Status of Irish Aquaculture 2003

November 2004

A report prepared
by
Marine Institute, Bord Iascaigh Mhara and Taighde Mara Teo

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All photos courtesy of BIM.

Acknowledgements

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INTRODUCTION

1.1 Aim and Scope of Report

This is the first joint report on the status of Irish aquaculture, which has been produced in collaboration by the three main State agencies that provide support services in the areas of research and development to the industry – Bord Iascaigh Mhara, the Marine Institute and Taighde Mara. The value of industry output was over €1 billion in the period from 1990 to 2003 (see Appendix I) and this represents a significant socio economic impact in the coastal areas of the south and west coast.

The aims of the report are to:

- provide an objective and comprehensive source of information on the status of Irish aquaculture in 2003;
- show the main trends in the production, employment and market statistics for the Irish industry in 2003;
- summarize the current licensing activity which is the responsibility of the Department of Communications, Marine and Natural Resources;
- show the wide range of monitoring programmes for farmed shellfish and finfish which are carried out primarily by the Marine Institute, in accordance with Irish and EU food safety and environmental requirements; and
- highlight the various research and development initiates in the area of aquaculture, which are underway in the agencies and third-level institutions.

We hope that this will become an annual report and that it will provide useful reference material for the industry, trade customers, investors, researchers and interested parties.

1.2 Brief Overview of Irish Aquaculture Industry

Since the initial developments in the early 1970s the Irish aquaculture industry has grown to become an important contributor to the national economy. There has been a steady, and in some cases exponential, increase, in both output and value, and in job creation. The diversity of sites used and the species farmed have also increased. The sector has grown in output value from €37.2 million (26,500 tonnes) in 1990 to €101.5 million (62,400 tonnes) in 2003. It employs 2,610 on a full and part time basis. Combined production from finfish and shellfish is projected to increase to 97,000 tonnes, valued at €175.6 million, in 2008.

Mussels, Pacific oysters (C. *gigas*), native oysters (*O. edulis*), clams and scallops are the main shellfish species being produced in Ireland at present. Mussels, which are farmed using both suspended ropes (intensive) and bottom-culture (extensive), account for 80-90%, by volume, of annual shellfish production. Oysters (principally Pacific oysters) account for a further 10-15%. Other species farmed on a smaller scale include abalone and purple sea-urchins. Shellfish farming is practiced in every coastal county with the exceptions of Wicklow and Dublin (Figure 1).

Salmon and rainbow trout are the two principal finfish species farmed at sea. Salmon consistently accounts for 85-95%, by volume, of annual finfish production. Finfish farming is restricted to five western seaboard counties – Donegal, Mayo, Galway, Kerry and Cork (Figure 1). Production of turbot in land-based facilities is ongoing on a small-scale and research into the feasibility of culturing new species such as cod and halibut is also being carried out.

Seaweed culture, though in its infancy in Ireland, has the potential to expand significantly in the coming years.

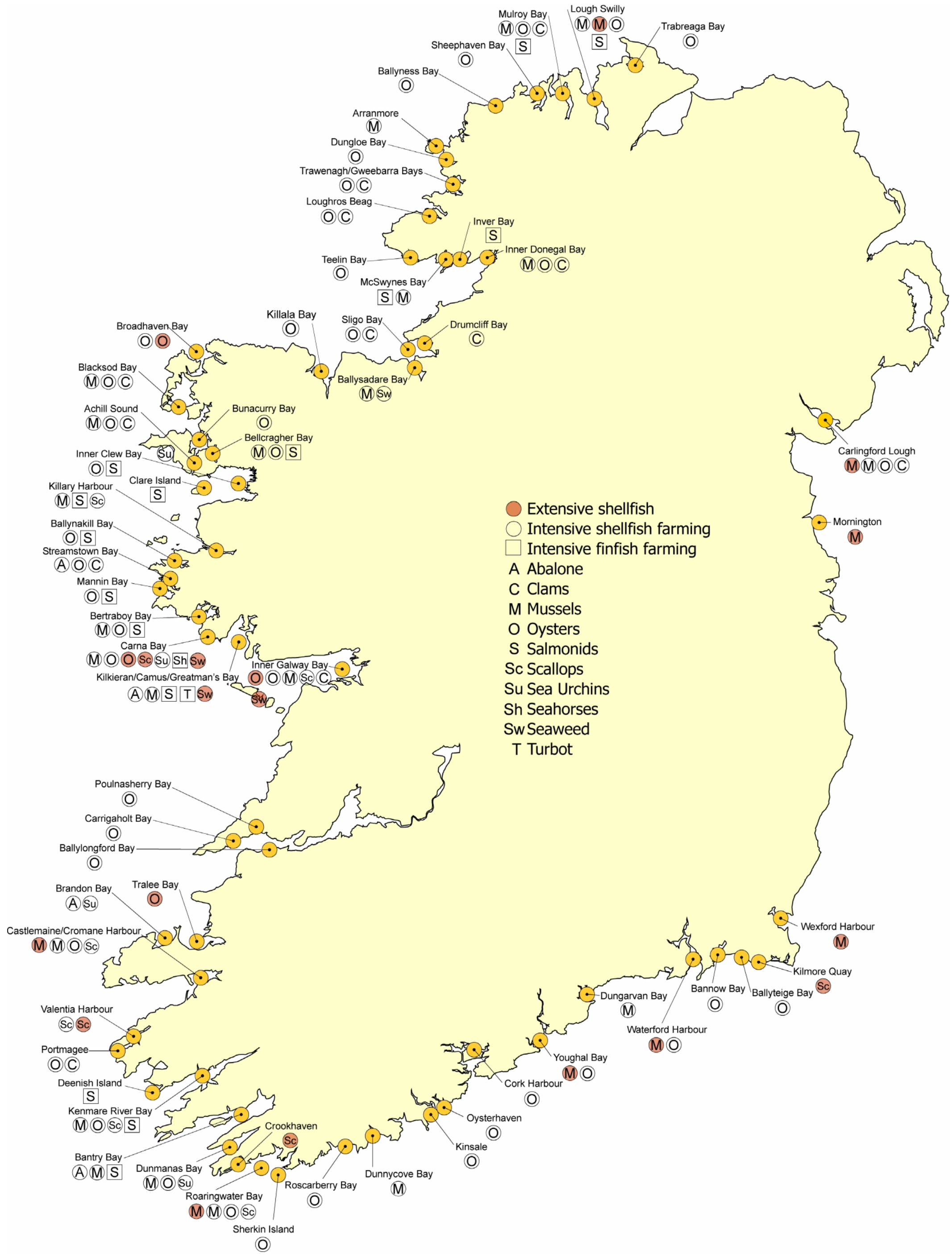

Figure 1: Finfish and shellfish production areas.
(Reproduced with permission, from EPA, 2004. Source data – BIM).

2003 PRODUCTION SUMMARY

2.1 Shellfish

Progress made in shellfish production levels over the last few years was consolidated during 2003 as a result of favourable environmental conditions and continuing strength in market price and demand (Figure 2 and Appendix I). Total production in the shellfish sector for 2003 amounted to 44,678 tonnes, of which mussels accounted for almost 39,300 tonnes (90%). The total value of shellfish production in 2003 was €41.8m.

The rise in output from the bottom-grown mussel sector in 2002 was sustained and there was a 25% increase from 24,000 tonnes in 2002 to almost 30,000 tonnes in 2003 (67% of the total shellfish harvest). The rope mussel sector continued its recovery from the biotoxin-related difficulties experienced in 1999 and 2000 – with output increasing from 7,700 tonnes in 2002 to 9,300 tonnes in 2003. In the period 2000-2003 bottom and rope mussel harvests have increased by 40% and 130%, respectively. Mussels accounted for 72% (€29.2m) of the total value of shellfish output in 2003 (Appendix I). Bottom mussels were valued at €21.6m and rope mussels at €7.5m.

Pacific oyster production dropped from 5,444 tonnes in 2002 to 4,830, valued at €9.9m, in 2003 (down 12%). Since 2000, the production of Pacific oysters has dropped by 4% but value has increased by 45% - emphasising the added value product that oysters have become. Native oyster production increased from 280 tonnes in 2002 to 325 tonnes in 2003 (+16%). Scallop production increased by 16% from 2002 to 2003 (67 to 80 tonnes), whereas production of clams decreased by almost one third during the same period (from 214 to 154 tonnes).

The new species element of shellfish aquaculture made steady progress in 2003 with the production of urchins and abalones climbing steadily towards a full-scale commercial level.

Activity levels in terms of bottom mussel seed collection in 2003 were very high. More than 24,000 tonnes of seed was sourced from the East Coast, together with a further 6,000 tonnes from Carlingford and Lough Foyle. This was relayed in beds on a 32-county basis.

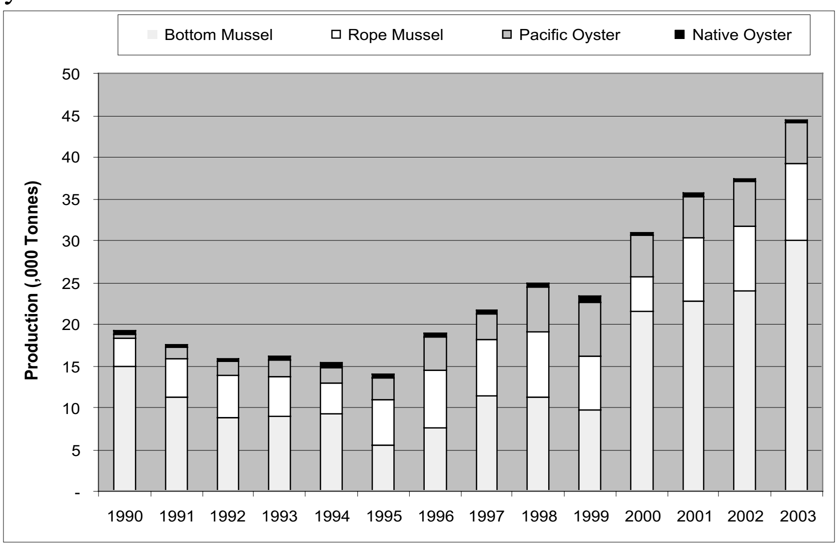

Figure 2: Annual production (tonnage) of the principal farmed shellfish species for the period 1990-2003. See also Appendix I. (Source – BIM, 2004)

2.2 Finfish

In contrast to the strong farmed shellfish performance, the marine finfish farming sector had a challenging year in 2003. Total output decreased from 23,300 tonnes in 2002 to 17,700 in 2003. The total value of finfish production in 2003 was €59.7m, down from €87.3m in 2002 (-32%) – See Appendix I.

Farmed salmon output from processing plants fell from 21,423 tonnes in 2002 to 16,347 tonnes in 2003 – a 23.7% decrease (Figure 3 and Appendix I)[1]. Farmed salmon accounted for 91% (€54.2m) of the total value of farmed finfish in 2003(Appendix I). The value of farmed salmon in 2003 decreased by 30.2% compared with the 2002 figure (€77.7m).

The decline in salmon production over the period 2001-03 (from 23,300 to 16,300 tonnes) has resulted from a combination of factors including company receiverships and difficulties with survival at sea. Major mortalities in the Donegal Bay area, resulting in 70-80% of the production of three well-established salmon farms being lost (See Section 9 below), were also an important contributory factor. A recurrence of the Pancreas Disease virus was also observed on the west and southwest coasts, resulting in typically high mortality rates.

Production of sea-reared trout also declined significantly during 2003 from levels in 2002 –from 888 to 270 tonnes. This continues the downward trend since 2000, when 1,360 tonnes were produced.

Progress was achieved in the cultivation of new species with on-going development of existing projects focused on the farming of turbot and halibut.

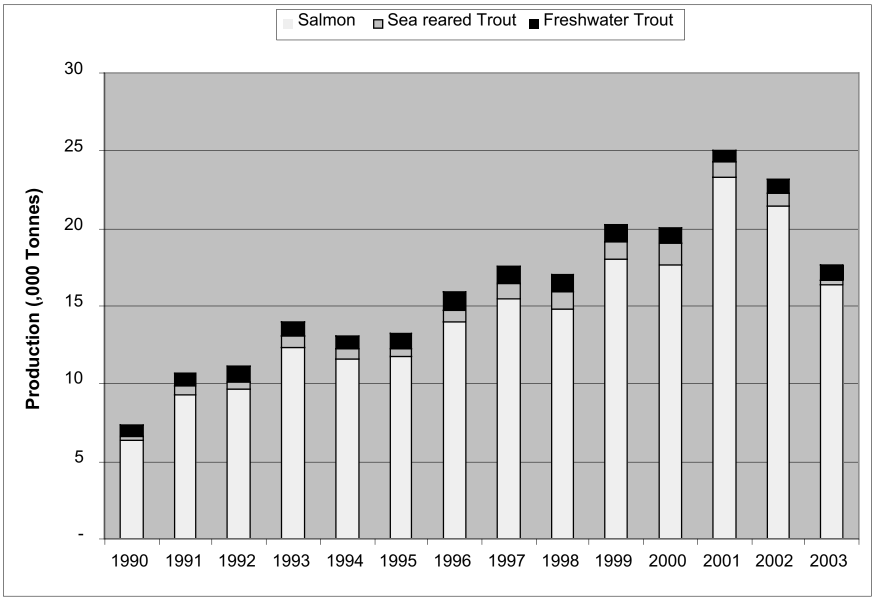

Figure 3: Annual production (tonnage) of the principal farmed finfish species for the period 1990-2003. See also Appendix I. (Source – BIM, 2004)

[1] Production figures are based on the annual BIM production survey (BIM, 2004), which, in turn, is based on returns to BIM from packing stations and processing plants, rather than on returns from the primary producers.

EMPLOYMENT

3.1 Finfish and Shellfish

The number of people employed in the aquaculture industry during 2003 on a full-time, part-time and casual basis was 942, 1,119 and 550, respectively (Table 1). This amounts to 2,611 in total - or 1,593 full-time equivalents (FTE[2]). These figures represent a slight increase on the 2002 employment levels (Figure 4) but they remain lower than the peak of the late 1990s. Employment in the shellfish sector accounts for roughly 70% (both total numbers and FTE) of the total employed in aquaculture. The shellfish sector is, however, much more dependant upon part-time and casual labour than the finfish sector.

Table 1: Employment in the Irish Aquaculture Industry in 2003. (Source – BIM)

	Full-time	*Part-time*	*Casual*	*Total*	*FTE**
Finfish	370	231	51	652	494
Shellfish	572	888	499	1,959	1,099
Total	942	1,119	550	2,611	1,593

*FTE – Full-time Equivalents

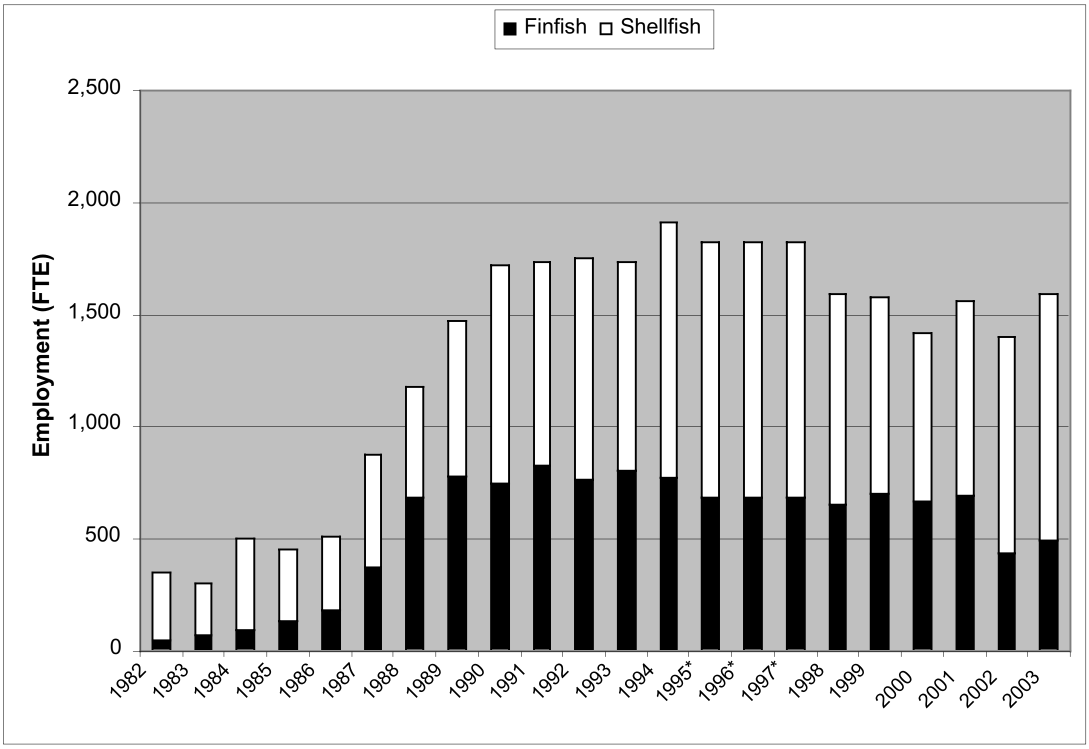

Figure 4: Employment levels in the aquaculture sector for the period 1982-2003. Figures for 1995-97 are estimates. (Source – BIM).

[2] FTE = Full-time + (Part-time/2) + (Casual/6)

Plate 2: Shellfish Harvesting

Plate 3: Finfish Site

EXPORT SUMMARY

4.1 Finfish

In 2003, the export value of farmed salmon and trout products was €50.1m, with salmon accounting for 93% (€46.7m) of this (Table 2)[3].

Table 2: Farmed finfish exports in 2003. (Source – BIM)

	Salmon		*Trout*		*Total*	
Product	*Volume (t)*	*Value (€ ,000)*	*Volume (t)*	*Value (€ ,000)*	*Volume (t)*	*Value (€ ,000)*
Fresh exc. fillets	11,160	37,266			11,160	37,266
Frozen exc. fillets	70	365	82.1	293	152	658
Smoked	386.5	6,603	0.7	10	387	6,613
Fillets f/c	319.1	1,590	907.6	3,094	1,227	4,684
Fillets s/b	0.3	7			0	7
Fillets frozen	2.8	14			3	14
Canned	241.1	863			241	863
Total	**12,180**	**46,708**	**990**	**3,397**	**13,170**	**50,105**

f/c = fresh chilled; s/b = salted/brine

The principal export markets for farmed salmon in 2003, were France, Germany, Great Britain and Spain (Table 3). The French market alone accounted for 55%, by value, of exported farmed salmon. Other important markets include Italy, Belgium, Luxembourg, Denmark, Holland and Switzerland.

Table 3: Principal export markets for farmed salmon products in 2003. (Source – BIM)

	Export Value (€ ,000)	*% of Total*
France	25,701	55.0
Germany	6,987	15.0
Great Britain	4,984	10.7
Spain	2,540	5.4
Italy	1,757	3.8
Belgium/Luxembourg	1,528	3.3
Holland	963	2.1
Switzerland	855	1.8
Denmark	635	1.4
Others	759	1.6
Total	**46,709**	**100**

4.2 Shellfish

The export value of shellfish in 2003 was €39m. This was made up of oysters (€35.3m) and mussels (€3.8m). The total volume exported was 22,702 tonnes (1,251 tonnes oysters and 21,451 tonnes mussels).

[3] Export figures include freshwater-reared trout.

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AQUACULTURE LICENCES AND APPEALS

5.1 Licences Issued During 2003

Under the Fisheries (Amendment) Act 1997, all aquaculture operations must be licenced. Licences are issued by the Minister for Communications, Marine and Natural Resources. During 2003, new applications for aquaculture licences were submitted for 50 shellfish and eight finfish operations. In addition, 55 licence renewal applications for existing licences were submitted. Twenty five shellfish licences were granted during 2003 and a further 12 ministerial decisions (11 grants and 1 refusal) were appealed to the Aquaculture Licence Appeals Board – ALAB (See below). Eight finfish aquaculture licences were granted during 2003 and one ministerial decision to grant a licence was appealed to ALAB. The decision to grant was overturned. Seven existing shellfish and five existing finfish licences were renewed during the year.

5.2 Extant Licences

There are currently 646 aquaculture licences distributed amongst 11 coastal counties (Table 4 - see notes). Almost 55% of these licences relate to just three counties, Cork, Galway and Donegal. On a species basis, oysters account for 50% of all licences held and mussels for a further 29.5%.

Table 4: Distribution of aquaculture licences by county and species (Source: DCMNR).

	Finfish	*Oysters*	*Mussels*	*Clams*	*Other Shellfish*	*Total*
Louth	-	22	12	1	-	35
Wexford	-	8	11	-	-	19
Waterford	-	36	2	-	-	38
Cork	6	27	56	2	18	109
Kerry	3	36	22	4	5	70
Limerick	-	1	-	-	-	1
Clare	-	16	2	1	1	20
Galway	24	48	49	1	4	126
Mayo	3	69	7	7	3	89
Sligo	-	2	2	17	1	22
Donegal	12	59	27	12	7	117
Total	**48**	**324**	**190**	**45**	**39**	**646**

Notes: i) These figures relate to licences. There may be multiple sites associated with one licence.
ii) Lapsed licences are included as they may still be in operation.
iii) Other shellfish includes scallops, abalone and sea urchins.

5.3 Aquaculture Licence Appeals

Following the decision by the Minister for Communications, Marine and Natural Resources to grant, refuse, revoke or amend an aquaculture licence, an appeal can be lodged to the Aquaculture Licences Appeals Board (ALAB). ALAB was established in 1998 under Section 22 of the Fisheries (Amendment) Act, 1997. Its function is to provide an independent authority for the determination of appeals against decisions of the Minister for Communications, Marine and Natural Resources on aquaculture licence applications. The Board, in determining the appeals has the option of:

i. confirming the decision of the Minister to grant or refuse a licence; or
ii. determining and issuing its own aquaculture licence as if the application for the licence had been made to the Board in the first instance.

Additionally, the Board may alter the terms or conditions of a licence decision granted by the Minister by issuing its own licence with additional or altered terms and conditions.

In 2003, ALAB received a total of seven appeals; a considerable decrease on the numbers received in previous years (Table 5). The seven appeals received were in relation to just two Ministerial licence decisions (to grant licences for salmon farming) from a total of 38 Ministerial decisions made in 2003 that were subject to appeal. In addition to these seven appeals, there were 10 appeals awaiting decision from 2002.

Plate 1: Finfish Aquaculture Site

ALAB made a total of 16 determinations in 2003 – of these, 10 related to appeals received in 2002. This resulted in the granting of two aquaculture licences with revised conditions, one in respect of salmon (seven appeals) and one in respect of extensive scallop cultivation (two appeals). The Board also upheld six appeals (in relation to one licence) by refusing to grant an aquaculture licence for the cultivation of salmon. In the case of one appeal against the Minister's decision to refuse to grant a licence for the cultivation of mussels, the Board confirmed the decision of the Minister.

Table 5: Aquaculture licence appeals received and Board determinations by the Aquaculture Licences Appeals Board 1999-2003. (Source – ALAB, 2004).

Year	*Appeals Received*	*Withdrawn*	*Invalid*	*Board Determinations*	*Licences Granted*	*Confirmed Ministers Decision*	*Appeals Upheld*
1999	88	0	2	25	16	7	0
2000	38	0	2	83	37	5	2
2001	76	30	1	38	14	1	1
2002	13	3	2	29	24	0	2
2003	7	0	0	16*	2	1	6

* Of these, 10 related to appeals received in 2002.

AQUACULTURE RESEARCH & DEVELOPMENT

6.1 Research

The Marine RTDI Programme of the National Development Plan NDP (2000-2006) aims to provide the research, development, technology and innovation (RTDI) capacity and infrastructure to enable Ireland to fully utilise its marine resource potential in a sustainable manner. The Marine Institute is the implementing body for the €52.6m Marine RTDI measure. Aquaculture-related projects are funded under Sub-Measure 3 of the programme - Establishment of a Marine RTDI Fund to support project based RTDI in identified & targeted areas.

During 2003, €0.26 million was awarded to successful projects in the aquaculture sector of Sub-Measure 3 of the Marine RTDI measure (Appendix II). This brings to €1.9 million the amount spent on aquaculture-related projects thus far under the NDP Marine RDTI Programme, or 36% of the total grant-aid investment to date of €5.2 million.

Ongoing projects include a mussel seed resource assessment which is investigating the primary drivers of seed mussel recruitment in the Irish Sea. Projects funded during 2003 include, turbot broodstock management and larviculture; offshore salmon cage development; intensive sea urchin larval culture; and development of fish feed from fishing industry waste. Further details on funded projects are provided in Appendix II.

Taighde Mara Teo., a wholly owned subsidiary of Údarás na Gaeltachta, is a Marine Resource Research and Development Company. Its principal function is to promote, assist and meet the requirements of all sectors of the aquaculture industry in Gaeltacht areas. In particular it supports the growing interest in the farming of new and novel species (e.g. abalone, cod and seahorses). During 2003, Taighde Mara supported a number of aquaculture research projects, for example juvenile cod production, abalone on-growing, re-introduction of clams to Dungloe Bay and seahorse production. Further details of research projects are provided in Appendix II.

6.2 Commercial Development

The Aquaculture Development Measures of the two Regional Operational Programmes of the NDP 2000-2006 provided the overall framework for BIM's aquaculture development programmes and activities in 2003. This is the main instrument for promoting investment in aquaculture in Ireland. During 2003, BIM made grant payments of €2.07 million to 24 projects under this programme, comprising €1.68 million in EU grants and €0.39 million in exchequer grants - generating total investment of €4.39 million (Table 6). Complementing the NDP Aquaculture Development Measure, BIM administers a Pilot Aquaculture Grant Scheme under which small-scale aquaculture projects are promoted in a pilot development phase prior to full-scale commercial development under the NDP. The scheme also pilots the introduction of new technology and the opening up of new site locations for aquaculture. Grant payments of €0.94 million were made under this scheme, generating investment of €2.21 million (Table 6). Finally, a further €0.16 million was paid to 17 projects under the Fish Handling Grant Scheme, which aims to improve quality and hygiene in the marketing of fish and shellfish, generating investment of €0.41 million.

Table 6: Aquaculture development grant payments during 2003 (Source: BIM).

Category	*BIM (€)*	*NDP (€)*
Salmon	155,199	981,820
Trout	-	3,535
Turbot	5,683	-
Perch	36,497	-
Oysters	166,714	351,586
Rope Mussels	338,799	158,444
Bottom Mussels	70,214	46,172
Clams	23,383	4,182
Scallops	6,170	-
Abalone	43,872	-
Sea Urchins	2,995	-
Ornamental	3,210	-
General	79,548	-
Seaweed	6,953	-
Quality & Environment	-	523,854
Total	**€939,236**	**€2,069,592**

Note: Amounts for NDP grants include EU and Exchequer funding.

Approval for further grant payments under the three schemes outlined above was given in 2003, as follows:
Overall national investment approved for NDP grant assistance in the aquaculture industry during 2003 amounted to €15.15 million across 21 projects. Approval for fifteen projects prioritised by BIM amounted to €9.84 million. A further six projects prioritised by Údarás na Gaeltachta in the Border, Midlands and West Region (BMW) region, with an investment of €5.31 million, were also approved. Of the total investment of €15.15 million, the extensive cultivation and the intensive suspended culture of mussels accounted for 49%, the development and modernisation of salmon farming accounted for 38.2% and the development of oyster and abalone farming accounted for 6.4% each.

- Under the Pilot Aquaculture Grant Scheme, 58 projects were approved for BIM grant assistance of €0.42 million on aggregate investment of €0.97 million.
- Seven projects were approved for exchequer grants of €0.71 million on investment costs of €0.18 million under the Fish Handling Grant Scheme.

In summary, the take-up of BIM and NDP grant-aid during the course of 2003 reflected the production trends in the Irish aquaculture industry. Demand and draw down of grant-aid from the shellfish sector was strong and in particular, the bottom mussel growing element put forward several large-scale projects. In contrast, investment and grant uptake by marine finfish farmers was markedly lower than in previous years.

6.3 BIM Technical Development Programme

During 2003 BIM's Technical Development Programme focused on a number of new and ongoing projects.

Finfish

Farm Monitoring/Automation

Two new environmental oxygen monitoring systems were installed on salmon farms in Killary and Bantry Bay during 2003. The systems allow dissolved oxygen levels in the cages to be monitored in real time. The information is then transmitted via either radio or SMS to a shore base. If extremely low dissolved oxygen levels occur (e.g. due to algal blooms) farms can switch on aeration/oxygen systems. Furthermore, the measurement of dissolved oxygen levels enables feed to be dosed optimally. Both systems worked well and further systems have been purchased by the industry for use in other locations.

New oxygenation dosing and monitoring systems, in conjunction with improvements in water filtration, have also been used to improve the performance in the freshwater sector, in the production of both salmon smolts and trout. Several farms now have temperature control systems for eggs and fry, which have improved growth rates and survival at the early stages. These ongoing improvements in the freshwater sector have resulted in larger smolts going to sea and improved economic competitiveness. In addition, work is continuing on introducing new effluent treatment systems etc. to further reduce any environmental impacts of farms.

Trials using remote radio telemetry to control an offshore feed barge system were completed during 2003. The project achieved its primary objective in that the number of feeding days lost was reduced by 80% over a two year period, with a consequential increase of 50% on average harvest weights. By increasing the average weight by nearly 1.5 kg it is estimated that on a price per kg basis, the value of the harvest was improved by, on average, 15%.

Salmon Breeding

An ongoing salmon selection-breeding programme (in association with Icelandic partners), which commenced in 1999, continues to do well. Five year-classes of selected family ova have now been incubated and hatched. Four year classes have been put to sea and three year classes have been harvested. The improvement to date of the performance of the selected stock has led to orders being placed for smolts from these improved family lines from several of the Irish salmon farms.

Trout

In order to try and rationalise the trout sector and increase profitability a report on the existing and future infrastructure needs of the sector was completed and a series of meetings held with the main players to progress the findings. Various improvements on farm practices (see Farm Monitoring/ Automation above) have been initiated and work is currently ongoing where a comparison will be carried out using a tank-based system as distinct from using the existing ponds.

Eels

The Report of the National Eel Review Group (of which BIM and the Marine Institute are members) was finalised in December 2003, and presented to the Minister for

Communications, Marine and Natural Resources. The European eel stock is now outside safe biological limits, and management plans are being put in place in many regions. A five-year intensive programme for stock enhancement, through capture of juvenile (glass-eels/elvers) is strongly recommended for 2005-2010. From an aquaculture perspective it is recommended that provision of glass eels for culture in aquaculture systems be carefully managed on a case by case basis. The report also recommended that consideration be given to the restocking of on-grown eels.

Novel Species

A report produced by BIM in 2003 entitled 'Seahorses to Sea Urchins – the Next Big Splash in Irish Aquaculture', examined the technical, economic and market potential of four relatively new species under culture in Ireland - perch, seahorses, abalone and urchins (BIM, 2003a). Cod farming, which is being promoted by Norway and Scotland, is also examined in some detail, although it is not thought to represent an opportunity in Ireland.

A modular re-circulation system for turbot culture was placed on a commercial farm in Co. Galway. This comprises a direct technology transfer from the U.S.A. to Ireland. It is proposed that the installation will serve as a demonstration opportunity and as a test-bed for the installation of other similar systems in the country.

Rotifers are an essential component of the diet of many early stages of new finfish species. A continuous rotifer and algal system, funded by BIM, was installed in Carna, Co. Galway. This system will be used to provide feed for early stages of seahorses and several finfish such as turbot, halibut and cod. It will also be used for training purposes to enable a suitable freshwater system for perch etc. to be established.

A pilot perch and pike farm had its first hatch of both species in 2003. This project comprises a 10 tonne on-growing unit. It is an extensive aquaculture operation using environmentally friendly methodologies – ponds, a reed-bed and a windmill to pump water.

Shellfish

Considerable work was carried out by BIM during 2003 to enable the Department of Communications, Marine and Natural Resources (DCMNR) to designate shellfish waters according to EU Directive 79/923 on the quality required of shellfish growing waters. The process involves; collating extensive background information for each shellfish growing area, including all shellfish farming activity and details of all discharges into the water catchment of the area; clarifying monitoring parameters and carrying out a monitoring programme; preparing descriptions of all existing and potential areas for designation (this includes the detailed use of the BIM aquaculture GIS system); preparing water quality improvement programmes; and establishing a continuing feedback process and reporting structure.

In conjunction with the DCMNR; the Northern Ireland Department of Agriculture and Rural Development; Aquaculture Initiative; and the Loughs Agency, BIM helped to develop a bottom seed mussel policy for use in the 32 counties. To provide essential background information BIM (in conjunction with other Agencies) carried out extensive mussel-seed surveys, using a RoxSwath system and underwater ROV (Remotely Operated Vehicle), on the East Coast, Carlingford Lough, Lough Foyle, Cromane, Galway Bay and Lough Swilly.

Two, new, Norwegian systems for the culture of mussels were tested during 2003. The systems use a continuous floating pipe system as distinct from barrel-like floats and can be moored either singularly or in a grid mooring system. The two systems installed were the Smartfarm system and the MAQSY system. Trials are ongoing in Bantry Bay, Lough Swilly and Kenmare Bay.

Work on gigas oysters continued with another farm installing the BST system, (the adjustable long-line system mounted on poles for growing oysters). The trials using native oysters in this system at the nursery stage gave very good results. Two visits to France were arranged to assess the supply of gigas for the 2004 season. Detailed reports were published and distributed to the industry as an insert in the Aquaculture Newsletter. The bottom culture of gigas oysters was further expanded in Clew Bay and Ballynakill Harbour.

E-Aqua Initiative

An INTEREG application on ICT and e-commerce in aquaculture was approved in the last quarter of 2003. The project is an Atlantic rim project involving partners from Ireland, France, Scotland and Spain. The Spanish (CETMAR) are the lead partners and BIM and Aqua TT are the Irish partners. The aim of the project is to promote and integrate IT technology in aquaculture SMEs in the host countries.

Environment

In July 2003, a new initiative called ECOPACT was launched (BIM, 2003b). ECOPACT is an environmental code of practice for the aquaculture industry. For a sector like the Irish aquaculture industry, which is made up of many small companies, existing accredited Environmental Management Systems such as ISO 14001 and the European Union Eco-Management and Audit Scheme (EMAS) are difficult to achieve and maintain because of the complexity and burden of administration associated with them. This is why ECOPACT has been brought forward.

It is designed to provide a solid basis for Irish fish farmers to set up their own highly effective environmental management system, which will impact positively on their communities and on the environment. By the end of 2003, three companies had successfully moved through the system and achieved certification under ECOPACT. In order to successfully deliver ECOPACT it has been married into the CLAMS programme (See Section 9.2). By linking ECOPACT with CLAMS the effect is the provision of a national delivery system for the environmental management system approach through a widespread locally based network that is strongly supported by all the agencies.

6.4 AquaReg

AquaReg is a €2.5 million initiative, funded under the INTERREG IIIC programme, to support aquaculture projects in peripheral coastal communities of Ireland (BMW Region), Spain (Galicia) and Norway (Trøndelag). It was launched in 2003 and is administered in Ireland by the Marine Institute. The objectives of the programme are to promote innovation and business development; stimulate sustainable development in aquaculture; and create employment in aquaculture. Three strategies were developed to achieve these objectives:

- *AquaLink* aims to link aquaculture business and research to promote the introduction of new species - focusing on juvenile production.
- *AquaEd* addresses a critical issue for the aquaculture industry – recruitment and training of key personnel.
- *AquaPlan* addresses the need for integrated spatial planning and management of the coastal zone.

Four of the six successful projects from the first AquaReg call for proposals have partners in the BMW region.

- The Marine Institute is leading a Coastal Zone Management project to facilitate the development of aquaculture and inshore fisheries.
- The Irish Salmon Growers' Association Ltd. (ISGA) will lead a project on aquaculture by-products - to compile a databank of information on waste management solution suppliers, facilities and consultants.
- The Martin Ryan Institute, in NUI Galway, is a partner in a project aimed at developing a novel and simple method for cost-effective production of lobster juveniles.
- BIM is a partner in a project on the development of efficient transportation and storage requirements for live crustaceans.

Further details on the successful projects are provided in Appendix II. The total funding to the region was €315,000.

AQUACULTURE MONITORING – SHELLFISH

7.1 Biotoxin and Phytoplankton Monitoring

The Marine Institute is responsible for monitoring the presence of biotoxins (Box 1) in Irish shellfish and the analysis of seawater for the presence of toxin-producing phytoplankton. The monitoring, which consists of chemical analysis and bioassays to detect toxins in shellfish and phytoplankton analysis to identify known toxin-producing species, is designed to detect toxicity in shellfish growing areas before harvesting, thereby providing the necessary information to restrict the placing of toxic shellfish on the market.

Box 1: Information on Biotoxins

Although the majority of phytoplankton species are harmless to humans, some contain *biotoxins* that, whilst harmless to the organism itself, can cause illness and even death in extreme cases through the consumption of contaminated shellfish. In Ireland, shellfish poisoning is currently a year-round occurrence with most closures being attributed to *Dinophysis* species. However other toxic species that are problematic to the Irish aquaculture industry are *Pseudo-nitzschia*, *Alexandrium* and *Protoperidinium* species.

Dinophysis species are associated with Diarrhetic Shellfish Poisoning *(DSP).* This can cause diarrhoea, nausea, vomiting, abdominal pain and chills to humans after the consumption of contaminated shellfish. *Dinophysis* can be observed throughout the year along the Irish coast, although are mostly present during the summer months, and are known to cause most closures of bays in the shellfish industry since the monitoring programme has come into existence.

Pseudo-nitzshia species are the causative agent of Amnesic Shellfish Poisoning *(ASP)* in scallops. They are found in all areas of the Irish coast although have to occur in numbers as high as 50,000 plus cells per litre to cause toxicity in shellfish.

Dinoflagellates are the cause of Paralytic Shellfish Poisoning *(PSP).* To date the only known positive results for this toxin in Ireland have been in Cork Harbour. However, *Alexandrium tamarense*, thought to be the causative phytoplankton, have been observed along the west and south coasts.

Protoperidinium species have been linked to Azaspiracid *(AZP)* toxin in shellfish. This toxin came to prominence in 1995 when at least eight people in the Netherlands became ill after eating mussels from Killary Harbour. Symptoms included nausea, vomiting, diarrhoea and stomach cramps. *Protoperidinium* is found widely around the Irish coast and is easily identifiable to the trained eye. It is still to be confirmed if this species is the cause of AZP studies are ongoing.

Biotoxin detection

Shellfish toxins are detected in compliance with EU Directives using both chemical and bioassay methods. Bioassays are broad spectrum tests that are widely used in Europe as the primary method of detecting such toxins. The following methods are used:

DSP - bioassay and chemical analysis;
PSP – bioassay and immunoassay;
ASP - chemical analysis;
AZP - bioassay and chemical analysis.

Ireland is obliged under European legislation (Council Directive 91/492/EEC) to have a National Marine Biotoxin Monitoring Programme to monitor shellfish harvesting areas for the presence of toxins produced by several different species of marine phytoplankton (See Box 1). The objectives of the programme are:

a) to protect consumers of Irish shellfish by promoting food safety in the sector;
b) to work with industry partners in the development of the industry; and
c) to develop a harmonious biotoxin management system that provides for industry requirements in line with consumer safety.

Details of the Biotoxin Monitoring Programme are outlined in a Code of Practice produced by the Food Safety Authority of Ireland (FSAI) (www.fsai.ie/sfma/about_cop.asp). It includes information on how shellfish samples are to be collected, and analysed; reporting procedures; and the procedures for opening/closing shellfish production areas. The Department of Communications, Marine and Natural Resources (DCMNR) is contracted by the FSAI to implement the Marine Biotoxin Monitoring Programme in Ireland. The Marine Institute carries out marine biotoxin testing on behalf of the DCMNR. The four main toxins covered under the programme are Diarrhetic Shellfish Poisoning (DSP), Azaspiracid Poisoning (AZP), Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP) (Box 1). Other toxins are also tested on an ongoing basis.

If toxins are detected at levels that are unsafe for human consumption, the harvesting and sale of shellfish from the production area is prohibited. The ban on harvesting and sale of shellfish is lifted only after thorough scientific analysis of samples show that the product is safe for human consumption. Before harvesting from any production area, two samples, taken a minimum of 48 hours apart, must have biotoxins below the regulatory limit. With the first of these two clear samples the area is assigned a 'Closed Pending' status and with the second the area is assigned an 'Open' status. If a result is positive for biotoxins then the area is assigned a 'Closed' status and the area will need two clear results a minimum of 48 hours apart to return to an 'Open' status. The frequency of testing is laid down for each species and this may have seasonal variation. If the frequency is not adhered to then the area loses its 'Open' status.

Closures of shellfish growing areas as a result of biotoxin contamination in shellfish are common in summer and autumn. The duration of these closures varies from year to year. In 2003, there were relatively few closures compared to other years and most closures resulted from elevated levels of DSP toxins Okadaic Acid and its derivatives.

DSP in 2003

During 2003, 2,675 samples were submitted for DSP bioassay analysis and chemical confirmatory analysis. Mussel samples (1,459 samples – 54.5% of total) were submitted on a weekly basis while Pacific and native oysters (944 samples - 35.3%) were submitted on a fortnightly basis during summer months and a monthly basis during winter months. The balance of the samples tested, with the exception of a small number of clams, were non-farmed species (e.g. Razor Clams and Surf Clams).

Overall, 3.3% of samples tested (88) positive in 2003. This compares with 3.5% for 2002 and 17.6% for 2001. All but two of the positive bioassay results were obtained in mussel samples from just six counties (Figure 5a) - with 63% of all positive samples coming from County Cork. The remaining two positives were from wild fisheries on the east coast. DSP toxicity increased during the period from June to September, before decreasing during late autumn/early winter (Figure 6). The presence of DSP toxicity in January 2003 is most likely due to carryover of toxicity from 2002.

PSP in 2003

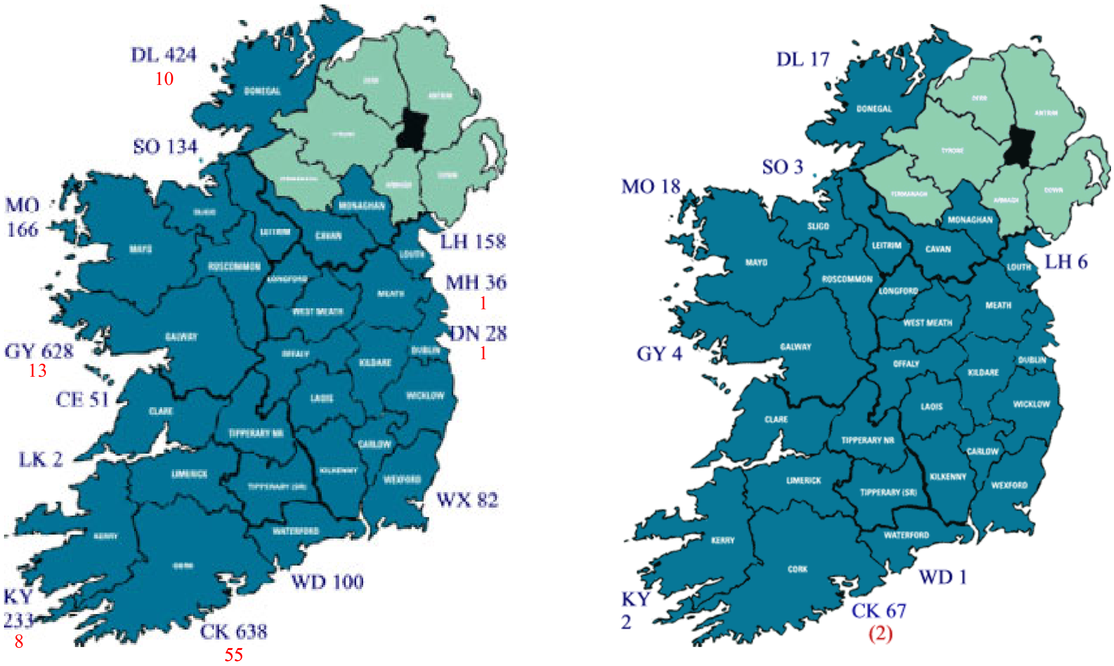
The presence of *Alexandrium* spp., a potentially toxic phytoplankton, producing PSP toxins, triggers the testing of shellfish samples. A total of 118 samples of shellfish (58 mussels, 59 Pacific oysters and 1 native oyster) were analysed, using bioassay, for the presence of PSP toxicity during 2003, following detection of *Alexandrium* spp. in the water column (Figure 5b). In mid-September 2003, two samples (mussels and Pacific oysters) from Cork Harbour tested positive for the presence of PSP toxicity above the regulatory level, resulting in the closure of production sites in the area. All other samples analysed tested negative for PSP toxins.

AZP in 2003

All samples analysed for DSP are also analysed for AZP, using both bioassay and chemical analysis. Only two areas were closed during 2003 due to the presence of Azaspiracids (the toxin responsible for AZP) above the regulatory limit, with positive bioassays. The two areas concerned were Bruckless, Co. Donegal and Inverin, Co. Galway. In both cases the positive bioassays occurred in mussel samples.

ASP in 2003

ASP occurs mostly in scallops, although it has been confirmed in mussels. Consequently, chemical analysis for the presence of Domoic Acid (DA) and Epi-Domoic Acid focuses on natural and managed scallop beds. A small number of mussels from aquaculture areas are also sampled annually. During 2003, a total of 649 samples (scallops) were submitted. Fifty seven (8.8%) of the tissues analysed had levels of DA greater than the regulatory limit. None of the mussel samples tested in 2003 showed levels of DA greater than the regulatory limit.



(a) (b)

Figure 5: Number of samples submitted and positives (red) for DSP (a) and PSP (b) on a county basis during 2003. Note – the two positive DSP results on the east coast were from Razor Clams (not an aquaculture species).

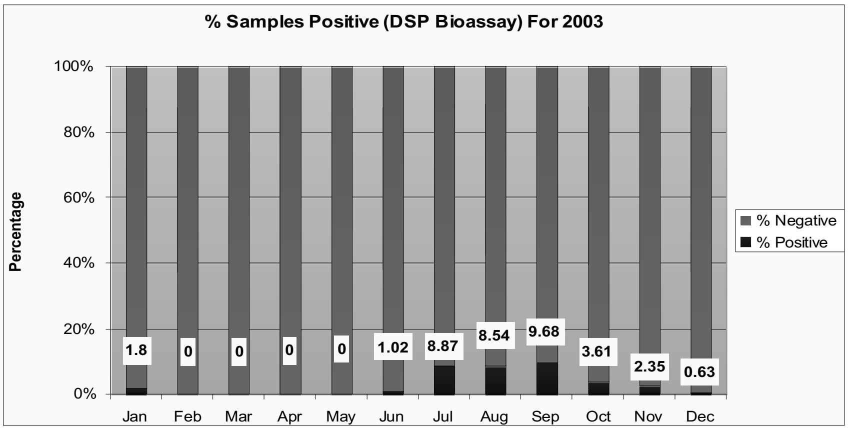


Figure 6: Positive DSP (bioassay) samples during 2003.
Note – this includes positives (two) from non-aquaculture areas on the east coast.

AZP in 2003
All samples analysed for DSP are also analysed for AZP, using both bioassay and chemical analysis. Only two areas were closed during 2003 due to the presence of Azaspiracids (the toxin responsible for AZP) above the regulatory limit, with positive bioassays. The two areas concerned were Bruckless, Co. Donegal and Inverin, Co. Galway. In both cases the positive bioassays occurred in mussel samples.

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Report Turnaround
Speedy turnaround of samples submitted for biotoxin analysis is essential to the shellfish industry. The Marine Institute aims to have a turnaround time of three days or less for 90% of samples – in line with its' contract with the FSAI.

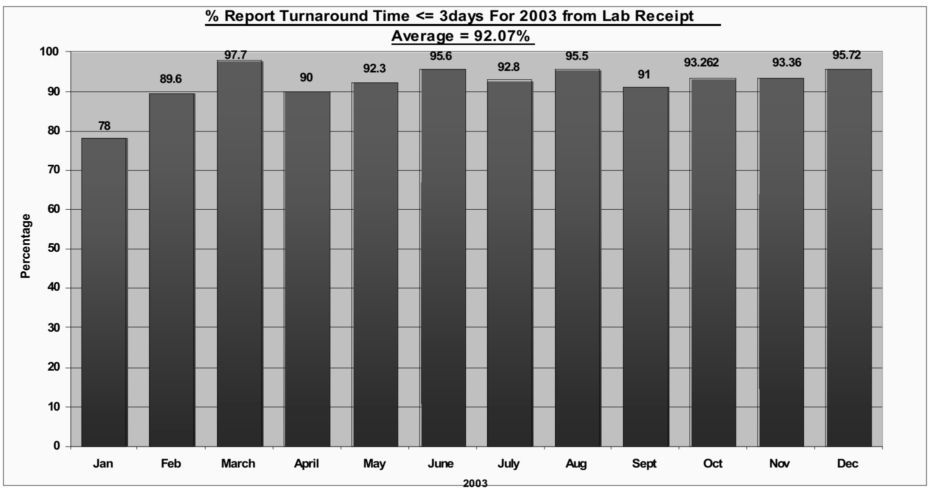


Figure 7: Percentage of reports for DSP/AZP and PSP bioassays available within three days of receipt of shellfish samples during 2003.

During 2003 the percentage of reports for DSP/AZP and PSP bioassay available within three days of sample receipt ranged from 78% to 97.7% (Figure 7). On an annual basis, of the 2,793 samples analysed during 2003 92.4 % of reports were available within three days

Phytoplankton Monitoring

In addition to specific biotoxin monitoring using chemical and bioassay methods, as outlined above, the Marine Institute has an ongoing phytoplankton monitoring programme in place since the 1980s. During this period, phytoplankton has been closely monitored to further the understanding of populations around the Irish coastline, particularly in relation to shellfish toxicity. Local DCMNR sea fishery officers, or an assigned person, take samples on a regular basis from shellfish production areas. These samples are sent to regional labs in Galway and Bantry for analysis. All phytoplankton species are identified and enumerated in this programme although particular emphasis is put on harmful species (Box 1).

The results of phytoplankton analysis are compiled into a central database and reports are compiled on toxic and other known harmful species. These reports include information on the concentration of toxic/potentially harmful species, dominant phytoplankton, and comments on which phytoplankton in the report are of most threat to human health and the aquaculture industry. Phytoplankton reports are circulated to the aquaculture industry, DCMNR sea fishery officers and all other interested parties. They are also available online.

During 2003, sampling frequency was weekly during ‘high toxicity risk’ periods (spring to autumn) and was reduced to monthly in winter when little or no phytoplankton growth occurs. Over 1,500 phytoplankton samples were analysed (Figure 8). Of these, the numbers containing known toxin-producing phytoplankton were:

DSP	=	318
PSP	=	231
ASP	=	722 (27 samples >100,000cells/litre)

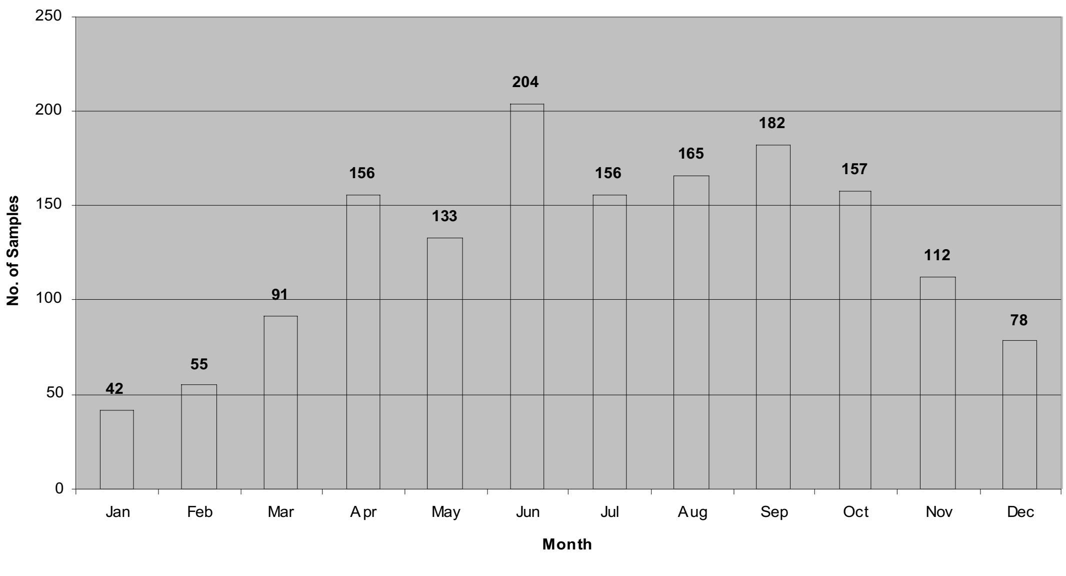


Figure 8: Number of samples submitted for phytoplankton analysis during 2003.

7.2 Microbiological Quality of Shellfish Waters

The results for monitoring of shellfish from production areas for bacterial contamination in accordance with European Directive 91/492/EEC dictate the requirements, where necessary, for controls on harvesting or the use of processes (*i.e.* heat treatment, depuration or relaying) needed to reduce the level of bacterial contamination to acceptable levels (Box 2). Consequently, shellfish production areas are classified twice yearly by the Department of Communications, Marine and Natural Resources. The production areas sampled in the monitoring programme are principally oyster and mussel cultivation areas, but some clam and sea urchin areas are also included. A summary of designations in November 2003[4] is given in Table 7, along with previous classifications (See also Figure 9). Some production areas are sub-divided and may have more than one classification. Additionally, production areas can have different classifications for different species, e.g. sea urchins from a production area can be harvested directly for consumption (Category A) but mussels need depuration prior to consumption (Category B).

Table 7: Microbiological Classification of Irish Shellfish Waters under European Directive 91/492/EEC (Refer to Box 2).

	Nov 2003	July 2003	Dec. 2002
No. Prod Areas	58	58	58
A	12	10	14
A & B	8	7	4
B	36	39	38
B & C	1	1	1
C	1	1	1

Box 2: Microbiological Classification of Shellfish Production Areas under Directive 91/492/EEC

European Directive 91/492/EEC lays down conditions for the production and placing on the market of live bivalves molluscs (mussels, oysters, scallops and clams) and other shellfish (such as sea urchins) intended for immediate human consumption or for further processing before consumption. The directive provides for strict controls including the monitoring of shellfish from production areas for bacterial contamination (sewage indicator organisms), algal biotoxins and chemical contaminants. Regulation S.I. No. 147 of 1996 gives legal status to the Directive in Ireland and the Department of Communications, Marine and Natural Resources is the responsible authority for its implementation.

In *Category A* areas, shellfish can be collected for direct human consumption. Shellfish having either <230 *E. coli* or <300 faecal coliforms/100g of flesh comply with this category.

In *Category B* areas, shellfish must undergo purification in an approved plant for 48 hours prior to sale for direct human consumption. Shellfish in these areas must have 90% compliance with standards in the range 230-4,600 *E. coli* or 300-6,000 faecal coliforms/100g of flesh.

In *Category C* areas, relaying is required over a long period (at least two months) in clean sea water prior to sale for direct human consumption. These areas are those with shellfish with 6,000-60,000 faecal coliforms/100g of flesh.

Prohibited areas are those where shellfish with >60,000 faecal coliforms/100g of flesh occur.

After purification and/or relaying all shellfish must comply with the standards for Category A waters.

[4] Live Bivalve Molluscs (Production Areas) Designation, 2003.

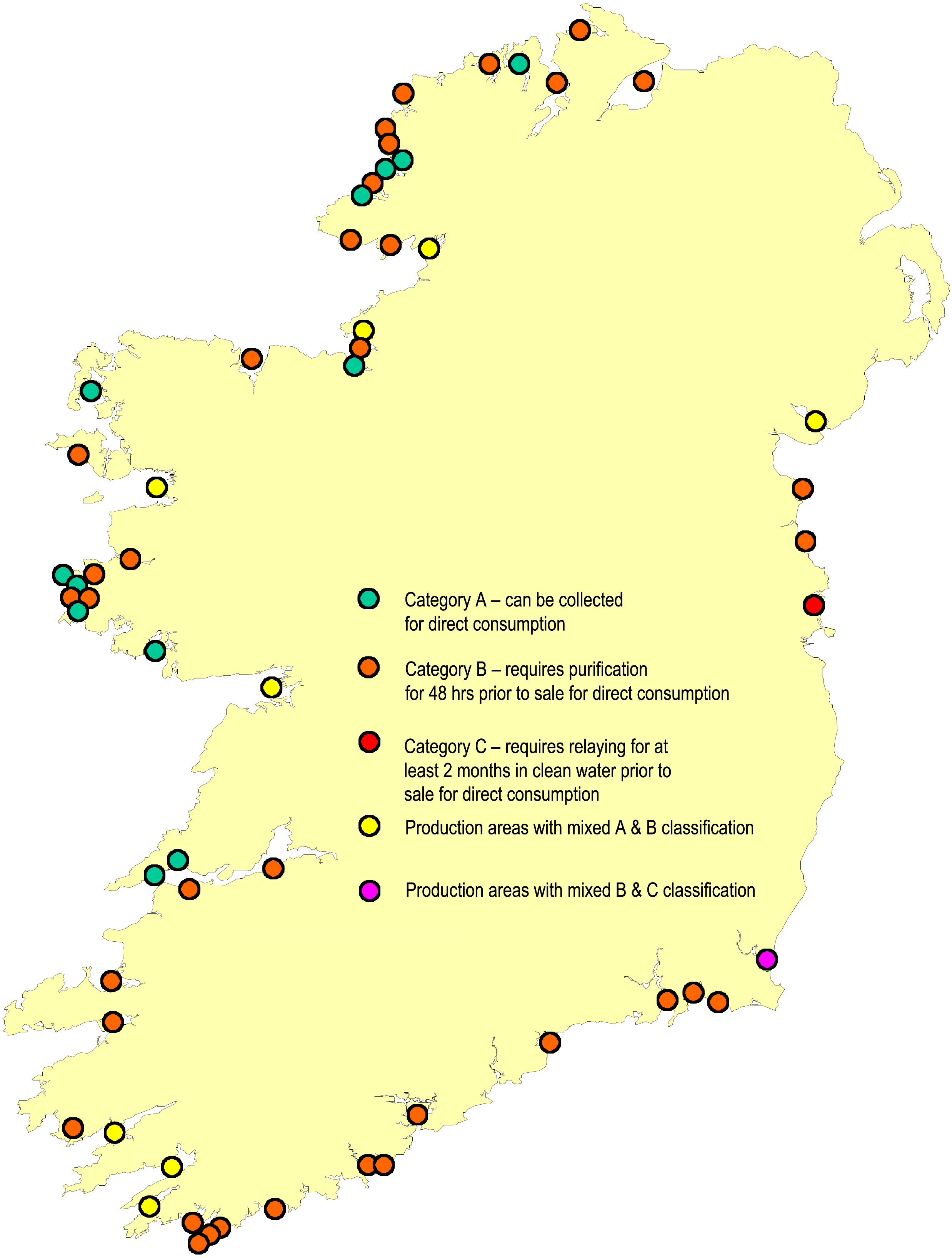


Figure 9: Microbiological classification of shellfish production areas November 2003 in accordance with Council Directive 91/492 (See Box 2). (Source – DCMNR).

7.3 Contaminants in Shellfish and Shellfish Waters

The level of contaminants in shellfish (Box 3) can provide valuable information on the quality of the shellfish and the waters in which they are grown. Monitoring of a range of parameters in shellfish growing waters, including waters designated by S.I. 200 of 1994, is undertaken to ensure that the quality of edible species is maintained or enhanced. The determination of trace metal and chlorinated hydrocarbon concentrations in shellfish growing areas is carried out by the Marine Institute in part fulfilment of the monitoring requirements of various EU legislation, including:

- EU Council Directive 79/923/EEC on the quality required of shellfish growing waters (as implemented in Ireland by Statutory Instrument No. 200 of 1994);
- EU Directive 91/492/EEC laying down the health conditions for the production and placing on the market of live bivalve molluscs; and
- Commission Regulation 466/2001/EC (as amended by Regulation 221/2002/EC).

Box 3: Contaminants

Trace metals exist naturally in the environment and many, including chromium, copper, iron and zinc are essential elements for living organisms. However, some trace metals such as mercury, lead and cadmium are not required for metabolic activity and can be toxic at quite low concentrations. These three elements occur naturally in the earth's crust, but they can also be introduced into the aquatic environment from activities such as mining, industry and agriculture. Once in the aquatic environment these metals can be bio-accumulated in shellfish tissues. Chromium contamination results mainly from human activities.

Polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) are man-made compounds that are ubiquitous air and water-borne contaminants. These are persistent pollutants with a tendency to bio-accumulate in shellfish tissues and bio-magnify through the food chain.

EU Commission Regulation 466/2001/EC (as amended by Regulation 221/2002/EC) sets maximum levels for mercury, cadmium and lead in bivalve molluscs of 0.5, 1.0 and 1.5 mg kg^{-1} wet weight, respectively. The UK is the only country at present to set down a guideline value of 50 mg kg-1 for Zinc in food; however this excludes shellfish. There are no published guidelines for acceptable concentrations of chromium, silver and nickel in shellfish. Therefore, results are compared against other areas to assess for any obviously elevated results. Oysters accumulate silver to a higher concentration than mussels and this is evident from the results obtained. Oysters are also known to accumulate high levels of zinc, particularly in the digestive glands.

In the absence of EU standards for other (non-metal) contaminants in shellfish, monitoring results are compared to the strictest guidance or standard values available in other European countries.

During 2003, samples of shellfish (mussels, Pacific oysters and native oysters) from 29 locations where shellfish are grown were analysed for metals (mercury, cadmium, chromium, copper, lead, zinc, nickel and silver). The results for 2003 are presented in summary format in Table 8 and compared with guidance and standard values for the various contaminants.

The principal points are as follows:

- Water quality parameters measured during sampling of the shellfish growing areas in 2003 was good and conformed to the guidelines of Council Directive 79/923/EC with respect to pH, temperature, suspended solids, salinity and dissolved oxygen.
- All shellfish samples tested for mercury and lead were well within the respective limits of 0.5 and 1.5 mg kg^{-1} wet weight, as set by European Commission Regulation 466/2001/EC, (as amended by Regulation 221/2002/EC).
- All shellfish samples tested for cadmium were within the limit of 1.0 mg kg^{-1} wet weight, as set by European Commission Regulation 466/2001/EC, (as amended by Regulation 221/2002/EC). However, one sample (*O. edulis* Castlegregory) was close to this limit (0.97 mg kg^{-1}). There is little historical information for this shellfish growing area. Further samples will be taken in 2004 to investigate whether this value was anomalous or reflects elevated cadmium in this area. The second highest cadmium level was 0.57 mg kg^{-1}.
- No specific growing area stands out as having notably elevated levels of zinc, chromium, silver or nickel in comparison with other areas.

The results for 2003 are consistent with those from previous years (e.g. Glynn *et al.*, 2004, Glynn *et al.*, 2003a, b; McGovern *et al.*, 2001) and are evidence of the continued clean, unpolluted nature of Irish shellfish and shellfish producing waters.

Table 8: Results of monitoring of shellfish-growing areas in 2003 and guidance and standard values for contaminants. (Source – Marine Institute).

Contaminant	*Range for 2003 (wet weight)*	*Guidance/Standard Value (wet weight)*	*Qualifier*	*Country*
Cadmium	0.04 - 0.97 mg kg^{-1}	1.0 mg kg^{-1}	Guidance	EC[1]
Lead	0.02 - 1.04 mg kg^{-1}	1.5 mg kg^{-1}	Guidance	EC[1]
Mercury	0.01 - 0.04 mg kg^{-1}	0.5 mg kg^{-1}	Standard	EC[1]
Copper	1.04 - 37.1 mg kg^{-1}	20 mg kg^{-1}	Standard	Spain[2]
Zinc	12.6 - 403 mg kg^{-1}	-	-	
Chromium	0.05 - 1.12 mg kg^{-1}	-	-	
Silver	0 - 2.63 mg kg^{-1}	-	-	
Nickel	0.02 - 0.60 mg kg^{-1}	-	-	

Notes: 1. Commission Regulation 466/2001/EC (as amended by Regulation 221/2002/EC). 2. This value does not apply to oysters for which a higher value of 60 mg kg^{-1} has been set. Mussels sampled in 2003 were all <3 mg kg^{-1}.

7.4 Shellfish Health Status

The Fish Health Unit of the Marine Institute carries out sampling and testing for shellfish diseases in compliance with EU Directive 91/67/EEC and associated Commission Decisions (See Box 6 in Section 8.5). At least 30 native oysters (*O. edulis*) are sampled from each growing area in the country twice per year, first in spring and again in autumn. In addition to this routine screening, abnormal mortalities must be notified to DCMNR / MI and an investigation into their cause is carried out immediately.

All movements of shellfish within the country are strictly controlled by DCMNR. Shellfish may move only under permit and movements of susceptible species from *Bonamia* positive areas to *Bonamia* negative areas are prohibited. Movements of live molluscs into and out of the country are strictly controlled, as laid down in Council Directive 91/67/EEC.

The following are the main points relating to the shellfish disease monitoring programme during 2003:

- All *O. edulis* growing areas were tested twice during the year (spring and autumn) for the presence of the List II parasites *Bonamia ostrea* and *Marteilia refringens. 1,251* oysters were tested in the course of this screening programme. The whole coastline of Ireland remains free of *Marteilia refringens*, but the pattern of distribution of the parasite *Bonamia ostrea* has changed. After the discovery of the listed disease Bonamiosis in wild native oyster beds in Achill, Co. Mayo, during routine sampling in autumn 2002, an epidemiological investigation was carried out to try to determine the origin of the disease and to prevent further spread. A total of 780 oysters were tested as a result of this investigation. Increased surveillance in Blacksod Bay, close to Achill, resulted in the detection of the parasite of *B. ostrea* in one out of 447 oysters. Despite an extensive epidemiological study, the origin of the disease could not be determined with certainty. Both areas have lost the Approved Zone Status for the disease. The addition of Achill and Blacksod Bay brings to six the number of areas without Approved Zone Status for Bonamiosis – the other four being Clew Bay, Ballinakill, Galway Bay and Cork Harbour.
- *414* shellfish were examined for diagnostic purposes, generally as a result of mortality events at aquaculture facilities.
- Summer Mortality Syndrome continued to cause significant mortalities in Pacific oysters in Bannow Bay, Co. Wexford. Around 50% mortality was experienced in late June 2003 on two of the four farms in the bay. These mortalities are linked to environmental stress and physiological state of the animals.

AQUACULTURE MONITORING - FINFISH

8.1 Sea Lice Monitoring

Sea lice, an external parasite on salmon, are regarded as having a serious damaging effect on cultured salmon, resulting in major economic losses to the fish farming community. They inflict damage to their hosts through their feeding activity on the host's body. Sea lice affect salmon in a variety of ways, mainly by reducing fish growth; loss of scales which leaves the fish open to secondary infections and damaging of fish, which reduces marketability.

In 1991 in response to concerns about the possible impacts of sea lice from salmon farms on wild populations of sea trout, a sea lice monitoring programme was initiated by the Department of the Marine. In 1992/1993 the programme was expanded and a programme of control measures was put in place through the Single Bay Management process (Box 4). On a precautionary basis treatment triggers for lice control on salmon farms were set and reviewed periodically. This process culminated in the publishing in May 2000 of the *Offshore Finfish Farms - Sea Lice Monitoring and Control Protocol* (Department of the Marine and Natural Resources, 2000a). The Marine Institute is charged with carrying out regular inspection of sea lice levels around the country in accordance with these protocols. The sea lice management and control plan seeks to:

- Provide an objective measurement of infestation levels on farms;
- Investigate the nature of the infestations;
- Provide management information to drive the implementation of the control and management strategy; and
- Facilitate further development and refinement of control and management strategies.

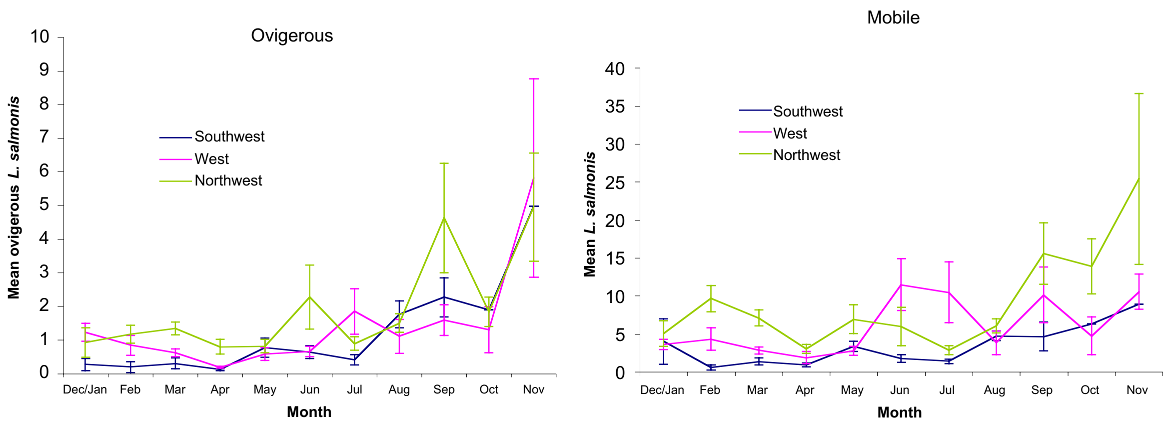
All fish farms undergo lice inspections 14 times per year. One lice inspection takes place each month at each site where fish are present, with two inspections taking place each month during the spring period of March to May. Only one inspection is carried out in the December/January period. At each inspection two cages are sampled for each generation of fish on-site. The results of the sea lice surveys are reported to stakeholders (DCMNR, BIM, Irish Salmon Growers Association, individual farms and Regional Fisheries Boards) on a monthly basis and are published annually by the Marine Institute with detailed monitoring results by farm (e.g. O'Donohoe *et al.*, 2004; 2003). When lice levels exceed pre-set treatment figures (the treatment trigger level), advice is given to treat the affected stock.

Sea lice treatment trigger levels contained in the sea lice protocols are designed to minimise any risk of transmission of sea lice from fish farms to wild sea trout stocks. Over the period since the initiation of Single Bay Management (Box 4), treatment triggers have been progressively reduced from a starting point of 2.0 egg-bearing (ovigerous) female lice per fish during the spring period to the current levels of 0.3 – 0.5 egg-bearing female lice per fish. Outside the critical spring period, a level of 2.0 egg-bearing female lice per fish acts as a trigger for treatments. Where numbers of mobile lice are high, treatments are triggered even in the absence of egg-bearing females.

In 2003, 424 sea lice inspections were carried out at 42 sites (38 Salmon, 3 Rainbow Trout and 1 mixed) in the three finfish growing areas around the coast – the West (Counties Mayo and Galway), the Northwest (Co. Donegal) and the Southwest (Counties Cork and Kerry). The principal results arising from this programme of monitoring, taken from O'Donohoe *et al.* (2004), are:

- A trend of increasing lice levels (both ovigerous and total mobile) from the end of the spring period onwards was evident for both egg-bearing females and total lice, with peaks in September and November (Figure 10).
- In all three regions, mean egg-bearing female numbers were elevated in the month of November. This contrasts, both in timing and lice levels, with the 2002 results, when the harvesting was essentially completed in October.
- Overall, 80.7% of inspections were below treatment trigger levels as outlined in the DCMNR protocols (Department of the Marine and Natural Resources, 2000a). Compliance with the treatment trigger levels for 2003 can be further categorised as follows - 94% of rainbow trout inspections; 98.7% of smolt stock inspections; 67% of one sea-winter fish inspections; and 50% of two sea-winter fish inspections.
- In the northwest region, levels were in excess of treatment trigger levels on 45.7% of inspections of one sea-winter salmon. In the west and southwest, levels were exceeded on 27.5% and 20% of inspections, respectively.
- During the critical spring period (March – May) 58.3% of inspections exceeded the treatment trigger (0.3 – 0.5 egg-bearing female lice per fish) in the northwest. The figures for the west and southwest were 30.6% and 25%, respectively.
- There was no appreciable difference in mean levels of egg-bearing females recorded during the month of May compared with May 2002 (Figure 11).

A slight increase has been noted in the mean number of egg-bearing females and total lice numbers on a national basis for 2003 and 2002, compared with 2001 (Figure 11) (O'Donohoe *et al.*, 2004). Despite this slight increase, numbers of egg-bearing females and total lice are lower than the levels recorded in the early 1990s. The progressive introduction of Single Bay Management from 1992 onwards is believed to have contributed greatly to this reduction. The compliance level of 80.7% for 2003 compares with 87% in 2002 (O'Donohoe *et al.*, 2003 and 91% in 2001 (McCarney *et al.,* 2002).



(a) (b)

Figure 10: Mean (and standard error) ovigerous (a) and mobile (b) sea lice (*L. salmonis*) per month per region in 2003 (From: O'Donohoe *et al.*, 2004).

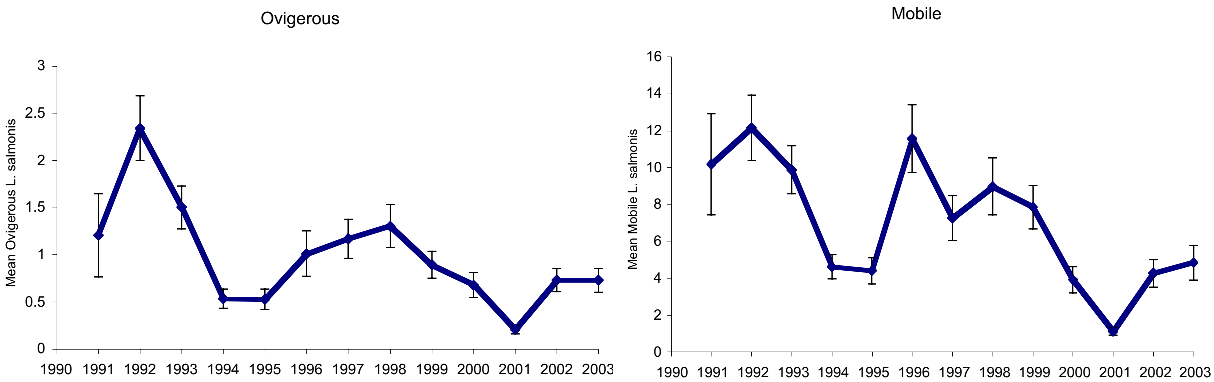


Figure 11: May mean and standard error ovigerous (a) and mobile (b) sea lice (*L. salmonis*) on one sea-winter salmon 1990-2003 (From: O'Donohoe *et al*., 2004).

Box 4: Single Bay Management

Single Bay Management

Single Bay Management is a locally based, co-operative approach to management of sea lice and disease within a bay. It relies on integrated management rather than solely treatment to reduce sea lice infestation and disease on Irish salmon farms and has been progressively implemented since 1992.

Single Bay Management involves:

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

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. Protocols for fallowing of finfish sites have been implemented by DCMNR (Department of the Marine and Natural Resources, 2000b) 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. The setting of appropriate treatment trigger levels is an integral part of implementing a targeted treatment regime. Together, these components work to reduce the development of infestations and to ensure the most effective treatment of developing infestations. They minimise lice levels whilst controlling reliance on, and reducing use of, veterinary medicines. **N.B.** The agreed husbandry practices cover a range of related fish health, quality and environmental issues in addition to those specifically related to lice control.

Factors that may have contributed to the overall sea lice levels for 2003 include both sea temperature and fish health problems. On average, mean monthly sea temperatures were higher in 2003 than both 2002 temperatures and the 30 year mean (worked from source data from Met Éireann). The life cycle of sea lice is accelerated by an increase in sea temperatures (Hogans and Trudeau, 1989). Symptoms of pancreas disease (PD) were reported in all three regions in late summer/autumn. Weakened fish are more susceptible to a greater parasitic burden and are more difficult to treat.

8.2 Benthic Monitoring

In May 2000, the Department of the Marine and Natural Resources implemented a series of Protocols to monitor fish farming activities in Ireland (Department of the Marine and Natural Resources, 2000abcd, 2001). An annual benthic monitoring survey forms a part of these protocols (Department of the Marine and Natural Resources, 2001). Adherence to the benthic monitoring protocols are now included as a condition in all new (and renewed) marine finfish aquaculture licences. All finfish farms that are subject to the monitoring protocols must carry out an annual survey at each site (production and smolt) included in the relevant licence. The level of detail required in the benthic survey is dependent on the biomass held at the site and the local hydrographic conditions (See Box 5). The surveys are carried out on behalf of the farmers by a consultant chosen by them from an approved list of consultants. Consultants are subject to random verification auditing by the Marine Institute.

Box 5: Benthic Impacts at Aquaculture Sites

Finfish farming results in inputs to the marine environment in the form of uneaten feed and faecal material. This oxygen-consuming organic 'rain' falls to the seafloor and can result in stress on the benthic environment, *i.e.* de-oxygenated sediments. This, in turn, can lead to changes in the benthic community structure, including a decrease in faunal diversity and increases in the abundance of so-called 'opportunistic' species associated with deteriorated conditions (e.g. the polychaete worms *Capitella capitata* and *Malacoceros fuliginosa*). The hydrodynamics of cage sites dictate the potential for organic build-up and associated impacts on benthic communities. Stratified, semi-enclosed water bodies with poor water exchange are most at risk from such inputs. Under conditions of adequate tidal exchange, the impacted area tends to be confined to the immediate vicinity of the cages and sediment quality generally returns to normal within 10-20m of the farm perimeter (Gowan, 1990). In sheltered bays the area of sediment enrichment can be more extensive. Consequently, the sea bed under and adjacent to finfish aquaculture sites is monitored annually with a view to minimising the impact and in order to ensure environmental quality is within acceptable limits.

Benthic monitoring is not carried out at shellfish culture sites. The deposition rate of detrital material, faeces and pseudo-faeces (ejected food material and associated mucus), under mussel long-lines and rafts is perceived to be considerably less than under fully stocked salmon cages. However, cumulative impacts of year-round production may be observed in high production areas. As with salmon farms, the hydrodynamics of mussel culture sites dictate the potential for organic enrichment and associated impacts on benthic communities.

The monitoring protocols allow for a certain degree of impact on the seabed beneath and adjacent to the fish cages, with the acceptable level of impact decreasing with distance from the cages. In the event of a breach of the allowable impact levels, the licencee must submit a *Benthic Amelioration Plan* to the Department of Communications, Marine and Natural Resources with the aim of achieving an acceptable benthic standard in the licenced area as soon as possible. The plan may include actions such as a feed waste control plan; a reduction in the documented volumes of fish feed into the licenced area in question; movement of all production cages; and a reduction in production tonnage. A subsequent survey of the impacted area determines if the amelioration plan has been successful.

The Benthic Monitoring Unit (BMU) of the Marine Institute compiles annual reviews of benthic monitoring at finfish aquaculture sites based on survey reports submitted to the Department of Communications, Marine and Natural Resources (e.g. O'Beirn, 2004). The number of sites subject to the monitoring protocols increased from 55 in

2002 to 62 in 2003 (out of a total of 67 sites). Seven sites within Inver Bay, Co. Donegal that would normally be subject to annual monitoring surveys, were exempted from carrying out the surveys due to the large-scale mortalities that were experienced during the summer of 2003 (See Section 9.1). Benthic surveying carried out as part of a wider investigation to these events were considered sufficient for assessment of the benthic conditions. Therefore, the number of sites subject to the protocols in 2003 was 55. However, the number of sites actually surveyed decreased from 34 to 24. The level of reporting compliance with the protocols was 24 sites out of 55 *i.e.* 44% (Table 9). This compares with 61% during 2002 and 65% compliance during 2001.

All of the sites surveyed in 2003 had acceptable benthic conditions - as laid down in the protocols - (Table 9). However, one site in Co. Galway had conditions that warranted concern. Images taken three months after the last fish had been removed from the site showed heavy impact on the seafloor, indicating the need for careful attention in the future. For a number of sites the Marine Institute recommended that, despite acceptable benthic conditions, the feeding regime and/or the biomass loading in cages at this site should be monitored closely in order to minimise food wastage and impact on the benthos.

Table 9: Reporting and Environmental Guideline Compliance with DCMNR Benthic Monitoring Protocols in 2003. (Source – Marine Institute)

Location	*No. of Sites Subject to Protocols*	*Site Reports Submitted for 2003*	*No. of sites with acceptable benthic conditions*
Donegal			
Lough Swilly	1	1	1
Mulroy Bay	9	9	9
Inver Bay	7	n/a	n/a
McSwyne's Bay	3	0	n/a
Mayo			
Clew Bay	7	2	2
Galway			
Clifden Bay	1	0	n/a
Killary Harbour	2	0	n/a
Betraghboy Bay	4	0	n/a
Greatman's Bay	3	0	n/a
Kilkieran Bay	19	11	11
Kerry/Cork			
Bantry Bay	3	1	1
Kenmare River	3	0	n/a

n/a = Not Applicable. See main text re. Inver Bay.

8.3 Residues Monitoring in Finfish

European Union (EU) Directive 96/23 of the 29th April 1996 requires member states to monitor certain 'substances and residues thereof [5]' in live animals and animal products. The Department of Agriculture and Food (DAF) are responsible for implementing the Directive in Ireland. The Marine Institute, through DCMNR, is charged with the responsibility of monitoring farmed finfish. The Food Safety Authority of Ireland (FSAI) co-ordinate the activities of the various departments and agencies involved in delivering this programme.

The objectives of the residues programme are:

- to ensure that Irish farmed finfish are fit for human consumption and do not contain unauthorised substances or substances exceeding their Maximum Residue Limit (MRL)[6];
- to provide a body of data to assure that Irish farmed finfish is of a high quality -this is particularly important for supporting the export market; and
- to promote good practice in aquaculture.

Any species of farmed finfish that is produced in greater quantity than 100 tonnes annually is subject to analysis under the Residue programme. Based on this production level requirement, three farmed species (salmon, fresh-water trout and sea-reared trout) are currently monitored. Other species that will be included in the future, depending on production levels, are arctic charr, eel and turbot.

The National Residues Control Plan for aquaculture is submitted annually to DAF for inclusion in the overall national plan and onward transmission to the European Commission. It outlines the sampling frequency and analysis that will be undertaken. For aquaculture, a wide range of substances are tested for (Table 10). These are specified in the National Residues Control Plan (NRCP) and are reviewed annually.

Samples of farmed finfish are collected at the time of harvest by an officer authorised under the Animal Remedies Act, 1993. Samples are maintained under a strict chain of custody. Archive sub-samples are retained at the Marine Institute and are available for testing by reference laboratories in the event of a disputed result.

Directive 96/23 requires that following initial "screening" tests on samples, positive test results are confirmed using appropriate test methodology and according to EU guidelines. The Marine Institute reports all positives results to DCMNR, FSAI and DAF. Decisions in relation to the positive result(s) and follow-up action are made by the Case Management Group (CMG). The CMG is made up of representatives from DCMNR, FSAI and the Marine Institute. Follow-up action may involve further sampling, investigations and criminal proceedings.

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[5] As defined by Directive 96/23 a "residue" shall mean "a residue of substances having a pharmacological action, of their metabolites and of other substances transmitted to animal products and likely to be harmful to human health". This includes banned and authorised substances such as steroids, therapeutic treatments and environmental contaminants.

[6] Authorised compounds have Maximum Residue Limits (MRL) prescribed by the EU. This is the maximum concentration allowable in the edible portion of the animal at the time of harvest. Generally, MRLs will not be exceeded if withdrawal periods are adhered to; *i.e.* the animal is not slaughtered for a set period of time after treatment. Unauthorised substances have no MRL and should not be detected.

The results of this programme are submitted annually to DCMNR, DAF and FSAI. It is the responsibility of DAF to coordinate the results for all farmed animals and products and to submit the results to the EU. This report is also released into the public domain. The individual test results for specific aquaculture sites are also reported to the companies who supplied samples.

During 2003, target samples were collected on 35 occasions from fish farms and packing plants for residues testing in accordance with the NRCP. Generally, five fish were taken from each producer. Of the 168 target samples taken, 155 were farmed salmon; eight were fresh water trout; and five were sea-reared trout. Additional samples were taken at all stages of production from two farms for analysis of unauthorised substances (Group A) and malachite green. A further 22 suspect samples were collected arising from issues relating to a positive leuco-malachite green sample.

The main findings of the 2003 residues monitoring programme are:

i. No positive results were obtained for banned (Group A) compounds.
ii. Of the 163 samples screened for '*Antibiotic Residues*' (Group B1), only three positive results were obtained - all from the same farm. Further analysis of the five samples taken from the farm in question revealed the presence of oxytetracycline at a concentration in excess of the MRL in four out of the five cases. DCMNR carried out a follow-up investigation into these positive results.
iii. None of the samples tested for '*Other Veterinary Drugs'* (Group B2) **-** generally authorised or unauthorised sea lice treatments – were positive. However, a number of samples were found to contain emamectin benzoate and cypermethrin below their MRLs.
iv. "*Other Substances and Environmental Contaminants*" (Group B3) includes dyes (malachite green and its metabolite, leuco malachite green), metals, PCBs and chlorinated pesticides. Nine samples of farmed salmon were shown to be positive for leuco-malachite green[7]. These nine samples came from two different farms. A follow up investigation was carried out by the DCMNR in both cases. For the remaining substances in this group, all samples were compliant with the relevant EC Regulations for metals and guidance levels for PCBs and chlorinated pesticides as set by a number of OSPAR member states - and were consequently reported as negative.

A summary of the results for residues monitoring in 2003 is given in Table 10.

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[7] Article 6 of Directive 2001/82/EC requires the inclusion of pharmacologically active substances in Annex I, II or III of Regulation 2377/90. Malachite green and leuco malachite green are not included in these Annexes and have never been evaluated according to this regulation. The use of this substance in food producing animals is therefore illegal.

Table 10: Summary of 2003 Residue Monitoring Results for Target Samples. (Source – Marine Institute)

Residue	*No. Examined*	*Compliant*	*Non-compliant*	*Source of Maximum Level to assess compliance #*
***Group A** - Unauthorised Substances*				
Corticosteroids (Dexamethasone)	80	80	0	(v)
Beta-agonists	80	80	0	(v)
Chloramphenicol	80	80	0	(v)
Nitrofurans	45	45	0	(v)
***Group B** - Therapeutic Treatments*				
B1 – Antibiotic Residues				
Antimicrobial Screening*	163	163	**3**	(i)
Tetracycline*	5	1	**4**	(i)
B2 – Other Veterinary Drugs				
Emamectin benzoate	162	162	0	(i)
Ivermectin	160	160	0	(ii)
Cypermethrin	163	163	0	(i)
Teflubenzuron	162	162	0	(i)
Diflubenzuron	162	162	0	(i)
B3 - Other Substances & Environmental Contaminants				
Malachite Green	62	62	0	(ii)
Leuco Malachite Green	62	53	**9**	(ii)
CB Congener 28	34	34	0	(iii)
CB Congener 31	34	34	0	
CB Congener 52	34	34	0	(iii)
CB Congener 101	34	34	0	(iii)
CB Congener 105	34	34	0	
CB Congener 118	34	34	0	(iii)
CB Congener 138	34	34	0	(iii)
CB Congener 153	34	34	0	(iii)
CB Congener 156	34	34	0	
CB Congener 180	34	34	0	(iii)
HCB	29	29	0	(iii)
Gamma – HCH	21	21	0	(iii)
Dieldrin	21	21	0	
cis-Chlordane	31	31	0	
trans-Nonachlor	22	22	0	
trans-Chlordane	33	33	0	
Mercury	36	36	0	(iv)
Lead	36	36	0	(iv)
Cadmium	36	36	0	(iv)

* - Non-compliant results for anti-microbial and tetracycline analysis are the same samples

\# - i) Maximum Residue Limit set according to Council Regulation (EEC) No 2377/90; ii) These compounds are not authorised for use in finfish, and should not be detected.; iii) Strictest standards applied by OSPAR contracting countries. (OSPAR: A compilation of standards and guidance values for contaminants in fish, crustaceans and molluscs for the assessment of possible hazards to human health, Update 1992, JMP 17/3/10-E); iv) Commission Regulation (EC) No 466/2001 as amended by Regulation (EC) 221/2002; (v) Substances banned by Council Regulation (EEC) No 2377/90 (Annex IV) and should not be detected.

8.4 Fish Farm Escapees

The physical nature of salmon cages is such that they are vulnerable to damage by storms, predators and collisions, and escapes from confinement inevitably occur. Fish are also lost during routine handling operations. Escaped salmon can enter rivers where they breed and interbreed with wild salmon, thereby potentially changing the genetic make-up of wild populations. Large-scale experimental simulations of farm salmon escapees have shown that farmed salmon have both genetic and competitive impacts on wild populations (McGinnity *et al*., 2003).

Mandatory reporting of fish farm escapees has taken place since 1996. Fish farm operators provide information to DCMNR on the location, number, age, time at sea and average weight of the escaped fish; the reason for the escape; and measures taken to prevent or reduce the impact of the escape. In 2003 there was just one reported incident, in the Clew Bay area, involving 2,800 rainbow trout. This is considerably less than previous years. For example, between 1996 and 2000 there were 13 reported incidents involving 189,000 adults and 120,000 smolts.

Wild salmon catches are examined on a routine basis from fish dealers' premises in Ireland in order to identify fish farm escapees and estimate their proportion in the catch. The catch examined comprises principally of drift net catches from the major salmon fishing areas of Donegal, Mayo, Galway and Limerick and the South West (Cork and Kerry). The identification of escapees is based on a combination of external characteristics including fused or poorly developed fins and operculum (the gill covering).

In 2003, Marine Institute staff examined 59,000 fish from the commercial salmon harvest. The proportion of salmon identified as farm escapees based on external examination was 0.11% (just 63 fish), on a national basis. Figures ranged from 0.05% in the southwest to 0.42% in the northwest (Marine Institute, unpublished). These values are within the range of values (0.07-0.41%) recorded since 1991 (Ó Maoiléidigh *et al*., 2002). Approximately 0.7 tonnes of farmed salmon escapees are estimated to have been taken in the national catch in 2003 which, again, is at the lower range of values for recent years – 0.72 – 5.39 tonnes in the period since 1991. It is emphasised that these figure should be regarded as an underestimate due to the difficulties in identifying escapees from morphological characters alone and also because escapees may not always be included in the catches brought to sale in established dealer's premises. The identification of features is subjective and differing interpretations may occur. Furthermore, there is no systematic reporting of fish farm escapees in riverine catches. Overestimation of the number of escapees in the catch can also occur. For example, many of the features of farmed fish could be common to adult fish originating from ranching or enhancement programmes which would be returning to some areas in relatively large numbers.

8.5 Finfish Health Status

The Fish Health Unit (FHU) of the Marine Institute supports the aquaculture industry and the inland fisheries sector in maintaining Ireland's superior fish health status. It provides both statutory services (in line with EU Directives), and diagnostic support. These services include bacteriology, virology, histology, parasitology and molecular biology.

The classification outlined in Box 6 below, forms the basis for trade in live fish within the EU. According to this framework, Ireland has obtained the highest classification possible for finfish and can trade freely with any country within the European Community, and beyond. It is on the basis of maintaining Ireland's Approved Zone Status (the highest health status achievable under the current regime) for Viral Haemorrhagic Septicaemia (VHS) and Infectious Haematopoetic Necrosis (IHN) that most of the statutory testing is carried out.

Box 6: Diseases of Finfish and Shellfish

EU Directive 91/67/EEC (as transposed into Irish Law by S.I. 253 of 1996) concerns the animal health conditions governing the placing on the market of aquaculture animals and products. It represents the main fish health legislation under which the Irish aquaculture industry is regulated. The aim of the Directive is to prevent the spread of fish and shellfish diseases whilst promoting trade in aquaculture animals and products, and providing protection for countries (such as Ireland) which have a very high health status. EU Directive 91/67/EEC categorises the main fish diseases into three lists:

List I diseases are exotic to the EU and must be eradicated from any place in which they are found. ISA (Infectious Salmon Anaemia) is the only disease on this list. The ISA virus was isolated from two rainbow trout farms in Ireland in 2002. The virus was isolated in the absence of clinical disease and was picked up as part of a routine screening programme. Both cases were managed as per the Irish ISA Withdrawal Plan, which was approved by the EU Commission in 2001.

List II diseases are present in certain parts of the EU but not in others. These diseases can cause a severe economic impact on infected sites. The List 2 finfish diseases are VHS (Viral Haemorrhagic Septicaemia) and IHN (Infectious Haematopoetic Necrosis). IHN has never been detected in Ireland but a marine strain of VHS (Genotype 3) was detected in turbot, which were cultivated at Cape Clear off the southwest coast, in 1997*. The farm was cleared and fallowed according to the procedures laid down in Council Directive 93/53/EEC.

The List II shellfish diseases are Bonamiosis and Marteliosis – both of which occur in the native (flat) oyster *Ostrea edulis*. Under Commission Decision 2002/300, the entire coastline of Ireland obtained Approved Zone status with respect to Marteiliosis, and the entire coastline of Ireland with the exception of Clew Bay, Ballinakill, Galway Bay and Cork Harbour obtained Approved Zone status with respect to Bonamiosis. However, following the detection of *B.ostrea* in Achill and Blacksod Bays later in 2002 these bays have now been added to the list of *Bonamia* poisitive areas in the country.

Box 6: Diseases of Finfish and Shellfish (contd.)

List III diseases are widespread in certain parts of the EU, but certain countries have farms or zones, which are free of these diseases. The finfish diseases of interest on this list are IPN (Infectious Pancreatic Necrosis), Furunculosis, ERM (Enteric Redmouth Disease) and BKD (Bacterial Kidney Disease) and *Gyrodactylus salaris*. BKD and *G. salaris* have never been detected in Ireland. Furunculosis and ERM have been detected in Ireland in the past but are well controlled by the use of licenced vaccines. IPN has been isolated sporadically in Ireland since the 1980s, both in rainbow trout and Atlantic salmon. Because this virus has caused significant losses in countries such as Scotland and Norway in the last few years, the Marine Institute and DCMNR are currently working with the aquaculture industry to develop a Code of Practice in relation to IPN, aimed at maintaining Ireland's current strong health status in relation to this disease.

Other diseases such as Pancreas Disease, Piscirickettsiosis and gill disease have also occurred in Ireland. These diseases are not listed in Irish or European Fish Health legislation. Nevertheless, all mortality must be reported and movements between sites may only occur under permit.

* It is likely that only VHS Genotype 1 will be listed under the new fish health legislation that is currently being drafted by the EU Commission. This genotype has never been listed in Ireland.

All marine and freshwater finfish sites in the country are inspected at least once per year. Farms holding broodstock are inspected twice per year. A farm visit consists of a full inspection of all ponds/cages and full post-mortem (including, bacteriological, virological and histological analyses) of at least 30 fish. Farm records (*e.g.* stock movement, medicine usage and mortalities) are inspected and a report is made of the visit outlining the information required under Directive 91/67/EEC.

Under the terms of each Aquaculture Licence, any farm experiencing 'abnormal' mortality must report it to DCMNR/Marine Institute. All such mortalities are investigated by the Marine Institute, generally in conjunction with the farm veterinarian, and findings are reported back to DCMNR. In order to prevent the spread of disease through the movement of fish between sites (*e.g.* smolt transfers to sea) a movement permit is required. When an application is made to DCMNR for a movement permit, the health status of the fish is ascertained either by site inspection by the Fish Health Unit of the Marine Institute or via the submission of a recent veterinary report by the farmer's practitioner. Only clinically healthy fish may be moved.

The following are the main points relating to the finfish health monitoring programme during 2003:

- All marine and freshwater finfish sites were inspected and sampled as outlined in Council Directive 91/67/EEC. *2,043 finfish* were tested for the presence of diseases listed in Annex A of this Directive. Ireland continues to remain free of ISA, VHS, IHN, BKD and *G. salaris*. The IPN virus was however, isolated from sub-clinically infected post-smolts on a single site, as a result of routine screening.
- *2,237 finfish* were examined for diagnostic purposes, generally as a result of mortality events at aquaculture facilities. A clinical case of IPN was identified in salmon fry in a hatchery in the west of Ireland in March, 2002. A rigorous testing programme was carried out to establish if other stocks on that site were also infected. Follow-up testing was also carried out on smolts, which had been transferred to sea from that hatchery. As a result, the virus was isolated from one out of three cages on the marine site. In total, more than 600 fish were screened for IPN following the outbreak. Although the percentage mortality associated with the outbreak in the hatchery was quite low, all fry on site were culled and the site was disinfected and fallowed. A Risk Reduction Programme was implemented on the sea site, where percentage mortalities was also low.
- Other significant results obtained from diagnostic samples were the isolation of *Aeromonas salmonicida* from a batch of moribund salmon smolts and *Yersinia ruckerii* from rainbow trout on a single site. A number of species of *Vibrio* were also detected from kidney swabs taken from marine stage salmon.
- An epidemiological screening programme was carried out on wild fish in Bealacragher Bay, Co. Mayo in relation to the isolation of ISA virus in that area in 2002. Almost 400 wild fish were tested using virus isolation techniques. ISA virus was **not** isolated.
- The FHU carried out extensive testing and pre-movement clinical checks to facilitate the export of live fish and shellfish to other EU member States and to third countries such as Chile.
- Extensive fish health investigations following the loss of almost one million farmed fish in Donegal Bay in the summer of 2003 did not result in the identification of any primary fish pathogens. Further details of this incident are provided in Section 9.1 of this report.

OTHER ISSUES AND INITIATIVES DURING 2003

9.1 Donegal Bay Mortalities

During the summer of 2003 major mortalities occurred at three fish farms in Inver Bay and McSwyne's Bay in Donegal Bay. A rise in mortalities was first reported in early July 2003. The mortality rate increased dramatically during July and continued into August and September. By September, approximately one million fish had died, resulting in severe economic losses for the farms concerned. Mortality rates at individual farms were estimated by BIM as ranging from 24% to 94%. Initial investigation focused on disease as a possible cause but the involvement of a bacterial or viral pathogen was ruled out.

Having excluded disease and following consultation with the various stakeholders, a broader investigation into the cause of the mortalities was launched by the Marine Institute. The following potential causes were considered:

- Primary fish pathogen
- Farm practices
- A spill or discharge of a toxic chemical
- Potential contamination associated with a nearby dredge spoil dumpsite
- Sediment disturbance from fishing activity resulting in the release of toxic gas(es)
- Other physico-chemical water quality factors
- Misuse or accident with chemical (veterinary) treatment
- Biotoxin associated with a Harmful Algal Bloom
- Jellyfish or siphonophore event

The Marine Institute carried out extensive investigations to try to determine a possible cause, including, an examination of the fish health and farm management practices at the sites; surveys of the benthic conditions in Inver Bay; assessment of water chemistry and residues; investigations into the presence of harmful phytoplankton, and jellyfish; and a review of the Killybegs harbour dredging and disposal operations that took place in 2002.

An extensive report of these investigations (Cronin *et al.*, 2004) concluded the following:

- There was no evidence to suggest that the initial mortality event was caused by a fish pathogen. Secondary bacterial and parasitic infections were observed at a later stage in the event, once gill tissue had been compromised by the initial insult.
- Farm management practices were generally acceptable. There was no evidence to suggest that misuse of, or an accident with, a chemical (e.g. veterinary treatment) on one of the farms, was responsible for the fish kill.
- Chemical testing did not indicate any substance or pollutant that would suggest a causative agent for the fish kill. There was no evidence to show that a chemical pollution event occurred, and testing did not identify any residual substances or toxicity that could be associated with a significant pollution event.
- Given the healthy state of the benthos in Inver Bay and McSwyne's Bay, release of toxic gas (hydrogen sulphide H_2S) from the sediments in sufficient

quantities to be a primary cause of the fish kill seems highly unlikely. The liver pathology of fish supports this finding.

- Considering the review of the Killybegs sediments disposed of at sea; the mechanisms for adverse effects of contaminated sediments on marine biota; results of water quality monitoring carried out; and a review of the hydrography in Donegal Bay, the likelihood of contaminated sediment from the Killybegs sediment disposal site being implicated in this fish kill were considered to be extremely remote.
- While not directly responsible for the fish kill, environmental stress (including water temperatures above those considered optimal for farmed salmon) coupled with secondary bacterial colonisation of the gills and parasitic infection, could have exacerbated and prolonged the mortality event.
- It is possible that some form of jellyfish/siphonophore swarm may have caused an initial insult to the fish in Donegal Bay. This initial insult, coupled with high water temperatures, low oxygen levels and secondary bacterial colonisation of the gills, could have been enough to give rise to the losses observed.

In summary, the Marine Institute investigations (Cronin *et al*., 2004) concluded that it appears most likely that the initial insult to the fish may have been caused by a biological event such as a siphonophore bloom in both Inver and McSwyne's Bays, which probably coincided with an intrusion of offshore water that occurred in early July when water temperatures were very high. Subsequent to the initial event, secondary bacterial and parasitic infections were noted. These infections would have added considerably to the stress of fish, which were already severely debilitated.

9.2 Co-ordinated Local Aquaculture Management Systems (CLAMS)

The Co-ordinated Local Aquaculture Management Systems (CLAMS) process is a nationwide initiative to manage the development of aquaculture in bays and inshore waters at a local level. It allows for the successful integration of aquaculture into the coastal zone, whilst recognising the need to improve environmental compliance, product quality and consumer confidence. The process has been adopted and CLAMS plans have been published for nine bays around the coast, as a proactive step by fish and shellfish farmers, to encourage public consultation on their current operations and their future plans. These areas are:

- Bannow Bay
- Roaringwater Bay
- Castlemaine Harbour
- Lough Swilly
- Clew Bay
- Killary Harbour
- The North Shannon Estuary
- Dungarvan Harbour
- Kilkieran Bay

The CLAMS process continued to develop during 2003, implemented by BIM's regionally-based Development Officers. New CLAMS groups were established in Ardgroom Harbour, Co. Cork and in the South Shannon Estuary. Initial work undertaken during 2003 includes removal of discarded trestles, beach cleanups, environmental monitoring and the development of shared navigation warning systems. Work programmes carried out by BIM's regional staff on behalf of several established CLAMS Groups included, phytoplankton and environmental monitoring, assessment of mussel growth rates, chlorophyll distribution and jellyfish monitoring.

It is envisaged that by the end of the NDP in 2006, every major aquaculture embayment in Ireland will have a completed CLAMS plan and an active local CLAMS group.

Plate 2: Oyster Trestles

9.3 Quality

The provision of recognised quality assurance schemes is essential to promote and authenticate the reputation for quality of Irish aquaculture products. During 2003, BIM continued to concentrate on improving quality standards in order to provide first-class third party verified quality assurance schemes for farmed fish and shellfish. Considerable progress was made in this regard, with the major focus being the introduction of the Quality Seafood Programme (QSP) and its development from a marketing and legal perspective. QSP is essentially a marketing tool facilitating the communication of industry quality standards directly to the buyer and consumer. The Irish Quality Salmon Scheme was used as the start-up for the QSP during 2003. Presence of the mark assures that the salmon has been hatched, raised, harvested and packed under the strictest levels of food hygiene and that the product can be fully traced from hatchery to packing.

All scheme members must go through the certification process every year. This process involves the units being audited by an external auditor and the audit report then being submitted to a certification committee for approval. Therefore, certified membership numbers of the schemes change on a regular basis.

The Irish Quality Trout Scheme received full approval from the Irish National Accreditation Board (INAB) and was launched in September 2003, with the first certificates being awarded by the Minister for Communications, Marine & Natural Resources. This unique scheme was developed in close co-operation with the Cross-Border Aquaculture Initiative, the Food Standards Agency (Northern Ireland), the Food Safety Authority of Ireland and growers from both North and South of the border.

In April 2003, the Irish Quality Mussel Scheme also received approval from INAB and the first accredited members received their certificates at the prestigious European Seafood Exposition in Brussels. Two of the four main mussel processors were fully certified by the end of 2003 and a number of larger mussel growers and dredgers were in the process of being assessed as part of the certification system. Presence of the mark assures that the mussels have been harvested, processed and packed under the strictest levels of food hygiene and that the product can be fully traced from harvest to packed processed product.

The Irish Quality Oysters scheme is due for development during 2004. The BIM/Guinness Oyster Awards promote high levels of quality and environmental awareness amongst growers in order to enhance the profile of Irish oysters on home and overseas markets. In 2003 awards were presented to two Pacific and one native oyster farm.

REFERENCES

ALAB, (2004). Aquaculture Licences Appeals Board – Annual Report 2003. ALAB, Dublin.

BIM (2003a). Seahorses to Sea Urchins – The Next Big Splash in Irish Aquaculture. Bord Iascaigh Mhara, Dublin.

BIM (2003b). ECOPACT - Environmental Code of Practice for Aquaculture Companies and Traders. BIM, Dublin.

BIM (2004). BIM Irish Aquaculture Production 2003. Unpublished report. BIM, Dublin.

Cronin, M., Cusack, C., Geoghegan, F., Jackson, D., McGovern, E., McMahon, T., O'Beirn, F., O'Cinneide, M. and Silke, J. (2004). Salmon Mortalities at Inver Bay and McSwyne's Bay Finfish Farms, County Donegal, Ireland during 2003. *Marine Environment and Health Series*, No. **15**, 2004.

Department of the Marine and Natural Resources (2000a). Monitoring Protocol No. 3. for Offshore Finfish Farms – Sea Lice Monitoring and Control.

Department of the Marine and Natural Resources (2000b). Protocol for Fallowing at Offshore Finfish Farms.

Department of the Marine and Natural Resources (2000c). Monitoring Protocol No. 4 for Offshore Finfish Farms - Audit of Operations.

Department of the Marine and Natural Resources (2000d). Monitoring Protocol No. 2 for Offshore Finfish Farms – Water Column Monitoring.

Department of the Marine and Natural Resources (2001). Monitoring Protocol No. 1 for Offshore Finfish Farms-Benthic Monitoring.

EPA (2004). Ireland's Environment 2004. Environmental Protection Agency, Wexford.

Glynn, D., Tyrrell, L., McHugh, B., Rowe, A., Costello, J., and McGovern, E. (2003a). Trace Metal and Chlorinated Hydrocarbon Concentrations in Shellfish from Irish Waters, 2000. *Marine Environment and Health Series,* No. **7**, 2003.

Glynn, D., Tyrrell, L., McHugh, B., Rowe, A., Monaghan, E., Costello, J., and McGovern, E. (2003b). Trace Metal and Chlorinated Hydrocarbon Concentrations in Shellfish from Irish Waters, 2001. *Marine Environment and Health Series*, No. **10**, 2003.

Glynn, D., Tyrrell, L., McHugh, B., Monaghan, E., Costello, J., and McGovern, E. (2004). Trace Metal and Chlorinated Hydrocarbon Concentrations in Shellfish from Irish Waters, 2002. *Marine Environment and Health Series*, No. **16**, 2004.

Gowan, R.J. (1990). An Assessment of the Impact of Fish Farming in the Water Column and Sediment Ecosystem of Irish Coastal Waters. Department of the Marine.

Hogans, W. E. & Trudeau., D.J. (1989). Preliminary studies on the biology of sea lice, *Caligus elongatus*, *Caligus curtus* and *Lepeophtheirus salmonis* (Copepoda: Caligoida) parasitic on cage-cultured salmonids in the Lower Bay of

Fundy. *Canadian Technical Report of Fisheries and Aquatic Sciences*, No. **1715**: 14pp.

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

McGinnity P.; Prodöhl P.;Ferguson A.; Hynes R.; Maoiléidigh N., Baker N.; Cotter D.; O'Hea B.; Cooke D.; Rogan G.; Taggart J.; Cross T. (2003). Fitness reduction and potential extinction of wild populations of Atlantic salmon, *Salmo salar*, as a result of interactions with escaped farm salmon. *Proceedings of the Royal Society: Biological Sciences*, **270**: 2443-2450

McGovern, E., Rowe, A., McHugh, B., Costello, J., Bloxham, M., Duffy, C. and Nixon, E. (2001). Trace Metal and Chlorinated Hydrocarbon Concentrations in Shellfish from Irish Waters, 1997-1999. *Marine Environment and Health Series*, No. **2**.

O'Beirn, F.X. (2004). A Review of Benthic Monitoring at Irish Finfish Aquaculture Sites in 2003. A report submitted to the Department of Communications Marine and Natural Resources. Marine Institute. 9pp.

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

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

Ó Maoiléidigh, N., Cullen, A., McDermott, T., Bond, N. and McLaughlin, D. (2002). Review of Irish salmon aquaculture escapee data. Theme Session T, ICES CM 2002/T:10.

LEGISLATION

The following is the full reference for legislation referred to in this report.

European

Council Directive 79/923/EEC of 30 October 1979 on the Quality Required of Shellfish Waters. O.J. L 281, 10/11/1979, pp. 47-52.

Council Directive 91/67/EEC of 28 January 1991 Concerning the Animal Health Conditions Governing the Placing on the Market of Aquaculture Animals and Products. O.J. L046, 19/02/1991, pp 1–18.

Council Directive 91/492/EEC of 15 July, 1991 Laying down the Health Conditions for the Production and Placing on the Market of Live Bivalve Molluscs. O.J. L268/1, 24/09/1991, pp 1-14.

Council Directive 93/53/EEC of 24 June 1993 Introducing Minimum Community Measures for the Control of Certain Fish Diseases. O.J. L175, 19/07/1993, pp. 23-33.

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. O.J. L125, 23/05/1996, pp. 10-32.

94/306/EC of 16 May 1994 Laying down the Sampling Plans and Diagnostic Methods for the Detection and Confirmation of Certain Mollusc Diseases. O.J. L133, 28/05/1994, pp. 51-53.

2002/300/EC of 18 April 2002 Establishing the List of Approved Zones with Regard to Bonamia ostreae and/or Marteilia refringens (notified under document number C (2002) 1426). O.J. L103, 19/04/2002, pp. 24-26.

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.

Commission Regulation (EC) No 466/2001 of the 8th March 2001 setting maximum levels for certain contaminants in foodstuffs as amended by Commission Regulation 221/2002/EC.

National

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

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

S.I. No. 147 of 1996. European Communities (Live Bivalve Molluscs) (Health Conditions for Production and Placing on the Market) Regulations, 1996.

S.I. No. 253 of 1996. European Communities (Aquaculture Animals and Fish) (Placing on the Market and Control of Certain Diseases) Regulations, 1996

Appendix I – Irish Aquaculture Production 1990-2003

VOLUME (tonnes)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total 1990-2003
Rope Mussel	3,380	4,700	5,091	4,773	3,707	5,500	7,000	6,694	7,790	6,467	4,045	7,580	7,699	9,313	**83,739**
Bottom Mussel	15,000	11,200	8,731	8,884	9,260	5,500	7,500	11,458	11,306	9,644	21,615	22,793	24,000	29,976	**196,867**
Gigas Oyster	361	1,278	1,750	2,014	1,862	2,539	4,000	3,135	5,369	6,555	5,031	4,909	5,444	4,830	**49,077**
Native/Edulis Oyster	420	366	334	450	590	400	400	400	516	696	266	431	280	325	**5,874**
Clam	60	50	79	84	110	103	125	218	233	121	92	91	214	154	**1,734**
Scallop	-	-	-	-	-	-	-	24	25	33	61	49	67	80	**339**
Other Shellfish	-	-	-	-	-	28	-	-	-	-	na	na			**28**
Total Shellfish	**19,221**	**17,594**	**15,985**	**16,205**	**15,529**	**14,070**	**19,025**	**21,929**	**25,239**	**23,516**	**31,110**	**35,853**	**37,704**	**44,678**	**337,658**
Salmon ova/smolt	-	-	-	-	-	-	-	-	-	-	-	-			
Salmon	6,323	9,300	9,696	12,366	11,616	11,811	14,025	15,422	14,860	18,076	17,681	23,312	21,423	16,347	**202,258**
Sea reared Trout	324	560	432	677	613	470	690	1,020	1,046	1,077	1,360	977	888	270	**10,404**
Freshwater Trout	705	845	965	906	854	1,003	1,160	1,161	1,155	1,098	1,053	730	915	1,081	**13,631**
Other Finfish*	0	0	0	0	0	15	30	0	24	89	76	63	54	40	**391**
Total Finfish	**7,352**	**10,705**	**11,093**	**13,949**	**13,083**	**13,299**	**15,905**	**17,603**	**17,085**	**20,340**	**20,170**	**25,082**	**23,280**	**17,738**	**226,684**
Total Aquaculture Volume	**26,573**	**28,299**	**27,078**	**30,154**	**28,612**	**27,369**	**34,930**	**39,532**	**42,324**	**43,856**	**51,280**	**60,935**	**60,984**	**62,416**	**564,342**

* Includes Turbot and Charr

VALUE (€'000)														
														Total
Species	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003** **1990-2003**
Rope Mussel	1,717	2,343	2,974	2,727	2,118	3,143	4,000	4,252	5,094	4,298	2,358	4,205	5,489	7,568 **52,285**
Bottom Mussel	2,286	1,715	1,816	1,850	2,703	1,864	2,542	4,431	5,028	4,115	10,562	12,691	16,896	21,653 **90,152**
Gigas Oyster	646	1,379	3,000	3,197	2,837	2,095	4,571	4,020	7,025	9,231	6,813	7,993	11,912	9,920 **74,640**
Native/Edulis Oyster	2,108	1,859	994	1,524	1,847	1,412	1,524	1,270	1,971	2,913	1,027	2,060	1,157	1,324 **22,989**
Clam	305	180	251	245	321	131	516	705	827	424	361	589	1,421	795 **7,070**
Scallop	-	-	-	-	-	-	-	216	93	127	338	339	333	380 **1,825**
Other Shellfish	-	-	-	-	-	61	-		104	531	53	65	684	142 **1,640**
Total Shellfish Value	**7,061**	**7,476**	**9,035**	**9,543**	**9,827**	**8,705**	**13,152**	**14,894**	**20,142**	**21,639**	**21,512**	**27,941**	**37,892**	**41,782** **250,602**
Salmon ova/smolt	-	-	-	-	-	-	-	-	-	2,616	4,401	2,905	4,848	2,000 **16,770**
Salmon	26,736	38,413	38,609	49,618	47,493	46,790	47,333	47,638	51,412	55,463	62,772	70,869	77,731	54,198 **715,075**
Sea reared Trout	1,131	1,671	2,150	1,371	1,947	2,598	1,927	2,720	2,980	3,525	4,831	2,837	2,108	870 **32,666**
Freshwater Trout	2,286	2,360	2,576	2,576	2,331	1,401	2,856	2,929	3,320	3,106	2,734	1,997	2,557	2,318 **35,347**
Other Finfish**	-	-	-	-	-	95	211	-	217	301	429	556	82	350 **2,241**
Total Finfish Value	**30,152**	**42,445**	**43,335**	**53,565**	**51,771**	**50,883**	**52,327**	**53,287**	**57,929**	**65,011**	**75,167**	**79,164**	**87,326**	**59,736** **802,100**
Total Aquaculture Value	**37,213**	**49,921**	**52,370**	**63,109**	**61,598**	**59,589**	**65,479**	**68,181**	**78,071**	**86,649**	**96,679**	**107,106**	**125,218**	**101,518** **1,052,701**

**Includes additional value from undisclosed volumes (000's)

Appendix II - Aquaculture Research and Development Grants

1: Successful Aquaculture Sector Grant-aid Awards under Sub-Measure 3 of the Marine RTDI Programme of the NDP (2000-2006) – administered by the Marine Institute.

2002

Reference	*Project Title*	*Grant-aid (€)*
Strategic Projects		
ST/02/02	Isolation and purification of azaspiracids from naturally contaminated materials, and evaluation of their toxicological effects.	419,854.00
ST/02/03	Resource and Risk Assessment of Mussel Seed in Irish Waters	361,362.00
ST/02/01	Biological Oceanography of Harmful Algal Blooms off the West Coast of Ireland (BOHAB)	199,750.00
Fellowships		
PDOC/01/002	Sealice biology and interactions	157,400.00
PDOC/01/003	Investigations into the hatchery rearing of Cod (*Gadus morhua*) in Irish conditions	210,000.00
PhD/01/006	Health and disease in clams, *Ruditapes philippinarum*, in Ireland, with particular reference to brown ring disease.	118,137.00
Applied Industry Grants		
IND/02/01	A Novel Ongrowing System for Abalone	44,484.00
IND/02/05	Technological and Scientific Development of Turbot Broodstock Management and Larviculture in Ireland	97,236.00
Networking and Technology Transfer		
NTT/02/01	Aquaculture Information for Non-Experts	4,960.00
NTT/02/06	World Aquaculture Conference 2003	1,000.00
NTT/02/11	Support for www.aquaculture.ie website	2,000.00
NTT/02/13	Production of career promotion in aquaculture materials as contribution to PICES project	5,000.00
NTT/02/15	Support for Irishseafood.com Website	2,800.00
TOTAL		**1,623,983.00**

(Source – Marine Institute)

2003

Reference	*Project Title*	*Grant-aid (€)*
Applied Industry Grants		
IND/03/04	Technological and Scientific Development of Turbot Broodstock Management and Larviculture in Ireland. Part II - Further Development and Commercial Application	58,100
IND/03/05	Establish a commercial use for starfish	66,264
IND/03/06	Dunlop Offshore Cage Development Programme	42,868
IND/03/07	A Novel System for Intensive Larval Culture of the Sea Urchin *Paracentrotus lividus*	38,958
IND/03/11	Development of an artificial roe enhancement diet based on waste products from the fishing industry	54,308
Networking and Technology Transfer		
NTT/03/01	Aqua Nor 2003 (Aqua TT) - Mobility	500
NTT/03/02	Aqua Nor 2003 (Aqua TT) - Mobility	500
NTT/03/03	Aqua Nor 2003	500
NTT/03/04	Aqua Nor 2003	500
NTT/03/13	Aqua Nor 2003 - Mobility	500
NTT/03/06	Viral Diseases in farmed Salmonid Fish (Vet-Aqua International) - Workshop	500
TOTAL		**263,498**

Further information on these awards is available at www.marine.ie/marinertdi

2: Taighde Mara Teo. - ongoing aquaculture research projects

- Assessing the use of whelk shell fragments, supplied from the processing industry, as cultch for native oyster (Industry partner - Comharchumann Sliogéisc Chonamara)
- Re-introduction of manila clams to Dungloe Bay after voluntary eradication following Brown Ring Disease (BRD) (Industry partner - Sliogéisc na Rossan)
- Assessment of modular re-circulation units for abalone on-growing, growth and survival of Irish produced abalone seed under constant conditions (Industry partner Feirm Éisc Chléire Teo.)
- Supporting research and development phase of seahorse production using re-circulation (Industry partner - Eachuisce Éireann Teo.)
- Juvenile cod production (Sub-contractor/partner with Carna Shellfish Research Laboratory, NUIG)
- Assessment of sub-surface long-lines in an exposed site in outer Galway Bay (Industry partner - Glendara Shellfish)

3: Projects funded under AquaReg

i) The Marine Institute is leading a Coastal Zone Management Project, under the *AquaPlan* strategy, between coastal communities in Ireland, Trondelag, in Norway and Galicia, in Spain. The project aims to facilitate the development of aquaculture and inshore fisheries in these regions. Through direct communication and feedback from the stakeholders and relevant bodies in each region, the Coastal Zone Management Project will review existing aquaculture management practices and identify the strengths and gaps of these. Information will be disseminated through seminars and workshops together with a review of other EU and US aquaculture management approaches. A code of best practice will be produced and a pilot study will be performed in each of the three regions to test the theory in practice. The Marine Institute has received funding of €93,500.

ii) Under the *AquaLink* strategy the Irish Salmon Growers' Association Ltd. (ISGA) will lead a project on Aqua By-Products working with Norwegian partner Norske Sjømatbedrifters Landsforening and Centro de Investigacions Mariñas, in Spain. The aim of this project is to compile a databank of information on waste management solution suppliers, facilities and consultants. This will be an electronic "one stop shop" for aquaculture and processing companies to find solutions for by-products of their business. Once set up, the database will be shared between the countries and updated on a regular basis to ensure that the information remains valuable and relevant. The database will act as an information resource for industries in dialogue with local, national and European authorities on waste management legislation and regulation. ISGA received funding of €144,500.

iii) The Martin Ryan Institute, in NUI Galway, will also be working in collaboration with the Norwegian Institute for Nature Research and IGAFA (XUNTA de Galicia) under the *AquaPlan* strategy. The project aims to develop a novel and simple method for cost-effective production of lobster juveniles. It will develop guidelines for regional lobster restocking and active collaboration and knowledge/technology transfer between research and training institutions in the regions involved in AquaReg and regionally managed lobster industries. The Martin Ryan Institute received funding of €58,500.

iv) Another project that will benefit Ireland's Inshore Fishing industry relates to the development of efficient transportation and storage requirements for live crustaceans (crabs) from the fisherman to the market place. BIM is the Irish partner in this project and received funding of €18,500.