Galway
648	Gorlan Connemara Teo	Lough Ahalia	Fresh	Galway
80	Marine Institute	Furnace*	Fresh	Mayo

License No.	Company Name	Site Name	Water Type	County
AQ 202	Marine Harvest Ireland	Mulroy Bay	Fresh	Donegal
AQ 286	Eany Fish Products Ltd	Inver Bay	Fresh	Donegal
AQ286	Eany Fish Products Ltd	Inver Bay (A)	Marine	Donegal
FCL 199	Murpet Fish Company	Deenish	Fresh	Donegal
Q19	Glanmore Shellfish	Glanmore	Fresh	Kerry
T12 77C	Marine Harvest Ireland	Millstone	Marine	Donegal
T12/77/7	Marine Harvest Ireland	Glinsk	Marine	Donegal
T12/77B & 77D	Marine Harvest Ireland	Moross 1 & 2	Marine	Donegal
T12/82	Marine Harvest Ireland	Millford	Marine	Donegal
T12/82A &82B	Marine Harvest Ireland	Cranford A, B, C	Marine	Donegal
T5	Portside Fish Farm	Inver Bay A	Marine	Donegal
T5	Portside Fish Farm	Inver Bay B	Marine	Donegal
Unknown	Mannin Salmon	Beaghcauneen Lake, Clifden	Fresh	Galway
Unknown	Araglen Trout Farm	Araglen	Fresh	Cork
Unknown	Ballyare Fish Farms Ltd.	Rathmelton	Fresh	Donegal
Unknown	Curraun Fisheries	Bellacragher Bay	Marine	Mayo
Unknown	Delphi Fishery	Dephi*	Fresh	Galway
Unknown	Douglas Shellfish Ltd	Kilworth	Fresh	Cork
Unknown	Eir Nor Teo.	Borlin Derrynafinchin Bantry	Fresh	Kerry
Unknown	Eir Nor Teo.	Glentrashna,Lauragh	Fresh	Kerry
Unknown	ESB Fisheries Conservation.	Ballyshannon*	Fresh	Donegal
Unknown	ESB Fisheries Conservation.	Carrigadrohid*	Fresh	Cork
Unknown	ESB Fisheries Conservation.	Parteen*	Fresh	Tipperary
Unknown	Goatsbridge Trout Farm	Ballyduff	Fresh	Kilkenny
Unknown	Goatsbridge Trout Farm	Goatsbridge	Fresh	Kilkenny
Unknown	PDS Perch	Gowna	Fresh	Cavan
Unknown	Rathvilly Trout Farm	Rathvilly	Fresh	Carlow
Unknown	Rooskey	Rooskey	Fresh	Roscommon
Unknown	Salmo Nova Ltd Garryhill Hatchery	Garryhill	Fresh	Carlow
Unknown	Stofinfiskur Ireland Ltd	Bunatober	Fresh	Galway

** fish for restocking of wild fisheries. Other hatcheries for restocking are not included*

3. A review of medicine and disinfectant usage in Irish finfish aquaculture 2004 –2006

The trade names, active ingredients and whether the product is used by freshwater, marine of both types of fish farms are listed in Tables 3 and 4. The percentage active ingredients in the formulations of medicines and disinfectants and the quantities used are shown in Tables 5 and 6 for the years 2004 to 2006 inclusive. The breakdown per year of the medicines and disinfectants used are shown in Tables 5 and 8. The quantities of the products and active ingredients used in freshwater or the marine farms for the three years are shown in Tables 9 and 10.

Table 3: Medicines used in finfish aquaculture (freshwater and/or marine farms) in Ireland 2004 – 2006

Medicine	Active Ingredient	FreshwaterMarine/Both	Form	Treatment
Alphamax	Deltamethrin	Marine	Liquid	Bath
Betamox LA	Amoxycillin	Freshwater	Liquid	Injection
Ektobann	Teflubenzuron	Marine	Powder	Feed
Excis	Cypermethrin	Marine	Liquid	Bath
Florocol	Florfenciol	Both	Powder	Feed
Maracycline	Oxytetracycline hydrochloride	Both	Powder	Feed
MS 222	Tricaine methane sulphonate	Both	Powder	Bath
Pyceze	Bronopol	Both	Liquid	Bath
Slice	Emamectin benzoate	Both	Powder	Feed
Sulfatrim	Trimethoprim & sulphadiazine	Both	Powder	Feed

Table 4: Disinfectants used in finfish aquaculture (freshwater and/or marine farms) in Ireland 2004 – 2006

Disinfectant	Main Active Ingredient	Freshwater/Marine Both	Form
Biosolve	Sodium hydroxide	Freshwater	Liquid
Buffodine	Iodine	Freshwater	Liquid
FAM 30	Iodine, phosphoric acid, sulphuric acid	Both	Liquid
Formalin	Formaldehyde	Freshwater	Liquid
Halamid	Sodium p-toluenesulfonchloramide (chloramine T)	Freshwater	Powder
Hydrogen peroxide	Hydrogen peroxide	Marine	Liquid
Vetrefoam	Sodium hydroxide	Freshwater	Liquid
Virkon Aquatic	Pentapotassium bis (peroxymonosulphate) bis (sulphate)	Both	Powder
Virudine	Iodine, orthophosphoric acid, sulphuric acid	Both	Liquid

Table 5: Percentage active ingredients and quantities of medicines used in finfish aquaculture in Ireland 2004 – 2006 (AR 16 – exceptional temporary license issued by Dept. of Agriculture, cascade – refers to process veterinarians may use under the Animal Remedies Regulations 2005 where there is no authorised animal remedy, MA – marketing authorisation, POM – prescription only medicine, POM (E) – prescription only exempt medicine).

Medicine	Percentage Active Ingredient	Quantity '04 – '06 (litres or kg)	Quantity active '04 – '06 (l or kg)	Authorisation status*
Alphamax	1	341	3.41	AR16
Betamox LA	15	2.4	0.36	Cascade(full MA for terrestrial animals)
Ektobann	100	177	177	AR16
Excis	1	415.2	4.15	Full MA for salmon – POM (E)
Florocol	50	45	22.5	AR16 & cascade (full MA in UK)
Maracycline	100	2,465	2,465	Full MA for salmon – POM
MS 222	100	159	159	MA pending
Pyceze	50	69	34.5	Cascade (full MA in UK)
Slice	0.2	11,865	23.7	Full MA for salmon – POM
Sulfatrim	50	98	49	License expired and medicine no longer available

The status of all medicines is subject to change but the status of listed medicines at the time of writing is given.

Table 6: **Percentage of active ingredients and quantities of disinfectants used in finfish aquaculture in Ireland 2004 – 2006.**

Disinfectant	Percentage Active Ingredient	Quantity '04 – '06 (litres or kg)	Quantity active '04 – '06 (l or kg)
Biosolve	1 - 5	75	3.75#
Buffodine	1	28	0.28
FAM 30	2.75% iodine	100	2.75
Formalin	39	2,050*	799.5*
Halamid	100	540	540
Hydrogen peroxide	35	1500	525
Vetrefoam	1 - 5	5	0.25#
Virkon Aquatic	50	2,250	1,125
Virudine	3% iodine	275	8.25

estimated quantity.
 # percentage active taken at 5%

Table 7: Quantities (litres or kilograms) of medicines (and active ingredients) used in finfish aquaculture in Ireland 2004 – 2006.

	Quantity of Active Ingredient					
Medicine	***2004***	***2005***	***2006***	***2004***	***2005***	***2006***
Alphamax	0	14.5	326	0	0.15	3.26
Betamox LA	0	2.4	0	0	0.36	0
Ektobann	0	0	177	0	0	177
Excis	182.8	228.8	3.6	1.83	2.29	0.04
Florocol	15	17.5	12.4	7.5	8.75	6.2
Maracycline	251.5	949	1264.5	251.5	949	1264.5
MS 222	56.7	66.9	35.2	56.7	66.9	35.2
Pyceze	16	28	25	8	14	12.5
Slice	4,169	4,500	3,193	8.34	9	6.39
Sulfatrim	67	31	0	33.5	15.5	0

Table 8: Quantities (litres or kilograms) of disinfectants (and active ingredients) used in finfish aquaculture in Ireland 2004 – 2006.

Quantity of Active Ingredient						
Disinfectant	***2004***	***2005***	***2006***	***2004***	***2005***	***2006***
Biosolve	0	55	20	0	2.75	1
Buffodine	1	12	15	0	0.12	0.15
FAM 30	100	0	0	5	0	0
Formalin*	683	683	683	266.4	266.4	266.4
Halamid	210	137	193	210	137	193
Hydrogen peroxide	0	0	1500	0	0	525
Vetrefoam	0	5	0	0	0.25	0
Virkon Aquatic	40	570	1640	20	285	820
Virudine	100	105	70	3	3.15	2.1

* Estimate

Table 9: Quantities of medicines used (and active ingredients) in finfish aquaculture (freshwater and/or marine farms) in Ireland in the three years 2004 to 2006 (in litres or kilograms).

Medicine	Quantity used in freshwater (FW)	Quantity of active in FW	Quantity used in marine (SW)	Quantity of active in SW
Alphamax	0	0	341	3.41
Betamox LA	2.4	0.36	0	0
Ektobann	0	0	177	177
Excis	0	0	415.2	415.2
Florocol	8	4	37	18.5
Maracycline	105	105	2360	2360
MS 222	132	132	27	27
Pyceze	67	33.5	2	1
Slice	22.5	0.05	11842.5	23.7
Sulfatrim	18	9	80	40

Table 10: Quantities of disinfectants used (and active ingredients) in finfish aquaculture (freshwater and/or marine farms) in Ireland in the three years 2004 to 2006 (in litres or kilograms).

Disinfectant	Quantity used in freshwater (FW)	Quantity of active in FW	Quantity used in marine (SW)	Quantity of active in SW
Biosolve	75	3.75	0	0
Buffodine	28	0.28	0	0
FAM 30	40	1.1	60	1.7
Formalin*	2,050	799.5	0	0
Halamid	540	540	0	0
Hydrogen peroxide	0	0	1500	525
Vetrefoam	5	0.25	0	0
Virkon Aquatic	2220	1110	30	15
Virudine	25	0.75	245	7.35

**Estimate*

4. Use of medicines and disinfectants in finfish aquaculture & environmental toxicity data

4.1 Medicines

Alphamax

Alphamax is used for the treatment of sea lice at a treatment dosage of 0.2 to 0.3ml/m^3 with the 10mg/ml formulation (2 - 3µg/litre for 30 – 40 minutes). It is used with either a tarpaulin to enclose the treatment pen or more commonly in a well-boat where the treatment volume is more easily controlled and also significantly reduced. The active ingredient is deltamethrin, a synthetic pyrethroid which is widely used in terrestrial ectoparasite control in Ireland for cattle and sheep. Deltamethrin is highly toxic for fish, the 96-h LC_{50} ranging between 0.4 and 2.0µg/litre and is also toxic to aquatic invertebrates (48-h LC_{50} for *Daphnia* is 5µg/litre)[4]. The product is toxic to crustaceous animals, and it is not recommended that it be used close to installations where crabs and lobsters are kept (< 200m), or where local sea currents lead to risk of exposure[5]. However, extensive field studies, in experimental ponds, and field use have shown that this high potential toxicity is not realised. Deltamethrin is not mobile in the environment because of its strong adsorption on particles, its insolubility in water, and very low rates of application.

Betamox LA

Betamox LA is a long acting injection formulation of amoxycillin trihydrate which is licensed for use in terrestrial domesticated animals where a broad spectrum antibiotic is required. It has been used occasionally in fish at risk from furunculosis by injection at the time of vaccination at a dose of 0.1ml/fish. Amoxycillin is rarely used now in aquaculture and has a very short environmental half-life (hours)[6].

[4] World Health Organisation (1990) Deltamethrin. Environmental Health Criteria 97. WHO, Geneva
[5] Pharmaq (2005) Alphamax Material Data Sheet. Pharmaq, 21 November 2005
[6] Black, K. D. (1998) The environmental interactions associated with fish culture. In: Biology of Farmed Fish (ed. by K. D. Black & A. D. Pickering). Sheffield Academic Press, Sheffield.

Ektobann

Ektobann is an oral treatment for sea lice which has recently been licensed in Ireland under an AR16. The active ingredient is teflubenzuron which was previously subject to a full marketing authorisation for the treatment of salmon under the trade name Calicide. Teflubenzuron is a benzoyl urea compound registered in many countries (including EC states) for use on a range of crops. Environmental data demonstrates that teflubenzuron is strongly adsorbed by soils and sediments and has a low potential for bioaccumulation. Studies with the use of teflubenzuron by the Scottish Environmental Protection Agency (SEPA) in salmon farms in Scotland confirmed that although measurable levels of teflubenzuron were noted at distances up to 1000m in line with the main current flow, by 645 days after the last treatment, around 98% of the total load had been degraded or dispersed from the treatment site. In addition, no adverse effects were detectable on benthic biology or site crustacea and it was concluded that by later stages residual teflubnzuron was in a non-bioavailable form[7].

Excis

Excis is the trade name for another synthetic pyrethroid known as cypermethrin which has been used for the treatment of sea lice at the dosage of 0.5ml/m^3 for 60 minutes (5µg/litre). This pyrethroid has also been widely used in terrestrial ectoparasite control, however, tolerance of sea lice to this medicine in some areas in Ireland has curtailed the use of the product, as can be seen in Table 5. Cypermethrin is very toxic for fish (96-h LC_{50}s were generally within the range of 0.4 – 2.8µg/litre in laboratory tests) and aquatic invertebrates (LC_{50}s in the range of 0.01 - 5µg/l)[8]. However, the presence of suspended solids decreases the toxicity of cypermethrin by at least a factor of 2, because of adsorption of cypermethrin to the solids.

[7] SEPA (1999) Calicide (teflubenzuron) – authorisation for use as an in-feed sea lice treatment in marine cage salmon farms. Risk Assessment, EQS and recommendations. Policy no. 29. SEPA Fish Farming Advisory Group, SEPA, Stirling.
[8] World Health Organisation (1989) Cypermethrin. Environmental Health Criteria 82, WHO, Geneva

Florocol

Florfenicol is the active ingredient in Florocol and this antibiotic is used occasionally as an oral medicine for systemic bacterial infections at the dosage of 10mg active/kg biomass fish/day for 10 days. Both florfenicol and its metabolites will enter the water column by leaching from medicated feed and faeces and by excretion in the aqueous phase of the excreta. Experimental studies of the persistence in marine sediments have indicated that the concentration of florfenicol decreased rapidly in the sediment with a calculated half-life of 4.5 days[9]. The metabolite, florfenicol amine, was detected and it appears that florfenicol is rapidly degraded in sediment. In studies minimum inhibitory concentrations, LC_{50}, or EC_{50} values and NOELs were compared to the predicted environmental concentration (PEC) in water and sediment in both marine and freshwater environments and the PEC values refined based on degradation and dissipation and values given were as follows:

Compartment	PEC value
Marine sediment	224µg/kg
Seawater	0.0035µg/litre
Freshwater	<0.0625µg/litre

The PEC to predicted no effect concentration (PNEC) ratio values were established for a range of micro-organisms, plants, invertebrates and fish and all were found to be very low reflecting the lack of toxicity of florfenicol to aquatic organisms and the rapid degradation and dissipation of the compound[10].

[9] Hektoen, H. *et al*. (1995) Persistence of antibacterial agents in marine sediments. Aquaculture, 133, 175 – 184.
[10] Schering-Plough Animal Health (2000) Aquaflor Technical Monograph. SPAH, Union, NJ, USA

Maracycline

Oxytetracycline hydrochloride is the antibiotic in Maracycline which is used when required to orally treat systemic bacterial infections at the dose rate of 75 to 100mg/kg biomass/day for 10 days. This antibiotic is widely used in terrestrial medicine for humans and domestic animals. Oxytetracycline appears to have long residence times in sediments, with various half-lives reported of up to hundreds of days and trace of uptake has also been detected in oysters and crabs in close proximity to treated salmon pens in Canada[11]. Coyne *et al.* studied the fate of oxytetracyline in sediments at an Irish fish farm at Bertraghboy Bay[12]. It was reported that concentrations in sediments declined exponentially with time and were reduced to traces after 66 days. The half life in mussels was reported as approximately 2 days.

MS222

MS222 or tricaine methane sulphonate is used as a bath solution to sedate and anaesthetise fish for vaccination in freshwater and also for examination, sample weighing and lice count examinations in marine farms. It is used as a local anaesthetic in humans. It is used for fish at concentrations of 15 to 200mg/l and is rapidly absorbed through the gills. The elimination half-life in salmon muscle is 70 minutes (in freshwater) and tricaine is rapidly metabolised by the liver[13]. The compound is assumed to be biodegradable but it is recommended not to discard it into the environment[14].

Pyceze

Bronopol (2-bromo-2-nitropropane-1,3-diol) is an antimicrobial preservative, which is used in human shampoos, cosmetics, in food-contact materials and also as a bath treatment for the control of fungal infections in farmed

[11] Fisheries & Oceans Canada (2003) A scientific review of the potential environmental effects of aquaculture in aquatic ecosystems. Volume 1. Ottowa, Canada
[12] Coyne, R., Smith, P., Moriarty, P. (2001) The fate of oxytetracycline in the marine environment of a salmon cage farm. Marine Environment and Health Series, No. 3. Marine Institute. Dublin.
[13] EMEA (1999) Tricaine mesilate. Committee for Veterinary Medicinal Products, London, EMEA/MRL/586/99-Final April 1999.
[14] Pharmaq (2001) MS222: material health and safety data sheet. January 2001, Pharmaq Ltd., Fordingbridge, UK

salmonids and eggs and for bacterial challenges in cod eggs. Dosage rates are usually 30 – 50mg bronopol/l water for 30 minutes, repeated as required (sometimes daily). Ecological information indicates 96-h LC_{50}s for rainbow trout of 20mg/litre, 48-h EC_{50} for *Daphnia* of 1.4mg/l and 72-h EC_{50} for freshwater algae (*Selenastrum capricornutum*) of 0.16mg/l[15].

Slice

Emamectin benzoate is the active ingredient in Slice and is used at treatment levels of 50µg/kg of fish biomass per day for seven days. The available data indicate that the use of emamectin benzoate to treat lice infestations in salmon should create no risk of adverse impacts on sensitive pelagic life, vertebrate or invertebrate[16]. Whilst PEC: PNEC values for sediments in the vicinity of treated farms, derived from conservative models, indicate a risk to sensitive invertebrates, measured concentrations in sediments close to the farm indicate a much smaller localised risk. The environmental risk characterisation for emamectin is shown over:

Table 11: PEC and PNEC values for Emamectin benzoate in sediment

Compartment	PEC value ppb)	PNEC (ppb)	PEC:PNEC
Feed	5,000	1.11*	4,505
		6,820**	0.73
Faeces	156 – 637	1.11*	141 – 574
		6,820**	0.02 – 0.09

** derived from Arenicola marina exposed in sediment*
*** derived from Nephrops norvegicus exposed to medicated feed*

[15] Novartis (2004) Pyceze: material safety data sheet. 6th October 2004, Novartis Animal Vaccines Ltd., UK
[16] Schering-Plough Animal Health (2002) Potential environmental impacts of emamectin benzoate, formulated as Slice, for salmonids. Technical Report, Union, NJ, USA.

Sulfatrim

This broad spectrum antibiotic which is a potentiated sulphonamide (trimethoprim and sulphadiazine) is now no longer available as the license has expired and the formulation for aquaculture is no longer produced by the pharmaceutical company (Novartis). Dosage rate was 30mg/kg fish/day for eight days. Trimethoprim has a short environmental half-life, however, sulphadiazine is more persistent [17].

4.2 Disinfectants

Biosolve & Vetrefoam

The alkali, sodium hydroxide is the active ingredient in both of these heavy duty cleaning agents which are utilised on farms to degrease and clean equipment, boats, tanks, etc. prior to disinfection. It is corrosive and irritant and the organic components are biodegradable.

Buffodine

Buffodine is an iodine complex disinfectant for use against major fish viruses and is used for the disinfection of fish eggs. It is used as a short bath or rinse at 10 parts Buffodine to 1000 parts water and has 1% active iodine in the Buffodine.

FAM 30, Virudine and others

These iodophore disinfectants are used for farm equipment, tank, boat disinfection as well a for foot dips/baths and are corrosive and may cause long term adverse effects on the aquatic environment[18]. They are generally effective against pathogens in low concentrations but are inhibited in the presence of organic matter or hard water more than most disinfectants. They are one of the recommended disinfectants in the Irish infectious salmon

[17] Samulesen, O. B. *et al*. (1994) Stability of antibacterial agents in an artificial marine aquaculture sediment studies under laboratory conditions. Aquaculture, 126, 283 – 290.
[18] Antec (2004) Virudine safety data sheet HSD/37D. Antec International Ltd., Suffolk, UK

anaemia (ISA) withdrawal plan. The World Organisation for Animal Health (OIE) recommends that whenever iodine compounds are used for disinfection and are being discharged they should always be neutralised with an equivalent amount of sodium thiosulphate[19], however, this is not widely practised due to the impracticality of carrying out the procedure.

Formalin

Formalin is a formaldehyde solution which is normally purchased by the farms at 37 – 39% active and then used at 150 to 250ppm for 30 to 60 minutes. Solutions at less than 100ppm are readily biodegraded and formaldehyde is not known to be significantly bioaccumulated. Formaldehyde in lake water decomposed in approximately 30 h under aerobic conditions at 20°C and in approximately 48 h under anaerobic conditions[20]. Half-lifes of 24 – 168 h in surface water and 48 – 336 h in groundwater have been estimated. Environmental toxicity data for a wide range of terrestrial and aquatic organisms are available[21].

Halamid

Halamid is a trade name for sodium p-toluenesulfonchloramide, otherwise known as chloramine T and is a disinfectant active against bacteria, viruses, fungi and parasites. This sodium salt slowly decomposes in water to the hypochlorite anion and hence to weak hypochlorous acid. This is turn decomposes to chlorine and oxygen. The degradation product of chloramine T is p-toluene-sulfonamide (pTSA)[22]. There are results for toxicity testing on a range of aquatic species such as *Daphnia magna* (48 hour NOEC 1.8mg/l) and *Pimephales promelas* (35 day NOEC 1.5mg/l)[23]. It is used in freshwater at dosages from 2 to 20ppm for up to 60 minutes.

[19] OIE (2003) Manual of Diagnostic Tests for Aquatic Animals, 4th Edition. OIE, Paris
[20] World Health Organisation (2002) Formaldehyde. Concise International Chemical Assessment Document 40. WHO, Geneva.
[21] World Health Organisation (2002) Formaldehyde. Concise International Chemical Assessment Document 40. WHO, Geneva.
[22] Treves-Brown, K. M. (2000) Applied Fish Pharmacology. Kluwer Academic Publishers, Dordrecht
[23] Campbell, D. J. C. & Parsons, D. G. (1999) Halamid = Biosecurity. Fish Veterinary Journal, 3, 68 – 73.

Hydrogen peroxide

Hydrogen peroxide has many industrial uses as a bleaching and oxidising agent, however, there is a renewed interest in its use versus sea lice in salmon and as a disinfectant. Where it has been used as such the dosage is usually 1500ppm for up to 20 minutes. In the absence of a stabilising agent hydrogen peroxide rapidly decomposes to oxygen and water. Although hydrogen peroxide is toxic to some aquatic organisms including marine phytoplankton and crustacean, the rates of dilution and dissociation encountered on fish farms ensure that harmful effects on the environment are minimised[24].

Virkon Aquatic

Virkon Aquatic is used at 0.2 to 1% for at least 10 minutes and ecotoxicology data is available for fish and invertebrates (*Salmo salar* 96-h LC_{50} 24.6ppm, post-larvae tiger praws 96-h LC_{50} 10.31ppm, goldfish 48-h LC_{50} 500mg/l, *Daphnia magna* 48-h EC_{50} 6.5mg/l)[25].

[24] EMEA (1996) Hydrogen peroxide. Committee for Veterinary Medicinal Products, EMEA/MRL/061/96-Final, February 1996.
[25] Antec (no date) Antec Virkon (S) ecotoxicology summary. Safety data sheet. Antec International, Suffolk.

5. Finfish aquaculture regulation

5.1 Overview of fish medicine licensing in Ireland

The supply and use of medicines in Ireland is governed by the Animal Remedies Regulations 2005 (S. I. no. 734 of 2005) which were made under the Animal Remedies Act, 1993. Any product that claims a medical benefit for an animal must be assessed, registered and issued with a marketing authorisation (Veterinary Product Authorisation or VPA) by the Irish Medicines Board (IMB). Authorised medicines are prescribed for use on a case by case basis by a vet who may apply the veterinary cascade provisions, which itself can lead to problems with extended withdrawal periods, difficulties in importing products and extensive paperwork. In Ireland there are very few fully authorised medicines for salmon (four). There are no authorised medicines for trout, cod, perch or char so all these species have to be treated under the cascade. The few medicines that are available for salmon may be ineffective due to bacterial resistance or parasitic tolerance and hence special applications require to be made to the Department of Agriculture to allow the exceptional use of medicines available in other countries (the AR16 license), although for food-producing animals (as most farmed fish are classified) only products with an established maximum residue limit (MRL) which is classified at EC level can be used. Pharmaceutical companies may have to spend many millions of euro to have a medicine licensed in a country for a specific species and there is an increasing reluctance to invest in this process at present. Licenses require to be maintained (which costs money) and even though temporary AR16 licences may be issued by the Department of Agriculture in emergency or special case situations (for named farms), these are issued on the understanding that further applications will be made for full license.

5.2 Monitoring of aquaculture in Ireland

Residues Monitoring (Directive 96/23/EC)[26]: In accordance with this directive, salmon and trout from fish farms are routinely monitored for the presence of veterinary residues, contaminants and other substances. The purpose is to support consumer protection (food safety), ensure proper use of medicines (e.g. adherence to withdrawal periods), and control use of illegal substances. Monitoring is carried out by the Marine Institute on behalf of DCMNR and in liaison with FSAI. Annual residue control plans are agreed by DCMNR, MI and FSAI. The Department of Agriculture and Food (DAF) compile the National Animal Residues Control Plan for transmission to the EU. The sampling strategy depends on the substance. Primarily fish are sampled at harvest to ensure that levels of authorised medicines do not exceed Maximum Residue Levels (MRLs). However, fish are also sampled at other stages of production to target illegal substances such as malachite green. A summary of the outcome of recent residue monitoring is presented in table 12.

Benthic Monitoring: The Marine Institute compiles annual reviews of benthic monitoring at finfish aquaculture sites[27]. Finfish farms subject to such monitoring must submit annual returns as a requirement of their licence. Between 2003-2005 all surveyed sites had conditions that were deemed acceptable as per the monitoring protocols. However reporting was incomplete at 54%, 56% and 66% for the years 2003, 2004 and 2005 respectively.

[26] Council Directive 96/23/EC of 29 April 1996 on measures to monitor certain substances and residues thereof in live animals and animal products and repealing Directives 85/358/EEC and 86/469/EEC and Decisions 89/187/EEC and 91/664/EEC. *Official Journal L 125 , 23/05/1996 p. 0010 - 0032*

[27] Parsons. A, (2005) Status of Irish Aquaculture 2004& Browne, R. (2006). Status of Irish Aqauculture (2006). Reports produced by MI Galway, BIM and Taighde Mara Teo.

Table 12: Summary results for residue monitoring in finfish aquaculture (2003-2005[#])

Substances		Year	Number Non-compliant results / number of tests (no. samples)	Information on Non compliant
GROUP A Steroids Beta- agonists Chloramphenicol Nitrofurans GROUP B **Antibiotics** Oxytetracycline Oxolinic Acid Flumequine Sarafloxacin **Sea lice treatments** Ivermectin Emamectin benzoate Cypermethrin Teflubenzuron Diflubenzuron	GROUP B Cont'd **Others** PCBs Organochlorine pesticides Lead Cadmium Mercury Aflatoxin Malachite green Leuco Malachite Green	2003	13/ >1000 (202)*	9 MG/ LMG[Þ] 4 Oxytetracyline
		2004	8/ 900 (183)*	8 MG/LMG
		2005	2/ 731 (181)*	2 Emamectin

[#] 2006 residue results will be published by 31st March 2007

* The numbers presented are number of non-compliant results/the number of tests carried out (number of fish samples actually tested as). Note that multiple tests are often carried out on individual samples and some tests are for multiple parameters

[Þ] MG/LMG = Malachite Green/ leuco-malachite green

6. Conclusions

- There are a range of substances used in finfish aquaculture including veterinary medicines (primarily antibiotics, and sea lice treatments), disinfectants (mostly freshwater except hydrogen peroxide), feed additives and contaminants, antifoulants and nutrients associated with aquaculture waste. Currently the medicine used in the greatest quantity as active ingredient is the antibiotic oxytetracycline. The sea lice treatment used in the greatest quantity as active ingredient is teflubenzuron. It is not clear to the authors whether antibiotics and disinfectants are covered under the dangerous substance directive (DSD) but it is noted that SEPA have not set Environmental Quality Standards for antibiotics with respect to aquaculture. The pattern of medicine use in aquaculture is constantly changing.

- Although there are many more licenced sites, the Marine Institute Fish Health database currently lists 60 active sites of which 27 are marine. Again this is subject to frequent change.

- The process for authorisation of medicines is complex. Residues and benthic monitoring activities are outlined in this report and work is underway to develop a national approach for regulating chemical use and discharge for finfish aquaculture in Ireland.

ANNEX I: Inventory of Offshore Fishfarms. DCMNR - March 2007.

Inventory of Marine Installations

Offshore Fin fish farms

	File reference	Company/Licensee Name address	Site(s)	Tonnage / Area	Status (expiration)	Sch. I Subs	Sch. II Subs
1	**T9/93** AQ 176	**Comhlucht Bradain Chonamara Teo**	Lehannagh Pool	100t salmon	31/05/19		
	(G O'Donoghue)	Ardmore, Kilkieran Co G'way	in Bertraghboy Bay	22.5ha			
2	**T9/95** FCL 580	**Comhlucht Bradain Chonamara Teo**	Ballinakill Hbr site 95	Salmon & trout	21/02/78		
	(G O'Donoghue)	Tullymountain Salmon Farm	Freaghillaun site 132	in 30 cages(100t)			
		Drinagh, Errislannan, Clifden Co. G'way					
3	**T9/96** FCL 591	Ardbear Seafarms Ltd	Ardbear Bay Site 96B	Salmon & trout	Open ended		
	(G O'Donoghue)	Drinagh, Errislannan, Clifden Co. G'way	Clifden Bay	100t	licence		
4	T9/99/4 **AQ 349**	Tairgeoiri Biamara Atlantach Teo.	Site: 99A storage only	99A= Storage	14/11/11		
	(J O'Carroll)	Rinn, Carraroe Co. Galway	Site: 99C	99C= 500t salmon			
			GreatmansBay(Carraroe)	24.15ha			
5	**T9/105sf3** AQ178	Muir Gheal Teo	Illauneeragh/Lettercarrow	200t salmon	07/10/06		
	(D 'Ceallachain)	Lettermore, Co. Galway	Sites 105D & 105E	8ha			
6	T9/107 **AQ 169**	**Comhlucht Bradain Chonamara Teo**	Sealax	200t salmon	30/11/12		
	(G O'Donoghue)	Ardmore, Kilkieran Co G'way	in Bertraghboy Bay	11ha			
7	**T9/109/5** AQ 348	**Tairgeoiri Biamara Atlantach Teo.**	Keeraun Point	350t salmon	14/11/11		
	(J O'Carroll)	Rinn, Carraroe Co. Galway	Site 176	12ha			
8	**T9/109/6** AQ 426	**Tairgeoiri Biamara Atlantach Teo.**	Annaghvan Site 117A	Max 689t salmon	29/08/12		

	File reference	Company/Licensee Name address	Site(s)	Tonnage / Area	Status (expiration)	Sch. I Subs	Sch. II Subs
	(J O'Carroll)	**Rinn, Carraroe Co. Galway**	Lettemore Site 109A	Max smolt 690,000 (29.5ha)			
9	**T9/114** AQ 428	Eisc Iathglas Teo (Leased)	Ardmore Bay Site 114B	Max 1500t salmon	30/08/12		
	(D 'Ceallachain)	Ardmore, Kilkieran Co G'way	Macken Rocks Site 114A	Max smolt 480,000 37ha			
10	**T9/119** AQ 431	**D.M.C.I. (Leased)**	Golam Bay Sites 119A&B	285t salmon	19/08/12		
	(S O Laoi)	**Golam Teo An Tain, Casla Co. Galway**	Cuigeal Bay Site 119C	11.8ha			
11	**T9/124** AQ 648	**Screebe Fishery Ltd**	Lough Ahalia	60,000 smolts+ stock	07/04/08		
	(Marcus Carey)	Screeb House, Camus, Connemara Co. Galway	in Kilkieran Bay	Max 120,000 smolts			
12	**T9/127** AQ 180	**Ardbear Seafarms Ltd**	Clifden Bay/Hawk's Nest	100t salmon	22/06/12		
	(G O'Donoghue)	Drinagh, Errislannan, Clifden Co. G'way		4ha			
13	**T9/129** AQ102	**Iascaigh Innisbarra Teo DCMCI says he has ownership**	Site 129 at Innisbarra Bay	Harvest 200t trout & salmon.Produce	02/09/04		
	Status	(Has not been renewed yet)		150t salmon. 3ha			
14	**T9/134** AQ 430	**Iascaireacht Chuan Chaisin Teo**	Site 134A	384t salmon	29/08/12		
	(C McDonagh)	Furnish, Lettermullen Co. Galway	Coonawillween Bay	13.7ha			
15	**T9/140** AQ 122	Mannin Bay Salmon Company	Mannin Bay	200t salmon	30/06/09		
	(G O'Donoghue)	Market Street, Clifden Co. Galway	(Curhownagh)	3ha			
16	**T9/141** AQ 432	Muir Gheal Teo	Knock Bay Site 141A	Max smolt 550t	29/08/12		
	(D 'Ceallachain)	Lettermore, Co. Galway	Oilean Iarthach Site105C	1140t salmon	ALAB		
				25.5ha			
17	**T9/143** AQ 97/851	**Celtic Atlantic Salmon (Killary) Ltd.** Fintra House, Killybegs, Co Donegal **(Formerly Killary Salmon Company Ltd.)**	Inishdeihil (smolt site)	Max smolt 613,000	16/07/09		

	File reference	Company/Licensee Name address	Site(s)	Tonnage / Area	Status (expiration)	Sch. I Subs	Sch. II Subs
	(James Ryan)	Rosroe, Renvyle Co. Galway	Rosroe Killary Harbour	1900t salmon			
				37ha			
18	**T9/155** AQ 184	**Comhlucht Bradain Chonamara Teo**	Salt Point	400t salmon	31/12/10		
	(G O'Donoghue)	Ardmore, Kilkieran Co G'way	in Bertraghboy Bay	17.5ha			
19	**T9/155/1** AQ 183	**Comhlucht Bradain Chonamara Teo**	Rough Point	600t salmon	31/12/10		
	(G O'Donoghue)	Ardmore, Kilkieran Co G'way	in Bertraghboy Bay	12ha			
20	**T9/203** AQ 427	Eisc Uí Fhlatharta Teo	Birbeg Island Site 203B	Smolt 250,000	29/08/12		
	(Dara O'Flatharta)	Ardmore, Kilkieran Co G'way	Ardmore Bay Site 203A	546t salmon 19ha			
21	**T9/280** AQ 429	**Muirachmhainni Teo**	Cuigeal Bay Site 149A	Smolt 160,000	29/08/12		
	(Joe Lee)	Baile an tSagairt, Spideal	Dinish Site 136A	1386t salmon			
		Co. na Gaillimhe	Coonawileen Bay146A	244t salmon 30ha			
22	**T9/409** AQ 380	Feirmeoiri Bradain Chill Chiarain Teo	Red Flag Isl Site 409C	Smolt 1,195,000	31/01/12		
	(D 'Ceallachain)	C/o Muir Gheal Teo Lettermore Gallimhe	NaMacken Rocks 409B	Smolt 275,000			
			Birmore Isl Site 409A	Smolt 440,000			
				36.25ha			
23	**T9/455** TL 51	**Comhlacht Bradain Chonamara Teo**	Sites 93,107,155 & 155/1	70t cod	23/01/08		
	(D 'Ceallachain)	C/o Muir Gheal Teo Lettermore Gallimhe	Bertraghboy Bay	63ha			
24	**T10/51**	**Curraun Fisheries**	Bellcragher Bay	Salmon & trout			
	FLC/seeAQ163	Doughill, Westport Co. Mayo		90 cages			
	(Martin Hanley)						
25	**T10/54** AQ 166	**Seastream Ltd / Curraun Fisheries**	Inishcarraigh 54A Inishcannon 54B	800t salmon & trout	20/12/05 App for renewal		
	(Martin Hanley)	Doughill, Westport Co. Mayo	Carrickahash 54C	9ha			
26	**T10/58/4** AQ 5 See AQ 277	**Clare Island Seafarms Ltd** C/o Marine Harvest Irl, Kindrum	Site: 58A Clew Bay	Smolts 800,000	26/06/10		
	(Jan Feenstra)	Letterkenny Co. Donegal	**(Smolts site only)**	23.1ha			

	File reference	Company/Licensee Name address	Site(s)	Tonnage / Area	Status (expiration)	Sch. I Subs	Sch. II Subs
27	**T10/58/8** AQ277	**Clare Island Seafarms Ltd**	Portlea, Clare Isl 58B	3166t salmon	26/06/10		
	(Jan Feenstra)	C/o Marine Harvest Irl. Kindrum Letterkenny, Co. Donegal	Darby's Pt Achill Isl 58C	Hold max 200t 32ha			
28	**T10/67** AQ 163	**Curraun Fisheries Ltd**	Iniscannon Site 67B	350t salmon	18/12/05 App for renewal		
	(Martin Hanley)	Doughill, Westport Co. Mayo	Iniscoragh Site 67A	6ha			
29	**T12/63** AQ 285	**Creevin Salmon Farm**	Inver Bay	400t salmon	19/07/10		
	(Joe Rose)	Creevin, Mountcharles Co. Donegal		86.5ha			
30	**T12/77sf 3 v**	**Marine Harvest Ireland**	Kindrum Bay 77A	600t salmon	14/08/11		
	AQ 202	Kindrum, Cashel, Letterkenny Co. Donegal	Moross I&2 77B & 77D	24ha ?			
	(J Feenstra)		Millstone 77C				
			Broadwater 77E				
			Cranford C Site 78				
31	**T12/77/7**	**Marine Harvest Ireland**	Glinsk	700t salmon	02/05/06		
	AQ 325	Kindrum, Cashel, Letterkenny		3.4ha			
	(J Feenstra)	Co. Donegal					
32	T12/82 **AQ196**	Marine Harvest Ireland	Milford Site 82	250t salmon	30/06/11		
	(J Feenstra)	Kindrum, Cashel, Letterkenny	Cranford 82A & 82B	9ha			
		Co. Donegal	in Mulroy Bay				
33	**T12/85** FCL 215	**Marine Harvest Ireland**	Anny Point in	500t salmon	27/11/06 App for renewal		
	(J Feenstra)	Kindrum, Cashel, Letterkenny	Lough Swilly	16ha			
		Co. Donegal					
34	**T12/85/2**AQ 324	**Marine Harvest Ireland**	Binnaweelmore 85A	1,000t salmon	02/05/11		
	(J Feenstra)	Kindrum, Cashel, Letterkenny Co. Donegal	Callagh 85C in Lough Swilly	40ha	No used		
35	**T12/96** AQ286	**Eany Fish Products Ltd**	Smolt Site 96A	Smolt 400,000	19/07/10		

	File reference	Company/Licensee Name address	Site(s)	Tonnage / Area	Status (expiration)	Sch. I Subs	Sch. II Subs
	(Willie Ward)	Inver Co. Donegal	Grower Site 96B Inver Bay	Max 400t trout & salmon 86ha			
36	**T12/266** AQ 173	**Ocean Farms Ltd**	Sites 84A,B,C,D&E	Smolt 800,000	28/11/09		
	(P Gallagher)	Killybegs Co. Donegal	in McSwynes Bay	1683t salmon	Currently being used by marine harvest		
				69.25ha			
37	**T12/276** AQ 284	**Ocean Farms Ltd**	Sites 276A,B & C	Smolt 825,000	19/07/10		
	(P Gallagher)	Killybegs Co. Donegal	in Inver Bay	1,880t salmon			
				140.5ha			
38	**T5/122/4** AQ321	**Cuan Baoi Seafarms Ltd**	Site 122A	Max smolts 250,000	22/04/11		
	(G Hofmaier)	Ballyhea, Dingle Co Kerry	Site 122	Hold no more than 500t			
			Gerahies	13.2ha			
39	**T5/444** AQ	**Silver King Seafoods Ltd**	Roancarraig	2,000 tonnes pa at site 444D and 600,000 smolts at 444E	31/10/15		
	(J Power)	Beara, Castletownbere Co. Cork	Co. Cork	(Not exceed 400,000 smolts			
				48.6ha			
40	**T5/233** AQ 199	**Silver King Seafoods Ltd**	Inishfarnard,	Not harvest more 500t	14/02/07 App for renewal		
	(J Power)	Beara, Castletownbere Co. Cork	Co. Cork	(Not exceed 400,000 smolts)			
				26ha			
41	**T5/427/2** AQ454	**Mr John Gerard Power**	Waterfall	Max 300t trout	17/06/14		
	(J Power)	Curryglass, Waterfall, Beara Co Cork	Bearhaven Hbr	12ha			
42	**T5/477** TL 40	**Mr John Gerard Power**	Palmer Point	Max 200t trout	05/11/05		
	(J Power)	Curryglass, Waterfall, Beara Co. Cork	Bearhaven Hbr	12ha			
43	T6/64 vol 4	**St Killian's Harvest Ltd**	Kilmakilloge Hbr	64A max 140t salmon	29/12/15		
	AQ 303	Ballyhea Dingle, Co. Kerry	2 sites 64A 64B	64B max 60t salmon			
	(G Hofmaier)			6.5ha			

	File reference	Company/Licensee Name address	Site(s)	Tonnage / Area	Status (expiration)	Sch. I Subs	Sch. II Subs
44	**T6/64/7** AQ 425	**St Killian's Salmon**	Doon Point	Max 1,000t salmon	23/01/15		
	(G Hofmaier)	Ballyhea Dingle, Co. Kerry	Kenmare River	Max smolt 265,000			
				22.25ha			
45	**T6/202** AQ 198	Silver King Seafoods Ltd	Deenish	Not harvest more 500t	14/02/07		
	(J Power)	Beara, Castletownbere Co. Cork	Co. Kerry	(Not exceed 400,000 smolts	App for renewal		
				14.5ha			

ANNEX 2: Inventory of Freshwater Licences

LAND BASED FARMS IN COUNTY GALWAY

LICENSEE	TOWNLAND		
Rafford Fish Farms Kiltulla Athenry Co Galway	Rafford		
Peter McGovern Stofnfiskur (Ireland) Ltd Bunatober Corrandulla Co Galway	Bunatober Corrandulla Co Galway		
Celtic Atlantic Salmon (Killary) Ltd Fintra Road Killybegs Co. Donegal	Lough Fee Connemara		
Mr Gerard O'Donoghue Ardbear Seafarms Ltd Ardbear Market Square Clifden, Co. Galway	Beaghauneen Lake Clifden		
Screeb Fishery Ltd Screeb House Camus Connemara Co Galway	Knockadav, Camus		
Celtic Atlantic Salmon (Killary) Ltd Fintra Road Killybegs Co. Donegal	Cloonnacartan Derryclare Lough		

LICENSEE	TOWNLAND		
Derryclare Hatchery			
Paul Sommerville Connemara Fisheries Ltd Dooras Cornamona Co. Galway	Lough Fadda		
Peter Mantle Delphi Fishery Delphi Lodge Leenane Co Galway	Tawnyinlough		
Western Regional Fisheries Board The Weirs Lodge, Earls Island, Galway	Cong Hatchery		(i)
Turbard Iarthar Chonamara Teo 1 Aras na Trá, Cois Cuain Lr Salthill, Co Galway Joe McElwee	Lettercallow		
Seahorse Ireland Limited Ard West Carna Connemara Co. Galway	Carna		

LAND BASED FARMS IN COUNTY MAYO

LICENSEE	TOWNLAND		
Western Regional Fisheries Board Cong Hatchery Cong Co. Mayo	Ashford		
Salmon Research Agency Furnace Newport Co. Mayo	Lough Furnace, Mayo		
Curraun Fisheries Ltd Doughill Mulranny Westport Co Mayo	Hatchery at Palmerstown Bridge, Killala		
Western Regional Fisheries Board Erriff Fishery Aasleagh Lodge Leenane Co. Mayo	Aasleagh Lodge Leenane		
Ballinrobe and District Anglers Station Road Ballinrobe Co. Mayo	Ballinrobe		
North Western Regional Fisheries Board Carrowmore Lake Hatchery Co. Mayo	Glencullen Incubation Station		

LAND BASED FARMS IN COUNTY SLIGO

LICENSEE	TOWNLAND		
Paul Kearney Keywater Fisheries Limited Maple Drive Boyle Co. Roscommon	Cloonloogh, Co. Sligo		

LAND BASED FARMS IN COUNTY DONEGAL

LICENSEE	TOWNLAND		
Neils B Truelsen Ballyare Fish Farm Ramelton Co. Donegal	River Lennon		
Jan Feenstra Marine Harvest Ireland Kindrum Cashel P.O. Letterkenny Co. Donegal	Kinnalough (Kinny Lough)		
Jan Feenstra Marine Harvest Ireland Kindrum Cashel P.O. Letterkenny Co. Donegal	Maghernalag ht (Kindrum Lough)		
Jan Feenstra Marine Harvest Ireland Kindrum Cashel P.O. Letterkenny Co. Donegal	Lough Altan		

LICENSEE	TOWNLAND		
Jan Feenstra Marine Harvest Ireland Kindrum Cashel P.O. Letterkenny Co. Donegal	Tievetooey, Pettigoe		
Mr John Gallagher ESB Fisheries Conservation Cathleen's Falls Ballyshannon Co. Donegal *Part leased to Seastream Limited*	Ballyhanna		
Buncrana Anglers Association Angling Centre Castle Lane Buncrana Co. Donegal	Sledran Glen		
Eske Angling Centre Hatchery Northern Regional Fisheries Board Station Road Ballyshannon Co. Donegal	Lough Eske		
Rosses Anglers Association C/o John Boyle Lough Tunny Dungloe, Co. Donegal	Gweedore Rd, Dungloe, Co. Donegal		

LAND BASED FARMS IN COUNTY WEXFORD

LICENSEE	TOWNLAND		
Silver King Seafoods Limited c/o Mr John Power Curryglass Waterfall Beara Co. Cork	Bunclody Hatchery		

LAND BASED FARMS IN COUNTY CORK

LICENSEE	TOWNLAND		
John Hayden Araglen Valley Trout Farm Limited (Ballynamudagh Unit) Araglen Kilworth Co Cork	Ballynamudagh Clangibbon		
Mr Michael Walsh Douglas Valley Hatchery Limited Kilclough Kilworth Co. Cork	Douglas River		
South Western Regional Fisheries Board 1 Neville Terrace Masseytown Macroom Co. Cork	Lough Allua, Ballingeary		

LICENSEE	TOWNLAND		
Mark Boyden Coomhola Salmon Trust Limited Mill Beag Coomhola Bantry Co. Cork	Mill Little Coomhola, Bantry		
Mr Gerard Manning ESB Fisheries Conservation Group Carrigadrohid Macroom Co. Cork (Leased to South West Smolts Ltd)	Carrigadrohid		
Ms. Eithne O'Brien Eir Nor Teo Borlin Derrynafinchin Bantry Co. Cork	Derrynafinchin (Borlin Falls on Coomhola River), Bantry		
Mr Gerry Mouzikitis Aquaculture Development Centre Distillery Fields University College Cork Co. Cork	Gerahies Bantry		
Ms. Frances Gallagher Rinn Bearna Aquatics Limited Glanturkin Whitegate Co. Cork	Whitegate		
Southern Regional Fisheries Board Mallow Hatchery Rockforest Mallow Co. Cork	Rockforest Mallow		(i)

LAND BASED FARMS IN COUNTY KERRY

LICENSEE	TOWNLAND		
Ms. Eithne O'Brien Eir Nor Teo Glantrasna Lauragh Co. Kerry	Glantrasna		
Brian O'Connell Inver Resources Ltd – Cloonee Hatchery Crescent House 10 Upper Hartstonge St Limerick	Cloonee West Carbery Co Kerry		
Fionan & Michael McCarthy Harbour View Cromane Lower Killorglin Co. Kerry	Cromane Lower Killorglin		

LAND BASED FARMS IN COUNTY TIPPERARY

LICENSEE	TOWNLAND		
Ms Oonagh Leonard Glenbrook Fish Farms Ltd Glen of Aherlow Co. Tipperary	Glen of Aherlow		
Peter Gibbs Santa Cruise Salmon Farm Carrigahorig Nenagh Co. Tipperary	Firmount Ormond Lower		
Mr Paddy Fitzmaurice Central Fisheries Board Balnagowan Mobhi Boreen Glasnevin, Dublin 9 (Roscrea Fish Farm and Roscrea Coarse Fish Farm)	Fanure, Roscrea		
ESB Fisheries Conservation Parteen Hatchery Parteen Weir Birdhill Co. Tipperary	Birdhill		
The Manager Southern Regional Fisheries Board Tinvane Hatchery Carrick-on-Suir Co. Tipperary	Tinvane Hatchery River Lingaun		
Seastream Limited Gortdrum Fish Farm Mulranny, Westport Co. Mayo	Gortdrum Tipperary		

LICENSEE	TOWNLAND		
Andrew & Philip Fryday, Clune, Clonoulty, Cashel, Co. Tipperary	Clune, Clonoulty, Cashel, Co. Tipperary		

LAND BASED FARMS IN COUNTY WICKLOW

LICENSEE	TOWNLAND		
IDAS Ltd Woodenbridge Arklow Co Wicklow	Ballymorris Lower		
IDAS Ltd Woodenbridge Arklow Co Wicklow	Ballinamona Arklow		
IDAS Ltd Woodenbridge Arklow Co Wicklow	Aughrim		
Silver King Seafoods Limited c/o Mr John Power Curryglass, Waterfall Beara Co. Cork	Bahana, Ballinaclash Wicklow		

OTHER LAND BASED FARMS

LICENSEE	TOWNLAND		
Dundalk Salmon Anglers Assoc. 76 O'Hanlon Park Dundalk Co. Louth	River Fane Stephenstown		
Cormac O'Sullivan Merginstown, Dunlavin Co. Wicklow	Poulaphouca, Ballymore Eustace		
Ballyneale Farm Ballingarry Co.Limerick	Ballingarry Co. Limerick		(i)
Scariff, Whitegate & Mountshannon Angling Club Scarniff Co. Clare	Cappaghabawn Park Scariff		
Celtic Atlantic Salmon (Killary) Ltd Fintra Road Killybegs Co. Donegal	Lough Allen Leitrim		
Mr Pat Doherty Virginia Hatchery c/o Eastern Regional Fisheries Board 15a Main Street Blackrock Co. Dublin	Virginia		
Philip Simpson Main Street Arvagh Co. Cavan	Knockaghy Cavan		

LICENSEE	TOWNLAND		
FCK Fishfarms Limited c/o P J Finlay Meeting House Lane Ballybay Co. Monaghan	Corkeeran Ballybay		
Mr Achim Rappl Blue Springs Limited Kiltybrannock ,Cloonloo Boyle, Co. Roscommon	Kiltybrannock		
Derek Rowley New Rooskey Rooskey Co. Roscommon	Rooskey Roscommon		(iv)
Emlagh Fisheries Limited Emlaghkeadew House Castlecoote Co. Roscommon	Castlecoote		
Cullionmore Fish Farm c/o Central Fisheries Board Balnagowan Mobhi Boreen Glasnevin Dublin 9	Cullionmore, Mullingar, Westmeath		
Lough Ree Fish Hatchery Assoc. 12 Ashford Cushla Monksland Athlone, Co. Westmeath	Coosan Westmeath		
Dr. Michael Connolly Irish Ornamental Fishfarms Ltd 2 Ballybride, Rathmichael, Co. Dublin	Garr Bridge, Rhode Offaly		

LICENSEE	TOWNLAND		
Mr Gerard Kirwan Goatsbridge & Coolroe Trout Farms, Goatsbridge Thomastown Co. Kilkenny	Jerpoint Church Goatsbridge		
Mr Gerard Kirwan Goatsbridge & Coolroe Trout Farms, Goatsbridge Thomastown Co. Kilkenny	Coolroe		
Mr William Connolly & Sons Ltd Red Mills Fish Farm Goresbridge Co Kilkenny	Grange Lower Gowrans Co Kilkenny		
Southern Regional Fisheries Board Inistioge Hatchery Anglesea Street Clonmel Co. Tipperary	Inistioge Co. Kilkenny		
John Hayden Rathvilly Trout Farm Waterstown Rathvilly Co. Carlow	River Slaney, Waterstown Carlow		