THE FARMED SALMONID HEALTH HANDBOOK

IFA Aquaculture

Version 1.0 (2011)

Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union
EUROPEAN REGIONAL DEVELOPMENT FUND
Marine Institute
Foras na Mara
SeaChange
Casadh na Taoide

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FOREWORD

This handbook was prepared in order to assist producers in establishing a sound framework which will protect animal health and promote fish welfare on Irish farms, as well as providing a platform for training for farm operators and their staff.

The 8 aims of the handbook are to:

1. Reduce the occurrence of disease in fish held in the culture facility.
2. Minimize the spread of disease to stocks within and outside the facility.
3. Maintain an environment that promotes the health of the fish.
4. Maintain an environment that reduces the susceptibility of fish to disease.
5. Prevent the introduction of exotic diseases or disease causing agents.
6. Protect public health and minimize disease risks to cultured and wild fish through judicious use of treatments.
7. Provide regulators with appropriate information.
8. Provide an outline of the obligations in National and European Fish Health Legislation.

The handbook represents the culmination of work from a number of individuals from private and government organisations, representing the Irish aquaculture industry. We are indebted to the staff of IFA Aquaculture, the Marine Institute, Department of Agriculture Food & the Marine, Vet Aqua International, Global Trust Certification and to the finfish producers who were involved in the process of developing this handbook.

This document is dedicated to the memory of Damien O Ceallachain, one of the pioneers of Irish aquaculture.

Development of the handbook was supported by the AquaPlan project (Grant-Aid Agreement No. PBA/AF/08/003), carried out under the Sea Change strategy with the support of the Marine Institute and the Marine Research Sub-programme of the National Development Plan 2007-2013, co-financed under the European Regional Development Fund.

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Chapter I. Introduction

The aim of this handbook is to give precise guidelines to all personnel involved in salmonid aquaculture in Ireland and to provide a standard for best practice in the industry, with fish health and welfare as the key objectives. This handbook should assist producers in establishing a sound framework which will protect animal health and promote fish welfare on Irish farms, as well as providing a platform for training for farm operators and their staff. The handbook is a live document and will be updated annually to reflect best practice. It will incorporate new and developing technologies as well as providing information on any new disease issues which may emerge over time. It is envisaged that the handbook will assist operators in meeting their statutory obligations as fish producers whilst also outlining various elements of best practice which are non-legislative in nature.

The handbook specifically aims to:

1. Reduce the occurrence of disease in fish held within the culture facility.
2. Minimize the spread of disease to stocks within and outside the facility.
3. Maintain an environment that promotes the health of the fish.
4. Maintain an environment that reduces the susceptibility of fish to disease.
5. Prevent the introduction of exotic diseases or disease causing agents.
6. Protect public health and minimize disease risks to cultured and wild fish through judicious use of treatments.
7. Provide regulators with appropriate information.
8. Provide an outline of the obligations in National and European Fish Health Legislation.

The attitude and competence of farm staff are vital in determining whether high standards of fish welfare can be achieved. It is the responsibility of management to ensure that there is a health and welfare ethos among staff and that staff are suitably trained and able to recognise indicators of poor health and welfare at an early stage. Managers must ensure that all staff have access to a current version of this document and are familiar with its content.

Managing the health of fish requires a program to determine health status and a system of recording performance, mortality and disease. This data is essential for monitoring trends and the early detection of emerging diseases, thus allowing for early intervention and remedial action to minimize the impact of the problem.

An essential part of the overall fish health plan is a written *Veterinary Health Plan* (VHP) which must be in place for each farm. This document should be written in consultation with the farms designated fish veterinary surgeon and updated at least once a year. This plan should take account of all fish diseases relevant to the farm and outline methods to detect and control them. The VHP must encompass the basic statutory requirements, as outlined in the national fish health legislation www.marine.ie/fishhealth, but it should also go well beyond these.

Water quality and the conditions of the surrounding environment should be maintained as close to optimum as possible. This handbook outlines the water quality requirements essential for fish welfare and details the monitoring protocol needed to maintain optimum conditions. A detailed environmental monitoring plan should be in place for each farm.

Good husbandry is essential for producing healthy fish. This handbook will outline the best practices for handling, feeding and growing salmonid fish.

It is inevitable for any industry involving animals that at some stage, medicinal intervention will be required. Medicines and chemicals used for disease control must be properly administered and monitored to protect the public, environment and fish. This requires adequate diagnostic support, safe storage, use and handling.

The spread of disease causing agents and disease impacts can be minimized within and between groups of fish, by managing disease outbreaks efficiently. A management plan should be implemented to ensure careful handling of dead fish, adequate hygiene and disinfection practices and restrictions put in place on fish movements. Best practice for biosecurity, waste management, bay management and fallowing are all covered in detail in the handbook. Identifying these risk factors is essential, if disease outbreaks are to be adequately controlled and optimum fish health and welfare are to be maintained.

Chapter II. Fish Health & Welfare

Over the last number of years the concept of fish health and welfare has been addressed at European level. The European Commission has identified the promotion of animal health and welfare standards as one of the main objectives for the future sustainable development of European aquaculture[1]. EU Directives 98/58/EC and 2006/88/EC (see Chapter VI (Appendix) Section 6.2.1) reflect this increased awareness of farmed fish health and welfare. In 2005, the *Standing Committee of the European Convention for the Protection of Animals kept for Farming Purposes* adopted specific recommendations concerning farmed fish and in 2008 the World Organisation for Animal Health (OIE) adopted guiding principles for fish welfare[2]. Furthermore, the European Food Safety Authority has produced specific documents on the welfare of rainbow trout[3] and Atlantic salmon[4].

Good management and husbandry practices are essential for the health and welfare of farmed fish. Key features of good management and husbandry include:

1. Careful site selection.
2. Monitoring of the environment to ensure optimum conditions.
3. Clear delegation of responsibilities.
4. Provision for the training and broadening of the skills of the workforce.
5. Planned stock selection and breeding programmes.
6. Effective record keeping.
7. Good hygiene practices.
8. Regular observation of the stock.
9. Regular veterinary inspection of the stock.
10. Regular biomass assessment of the stock.
11. Minimal disturbance of the stock.
12. Forward planning of all harvesting and grading programmes.
13. It is the responsibility of the manager to ensure that good husbandry practices are observed.

Fish must be protected from injury and disease through good management and husbandry practice and by rapid detection and treatment of disease. All fish farmers

[1] EC, 2009. Building a sustainable future for aquaculture: a new impetus for the strategy for the sustainable development of European aquaculture. Commission of the European Communities COM (2009) 162 final, 12 pp.
[2] OIE, 2009. Aquatic Animal Health Code, 12th edition.
[3] EFSA, 2008. Animal welfare aspects of husbandry systems for farmed trout. EFSA Journal 796, 1-22.
[4] EFSA, 2008. Animal welfare aspects of husbandry systems for farmed Atlantic salmon. EFSA Journal 736, 1-31.

should develop a *Veterinary Health Plan* (see Section 2.1) in consultation with a designated fish veterinarian.

The attitudes and competence of staff are a vital factor determining whether high standards of fish health and welfare can be achieved. It is the responsibility of management to ensure that there is a strong awareness of health and welfare issues among staff. It is essential that staff are suitably trained and are able to recognise indicators of poor health and welfare at an early stage.

All relevant legislation regarding notifiable diseases must be understood and adhered to. All staff must be familiar with normal fish behaviour and appearance and the stock must be routinely monitored for signs of disease. Changes in physical appearance (scale loss, parasites, injury, deformities), changes in general behaviour (swimming and shoaling behaviour, increased respiration, jumping) or changes in feeding response (normally aggressive feed response when feed presented) must be recorded and reported to management. Mortalities should be recorded for each unit and any increase should be investigated by a qualified fish health professional.

Important areas for good fish health and welfare include stocking only healthy fish, separation of different generations, reasonable stocking densities, good water quality, clean nets or tanks and regular veterinary surveillance.

Regular sampling of the stocks is essential and each farm should have a member of staff specifically trained in this area.

Table 1.

Measurement indices of welfare in farmed fish (adapted from Huntingford *et al.*, 2006[5]).

Changes in colour	Darkening of the skin colour is known to be associated with stress and may be used as an indicator of poor welfare.
Ventilation rate	The rate of opercular (gill cover) beats is increased during stress (e.g. low oxygen levels).
Changes in swimming patterns	Abnormal swimming can be used as a sign of poor welfare in fish. These may include excessive activity, lethargic swimming high in the water column, rubbing to dislodge ectoparasites.
Reduced food intake	Feeding patterns of fish are disturbed during and after stressful procedures, therefore an unexpected loss of appetite can be used as a sign of poor welfare.
Reduced growth rates	Growth of fish can be measured and compared with an expected growth curve. Deviations from the expected growth can be indicative of welfare problems.
Bodily injuries	Damage to the body of the fish may be used as a sign of adverse welfare e.g. damage due to predator attacks.
Disease states	Increased incidence of disease can occur due to a combination of environmental and management factors. Levels of both infectious and non-infectious (e.g. cataracts) diseases should be monitored and recorded.
Impaired reproductive performance	Good welfare of valuable broodstock is essential as stress is known to affect the reproductive capacity in fish.

[5] Huntingford, F. A., Adams, C., Braithwaite, V. A., Kadri, S., Pottinger, T. G., Sandøe, P. & Turnbull, J. F. **2006.** Current issues in fish welfare. *Journal of Fish Biology* **68,** 332-372.

2.1 Veterinary Health Plan

The objective of a *Veterinary Health Plan* (VHP) is to provide a documented outline to assist in the maintenance of a high health status and high standards of welfare conditions for cultured salmonids grown in Irish waters. The outline presented can form the basis for a site specific VHP that should be developed for each farm by the farmer in consultation with their veterinary surgeon.

The VHP must be applied by the management and staff of the operation who are responsible for keeping the health status of the fish at an adequate standard. This includes both general operatives on the site and site managers who have to make decisions on fish health. In addition, the VHP should be used during training of site staff.

The VHP is written in conjunction with a designated fish veterinarian and is frequently updated (at least annually) following regular visits by the veterinarian to the farm. The goals of the VHP are as follows:

1. To prevent and control fish diseases and ensure the maintenance of a high level of fish health and welfare on a particular site.
2. To minimize the environmental impact caused by the aquaculture site.
3. To rear fish in accordance with national and EU regulations, industry guidelines and the current best practices of the industry.

The VHP should cover the following five key areas:

1. General Management & Delegation of Responsibilities.
2. Fish Health Monitoring.
3. Therapeutic Treatments.
4. General Husbandry.
5. Biosecurity.

This handbook will provide useful guidance on the preparation of the site specific VHP.

2.2 Record Keeping

The operator must keep archived records, securely stored on site for a minimum period of five years. Records should be reviewed on a routine basis by the operator's veterinarian and/or fish health manager to look for epidemiological patterns in fish health and disease. These records must be readily available for inspection by the competent authority or for company audit purposes.

The farm fish health records should include but are not limited to:

1. Inventory records – site name, pen/tank identification, stock type, number and biomass of fish, pen or tank dimensions.
2. Fish movement records – origin, strain, number, transporter details, mode of transport, dates.
3. Mortality records including likely cause of death per farm unit (tank, pen, pond).
4. Daily stock observations.
5. Veterinary reports.
6. All prescriptions and *Veterinary Written Directions* in relation to medicated feed and a home mixer licence if the site has been granted one.
7. Animal remedies records listing details in schedule 7 of SI 867 of 2007.
8. Records of mitigative actions (other than therapeutants) taken to prevent or reduce disease, e.g. taking fish off feed due to a plankton bloom.
9. Results of disease surveillance, completed by the private veterinary practitioner and by the competent authority (Marine Institute).
10. Disposal and movement of mortalities.
11. Records of water quality parameters tested.
12. Feeding records – feed type, feeding levels, FCR (Feed Conversion Ratio).
13. Lice counts (on marine sites).
14. Biosecurity records – a Biosecurity Plan for the site as well as cleaning rotas, chemical logs, visitor records.
15. Training records.

2.3 Stock Observations

Fish must be routinely observed to determine their health status. All staff must be familiar with normal fish behaviour and appearance. Changes in physical appearance (scale loss, parasites, injury, deformities), changes in general behaviour (swimming and shoaling behaviour, increased respiration, jumping) or changes in feeding response (normally aggressive feed response when feed presented) must be recorded and reported to management. Removal of mortalities from the holding units should be carried out daily in freshwater and at least twice per week in marine sites. Any significant increase should be investigated by a qualified fish health professional. The cause of death should be classified according to the categories outlined in the *Veterinary Health Plan* and records kept of each mortality recovery.

The fish in each unit should ideally be observed several times per day principally by the feeders. In sea or lake pens, divers should check the fish in each unit at least twice per week. A trained biologist should observe the fish in each unit at least once per week and a fish veterinarian at least once every two months.

If the appearance, or behaviour, of a significant number of fish is abnormal, the frequency of surveillance should be increased as appropriate and a disease sampling programme should be implemented.

Behavioural changes to look out for include:

1. Altered swim pattern.
2. The presence of moribund fish.
3. Significant numbers of fish pointing into the current.
4. Significant numbers of fish jumping.
5. Reduction in appetite.
6. Increased respiration – gasping.

Changes in appearance to watch out for include:

1. Scale loss.
2. Lesions.
3. High lice levels and lice damage (marine sites).
4. Significant numbers of dark fish.
5. Significant numbers of thin fish.
6. Fin damage.
7. Snout damage.
8. Eye loss.
9. Deformities.
10. Cataracts.
11. Maturation.
12. Furuncules or boils.

The number of mortalities from each unit should be recorded after removal and, if possible, the cause of mortality ascertained using the following categories:

1. Number of runts and good condition fish.
2. Number of marked (lesions) and unmarked fish.
3. Number of feeding and non feeding fish.
4. Number of fish with predator damage (bird, seal etc.).
5. Number of fish with excessive scale loss.
6. Number of fish with gill damage.
7. Number of fish with deformities and the type of deformities recorded.
8. Number of maturing fish.
9. Number of fish with furuncules or boils.
10. Number of fish with fungal infection.
11. Number of fish with parasite damage and likely cause (e.g. lice, white spot).
12. Other.

2.4 Single Bay Management

Marine farms must operate according to the principles of Single Bay Management, a strategy which has been developed to reduce the levels of sea lice (*Lepeophtheirus salmonis*). All farmers within a particular bay must devise a Single Bay Management strategy to coordinate treatments and ensure that lice levels are kept to an absolute minimum. During the months January - May numbers of ovigerous (egg bearing) female lice must be maintained as close to zero as possible on all farmed fish by the use of appropriate treatments (where necessary). Farmers must coordinate treatments, both on farm and between farms, to maximise their effectiveness and minimise lice levels at all times of the year.

2.5 Routine Fish Sampling

Operators must have a plan for routine assessment of fish to determine their disease status and an action plan to prevent the spread of disease that will minimize the impact on fish and other organisms. Operators must regularly and systematically sample fish from each unit for signs of disease. If a disease is suspected, sampling levels should be increased according to a preset disease sampling protocol.

Routine sampling should include:

1. Weekly samples from selected units to assess sea lice infestation (marine).
2. Fortnightly health screening from selected batches of fish particularly looking at parasites of the skin and gills.
3. Monthly batch weights of all units.
4. Routine mortality post mortem.

Anaesthetising Fish

1. MS-222 (tricaine methane sulphonate) is the only fish anaesthetic agent licensed, for finfish intended for human consumption and for ornamental fish.
2. It is a white water-soluble powder which is stable when kept cool and dry.
3. A standard stock solution can be prepared by adding freshwater to 100 g of MS-222 to make up a 1 litre solution (10% w/v). Final working concentrations are outlined in Table II below. The stock solution should be stored in a dark bottle as it is sensitive to light.
4. MS-222 solutions are acidic and therefore the pH of the solution needs to be checked prior to use when dissolved in water with low buffering capacity e.g. fresh water. Sodium bicarbonate (250 mg per 100 mg MS-222) is used to buffer the solution.

5. MS-222 is a hypoxic agent, therefore it is best practice for the container used to be constantly aerated.
6. A withdrawal period of 70 degree days is required when MS-222 has been used in fish destined for human consumption or release into the wild.
7. The user should wear protective gloves.

Table II

Suggested dose rates for anaesthetizing fish with MS-222.

SPECIES	SEDATION	LIGHT - HEAVY
Trout	10 – 30 mg/L	30 – 180 mg/L
Salmon	7 – 30 mg/L	30 – 100 mg/L
Carp	20 – 30 mg/L	30 – 200 mg/L
Marine fish	8 – 30 mg/L	30 – 100 mg/L

2.5.1 Assessing sea lice levels on marine farms

On marine farms monitoring of sea lice levels should be conducted by suitably trained staff on a weekly basis, in addition to the national monitoring programme carried out by the Marine Institute (see Section 2.8). Lice counts should be conducted weekly on at least 10 fish from at least one third of the pens on site by a member of staff who has been specifically trained in the methodology and identification of the different stages of lice development. The pens should be sampled in rotation and all pens should be assessed at least once per month. All counts must be recorded and the records retained for at least 5 years. The following methodology should be used:

Ten fish should be sampled from the selected pen and anaesthetised. All the lice from each individual fish should be recorded and categorised into the following stages:

1. Ovigerous (adult female *Lepeophtheirus salmonis* (*Lep.*) with egg strings).
2. Other Adult (adult *Lep.* males plus adult *Lep.* females without egg strings).
3. Sub-adult (small mobile *Lep.*).
4. Attached juveniles (all lice that are at the attached stage).
5. *Caligus elongatus* (adults, including ovigerous are much smaller than *Lep.*).

As part of the control strategy, information from all other farms within an area should be reviewed and a Single Bay Management strategy developed between operators for the control of lice levels within the bay (see Section 2.4).

2.5.2 Health screening

Regular health screening is required to pick up early signs of disease and to allow an effective, rapid response to an emerging problem. A fortnightly health screening programme should be devised for each farm. Five fish from at least three units should be screened as follows:

1. Carefully examine each fish for any sign of scale loss, fin damage, lesions, spinal or jaw deformities, cataracts, maturation, lice/parasite damage or injury.
2. Examine the gills for discolouration, erosion or damage. If necessary samples of gill tissue should be examined microscopically.

If necessary the following screening should be carried out:

1. Using the back of a scalpel take a mucous scrape and examine microscopically for skin parasites.
2. In marine farms take a sample of blood for PD (Pancreas Disease) virus and antibody screening. Using a syringe take the blood from the caudal vein and transfer to a centrifuge tube. Spin the blood and pipette off the serum and transfer to an eppendorf tube and freeze.
3. Examine the internal organs. Check for signs of heart deformity, internal adhesions, abnormal colouration of the organs, blood spots, bloody fluid, abnormal swellings.
4. Place samples of the following tissues ($<1cm^3$) in a pot containing saline buffered formalin (one pot per fish) for histological processing: gills, heart (whole), liver, pyloric caecae, spleen, kidney, muscle (at lateral line below dorsal fin), brain. Ensure a 1:10 ratio of organs: buffered formalin.
5. If necessary take bacterial swabs of suspect tissue.
6. Histology, blood samples and bacterial swabs should be sent to a laboratory as soon as possible and analysed by a trained fish pathologist.

Under Directive 2006/88/EC and SI No. 261 of 2008 site inspections are carried out by the Fish Health Unit of the Marine Institute in accordance with the risk categorisation of the individual site:

1. High Surveillance: 1 visit per year from private services (Active Surveillance) and 1 visit/year by Marine Institute (Active Surveillance & Compliance).

2. Medium Surveillance: 1 visit per year alternating between the private services (Active Surveillance) and the Marine Institute (Active Surveillance & Compliance).

3. Low Surveillance**:** 1 visit every 2 years alternating between the private services (Active Surveillance) and the Marine Institute (Active Surveillance & Compliance).

The risk category for each farm is determined according to the following criteria:

High Surveillance Level

1. Sites importing live fish and ova (including "open" ornamental facilities).
2. Broodstock sites producing for themselves and others.
3. Sites producing stock for on-growing elsewhere within the country or abroad.
4. Marine sites (except those with protected water).
5. Aquaculture facilities with on-site processing units which process fish from other sites.
6. Quarantine facilities.

Medium Surveillance Level

1. Broodstock sites producing only for themselves.
2. Freshwater sites producing fish for human consumption, including those processing solely their own fish.
3. Sites producing fish for ranching purposes (i.e. those releasing fish back into the system from which the broodstock came).

Low Surveillance Level

1. Put & Take Fisheries.
2. Ornamental commercial aquaria.
3. Sites holding non-susceptible species.
4. Recirculation systems.

2.5.3 Monthly sample weights

Monthly sample weights of livestock in all units are essential for tracking performance and assessing overall health. It allows a large number of fish from each unit to be carefully examined. Any emerging problems will be picked up early, allowing rapid corrective action.

A large sample of 50 – 100 fish should be randomly selected, preferably using a seine or box net, and anaesthetised in manageable batches. All fish must be weighed on accurate, calibrated scales. Smaller fish (<100g) should be weighed in batches and larger fish (>100g) should be individually weighed.

Each fish should then be examined for the following:

1. Lesions.
2. Presence of external parasites (e.g. lice on marine fish, white spot on freshwater fish).
3. Fin damage.
4. Snout damage.
5. Eye loss.
6. Deformities.
7. Cataracts.
8. Maturation.
9. Scale loss.

Data from each unit should be compiled and a report produced.

Table III.

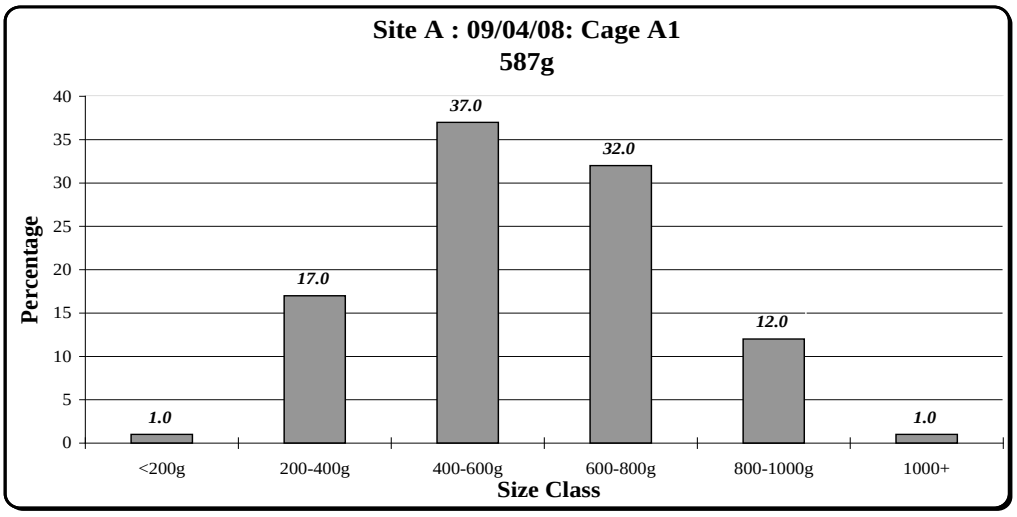
An example of a sample weight data sheet.

Cage: **A1**	***Date:*** **09-Apr-08**	***Site:*** **Site A**

Conditions: Good, Sampled with feed.

Av. Wt. (g)	**587**
Sample Size	**100**
% Maturing	**0.0**
% Lesions	**1.0**
% Scale Loss	**1.0**
% Spinal Deformity	**0.0**
% Jaw Deformity	**0.0**
% Cataracts	**0.0**

Size Distribution		
	N	**%**
<200g	1	1.0
200-400g	17	17.0
400-600g	37	37.0
600-800g	32	32.0
800-1000g	12	12.0
1000+	1	1.0



Comments

2.6 Notifiable Diseases

Under Directive 2006/88/EC and SI No. 261 of 2008, certain diseases are listed as *notifiable*. If a notifiable disease is found or suspected then it must immediately be reported to the Marine Institute. These diseases are categorised as follows:

Exotic: These are diseases which are not present in the European Community, but would have serious economic or ecological consequences if they were to appear. They must be eradicated if they are detected anywhere within the European Community. Included in this category is Epizootic Haematopoietic Necrosis (EHN), a disease of perch and rainbow trout and Epizootic Ulcerative Syndrome (EUS) affecting a range of estuarine and freshwater fish species.

Non-Exotic: These are diseases which are present within the European Community, but which are confined to certain geographical areas, where they result in serious economic consequences. If a non-exotic disease is detected in Ireland, the Marine Institute, with the assistance of the National Risk Assessment Committee, will decide whether or not immediate eradication is required. Included in this category are the diseases Infectious Salmon Anaemia (ISA, salmon and rainbow trout), Viral Haemorrhagic Septicaemia (VHS, rainbow trout, cod, turbot), Infectious Haematopoietic Necrosis (IHN, trout and salmon) and Koi Herpesvirus (KHV, carp).

National Measures: Article 43 of the Directive covers diseases which are not specifically listed. They are significant diseases which are widespread in certain parts of the European Community, but are absent from other parts. These diseases can cause significant economic losses at a local level. Ireland currently controls Bacterial Kidney Disease (BKD, salmon and trout), *Gyrodactylus salaris* (salmon and trout) and Spring Viraemia of Carp (Cyprinids) under this measure. If any of these diseases appears in Ireland, the Marine Institute, with the assistance of the National Risk Assessment Committee, will decide whether or not immediate eradication is required.

2.7 Disease Outbreak

It is a statutory requirement that any person who suspects or has had confirmation of the presence of a notifiable disease on a site, must contact The Fish Health Unit of the Marine Institute (Fax: 091 387201, email: notification@marine.ie).

Where increased mortality is observed the veterinary practitioner retained by the company must be contacted in the first instance. Where the cause of the mortality

remains unresolved following veterinary consultation, the Marine Institute must be contacted.

It should be noted that "*increased mortality*" is defined as "*that which is unexplained and significantly above the level of what is considered to be normal for the site under the prevailing conditions*".

Once an outbreak is recognized, all fish on site and fish on nearby sites that are epidemiologically linked to the affected fish, must be subject to an intensified monitoring and sampling program. The exact nature of the program should be designed in consultation with a veterinarian, or in the case of a notifiable disease with the Marine Institute.

In the case of a serious outbreak of a non-notifiable disease the following actions may be taken:

(a) Review fish health records of all stocks on site, affected and unaffected, including:

1. Input Dates.
2. Input Sizes.
3. Origins.
4. Strains.
5. Vaccinations.
6. Treatments.
7. Results of previous health screenings.
8. Water quality results.
9. Feed history.
10. Feed analysis results.
11. Mortality rates since input.

(b) At the veterinarians recommendation, the site may be quarantined. This action may be enforced based on clinical suspicion and may occur before definitive disease diagnosis.

(c) A well designed disease sampling program should be implemented.

1. At least 5 fish sampled from all discrete batches on site.
2. Samples taken of healthy and affected fish to establish disease progress.
3. Samples taken each week if necessary.
4. Samples analysed for bacteriology, histology and virology.
5. Mortalities carefully post-mortemed.

(d) Mortality removal should be carried out daily if possible. Mortalities should be stored in a secure manner and removed for rendering without delay.

(e) Strict adherence to biosecurity and disinfection protocols in place on the farm is essential.

(f) Disinfection procedures should be intensified.

(g) Fish movement or handling must be stopped.

(h) Visitors must not be permitted on site except where absolutely necessary.

(i) Separate equipment and gear must be designated for the affected site/unit.

(j) Therapeutic treatments or management procedures must be initiated where possible to ameliorate the outbreak.

(k) Water and feed samples may be necessary to compliment the investigation into the aetiology of the problem.

(l) Neighbouring farms should be notified as part of the Single Bay Management agreement.

(m) For notifiable diseases, the provisions of SI No. 261 of 2008 must be followed, under the supervision of the Marine Institute.

(n) A log of mortalities and unusual behaviour must be maintained throughout the outbreak. These records must be kept for at least 5 years.

2.8 National Sea Lice Monitoring

The ecto-parasitic sea louse, a tiny crustacean, is an economically significant pest of the marine farmed salmon industry worldwide. In Ireland, a mandatory national sea lice monitoring and control 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.

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[6]. This monitoring programme is backed up by mandatory licensing requirements imposed on marine fin-fish farmers through a protocol on management and control. In May 2008, the Department of Agriculture, Fisheries and Food published *A strategy for improved pest control on Irish salmon farms*, outlining a new National Sea Lice Monitoring Plan for the control of sea lice in Ireland[7].

[6] DMNR, 2000. *Monitoring protocol for offshore finfish farms – sea lice monitoring and control.*
[7] DAFF, 2008. *A strategy for improved pest control on Irish salmon farms.*

The 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 information to drive implementation of the control and management strategies.
- To facilitate further development and refinement of the control and management strategies.

2.8.1 Monitoring and Control Strategy

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

1. Separation of generations.
2. Annual fallowing of sites and, if possible, synchronous fallowing in bays with multiple sites.
3. Early harvest of two sea-winter fish.
4. Targeted treatment regimes, including synchronous treatments.
5. Agreed husbandry practices.

Together, these components work to reduce the development of infestations and to ensure the most effective treatment of developing infestations. They minimize 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 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.

2.8.2 Trigger Levels for Treatment

Treatment triggers during the spring period (March to May) are set close to zero (0.5 egg bearing females per fish). Timing of treatments is 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 per fish acts as a trigger for treatments. This is only relaxed where fish are under harvest or with the agreement with the Department of Agriculture, Marine & Food (DAMF) or its agent, the Marine Institute.

2.8.3 Synchronous Sea Lice Treatment and Control in Bays

Sea lice management is dependent on the availability of adequate sites and the separation of generations. All fish farms operating in a particular bay undertake appropriate synchronous sea lice treatment and control strategies through the Single Bay Management/CLAMS (Coordinated Local Aquaculture Management System) process. Close co-operation between the industry and government is essential to maximise the benefits of strategic sea lice management.

2.9 Training

All farm staff should receive introductory training in fish health and welfare. All staff should stay informed of emerging fish health and welfare issues and should be encouraged to attend fish health meetings and workshops. Records of all training should be kept. As part of the Marine Institute's *Sea Change* strategy, the AquaPlan Project has developed a range of specific training programmes for fish farm personnel in the area of fish health.

Chapter III. Environment

Maintaining good water quality is essential to fish health. Each farm must have a regular water monitoring program in place. This may include measuring temperature, dissolved oxygen, plankton, salinity and turbidity. The parameters measured will vary depending on whether the fish are confined to freshwater tanks or in an open marine site. On a freshwater land site, there must be adequate freshwater exchange to ensure the removal of metabolic wastes and to maintain oxygen levels. On a marine site, vigilance for phenomena such as algal blooms is essential. Appropriate monitoring must be in place to indicate when water quality is not adequate. A contingency plan must be in place in the case of an acute deterioration of water quality. This may involve stopping feeding of the fish and increasing the frequency and detail of water monitoring to establish probable cause of deterioration. Fish should be monitored closely during these events.

Under SI No. 93 of 1999, EC (Environmental Impact Assessment) (Amendment) Regulations 1999 an Environmental Impact Statement (EIS) is required for the following farm developments:

a. For any new marine finfish farm where annual production will exceed 100 tonnes, a detailed Environmental Impact Survey must be submitted to the relevant authorities covering aspects of local hydrography, biology and chemical characteristics together with the expected quantities and types of emissions into the environment.
b. Similarly, an EIS must be provided for all pen rearing of finfish in lakes or operations upstream of drinking water supplies, or where production would exceed 1 million smolts and with less than 1 cubic metre per second per 1 million smolts low flow diluting water.

Results of on-going monitoring programmes should be made available to DAMF and to the local Council Authorities in the case of the land (or lake) based operations.

3.1 Fish Requirements

As fish are in intimate contact with their aquatic environment, a reduction in the quality of the water can have serious implications for the health and welfare of the animal. The following guidelines for water parameters for farmed salmon and trout are adapted from reports published by the European Food Safety Authority[8,9] (EFSA).

[8] EFSA, 2008. Animal welfare aspects of husbandry systems for farmed Atlantic salmon. EFSA Journal 736, 1-31.
[9] EFSA, 2008. Animal welfare aspects of husbandry systems for farmed trout. EFSA Journal 796, 1-22.

3.1.1 pH

The water pH is important since fish need to maintain a constant internal pH and an acid/base balance in the blood. In seawater, the pH is more stable due to the higher buffering capacity of the sea. In freshwater pH can be affected by increased carbon dioxide due to respiration. This can become a problem in recirculation systems if inadequate filtration systems are used. pH can be acutely affected by acid rain. Safe levels of water pH depend on the interaction with a range of other water quality parameters, especially aluminium and ammonia.

Sudden decreases of pH can result in gill and skin irritation in salmon and trout. Acid irritates the gills resulting in excessive mucus production and can cause reddened areas on the abdomen. Eggs can tolerate a greater range of pH, as they are partially protected by the eggshell, whereas alevins are very sensitive to extremes of pH.

As a general guide, pH levels for salmon should be above 5.4 and preferably within the range 6.0 – 8.5 in freshwater and above 7.0 in seawater. Trout are slightly more tolerant, but levels below 5.0 and above 9.0 should be avoided. Rapid changes of acidity or alkalinity should be avoided for all stages of salmon and trout.

3.1.2 Temperature

Water temperature regulates the amount of dissolved oxygen that a body of water can hold. Additionally, increasing temperature facilitates the growth of many fish pathogens and increases the toxicity of many dissolved contaminants. All of these interacting factors have the capacity to compromise the health of farmed fish. As fish are cold blooded, increasing the water temperature increases the metabolic rate and hence oxygen consumption. At higher temperatures fish have a greater demand for oxygen, but there is less oxygen available in the water as the temperature rises. Rapid changes in temperature can lead to severe stress.

Temperature also affects growth and development and can lead to various deformities such as abnormal heart development and skeletal deformities, particularly at the juvenile stage.

In general, salmon seem to be able to adapt to temperatures in the range of 0-20°C, provided they are supplied with well oxygenated water. The lower lethal limit is considered to be around -1°C. Temperature optimum for growth of salmon in Ireland is in the range of 12-15°C depending on stage and size.

Incubation temperatures should not exceed 8ºC from fertilisation to the eyed stage, 10°C from eyed stage to hatch and 12°C to first feeding. Salmon smolts are considered to

have somewhat less tolerance than parr and ongrowing salmon, but can tolerate temperatures between 3-18ºC. Ongrowing salmon tolerate temperatures between 1-18°C, and, in Ireland, seem to display a preference for 12-14°C. At ovulation and spermatogenesis until spawning, broodfish should be held at temperatures between 8-12°C.

Trout can adapt to temperatures in the range of 0-22°C provided they are supplied with well oxygenated water. The lower lethal limit is considered to be around -1°C and the higher lethal limit is above 24°C. During the egg and alevin stages, temperatures exceeding 15°C should be avoided as should sudden temperature variations. In Ireland, temperature optimum for growth of rainbow trout is in the range of 12-14°C.

3.1.3 Salinity

Salinity changes affect osmoregulation in fish and many species have limited tolerance. In the marine stage salmon can tolerate a wide range of salinities.

During the early stages, from eggs up to pre-smolts, Atlantic salmon are adapted to salinities below 10ppt (parts per thousand). Eggs must be kept in pure freshwater just after fertilisation to allow normal water hardening (egg swelling), but thereafter small amounts of saltwater (typically up to 1ppt) can be added in order to adjust pH, detoxify aluminium, and increase ion concentration in acid water sources. The ability to tolerate salinity above 10ppt increases with increasing body size in freshwater parr, but full osmoregulatory capacity in full strength sea-water (> 30ppt) is only achieved after full smoltification.

After sexual maturation, Atlantic salmon lose much of their ability to osmoregulate in full strength seawater and will suffer high mortality if kept in seawater throughout maturation. Sexually mature salmon broodstock must be kept in freshwater or brackish water with salinity below 10ppt. After full smoltification the optimum salinity range for Atlantic salmon is 28-33ppt.

In general, larger trout are more tolerant of higher salinities than smaller sizes. Adaptation to full strength seawater is dependant on other water parameters such as temperature and oxygen levels.

3.1.4 Oxygen

The amount of dissolved oxygen in water varies with temperature and salinity. The amount of dissolved oxygen (mg/l) at 100 % water saturation (e.g. in equilibrium with atmospheric oxygen) decreases with increasing water temperature and salinity. Often the oxygen saturation shows marked variability with time of day and during the season in

farming units, due to variability in fish metabolism, algal production and consumption of oxygen as well as variability in water exchange. All life stages of salmon and trout have a high demand for oxygen. The relative oxygen consumption of salmon and trout increases with temperature, activity, feed consumption and stress level, while it decreases with increasing body size.

The dissolved oxygen concentration is considered as a key factor for welfare in salmon and trout farming. Critical levels for normal physiological functioning, feed intake and optimum growth vary for various life stages. The minimum of oxygen required varies amongst fish species, and varies also with size, age, physiological condition and health.

In general, salmon and trout will suffer impaired growth and appetite below 80% saturation. Mortality starts to occur at around 40% saturation. Dissolved oxygen levels should be maintained as close to 100% as possible for optimum appetite and growth although levels down to 70% can be tolerated.

3.1.5 Carbon Dioxide

Carbon dioxide (CO_2) is found naturally in most surface waters at levels of 1-2 mg/l and originates from diffusion from the atmosphere, microbial decomposition of organic matter and the respiration of micro-organisms, algae and aquatic plants. Naturally higher levels of CO_2 can be found in well or spring water. Within aquaculture systems, the primary source of CO_2 is fish metabolism. CO_2 is in equilibrium with the non-toxic bicarbonate ion, and its concentration depends on pH, temperature and salinity of the water, as well as the respiration of the fish and other organisms in the water.

High and medium increases in CO_2 can lead to gill lesions and can also elicit a severe stress response. Dissolved CO_2 levels can be higher in recirculation systems, particularly those with high stocking densities.

While there are reports of adverse effects on health from high levels of CO_2 there is wide disparity in the range of recommended safe levels.

3.1.6 Ammonia

Ammonia is produced as a waste product by the fish and leads to a rise in pH. Ammonia is present in 2 forms: un-ionised and ionized. Un-ionised ammonia (NH_3) is the most toxic form. Ammonia toxicity is higher at high pH and the proportion of the more toxic NH_3 form increases as salinity drops. Therefore, pH, temperature and salinity needs to known in order to estimate the toxic level of ammonia.

Ammonia affects osmoregulation and can result in fish producing an increased volume of urine in freshwater and increased drinking in saltwater. Ammonia also affects the gills by destroying the mucous layer. At sub-lethal concentrations ammonia can also impair immune function leading to increased susceptibility to infectious disease. In general the ammonia toxicity for adult Atlantic salmon held in sea-water appears to be roughly similar to that for freshwater salmon.

Ammonia levels can become critical in systems with restricted water flow, such as high stocking density fish tanks with added oxygen, during transport and in recirculated systems.

Concentrations of un-ionized ammonia higher than 0.02 mg/l for all stages of salmon and trout have been shown to cause tissue damage resulting in poor welfare. To maintain good welfare the maximum level of un-ionised ammonia (NH_3) should not exceed 0.02 mg/l for all stages.

3.1.7 Nitrite

In the presence of oxygen, ammonia is converted into nitrite which is slightly less toxic than ammonia. Nitrite breaks down red blood cells and oxidizes the iron in haemoglobin resulting in reduced oxygen carrying capacity causing listlessness. Levels of nitrite in farming systems are generally very low, with the compound rapidly converted to the significantly less toxic nitrate by nitrobacter bacteria. Nitrites are not usually a problem in aquaculture with flow-through or in adequately oxygenated water.

Nitrite concentrations of < 0.1 mg/l are adequate to protect fish health under most water quality conditions.

3.1.8 Aluminium

Aluminium toxicity can have a severely detrimental effect on fish welfare, but is generally the result of rapid reduction in pH due to external factors. Such circumstances are limited to specific locations and are not a general risk. Water treatment methods are available to reduce the problem.

Aluminium toxicity is usually associated with acid rain and acidified freshwater systems. It is well established that positively charged aluminium in acidic waters is toxic to fish due to accumulation of aluminium in fish gills.

Non-lethal concentrations of aluminium may severely affect the osmoregulatory capacity in smolting salmon, especially as there is an increasing susceptibility towards aluminium at periods with low pH during spring due to acidification.

Aluminium should be kept below 20µg/l which is the critical level smolts can tolerate. Pre-smolts and smolts are most sensitive to aluminium followed by younger stages whereas adults are the most tolerant.

3.1.9 Suspended solids

All natural waters contain some suspended solids. During spates (heavy floods) these can rise considerably. Effects such as gill surface hyperplasia, and excessive mucus generation on skin and gills are common. Furthermore, suspended organic solids can reduce oxygen availability.

In aquaculture conditions, most suspended solids derived from fish e.g. faeces, are removed to prevent them becoming too high. The design of the culture system influences the amount of suspended solids and self-cleaning systems are designed to prevent this problem. Water velocity > 3cm/s prevents solids such as uneaten food from settling.

The physical characteristics and total amounts of suspended solids in water are relevant in determining the extent of possible negative effects in salmon and trout gills and skin.

3.1.10 Water flow

Water flow rate is important for determining water quality aspects such as oxygen supply and removal of metabolites in tanks and pens, self-cleaning of tanks (removal of faeces and excess feed) and also for setting up a water current speed (body lengths/min) that affects the behaviour and distribution of the salmon in the rearing unit. Too high flows can be detrimental to salmon welfare and if too low, then waste products are not removed efficiently and oxygen levels can become critically low. In farming units water speeds of 0.5 to 2.5 body lengths /sec are frequently used. Tolerance to high flow and water currents depends on life-stage and body size.

Parr prefer high water flow rates whereas fry prefer areas of low flow within rivers and these life stage requirements are normally taken into account in fish farms.

Salmon and trout should have sufficient water flow for removal of waste products and uneaten food and for oxygen provision if not otherwise provided, but the flow should not be too great for the young fish to maintain station without excessive energy usage.

3.1.11 Water depth

Water depth will affect available space, gradients in hydrostatic pressure and light, as well as time for feed to sink through the water column, all factors that can affect salmon

and trout welfare. The water depth also affects the ability of the farmer to inspect and monitor the behaviour of the fish, such as feeding behaviour or behaviour indicative of diseases.

Salmon and trout need to be able to go to the surface to fill the swim bladder, and therefore require contact with air at the water surface to maintain neutral buoyancy in the water column.

During the alevin stage and until shortly after first feeding, salmon need a bottom substratum for vertical support, such as gravel, dense vegetation or artificial grass. Lack of such support will reduce survival, first feeding success and growth and may lead to deformities. The swimming depth (i.e. the vertical positioning) in sea pens depends on environmental gradients of light, temperature and salinity and is modulated by feeding response and health status. Where water depth does not allow for the direct observation of fish other methods (e.g. underwater cameras) should be used for effective monitoring.

3.2 Water Monitoring

Each marine farm must carry out water column nutrient monitoring at each site in accordance with Departmental guidelines[10]. Nutrient monitoring surveys shall be carried out monthly during the period December – March each year. A transect and the number of sampling stations along the transect shall be agreed following consultation with the Marine Environment and Health Services Division of the Marine Institute. Water samples for nutrient analysis shall be taken at each station on the agreed transect. Samples shall be taken at the surface, mid depth and 1 metre above the bottom. Analysis should include ammonia, nitrite, nitrate and phosphate. The water quality parameters must be monitored by an approved laboratory which participates in an inter laboratory proficiency scheme.

Each freshwater farm must carry out water analysis as requested by the relevant local authority.

Water quality monitoring is especially important for hatcheries. Monitoring equipment must be maintained in good functional condition. Failures of the water supply is a major consideration and back up systems are essential until the system failure can be addressed.

[10] DMNR, 2000. *Monitoring protocol for offshore finfish farms – water column monitoring.*

The following procedures should be followed:

1. The water quality parameters measured will depend on the husbandry system employed.
2. Increased vigilance is essential during high risk periods.
3. In the freshwater sites, temperature, dissolved oxygen and pH should be recorded daily. This can be done using an all-purpose probe. Probes should be of good quality, well maintained, serviced and calibrated regularly. Nitrite, nitrate and free ammonia should be measured on an infrequent basis, especially if a water quality problem is suspected. A water sample should be submitted to an appropriate laboratory for analysis of these parameters. High temperatures and biomass in the spring make it the most risky period, especially if there is a failure in oxygen delivery or a spate or flood in the river.
4. In land based tanks, water can be oxygenated through mechanical means or by liquid infusion. Whatever system is in place should be monitored frequently and appropriate alarms in place in the event of oxygen failure.
5. In seawater pens, temperature, oxygen (especially during summer months), salinity and turbidity should be quantified daily if possible. Zooplankton and phytoplankton monitoring should be carried out regularly to identify dangerous species where possible, either by submitting samples to an appropriate laboratory or by using a trained person on site.
6. Low oxygen in seawater pens may indicate badly fouled nets. Phytoplankton blooms may also result in de-oxygenation of water, in addition to causing toxic and physical damage to the fish.
7. A contingency plan should be put in place in case of acute deterioration in water quality.
8. A daily log of water quality parameters should be kept and monitored over time. This data should be analysed in conjunction with mortality levels and any behavioural patterns identified.

3.2.1 Contingency Plan in the event of deteriorating water quality

This plan should detail the personnel required to apply the control measures, list their responsibilities and identify a chain of command. Such a contingency plan should include elements of:

a) How to utilise partial or complete recirculation if available and appropriate.
b) How to increase flow rates or utilise an alternative water supply where available.
c) How to aerate or oxygenate, if dangerously low oxygen levels are recorded.

3.3 Effluent & Benthic Monitoring

3.3.1 Marine

Each marine farm license states that an annual benthic (sea bed) audit must be carried out at each site, according to Departmental guidelines[11]. The benthic monitoring requirements at a fish farm are dependent on the level of biomass held at the site and the local hydrography. The following table sets out the level of benthic monitoring required based on tonnage produced and mean current speeds at the fish farm:

Table IV

Level of benthic monitoring required for different size farms at different current speeds.

	<5 cm/sec	**5-10 cm/sec**	**>10 cm/sec**
0 – 499 Tonnes	Level 1	Level 1	Level 1
500 – 999 Tonnes	Level 2	Level 1	Level 1
> 1000 Tonnes	Level 2	Level 2	Level 1

The current speed is a mean value calculated from maximum current measurements over spring and neap tidal cycles at the surface and near the bottom. The tonnage refers to the maximum biomass predicted for each site. An annual survey must be carried out at each site (production and smolt) operated by a company. All sites will be subject to one of the two levels of survey:

Level 1:

Video/photographic and visual observations and recordings should be made at the following stations:

- At a minimum of 2 sites directly beneath the pens.
- At the edges of the pens.
- Two transects at right angles to each other. Along each transect sampling stations at +/- 10m, +/- 20m, +/- 50m and + 100m from the pens.
- At a control site.

In addition to the above, the following samples / measurements shall be taken at the same stations as above. These will be used to calculate sediment quality parameters.

- A minimum of one Redox potential readings shall be made at each sampling station.
- A single sediment sample for Organic Carbon measurement.

[11] DAFF, 2008. *Monitoring Protocol No. 1 for Offshore Finfish Farms – Benthic Monitoring*.

Level 2:

In addition to the above, three replicate grab samples shall be captured at each of the sampling stations. The exact location of sampling points should be agreed in advance with the Department of Agriculture, Marine and Food. The identification and abundance of macro-faunal invertebrates shall be estimated and tabulated. Identification of fauna to the level of species will be required.

An annual environmental survey will have to be conducted for each finfish culture site so that an assessment can be made of the impact of the farming operation on the seabed. The annual survey shall be carried out on behalf of the farmers by any consultant from a pool of approved consultants.

The survey should be carried out during peak biomass periods or at least within 30 days after the end of harvesting of a year class. However, it is appreciated that all sites requiring surveys at the farm most likely will be carried out in one visit therefore, the timing of the surveys should by dictated by grower sites (with greater biomass) with concurrent surveys at smolt or harvest sites. A similar timing schedule applies to each of the two survey types.

3.3.2 Freshwater

All freshwater aquaculture facilities require a *Discharge Licence* from the local Council Authorities. Permitted water discharge levels vary between local authorities.

The *Discharge Licence* sometimes stipulates the maximum allowable extraction rate as well as the frequency of water sampling.

Allowable levels of certain parameters for freshwater aquaculture are defined in SI No. 293 of 1988 – European Communities (Quality of Salmonid Waters) Regulations 1988:

BOD (Biological Oxygen Demand)	<5 mg/1
Suspended Solids	<25 mg/l
Total Ammonia	<0.3 mg/l
Un-ionised Ammonia	<0.02 mg/l

Chapter IV. General Husbandry

4.1 Transfers

Fish health status must be considered when evaluating the risks of moving fish stocks. Operators must ensure that only registered transporters are used and that all equipment used to transport fish safeguards the health of the fish being moved. They must ensure that the process minimizes the risk factors that may predispose the fish to disease, minimizes transfer of disease causing agents and reduces the risk of accidental loss of fish during transport activities.

4.1.1 Pre-Movement

In consultation with a qualified fish health professional, the diagnostic and treatment history of any fish being moved must be reviewed prior to transport. This includes mortality, diagnostic and treatment records and examination of a representative sample of fish shortly before transportation.

Fish must be clinically healthy prior to movement and must not come from a farm where there is any unresolved mortality. An exception may be made if a risk assessment demonstrates the animals to be moved originate from a part of the farm epidemiologically separate from the affected area.

Notification of intent to move finfish within the country must be made to the Marine Institute in writing (fax 091-387201 or email notification@marine.ie) at least 72 hours before the movement is due to take place. The written notification must be accompanied by a veterinary report summarising the outcome of a clinical inspection which has taken place within 1 week of the proposed transfer. An exemption of up to 1 month may be feasible for multiple movements from the same site or where transportation/ weather or other unforeseen issues arise. In such instances, if any disease situation is suspected or confirmed in the intervening period, the Marine Institute must be notified.

Juvenile stock must be sourced from farms with no clinical health problems. These farms must be certified as specific disease-free hatcheries in approved health zones.

A risk assessment should be conducted and the transfer of fish onto the site should only take place if the risk is acceptable.

4.1.2 Imports

It is in the farmers' interest to ensure that all imported fin fish have only been treated with medicines that are licensed in accordance with European legislation.

Consignments of live salmonids for import into Ireland from other EU countries must meet current regulatory requirements with regard to fish health. Specifically, fish of susceptible species must be certified in accordance with Commission Decision 1251/2008/EC.

4.1.3 Movement between sites

In Ireland, it is normal practice for net pen farm operators to transfer stocks during the production cycle within the site (to facilitate operations such as grading) and for some operators to move fish from one site to another to allow for fallowing, single year class maintenance and harvesting. Movements of already introduced stock can be by several methods including; simple hand net (from one tank, pond or pen to another); in transport tanks (within farm movements from one pond/tank to another or farm to farm); by suction or air lift pump (from one pond/tank/pen to another); by passive swimming (pen to pen); via boat towing of pens (site to site over relatively short distances) and by wellboat from one site to another.

1. All stocks must be subject to a health check by the farm biologist on the day of loading.

2. All equipment should be purpose designed, so as to allow, efficient movement of stock with minimal stress, the avoidance of damage and provide optimal conditions to safeguard the welfare of stock at all times.

3. Staff should be competent at carrying out the specific tasks involved in the movement of stocks.

4. All equipment should be maintained in good working order (from hand nets to wellboats) and should have a planned schedule for its hygienic use and disinfection (see Section 5.0).

5. Accurate and auditable records of all stock movements should be maintained to allow the complete tracing of stock from initial introduction to final transfer and to allow managers to request evidence from transport contractors/suppliers that transport equipment has been cleaned and disinfected.

6. Fish movements should be coordinated with other operators so as to maintain, single year class separation, maximum bay fallowing periods and minimize any unnecessary disease risks associated with the movement of one stock in proximity of another.

7. Multi-site deliveries with one transport consignment should be avoided.

8. Fish that are suffering from a viral or bacterial disease should only be moved if advised by a veterinarian in support of the welfare of the stock and following a comprehensive risk assessment.

9. Recovered stocks should not be moved until confirmation of the absence of disease has been advised by a qualified veterinarian and the competent authority in the case of listed diseases.

10. Regular inspections should be carried out during transport to ensure that water quality parameters are maintained within the optimum ranges.

11. Any water exchanges during transport must be carried out at places approved by the Marine Institute and under conditions which do not jeopardise the health status of the aquaculture animals being transported or any aquatic animals at the place of water exchange.

12. Helicopter buckets and road transport equipment used for fish transfer should be disinfected as required. Evidence of disinfection should be obtained from the transport company.

13. Wellboats should provide evidence of disinfection.

4.1.4 Wellboats

The Irish aquaculture sector uses wellboats for a variety of purposes. Risk of infectious disease transmission from one site to another is inherent in any movement or handling of fish. In order to minimize the risk of infectious disease transmission, high levels of biosecurity are required by those operating and using wellboats.

New fish health regulations require wellboat operators to register with the Marine Institute and to observe the following biosecurity standards:

Table V

Wellboat biosecurity stages.

Stage	To be completed:	Biosecurity steps:	When/where:
1	After each consignment of fish is unloaded	Brush or clean solids from all surfaces. Pressure clean the deck, wells, equipment, pumps and protective clothing using an appropriate detergent.	As soon as work has been completed on a site
2	When coming to Ireland from abroad AND when moving between bays in Ireland, except when carrying out shuttle runs between agreed management areas	Steam clean and disinfect all surfaces, including the hull down to the waterline	At a location at least 5km from an active fish farm
3	When leaving an area infected or suspected of being infected with a listed disease, either within Ireland or abroad OR If the vessel is entering Irish waters with a fouled hull that has not been de-fouled in the previous six months	Slip the vessel, clean and disinfect the hull below the waterline	A suitable port in the country of origin, or Belfast, Cork or Dublin Ports. Once slipped, the boat should steer a course at least 5km from an active fish farm *

**It may not always be possible to steer a course which is 5km or more from a fish farm. In such cases, wellboats must travel with their wells closed. Ballast water may not be discharged within 5 km of a fish farm.*

Statutory Requirements

It is mandatory for wellboats to:

- Adhere to the levels of cleaning and disinfection outlined above and retain paperwork to support these biosecurity measures (see below and checklist available on www.marine.ie/fishhealth).
- Keep a Transportation Log containing the information detailed below.
- Have an annual independent audit of operations completed by a private veterinary practitioner.
- Facilitate on the spot inspections by Marine Institute personnel.
- Notify the Marine Institute where the presence of a listed disease is suspected.

Paperwork Required

1. CLEANING & DISINFECTION

Table VI

Wellboat disinfection stages

Stage	Approved by	Notify the Marine Institute
1	Stage one cleaning must be signed off by the skipper and witnessed by another crew-member.	
2	Stage two disinfection must be signed off by the skipper and witnessed by another crew member. On arrival at the site of destination, the fish farm's site manager must also sign off stage two disinfection, having satisfied him/herself that the cleaning and disinfection has been carried out thoroughly. He/ she should also inspect the travel plan used by the boat en-route to the site before signing the checklist. Wellboats must travel with a clean (non-fouled) hull when entering Irish waters.	If a wellboat is coming from another country to work on an Irish site, a signed copy of the checklist must be faxed to the Marine Institute at 091-387201.
3	Stage three disinfection must be signed off by a vet	If a wellboat is coming from an area infected or suspected of being infected with a listed disease, a signed copy of the checklist should be faxed to the Marine Institute on 091-387201 before work commences on a new site.

2. TRANSPORTATION LOG

A Transportation Log must be kept for the vessel, containing at least the following information for each consignment:

- Date and time of loading.
- Name and address of the site of origin.
- Species transported.
- Number of fish transported.
- Size of fish transported.
- Date and time of un-loading.
- Name and address of the site of destination.
- Details of observed mortality during the journey (number of animals and general observations).
- Details of the route taken by the vessel when travelling to sites in Irish waters and between sites in Irish waters.

Fish Health Regulations are carried out under SI 261 of 2008. For more information see www.marine.ie/fishhealth.

4.2 Single Year Class

Stocking of single year classes and the separation of generations is known to reduce the risk of transferring infectious disease agents between stocks/generations.

Only one generation of fish should be held on any one site (and if possible only one generation of fish should be held in one bay or hydrographically linked water body).

Hatchery operations may have several overlapping year classes on site e.g. early incubation, fry rearing and/or broodstock. Rearing units must be kept separate as much as possible to prevent transmission of disease between classes and appropriate biosecurity measures put in place to protect each cohort.

4.3 Fallowing

It is a condition of all marine licences that each site must be fallowed for a minimum of four weeks between generations[12]. Fallowing is a recognised management strategy known to assist in the control of disease and parasite problems.

The goal of fallowing is to break infection cycles by removing susceptible hosts and by decreasing infection pressure at a given location. Fallowing should break the life cycle of sea lice thus reducing numbers on subsequent fish introductions. The process also allows for the complete breakdown of organic waste material associated with the farm on the surrounding sea bed area.

Fallowing is usually carried out prior to the introduction of a new population of aquatic animals into a previously used site. Experience has shown that with certain fish pathogens this approach can be ineffective and total bay or synchronous fallowing may need to be considered.

Currently in Ireland, the minimum statutory fallowing period for marine sites is one month. Where necessary this time frame should be extended to take account of the infective period of any pathogens of concern. Where this is unknown, the longest fallowing period possible should be used. A mandatory fallowing period of up to six months may be required before re-stocking following an outbreak of a notifiable disease.

The fallowing period begins after all susceptible species have been removed. This is followed by thorough cleaning and disinfection of the pen/tank infrastructure and ancillary equipment, using approved methods.

[12] DMNR, 2000. *Protocol for fallowing at offshore finfish farms.*

4.4 Feed & Nutrition

Farmers should ensure that they use feeds that have been formulated specifically for the life-stage of the species being farmed. Farmers should regularly review the specification and correct methods of use of diets with their supplier. Feed should only be sourced from reputable suppliers with nutritional expertise in formulating feed for the species concerned. Feed must comply with EU legislation in relation to animal feed stuffs.

A number of immunostimulant diets or supplements are currently available for salmonids. Given the emphasis on disease prevention rather then cure, these diets may be used as required. This may be prior to stressful events such as movement or in the face of a disease outbreak to boost immunity.

The farmer must adhere to the following standard operating procedures:

1. Each farm must have an up to date feed storage licence issued by the Department of Agriculture, Marine and Food.

2. Feed must be purchased from a licensed and reputable feed manufacturer.

3. Feed should be manufactured to a certified and accredited manufacturing standard.

4. Feed bags should be clearly labelled for example to include details such feed rate, date milled and if medicated. Feed data sheets should be readily accessible.

5. Feed in storage must be managed to ensure that it does not pass the expiry date and out of date feed must not be used.

6. Feed that has deteriorated in quality must not be used.

7. Clean equipment should be used to handle and transport feed.

8. Hazardous chemicals should not be stored in the feed area.

9. A feeding strategy must be devised in consultation with qualified technical staff to ensure the correct type and quantity of feed is fed to meet the physical and nutritional requirements of stocks at all times.

10. The feeding ration should meet the daily nutritional demands of each batch of fish in terms of energy requirement and nutrients required for healthy growth and vitality.

11. Feeding practices must ensure that feed is delivered in sufficient quantity to minimize fish crowding and damage. The feed should be delivered at a sufficient rate and over a large enough area to satisfy the fish population and prevent scale loss.

12. Regular observation of feeding behaviour should be undertaken to assist the assessment of feeding level. If necessary cameras should be used to observe feeding response and to facilitate optimum feeding and reduce feed waste. Any abnormalities in feeding behaviour should be reported to the site manager and recorded on the feeding sheet.

13. Accurate records of the quantity of food fed must be kept.

14. Feed conversion ratios (FCR) must be assessed on a regular basis and FCR kept to a minimum.

15. Automatic feeders should be maintained in good working order and cleaned regularly.

16. At critical/stressful periods during the cycle, fish may be fed approved diets containing vitamin supplements and/or immuno-stimulants.

17. The feed must be stored adequately according to manufacturer's instructions, and not exposed to extreme heat, light or humidity.

18. The feed must be protected from pests.

19. Adequate systems must be in place to prevent feed spillage.

20. Samples of all feed batches should be taken and stored in a freezer for future reference.

21. Clean equipment should be used to handle and transport feed.

22. Medicated and non-medicated feeds should be adequately separated.

23. Care should be taken to ensure the disinfection of feed trucks which may deliver to a number of farms during the same trip.

24. It is recommended that feed storage bins be inspected routinely, for example, twice yearly, and cleaned, repaired etc., if necessary.

25. Transport of medicated feed from storage to automated feeding equipment or in preparation for hand feeding should be done carefully. Any spillage should be immediately cleaned up and disposed of according to manufacturers instructions.

26. Should there be excess medicated feed remaining on a site the Manager should be responsible for contacting the manufacturer to determine proper handling and disposal.

27. It is the Manager's responsibility to ensure that there is sufficient feed in storage to minimize stress due to hunger and excessive competition for food.

28. Medicated feed should be administered in accordance with veterinary instructions and the Manager is responsible for keeping daily inventory records. Details of all prescriptions should be kept for a period of five years.

4.5 Handling & Grading

Certain husbandry operations require that the fish are crowded to facilitate access for handling (weighing, grading, counting, passive grading, bath treatments, pumping/brailing into wellboats, transport tanks for transfer or harvesting).

1. It is important that these operations are well planned, carried out with suitable equipment by competent personnel and during suitable environmental conditions.

2. All staff involved in procedures such as grading, pumping, fish vaccination and transportation should be aware of and have received training in good fish handling techniques.

3. When examining fish out of the water for more than 30 seconds they must be anaesthetised. Netting and holding equipment must be adequately designed to minimize damage to the fish.

4. When out of the water, the fish must be adequately supported by the operator by holding both the tail and supporting an area around the pectoral fins. After handling the fish should be monitored in a recovery bin to ensure full recovery.

5. Crowding is stressful to fish and should be kept to an absolute minimum (not exceeding 2 hours).

6. Operators should monitor environmental conditions (weather, water temperature, current, tidal cycle) to ensure optimum conditions.

7. Where appropriate, crowding a small population with a clean seine net is preferable to crowding the entire enclosure.

8. Fish should be starved for 24-48 hours before any operation requiring crowding.

9. The fish should be carefully monitored throughout the entire procedure.

10. At higher water temperatures (>12^{o}C) the level of dissolved oxygen in the water should be monitored.

11. If the fish show signs of excess stress during the crowding process the area available to them should be increased and/or oxygen should be diffused into the water. Oxygen levels should be kept as close 100% saturation as is possible.

12. Enclosure nets should be kept clean in order to prevent problems during crowding.

13. The size of the grader and pumps must be appropriate to the size of the fish.

14. Passive grading systems are encouraged wherever practical.

15. After a handling episode fish must be examined for signs of poor handling such as skin injury and scale loss. If such signs are noted, affected groups should be carefully observed for increased rates of mortality or illness in the subsequent weeks.

16. All handling events must be recorded in a daily log.

4.6 Stocking Density

The influence of the stocking density on the health and welfare of the fish will be influenced by the life stage, species, culture conditions and environment.

1. The stocking density of any marine pen should not exceed 20kg/m^3 at any time of year and ideally should not exceed 15kg/m^3 during the summer months.

2. The stocking density of freshwater units should not exceed 50kg/m^3 at any time of year and ideally should not exceed 35kg/m^3 during the summer months. Higher stocking densities are possible if reliable and well monitored oxygenation systems are in use.

3. Stocking density should be monitored in relation to health, fish behaviour and water quality to ensure that welfare is not compromised.

4. Levels should be reduced if problems arise.

4.7 Holding Units

The siting of the holding units must be carefully considered with regard to fish health and welfare, personnel safety and minimizing adverse affects on the environment. An adequate flow of clean water must be ensured at all times.

4.7.1 Pens

1. In marine sites maximum current speeds should not exceed 1.5 knots at peak spring tides. Equally, the daily maximum current speed should not be less than 0.5 knots.

2. In marine sites the pen net should not be less than 5 metres in depth and 4 metres in freshwater sites.

3. In marine and lake sites the net material should be smooth, knotless and non-abrasive.

4. The net must be adequately tensioned and weighted so as to maintain shape and volume.

5. The net should be kept free of bio-fouling and marine nets should be changed/ cleaned at least once every 3 weeks during the period April – September and as necessary at other times of the year.

6. All nets should be labelled so as to allow traceability to and from contract net cleaning facilities.

7. All nets should be serviced and tested at appropriate intervals to ensure that they are within specified limits for mesh strength and nets that do not meet specifications should be decommissioned.

8. Damage from predators should be minimized through the use of predator nets both above and below water.

4.7.2 Tanks

1. Tanks should be made of smooth non abrasive material and constantly checked for imperfections which could cause injury to the fish.

2. Holding units for salmon in freshwater must be designed so as to promote uniform flow and healthy growing conditions.

4.8 Predator Control

Management methods must be designed to reduce the attraction of predators to culture facilities and prevent predators attacking fish thus avoiding stress that could result in an increased risk of disease. The predator control strategy should consider the following:

1. A named person should be responsible for the predator control strategy on site.

2. Fish food and dead fish must be properly stored.

3. Predator exclusion methods must be used e.g. top-nets, outer predator nets, ultrasonic seal scarers, cone nets, sinker rings, tension nets and bird scarers.

4. Regular facility inspections must include checks for signs of predator attacks.

5. Top nets must be used in freshwater sites.

6. Predator netting or similar devices must be checked for signs of being breached and repaired as soon as possible upon detection.

7. Measures taken to protect fish from predators must consider predator welfare and not endanger the predator population.

4.9 Harvesting

Fish being moved via live haul to a harvesting station must be handled in as stress free a manner as possible. Fish must be seined, brailed, pumped and stunned humanely. The European Food Safety Authority has published reports on the welfare aspects of current stunning and killing methods of farmed Atlantic salmon[13] and trout[14]. The following harvesting strategies should be in place:

1. Representative samples of fish should be routinely analysed for residues of all treatments used prior to harvest.

2. The manager must fill out a *Traceability Sheet* for all fish harvested. This must contain details of origin, feed type, treatments given and residue analysis results. A copy of this report must be sent with the consignment of fish to the customer.

3. Equipment should be site specific, if possible, to minimize the risk of contamination between sites.

4. Non-porous equipment should be used on decks.

5. Cleaning and disinfection of all equipment should take place before entry onto the site.

6. When cleaning equipment, all visible organic matter should be removed with detergent. Disinfection of equipment should then be performed using an appropriate broad spectrum compound, diluted to the concentration recommended by the manufacturer. The disinfectant should be in contact with all surfaces and left for the recommended time period. Rinsing with fresh water afterwards may be done if necessary.

7. Fish must be starved for a period sufficient to evacuate faeces from the gut. The starvation period should not exceed 14 days.

8. Before commencing harvest at sea or transporting fish from a farm to a harvest station, the pen net should be examined for holes. This should be carried out before crowding the fish and at intervals during the operation.

[13] EFSA, 2009. Species specific welfare aspects of the main systems of stunning and killing of farmed Atlantic salmon. The EFSA Journal 2012, 1-77.
[14] EFSA, 2009. Species specific welfare aspects of the main systems of stunning and killing farmed fish: rainbow trout. The EFSA Journal 1013, 1-55.

9. Handling of fish should be carried out with the least stress possible and the method of slaughter employed should be performed in a humane manner and result in rapid and irreversible loss of consciousness.

10. Fish should be stunned prior to slaughter using either an automated percussive stunning machine or an automated electric stunner. If fish are killed without stunning, the method used must result in a rapid and irreversible loss of consciousness.

11. Bleeding should be carried out by cutting one side or both sides of the gill arches.

12. After bleeding the fish should be transferred immediately into iced water. The iced water/fish ratio should be sufficient to reduce the temperature of the fish to $<5^{o}C$ within 4 hours. The fish should then be immediately transported to the packing station.

13. Blood-water and effluent should be contained, and treated prior to discharge, in accordance with the requirements of the relevant effluent discharge licence. Untreated blood-water should never be released into the environment.

14. Blood-water leakage from the harvest raft should be prevented. Blood-water should be collected in harvest bins with sealed bin liners and secure lids then disinfected and disposed of in accordance with the requirements of the relevant effluent discharge licence.

15. The temperature of the iced water and fish should be continuously monitored.

16. At the end of each day of harvesting, all equipment should be cleaned and disinfected. All organic material should be removed with a detergent. Disinfection of the equipment should then be carried out ensuring that the disinfectant is in contact with all surfaces for the recommended time period.

17. All used disinfectant, organic matter washings and rinse water should be contained properly during harvest and slaughter, and treated prior to discharge, in accordance with the requirements of the relevant effluent discharge licence

18. Cross-infection should be prevented by ensuring harvest bins are thoroughly cleaned and disinfected between operations.

19. On site harvesting equipment should be site specific or if moved between sites should be cleaned with a degreasing agent and disinfected.

20. Protective clothing must be provided for staff and should be retained on the premises.

21. The farmer should ensure that the haulage company is both aware and active in all biosecurity matters relating to transport.

22. Bins and transport tankers should be disinfected prior to and after harvesting.

4.10 Vaccination

Vaccination is a key strategy in disease prevention. A strategic vaccination plan should be established for each specific site, taking the final destination of the fish into consideration. This is especially important if fish can only receive one vaccine. Vaccination is usually carried out at freshwater land based sites or lake sites. It is rarely carried out in marine stage fish.

4.10.1 Vaccination by injection

1. A risk assessment should be carried out in order to assist in deciding which vaccine to choose. It is recommended that all Atlantic salmon receive at least one vaccination prior to transfer to a marine site.

2. Only vaccines with market authorisations or an equivalent approval should be used.

3. Farms should ensure that fish are vaccinated against the diseases that are most commonly associated with the species in the intended area of culture (e.g. vibriosis, furunculosis, Pancreas Disease, IPN), based on efficacy, risk assessment and advice from a fish health professional.

4. Vaccination should only be carried out by competent staff under veterinary supervision.

5. High levels of hygiene must be maintained during the vaccination procedure. All vaccination equipment must be clean and disinfected.

6. Vaccination should form part of the VHP.

7. Vaccines are used to facilitate a protective immune response and are used under the conditions recommended by the manufacturer or under veterinary advice.

8. Prior to vaccination: (1) the health of the fish should be assessed (e.g. behaviour, appetite, mortality levels); (2) fish should be weighed and be an appropriate size for vaccination; (3) the correct type and quantity of vaccine should be refrigerated at the appropriate temperature; (4) the vaccine quality and expiry date should be checked.

9. Fish should be taken off feed (48-72 hours) prior to vaccination.

10. Vaccination equipment, tables and tanks to receive the vaccinated fish should be clean and disinfected. Strict biosecurity for off-site vaccination teams should be enforced.

11. Fish body wall thickness should be assessed and appropriate needle size used to ensure the vaccine is injected into the correct location in the peritoneal cavity (1-2mm penetration). A small number of test fish should be vaccinated, euthanized and examined.

12. Anaesthetic concentration can be adjusted by using a number of test fish. Speed of sedation should match vaccination rate. Monitor time to recovery regularly and adjust concentration of anaesthetic if necessary. Fish should take no longer then two minutes to recover.

13. Fish should be handled gently to minimize scale damage and mucous disruption.

14. Needles should be changed in accordance with manufacturers instructions (automated) or before they become blunt (manual vaccination).

15. Disinfect and clean surfaces and equipment frequently, especially between batches.

16. Ensure all personal involved in handling the vaccine are wearing suitable protection such as rubber gloves. In case of accidental self-injection the operator and the safety data sheet for the vaccine should be taken immediately to the nearest hospital or medical centre.

17. Discard any vaccine containers according to the manufacturer's instructions.

18. Monitor the fish for 48 hours post vaccination to ensure no adverse reaction to the product has occurred and post-vaccination mortality levels are within the expected range.

19. Records must be kept of all vaccination procedures conducted on site and must include the following: date of vaccination, identification of the groups of fish vaccinated, vaccine used (including batch numbers and method of application), details of dosage and the names of the personnel involved.

20. Vaccines must be used and stored in accordance with the manufacturer's data sheet and/or veterinary advice.

21. Vaccines must be stored in an appropriate container and must not be used after the expiry date.

22. Equipment used in vaccination should be maintained in a hygienic manner.

23. Booster vaccinations, if required, should be administered according to veterinary advice.

4.10.2 Vaccination by immersion

1. Prior to vaccination: (1) the health of the fish should be assessed (e.g. behaviour, appetite, mortality levels); (2) fish should be an appropriate size for vaccination; (3) the correct type and quantity of vaccine should be refrigerated at the appropriate temperature; (4) the vaccine quality and expiry date should be checked.

2. Vaccination equipment and tanks to receive the vaccinated fish should be clean and disinfected.

3. Shake the vaccine bottle well before use. Dilute with the appropriate amount of hatchery water immediately after opening.

4. Ensure the temperature of the diluted vaccine is not more then 5°C different from holding area.

5. The vaccination tanks should be oxygenated.

6. Vaccinate the fish in batches according to the size and weight of the fish and the volume of the vaccine. Accurate weighing of the fish is essential to ensure appropriate dosing.

7. Follow the data sheet for timing the immersion of the fish.

8. Ensure all personal involved in handling the vaccine are wearing suitable protection such as rubber gloves.

9. Discard any vaccine containers according to the manufacturer's instructions.

10. Monitor the fish for 48 hours post vaccination to ensure no adverse reaction to the product has occurred and post-vaccination mortality levels are within the expected range.

11. A vaccination log should be maintained with the details of all vaccinations received by each batch of fish. The expiry date, batch number, manufacturer, name of product and supplier should all be recorded. A copy of the data sheet should be retained also. These records should be maintained until the batch of fish in question has completed its life cycle.

4.11 Treatments

The company veterinarian will determine, where necessary, the appropriate medication to control and/or prevent the outbreak of disease. Delaying treatments causes welfare problems and may ultimately lead to increased medicine use. The veterinarian can supply the animal remedy and a *Veterinary Written Description* to the Manager and/or to the feed mill, where appropriate. The Manager will ensure that all animal remedies are administered according to veterinary advice and/or the manufacturer's instructions. All animal remedies must be administered in accordance with the relevant legislation: European Communities (Animals Remedies)(No. 2) Regulations 2007 as amended.

The Manager must ensure that the following detailed records are maintained in the *Animal Remedies Record Book* (or computer Log) for five years following treatment:

a. Aquaculture license number and name of holder.
b. Location of aquaculture facility.
c. Species of salmonid.
d. Name of the prescribing veterinarian.
e. A log naming the remedy, including:
    I. Name of the Animal Remedy/Therapeutant.

II. Name & address of the supplier
III. Date of receipt and quantity
IV. Administration method, dosage rate and water temperature.
V. Date treatment commenced.
VI. Frequency of treatment.
VII. Date of last treatment.
VIII. Quantity of unused/expired remedies.
IX. Name and signature of the person responsible for administering each treatment.
X. Minimum withdrawal period advised by the veterinarian or the manufacturer.

The Manager must present the *Animal Remedies Record Book* to an authorised officer (such as a Dept. Agriculture Marine & Food, Sea Fisheries Protection Agency or Marine Institute official) upon request.

The following procedures should also be followed:

1. Representative samples of fish should be routinely analysed for residues of all treatments used prior to harvest.

2. There should also be a regular periodic review to assess the efficacy of treatments so that medication regimes can be modified as appropriate.

3. Where treatment is necessary it should be initiated without delay to ensure good welfare and medicine management.

4. Accurate information should be provided to the attending veterinary surgeon so that correct dosages can be calculated for the fish concerned. Ensure that clear instructions for medication, dosage and administration are obtained and are communicated to the staff responsible for treatment.

5. The recommended course of treatment at the correct dosage should always be completed. In the event of the inability to complete the course due to adverse weather conditions, or where fish welfare would be compromised, treatment may be terminated. Where treatment is terminated early this should be recorded and advice sought from the veterinary surgeon.

6. All requirements for medicine withdrawal periods prior to the slaughter of fish for human consumption must be complied with.

7. Farmers must keep on file, appropriate data for all medicines used – e.g. product data sheets, package inserts or safety data sheets as available.

8. Farmers must report to the veterinary surgeon any suspected adverse reaction to a medicine in either the treated fish or farm staff that have had contact with the medicine.

9. Temperature may be important for maintaining efficacy of the medicine, and in the case of vaccines, dedicated refrigeration equipment should be available to keep them at the required storage temperature (normally between 2 and 8°C). A refrigeration logbook should be maintained for vaccines.

10. Medicines should be kept out of the reach of animals and children or anyone not supposed to handle them.

11. Unused medicines should be returned to the prescribing veterinarian or supplier and never sold or passed on to anyone else.

4.11.1 Medicated Feed

1. Only authorised in-feed treatments should be used, under veterinary prescription and instruction.

2. In feed treatments should be incorporated at a Compounder, licensed by DAMF to manufacture medicated feed on foot of receipt of a *Veterinary Written Description* supplied by a veterinarian.

3. DAMF also issue *Home Mixer Licences*, which permit manufacture of medicated feed on a site by suitably trained personnel where a pre-mix which has been prescribed by the veterinarian is incorporated by the trained personnel on foot of instructions in the *Veterinary Written Description* supplied by the veterinarian.

4. In feed treatments should be fed according to the *Veterinary Written Description* by suitably qualified personnel with extra vigilance to ensure maximum up-take of the medicated ration.

5. Feeding rate should be in line with the stock feeding rate (%bw/day) under the consultation of a veterinarian. Where further non medicated feeding is required, medicated feed should be fed as the first meal of the day.

6. A representative sample of medicated feed should be taken by sub-sampling across the total prescribed delivery, accurately labelled and frozen for one month after the fish are sold.

7. Accurate records of in feed treatments should be maintained.

4.11.2 Medicine Storage

All animal remedies must be stored in a locked room/container. Access to this store must be restricted to authorised personnel only. It is the responsibility of the site manager to ensure the following:

1. To maintain in and out records including type of medication, date received, batch code and date administered in the Chemical Store Log Book.

2. To restrict access to nominated personnel.

3. To keep the room/container tidy, secure, in a good state of repair and vermin-proof.

4. Ensure all chemicals are properly labelled.

5. Medicines are used in strict rotation observing expiry dates.

6. To ensure the proper disposal of empty containers.

7. All chemicals that are past the expiry date must be disposed of according to the manufacturer's instructions.

8. Product datasheets for all chemicals purchased by the company must be filed in the 'Datasheets file'.

4.11.3 Egg Disinfection

1. Eggs of salmonids are collected and disinfected to minimize the risk of transfer of pathogens from broodstock to progeny.

2. Methods used for pathogen reduction are based on vertically and horizontally transferred pathogens present or suspected in the broodstock.

3. Culturists are encouraged to consult a qualified fish health professional when designing their broodstock and egg handling protocols.

4. Before eggs are brought in for incubation, equipment must be washed, disinfected and thoroughly rinsed.

5. Operators must use a disinfectant that is recognized for use in aquaculture and follow manufacturer's instructions.

6. Strict hygiene should be observed at all times in the hatchery.

7. Equipment should be specific to the hatchery. In addition, hatchery tools should not be used between different tanks, raceways etc. Colour-coded labelling of tools may be helpful in keeping tools separate. Equipment should be cleaned, disinfected and properly stored after each use.

8. When cleaning equipment all visible organic matter should be removed with detergent. Disinfection of equipment should then be performed using an appropriate broad spectrum compound, diluted to the concentration recommended by the manufacturer. The disinfectant should be in contact with all surfaces and left for the recommended time period. Rinsing with fresh water afterwards may be done if necessary.

9. Observation of new batches of eggs or livestock should be carried out in order to detect infection with disease. This should be done if possible in a quarantine area. It is advisable to have the quarantine area physically separated from other areas on the site.

10. During spawning, it is important to avoid contamination of the gametes with organic material such as urine, faeces and blood. Eggs should be rinsed thoroughly with fresh water.

11. As soon as possible after fertilisation, an appropriate disinfectant should be used to disinfect pre-hardened eggs, using the correct concentration and contact time.

12. Careful handling of eggs is advisable to avoid damage and opportunistic disease infection.

13. Disinfection of eyed eggs is advisable prior to movement within the hatchery or another location, using an appropriate disinfectant at the correct concentration and for the recommended contact time.

14. All incoming batches of eggs or livestock should have records filed regarding date and origin of arrival/stripping, time, type and amount of disinfection and clinical observations.

4.12 Mortality Removal & Disposal

Mortality removal must be carried out regularly to prevent re-infection occurring which could potentially compromise the health of the stocks and to prevent a deterioration of water quality. The frequency of mortality removal will be determined by the site manager based on time of year and numbers/type of mortalities. Records of mortalities must be maintained for each unit. In the unlikely event of large scale mortalities, arrangements must be made for high temperature rendering.

The following procedures should be adhered to:

1. Regular removal of dead fish from holding units is essential to prevent the spread of disease.

2. The cause of mortality should be investigated by suitably qualified personnel in conjunction with a fish veterinarian.

3. A daily log of mortality numbers, categories and trends should be maintained in a specific mortality record log. Details should be entered on specific sheets that allow categorisation of mortalities. These records should be kept for at least three years.

4. In freshwater tanks/pens, mortalities should be removed and quantified daily. Every tank/pen should have its own equipment for this. This equipment should be maintained in disinfectant solution when not in use and cleaned regularly. In lake pens, nets may need to be raised to ensure all mortalities can be removed using a hand net.

5. In seawater pens, mortalities should be removed at least twice weekly, with the frequency of removal increasing in response to any increase in mortality. Where divers are employed they must disinfect all equipment and gear between each pen. In the event of increased mortality levels in a specific pen, this should be dived and mortalities removed only subsequent to all the other pens on the site. If possible, divers should not operate on two or more sites. If this is unavoidable, a different set of equipment should be used for each site.

6. Any increase in mortality above normal should be reported to the veterinarian.

7. Where divers are used for mortality removal specific disinfection procedures should be adhered to.

8. All equipment used for mortality disposal should be disinfected after the operation is completed.

9. Dead fish should be disposed of in a manner that will not facilitate the spread of disease.

10. Disposal of mortalities must adhere to relevant waste management regulations.

11. Disposal of mortalities at sea is prohibited.

12. Disposal of mortalities in land fill pits is prohibited.

13. Mortalities can be ensiled and the resultant material disposed of according to regulations.

14. There must be an emergency plan drawn up for the removal and disposal of increased levels of mortalities during unexpected disease outbreaks or loss of fish.

15. The containers used to store dead fish must be adequately designed to minimize the risk of leakage.

16. Mortalities must be collected and taken off site on a routine and frequent basis to minimize the potential spread of disease.

17. Only licensed transport companies can be used.

18. Only authorised rendering facilities can be used.

19. The transport truck must carry documentation describing the material being carried, the place of origin, the name and address of the carrier, the name and address of the rendering or processing facility. All documentation must be kept for 2 years.

4.12.1 Large Scale Mortality Event

If a sudden mass mortality is experienced on a farm the following procedure should be implemented:

1. The affected farm/site should be immediately designated as being in isolation. Where mortalities are due to infectious disease, a zone of those units/sites deemed most at risk of exposure to infection should be established.

2. Water quality should be analysed and in the case of land-based sites and hatcheries all equipment regulating water supply and quality should be assessed for damage.

3. If a notifiable disease is suspected the farm veterinarian and relevant authorities should be contacted immediately.

4. Other farms within the 'at risk' zone should be notified of the diagnosis or suspected diagnosis.

5. Nonessential deliveries or visits to the farm should be halted. Essential supplies should be delivered to the affected site last.

6. Movement of equipment, vessels, personnel etc. between sites should be immediately halted. Movement of staff between the affected farm and other farms should be halted.

7. Thorough disinfection of all equipment, clothing, vessels etc. should take place if there is to be movement between affected and non-affected sites. Footbaths and if practical, hand wash stations, should be maintained and used by all personnel before getting on and leaving the site. These footbaths should be located at all access points. They should be clearly visible and marked.

8. Mortality removal frequency should be increased depending on the mortality rate.

9. Moribund fish should be slaughtered in a humane and rapid manner.

10. Divers should be designated to affected sites. If this is not possible divers should dive affected units last. Diving equipment should be site specific. If this is not possible then the equipment should be thoroughly cleaned and disinfected before use between sites.

11. Mortalities should be transported in sealed containers to avoid spread via spillage or predators.

12. Fish should be transported to an approved disposal facility and rendered appropriately.

13. Should slaughter of affected fish be necessary then strict disinfection and cleaning regimes should be adhered to. All blood-water should be contained and treated.

14. An intensive sampling routine should be instated by the farm veterinarian and relevant authorities.

15. All surfaces that come in contact with infected material should be thoroughly cleaned and disinfected.

16. Unaffected fish should be placed under quarantine and monitored for a time period after the event, to be decided by the veterinarian, Manager and relevant authorities.

17. After the date of removal of the last affected fish from the facility a significant time period should elapse while the site remains fallow and before re-stocking takes place. Other sites in the 'at risk' zone should also follow this procedure.

18. When restocked the site should be monitored for a number of months for signs of disease.

19. Additional measures may also be required in the event of an outbreak of a listed disease (Directive 2006/88/EC or Additional Guarantee for Ireland).

20. Records should be kept of affected pens/tanks on a daily basis. Records of all visitors to the site must be maintained. These records should be stored and easily accessible.

4.13 Stock Records

Maintaining good records is essential to maintaining consistently healthy fish. Facilities must have an information management system, that provides timely information to identify and assess changes in fish health to allow for sound fish health management decisions. For individual groups of fish in the facility, operators must keep up-to-date fish health records including disease history and patterns of mortality, and records of movements of fish within the facility.

Accurate record of feeding rates (% body weight fed per day) and feed conversion ratios (FCR = feed consumed divided by biomass increase) for each unit are particularly useful

in tracking the health and performance of the stocks. Comparisons of feed rates and FCR between different batches of fish give vital clues as to the health of the population and the adequacy of the diet.

Regular recording of growth performance and mortalities for each unit is essential for tracking trends over time and between sites.

A weekly summary stock sheet should be produced for each site. The stock sheet provides essential information for the feeders and the general management. It is also required by the fish health professionals, regulators, insurers and for quality and customer audits.

Table VII

Sample weekly stock sheet.

Farm A 07G Stock Sheet *Week No.* ***9*** ***W/E:*** ***02/03/2008***

Cage	*Batch*	*Closing Number*	*Closing Bio. (kg)*	*Av. Wt. (g)*	*Feed (kg) To Date*	*% Morts To Date*	*Morts For Wk*	*% Morts For Wk*	*Feed (kg) For Wk*	*% Daily Feed Rate*	*ECR*	*Density (kg/m^3)*
A1	StrainA/HatcheryA	33,194	11,403	344	8,372	2.7	12	0.0	1,115	1.5	1.0	1
A2	StrainA/HatcheryA	30,487	8,711	286	5,030	4.7	15	0.0	1,030	1.8	1.1	1
A3	StrainA/HatcheryA	33,721	10,406	309	6,490	5.6	18	0.1	690	1.0	0.9	1
A4	StrainA/HatcheryA	32,506	9,513	293	7,025	4.4	10	0.0	1,025	1.6	1.2	1
A5	StrainA/HatcheryA	31,014	8,886	287	5,905	6.0	6	0.0	905	1.5	1.0	1
A6	StrainA/HatcheryA	34,911	8,305	238	5,125	3.0	25	0.1	725	1.3	1.1	1
A7	StrainA/HatcheryA	38,120	9,728	255	7,288	3.5	61	0.2	805	1.2	1.1	1
A8	StrainA/HatcheryA	35,196	8,206	233	5,780	4.9	19	0.1	780	1.4	1.1	1
		269,149	**75,159**	**279**	**51,015**	**4.3**	**166**	**0.1**	**7,075**	**1.4**	**1.1**	

4.14 Hatcheries

Hatchery operations may have several overlapping year classes on site e.g. early incubation, fry rearing and possibly broodstock.

1. Rearing units must be kept separate as much as possible to prevent transmission of disease between classes. Different biosecure areas should be created, possibly with colour coded equipment, with separate clothing and boots for each area.

2. Water quality monitoring is especially important for hatchery fish. Monitoring equipment must be maintained in good functional condition.

3. Failure of oxygen delivery and/or pumps is a major emergency for a hatchery site. The site must have a back up system for keeping dissolved oxygen at an adequate level until the system failure is addressed.

4. Egg disinfection must be carried out following fertilization and prior to movement to other sites.

5. Eggs must be checked daily for mortalities, presence of abnormalities or fungus and treated as necessary.

6. Mortality collection must be carried out daily and mortalities stored an appropriate distance from the hatchery to minimize inadvertent spread of disease.

7. Ice boxes and containers that are used for transporting eggs must be disinfected and disposed of hygienically by the receiver.

4.15 Broodstock

Broodstock may be held at marine, brackish and freshwater sites. All fish health considerations previously listed will apply though they differ slightly between saltwater and freshwater sites. For instance the water quality parameters for marine and freshwater sites will be different.

4.15.1 Diet

Broodstock require specially formulated diets to meet their nutritional needs prior to maturation. Feeding strategies must be applied that ensure optimum nutrition especially when fish start to mature. Proper storage of these diets, to ensure their nutritional content is maintained, is essential. Feed should be protected from light, humidity and extremes of temperature.

4.15.2 Biosecurity

Broodstock are held for longer periods than production fish. As a result, they may have been exposed to more pathogens and may be sub clinical carriers of disease. Also, on maturation they become more susceptible due to their compromised immunity, as a consequence of physiological changes. For these reasons staff and equipment should be designated for the broodstock facility and not used in the hatchery unit. There is a high risk of transferring pathogens from mature fish to susceptible young fry.

4.15.3 Stripping

Broodstock handling should be kept to a minimum. Adequate anaesthesia must be used when stripping ripe broodstock for gametes. This will help to protect both the broodfish and the gametes. If fish are to be euthanized post stripping it should be carried out in as humane a way as possible.

The milt and eggs must be traceable to individual parents. Screening of broodstock for diseases should be carried out on each batch of eggs and milt, if possible. Where individual parent testing is carried out, biosecurity measures in the incubation centre are of the utmost importance.

Eggs and milt must be mixed and transported to the hatchery in clean, labelled containers. Strict biosecurity and disinfection procedures must be adhered to in order to prevent transmission of infectious agents to the hatchery.

4.16 Minimizing Risk of Escape

Operators must minimize the risk of escape from fish culture facilities. Procedures such as fish input, grading, transfer of fish between sites and harvesting, which could increase the risk of fish escaping, should be carefully planned and supervised to minimize any risk.

All details of introductions, grading, transfers, treatments, handling or any other incident or occurrence that might have led to an escape must be recorded and reported to DAFF in accordance with current legislation.

Where fish are being transferred by helicopter, the receiving pen should be marked with buoys clearly visible from the air.

Netting and holding equipment must be adequately designed to minimize the risk of collapse and escape. All nets should be serviced and tested at appropriate intervals to ensure that they are within specified limits for mesh strength and nets that do not meet specifications should be decommissioned.

All marine pens should be clearly marked with navigational lights and/or radar reflectors to prevent the collision of any approaching vessels.

4.17 Diving

It is imperative that divers adhere to biosecurity and disinfection procedures at each facility. Equipment should be site specific, if possible. Divers moving between sites must disinfect their equipment in transit using appropriate disinfectant at adequate concentration and for an appropriate contact period.

1. Divers must adhere to strict biosecurity protocols and should be trained in all aspects of biosecurity.

2. Equipment should be site specific if possible to minimize the risk of contamination between sites.

3. Disinfection routines for divers should be implemented before and after operations on different sites and should be checked and recorded by a named member of site staff on each occasion.

4. All organic material should be removed from all suits and equipment.

5. Suits and equipment should be immersed in water containing a suitable disinfectant.

6. Divers must be fully trained and adhere to strict Health & Safety Regulations.

7. The healthiest or youngest fish at a site should be dived first.

8. Any abnormal behaviour in the fish should be reported to Management who will be responsible for reporting to the veterinarian if deemed necessary.

9. During a disease outbreak divers should be designated to dive the affected site.

10. Diver observations of fish behaviour, mortality levels, reaction to feed etc, should be recorded daily.

4.18 Culling

Fish killed as part of disease surveys or other management plans or due to illness must be euthanized in a humane manner. A sharp blow to the head or an overdose of anaesthetic are considered humane. Stunning of fish must result in immediate loss of consciousness that lasts until death. Fish are not to be stunned unless they can be killed without delay. If fish are killed without stunning, the method used must result in a rapid and irreversible loss of consciousness.

Chapter V. Biosecurity

Appropriate and effective biosecurity measures must be in place to minimise the introduction of new infections into the farm. A *Biosecurity Plan* is a requirement for any site wishing to obtain a *Fish Health Authorisation* under the current legislation.

Biosecurity is the mechanism through which the risks of introducing and transferring disease on and off site can be controlled. External barriers are those that are designed to prevent entry on and off the farm and internal barriers are those which prevent the spread of disease within a farm. Disease pathogens can be spread by introducing fish directly or by vectors of transmission such as fish material, staff and equipment (from hand nets to wellboats). In addition, fish stocks on site can be subject to disease pathogens from the surrounding environment.

5.1 Control Measures

There are three components of biosecurity control measures:

i) Ensuring ongoing fish health and welfare.
ii) External barriers: Preventing the entry of pathogens.
iii) Internal barriers: Minimizing disease spread within a site.

5.1.1 Ensuring fish health and welfare

An optimal level of fish health and welfare should be achieved by following the guidelines outlined in this handbook.

5.1.2 External barriers

1. A risk based approach to the hazards or vectors of disease transmission should be carried out.

2. In some instances, a risk assessment may conclude that the movement of certain items should be restricted and not taken from one site to another e.g. equipment used in the recovery and handling of mortalities.

3. Risk assessment should be disease specific and scientific in approach - using methods of disinfection known to kill or inactivate the pathogen.

4. Visitor logs should be used with declarations of contact with fish in the previous 24 hours. A specific biosecurity protocol should be established for the visitors to follow.

5. Divers must adhere to strict biosecurity and disinfection protocols.

6. Footbaths should be positioned at the entrance of all sites. These should be protected against dilution from rain and changed regularly.

5.1.3 Internal barriers

1. Specific disinfection points should be set up at the entry/exit to farm sites and should be adequate to ensure the hygienic management of staff and all equipment, including provisions for service vehicles.

2. Access to the facility should be restricted to personnel as much as possible.

3. Visitor numbers should be kept to a minimum.

4. Footbaths should be positioned at the entrance of all sites. These should be protected against dilution from rain and changed regularly.

5. Protective clothing should be site specific.

6. Personnel should not travel between sites if possible but, if essential, cleaning and disinfection of equipment should take place between sites.

7. Boat movement from site to site should be kept to a minimum and only after cleaning and disinfection of decks and equipment that has been in contact with fish stocks.

8. Special biosecurity arrangements for mortality handling and removal should be devised.

9. If possible, the broodstock holding, stripping and fertilisation unit should be separate to the hatchery/fresh water on-growing unit.

10. All equipment, trays, traps, filters etc, should be thoroughly cleaned, disinfected and fallowed prior to use.

5.2 Disinfection and Cleaning

A disinfectant can be defined as a substance which neutralises or inhibits the growth of a disease causing organism. Detergents are chemical compounds used for cleaning. When equipment is to be disinfected it is important that it is thoroughly cleaned first.

1. Disinfection procedures should form part of the *Veterinary Health Plan*.

2. Equipment should be kept clean at all times.

3. The manager is responsible for ensuring that there is sufficient disinfectant material in stock on site at all times.

4. Disinfection procedures should be carried out which prevent the contamination of other waters and aquatic animal populations with infectious material.

5. The decision on which disinfectant to use should be based upon their biocidal efficacy, their safety for aquatic animals and the environment.

6. The manufacturer's instructions for effective use of a disinfectant under aquaculture conditions should be followed.

7. The efficacy of disinfection is affected by a variety of factors: Disinfection occurs faster at higher temperatures; many disinfectants work within an optimum pH range; organic material and grease can reduce the efficacy of a disinfectant, so surfaces should be cleaned beforehand.

8. Disinfection of equipment should only be carried out after all visible organic matter has been removed with detergent. The disinfection should be in contact with all surfaces and left for the recommended time period.

9. Disinfectants should be stored in a self contained storage area, in suitable containers and clearly labelled. This area should be a restricted access area and locked at all times.

10. All used disinfectant, organic matter washings and rinse water should be disposed of appropriately.

11. Records should be kept of all disinfection procedures, documenting the disinfectant used.

Table VIII

A list of suitable disinfectants, dose rates and appropriate applications[15].

DISINFECTANT	EXAMPLE	DOSE	COMMENTS
Chloramine T	Halamid	1-2% (w/v), 5-30 mins	Reported effective against a range of pathogens.
Iodophor	FAM30, Virudine Vandodine	1:100 – 1:600 10 mins	Reported effective against ISAv and IPNv. Loss of brown colour indicates loss of efficacy. Iodine requires neutralisation before discharge. Stains and is corrosive.
Peroxy compounds	Virkon Aquatic Virasure	0.5-1% (w/v), 10-30 mins	Reported effective against fish pathogenic bacteria and viruses (BKD, furunculosis, ERM, ISA, IPN, rhabdoviruses).
Calcium oxide (quicklime)		0.5kg/m^2 for 4 weeks	For earth ponds (dried). Dangerous substance.
Chlorine dioxide	Cidox	1-1.5ppm ClO_2	Water treatment for processing plants.
Citric acid		2g/l (0.2%) w/v for 30 mins	Clothing.
Hydrogen peroxide	Hyperox	1:100 (1%), 30 mins	Routine disinfectant for surfaces inc. concrete and wood.
Sodium hypochlorite		100ppm, 10 mins 1000ppm, 10 mins 1000ppm, 6 hours	Boats, cages, tanks, hand nets, harvest equipment. Processing plant effluent. Nets. Leave to inactivate for a few days or neutralise with sodium thiosulphate after 3 hours.
Sodium hydroxide	Biosolve Plus	1:50-1:400, 20 mins	Degreasing & cleaning of wellboats, work boats, equipment, processing equipment & utensils.
Bronopol	Pyceze	20-50 mg/L, 30 mins	Effective control of fungal and bacterial pathogens.
UV		1188 J/m^2 (IPNv) 33 J/m^2 (ISAv) 8 J/m^2 (VHSv)	Freshwater intake. Efficacy compromised by organic loading. May be combined with ozone for treating processing effluent.
Heat		70°C, 2 hours – IPNv 60°C, 2 mins – ISAv	Cage nets, diving gear.
Formic acid			Ensiling
Ozone		8mg/l/min, 3 mins (redox 600 – 750mV)	Water intake & effluent. Costly and toxic to fish and humans.
Peracetic acid, hydrogen peroxide and acetic acid mix	Proxitane Kickstart Vanodox	0.2-2% 0.03-1% 1:300	General disinfection, reported effective for ISAv and IPNv.

The inclusion or exclusion of a particular brand does not indicate an endorsement or rejection of its use.

[15] Adapted from: Fraser,D.I., Munro,P.D. & Smail, D.A., 2006. Disinfection guide version IV. Practical steps to prevent the introduction and minimise the transmission of diseases in fish. Fisheries Research Services Internal Report 13/06, Aberdeen, UK.

Chapter VI. Appendices

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6.2 Legislation

This section lists some of the main legal instruments concerning the Irish finfish aquaculture industry.

6.2.1 European

Council Regulation (EEC) No 2377/90 laying down a Community procedure for the establishment of maximum residue limits for veterinary medicinal products in foodstuffs of animal origin. OJL 224, 18/08/1990.

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. OJL 125, 23/05/1996.

Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes.

Commission Regulation (EC) No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs as amended by Commission Regulation 221/2002/EC. OJL 077, 16/03/2001.

Commission Regulation (EC) No 221/2002 of 6 February 2002 amending Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs. OJL 037, 07/02/2002.

Commission Proposal (COM 2005, 297 final) for a Council decision concerning the Community position on a proposal Recommendation concerning farmed fish to be adopted within the 47th meeting of the Standing Committee of the European Convention for the Protection of Animals kept for farming purposes (Strasbourg, November 2005).

Council Directive 2006/88/EC of 24 October 2006 on animal health requirements for aquaculture animals and products thereof, and on the prevention and control of certain diseases in aquatic animals.

6.2.2 National

Animal Remedies Act, 1993 (Act No 23 of 1993).

Fisheries (Amendment) Act, 1997 (Act No 23 of 1997).

S.I. 786 of 2007. European Communities (Animal Remedies) (No. 2) Regulations 2007.

S.I. 12 of 2001. Water Quality (Dangerous Substances) Regulations for the purposes of giving effect to Directive 2000/60/EC establishing a framework for Community action in the field of water policy and giving further effect of Council Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment.

S.I. 44 of 2002. Animal Remedies (Amendment) Regulations giving effect to Article 96 of Directive 2001/82/EC.

S.I. 248 of 2003. European Communities (Animal By-Products) Regulations giving full effect to Regulation (EC) No. 1774/2002 and Directive No. 2002/33/EC.

S.I. 261 of 2008. European Communities (Health of Aquaculture Animals and Products) Regulations.

6.3 Supporting Documents

Codes of Practice

Belle, S. M. & Howell, L. **2002.** *Maine Aquaculture Association Recommended Code of Practice for Aquaculture in Maine*.

British Columbia Salmon Farmers Association. **2003.** *Required elements of a fish health management plan for public and commercial fish culture facilities in British* Columbia. www.agf.gov.bc.ca/fisheries/health/fish_health_management_plan.htm

Federation of European Aquaculture Producers. **2000.** *A code of conduct for European aquaculture*. www.feap.org

Irish Sea Fisheries Board. **2003.** EcoPact: Environmental code of practice for Irish aquaculture companies and traders. www.bim.ie

Federation of Scottish Aquaculture Producers. **2005.** *A code of good practice for Scottish finfish aquaculture*. www.scottishsalmon.co.uk/pdfs

Shetland Salmon Farmers Association. **2000.** *Shetland salmon farming industry code of best practice*. www.shetlandaquaculture.com/code-of-best-practice

6.4 Disease Information Leaflets