National activities in the field of Aquaculture: **IRELAND**

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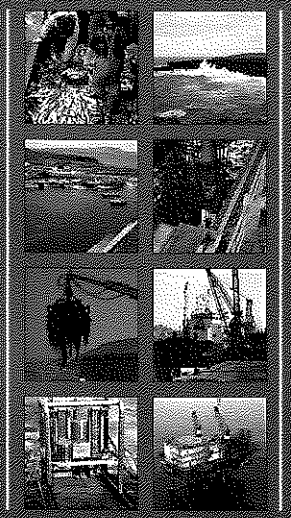

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This document was prepared in May 1995 by a group of invited aquaculture experts drawn from the Irish aquaculture industry, the Fisheries Research Centre, An Bord Iascaigh Mhara, Salmon Research Agency, Veterinary Research Laboratory, the Marine Institute and from University RTD laboratories. It was drafted as a contribution to the 1995 meeting of Directors of Fisheries Research Organisations of the European Union, and as a response to a review by DG XIV entitled *"European Aquaculture Research: current position and prospects"* (COM(94) 258 final).

In order to standardise the national presentations, the organisers of the 1995 Arcachon meeting devised the section headings under which the contents of this document are arranged:

- State of development
  - Species & technologies
  - Markets
- Limits and constraints
  - Government controls
  - Environment & site conditions
  - Biological, technical & economic constraints
- Potential for further development
- Priorities for EU research policy in the future
- Recommended actions for the Commission Services
- Main research programmes

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1. State of Development

1.1 Species & technologies

Modern finfish farming in Ireland commenced in the 1960s with **rainbow trout** *(Oncorhynchus mykiss)* grown in freshwater ponds, following the Danish model. In the 1970s, farming of rainbow trout in sea cages was developed (erroneously termed "sea trout"), followed by marine cage production of **salmon** *(Salmo salar)*. Farming of salmon in the sea developed rapidly during the 1980s, accompanied by a change from small inshore cages to large offshore structures. A large proportion of the biggest cages in world aquaculture (>100 tonne capacity) are located in Ireland.

Small quantities of **turbot** *(Scophthalmus maximus)* are being produced in two pilot operations which started in 1990.

Harvesting of **blue mussel** *(Mytilus edulis)* from estuarine beds which were subjected to varying degrees of cultivation have been practised for many years. The first pilot projects in rope cultivation were set up in the early 1970s, first with rafts and subsequently with long lines.

Similarly, extensive cultivation of **flat oysters** *(Ostrea edulis)* has been traditionally carried on at many locations around the Irish coast, virtually all from managed natural beds. Since the late 1960s, a large operation involving the spatting of flat oysters in 22 man-made ponds has been carried out in Cork Harbour; by the mid-1980s this had expanded to an annual production of approximately 80 tonnes.

Cultivation of the **Pacific oyster** *(Crassostrea gigas)*, generally grown in plastic mesh bags on trestles at the low water spring tide level, was introduced in the 1970s.

Small quantities of **Pacific clams** *(Ruditapes phillipinarum,* also known as *Tapes semidecussata)* are produced. Hatchery reared stock is ongrown in trays to about 10mm, then placed on sandy substrates and covered with light fine mesh to exclude crabs.

There is small scale hatchery production and ongrowing of European and Pacific **abalone** *(Haliotis tuberculata* and *H.discus hannai)*.

The reseeding of **scallop** beds *(Pecten maximus)* by broadcasting juveniles (50-60 mm) over the bottom is showing very promising results. These juveniles come from both wild (natural) production collected on suitable media (such as bags containing bundles of monofilament netting), and from hatchery output.

The technology of land-based cultivation using recirculation (of either sea water or fresh water) is developing in Ireland. At present, at least three pilot units are in use for turbot, eel and salmon smolts.

1.2 Markets

In view of the over-production of farmed fish in earlier years, it is important to stress that all finfish production in Ireland is now market led, as the result of regulatory measures introduced by the industry. This may need to be applied to mollusc aquaculture at some time in the future, but Ireland's full potential as a producer of farmed molluscs has not yet been achieved.

Increased emphasis should be placed on the development of new, cheaper products, in order to broaden the appeal and accessibility of farmed fish and shellfish.

The following is a brief overview of the main trends in the marketing of Irish aquaculture products.

1.2.1 Rainbow trout *(Oncorhynchus mykiss)*: Production of sea-reared and freshwater rainbow trout amounted to almost 1,500 tonnes in 1994. Trade statistics do not distinguish between the two categories of trout, but exports of frozen freshwater fish (probably trout) amounted to 1,060 tonnes. The bulk of freshwater production is sold on the Irish domestic market, which absorbs up to 800 tonnes; the remainder is sold on the UK market. Exports of sea-reared trout are mainly to France and Germany.

1.2.2 Salmon *(Salmo salar)*: Of the 11,600 tonnes produced in 1994, more than half was sold fresh on the French market. A further 10% (1,160 tonnes) was sold to the Great Britain and Northern Ireland. Increased promotion activity in the German market resulted in an expansion of exports.

Belgium and the Netherlands are also growing markets for Irish salmon, albeit from a low base. Approximately one third of farmed salmon production, or some 3,800 tonnes, is sold on the Irish market. Of this, an estimated 1,800 tonnes goes for smoked salmon production and some 2,000 tonnes are sold retail.

1.2.3 Molluscs: With the advent of *Europe sans Frontières* on 1 January 1993, the system whereby precise and comprehensive export statistics were collected by the Irish Customs & Excise authorities ceased. It has been replaced by a questionnaire and sampling system ("Intrastat") organised by the Central Statistics Office, but the Intrastat coverage is not all-inclusive and exports from some of the smaller companies are not being recorded; exports of some species of molluscs are therefore under-reported. Some improvements in coverage were achieved during 1994, however.

1.2.3.1 Pacific oyster *(Crassostrea gigas)*: The production (1,900 tonnes in 1994) is sold primarily to France, with smaller quantities being sold to the UK.

1.2.3.2 Flat oysters *(Ostrea edulis)*: Most of the 590 tonnes produced in 1994 were sold to UK and France.

1.2.3.3 Clams *(Ruditapes phillipinarum):* The production (110 tonnes in 1994) was sold mainly to the Spanish market. The unit export price in 1993-94 was in the order of £2,300 (2,800 ECU) per tonne, which has declined from the 1990 level of around £4,300 (5,300 ECU) per tonne. This reduction resulted from the export of larger quantities of clams to Spain from Italy.

1.2.3.4 Mussels *(Mytilus edulis):* Rope grown mussels are sold directly onto the fresh market in France, and also to locally based processing companies in Ireland. While some 4,800 tonnes were produced in 1993, production in 1994 was seriously curtailed as a result of toxicity problems. In general, all of the bottom grown mussels have been sold directly onto the fresh market in France. The frozen product is exported to a wider selection of markets including Benelux, Spain, Italy and the USA.

1.3 Production statistics

Data for the period 1980-1994 are provided in Table 1 and in Figures 1 and 2.

In terms of tonnage, Ireland has been mainly a mollusc producer (16,000 tonnes in recent years), made up largely of mussels (around 9,000 tonnes bottom cultured and 4,000-5,000 tonnes rope cultivated) and oysters (approximately 2,000 tonnes *C.gigas* and 400-500 tonnes *O.edulis*). The annual production tonnage of finfish increased steadily throughout the 1980s to its present level of 13,000 tonnes, the bulk of which is made up of salmon (11,600 tonnes) followed by rainbow trout grown in freshwater (900 tonnes) as well as in the sea (600 tonnes).

In terms of value, however, finfish production is dominant, accounting for £41m (50 mECU) compared to £7.7m (9.5 mECU) for molluscs.

The text table below summarises the statistics of production for the last four years, relative to 1980 as a base year (1980 production = 100):

	Volume		*Value*		Volume		*Value*	
Year	Salmon	Total finfish	*Salmon*	*Total finfish*	Mussels (rope)	Total molluscs	*Mussels (rope)*	*Total molluscs*
1980	100	100	*100*	*100*	100	100	*100*	*100*
1991	44,286	1,781	*41,443*	*3,739*	2,343	326	*2,636*	*554*
1992	46,171	1,846	*41,653*	*3,727*	2,909	307	*3,346*	*669*
1993	50,267	2,020	*45,399*	*4,126*	2,727	311	*3,068*	*707*
1994	55,314	2,177	*51,238*	*4,562*	2,118	298	*2,380*	*728*

2. Limits and constraints

2.1 Government controls

In Ireland, all aquaculture activities are subject to Government licensing regulations. The Department of the Marine is the sole regulatory authority for marine aquaculture, and shares regulatory responsibility for land-based and freshwater fish farming with the relevant Local Government authority.

Environmental Impact Statements are required for finfish projects exceeding 100 tonnes annual output. Mandatory monitoring programmes to assess the impacts of salmonid cage operations on the marine environment are in place, and cover water quality, sedimentation rates and impact on the benthos. Numbers of sea lice *(Lepeiophtheirus salmonis* and *Caligus elongatus*) on salmon in cages are monitored frequently throughout the year.

2.2 Environment and site conditions

The most serious environmental issues facing aquaculture are, firstly, "green" issues such as the use of antibiotics and pesticides for controlling diseases and parasites (principally the sea louse *(L.salmonis)*. Secondly, the populations of the true sea trout (the migratory form of the brown trout, *Salmo trutta*) in west of Ireland rivers experienced a spectacular crash in 1988-89 (without any sustained recovery as yet), and many people attribute this rapid decline to the concentration of salmon cultivation in that region. This is because a feature of the sea trout problem has been early return of the trout to fresh water, bearing very heavy infestations of sea lice (several hundred lice have been observed on individual fish), which, it is suggested, have come from the fish farms. Further research on the biology and ecology of sea trout and sea lice, and the interactions between these species, is required and is in progress.

The public perception of mollusc cultivation is much cleaner and "greener" than that of finfish farming, but aesthetic objections have been raised against mussel rafts and long-lines (and also against fish cages) on the grounds that they are visually obtrusive in areas of outstanding natural beauty. Both the farmers and the objectors are, in a sense, competing for the same resource: clean, deep sheltered water in areas of low population. These features, essential to the aquaculturist, usually also make for pleasing coastal scenery which attracts holiday-makers.

Competition for space with other users (fishers, amenity, water sports, birds, Special Protection Areas) are also major constraints and need to be addressed in the context of Coastal Zone Management.

The policy of fallowing and single bay management as developed with the finfish farming industry is noteworthy and has been spearheaded by Ireland. It has been shown to make the industry more competitive, more profitable and reduces environmental impacts, thereby maintaining the long-term use of sites. Fallowing has

also achieved reductions in the prevalence of economically important diseases such as pancreas disease and furunculosis *(Aeromonas salmonicida)* and is a simple and highly effective strategy in breaking the life cycle of such parasites as the sea lice *L.salmonis* and *C.elongatus*.

Ireland is currently developing an overall Coastal Zone Management policy which will deal with all these issues.

2.3 Biological, technical & economic constraints

There is evidence that growth rates and the general health status of cultivated fish and molluscs can be diminished by over-crowding. The carrying capacity of aquaculture areas needs to be clearly established, and corresponding stocking limits imposed, in order to ensure that this capacity is not exceeded and that product quality and environmental quality are both maximised. The long-term sustainability of aquaculture is poorly understood at present, because of the lack of suitable and reliable indicators.

To safeguard the aquaculture industry, and the native fauna and flora, Ireland's regulatory authority (the Department of the Marine) adheres fully to the terms of the International Code of Practice developed by the International Council for the Exploration of the Sea (ICES), in addition to the relevant EU Directives, when evaluating all proposals for introductions and transfers of aquatic organisms. Considerable concern has been aroused, therefore, by the accidental but inevitable introduction to Ireland, since the arrival of *Europe sans Frontières*, of non-native species in association with commercial imports of oysters *(C.gigas)* for aquaculture.

Aquaculturists can draw on a high level of scientific and technical expertise in Ireland, across a wide range of skills and disciplines. These resources are almost all located in the universities and in the public service, however, and there is a need to make them locally available in the same way as the agriculture support services. This needs to be addressed by the provision of a technical assistance programme to industry, and local support services, based in the production areas.

Notwithstanding the high level of expertise available within the country, Irish research institutes and programmes are hampered by poor funding generally, both in terms of the amount of money and its continuity. This makes it difficult or impossible to maintain the thrust of scientific research and development beyond short term commitments. Rather than new research structures for aquaculture, what is needed is a greater level and continuity of financial support, in order to run and maintain the existing facilities with maximum effectiveness and efficiency[1].

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[1] *Table 3 of "European Aquaculture Research: current position and prospects" (COM(94) 258 final) summarises Ireland's aquaculture research facilities as: 10 aquaculture research organisations (not including universities), 10 centres (at separate sites), 18 university departments and 3 large research facilities (>5,000 m²). Ireland is not as well endowed with aquaculture research facilities as this!*

The chief economic constraint facing the Irish aquaculture industry is a shortage of funds for capital investment and working capital. The present legislative framework does not provide the aquaculturist with adequate title of ownership of the site, and thus banks and other financial institutions consider aquaculture to be a high risk investment.

3. Potential for further development

3.1 New finfish species

The identification of new aquaculture species, and the development of culture techniques is important in alleviating the perceived problem of overdependence on salmon and trout. A broadening of the product base will allow greater diversity, and the utilisation of new techniques and sites. More varied production should also facilitate greater market access.

Species which are currently under investigation in Ireland include:

- Turbot *(Scophthalmus maximus):* Growth performance trials are ongoing in the Aquaculture Development Centre at UCC, and at the pump-ashore site at Bantry, Co.Cork. A commercial farm on Clear Island (Co.Cork) produced 15 tonnes in 1995. Further work is required on site suitability and optimum system design, development of marine larval ongrowing techniques, and associated systems.

- Arctic charr *(Salvelinus alpinus):* Growth trials on Swedish and native charr have been continuing since 1991; more recently, Canadian and Icelandic strains have been investigated. Further work is required on strain suitability, development of broodstocks, strain genetics and feed.

- Eel *(Anguilla anguilla):* A small warm water recirculation elver growing unit has been built in 1995. Further work is required on ongrowing techniques and system design, parasitology and disease transfer from wild stocks taken into culture, as well as on feed types.

Species to be investigated:

- Halibut *(Hippoglossus hippoglossus):* Norway and Scotland are currently farming this species. Work is required on suitability for culture in Irish conditions, ongrowing trials and techniques, system design, feed types and strain genetics.

- Pollan *(Coregonus autumnalis pollan):* Pollan is a cold water fish found in some Irish lakes. The pollan fishery in Lough Neagh (Northern Ireland) was of great importance to the local economy, having been worth an estimated £0.25m in 1976. The species is currently cultivated in France, Finland, Canada and Austria. Work is required to investigate suitability to culture in Ireland, ongrowing techniques, feed types and strain genetics.

- Sturgeon *(Acipenser spp.)* is also of interest. The Atlantic sturgeon *(A.sturio)*has been widely exploited for its flesh as well as its caviar, and the Siberian sturgeon *(A.baeri)* has also proved suitable for cultivation in Europe. Although it requires higher ambient temperatures than those found in Ireland, trials in warm water recirculation units might demonstrate useful results.

3.2 Shellfish Cultivation.

Further development of the species currently in commercial cultivation - mussels, Pacific oysters, and clams - lies in the optimisation of existing husbandry techniques in order to achieve improved quality and productivity. This is particularly important in relation to the nursery cultivation of clams and oysters. Strain selection for enhanced growth rates, improved meat yields, and disease resistance would further improve productivity and quality. Strategic development of suitable shellfish cultivation areas to maximise economic returns is also required

Several new species - notably scallops, abalone and sea urchins - are currently at the pilot scale of development in Ireland. Improvement in seed supply is a priority for these species, in order to create a secure base for their further development. The cost effectiveness of intensive cultivation of macroalgivores (abalone and sea urchins) using farmed seaweed species as a food source, must be examined. Further developments may lie in the ranching of these species on the sea bed - by providing artificial reefs and kelp forests, for example. In relation to scallops, primary consideration should be given to identifying natural seeding areas and nursery culture sites, in order to break the long (approx. four years) production cycle into two distinct phases and thus optimise the available culture areas.

Development of suitable offshore technologies would serve to overcome the identified constraints of site availability and user conflicts.

In addition to the above, future development potential lies in the areas of quality management and product development. The secondary processing of marine products in Ireland is capable of significant expansion, for which consistent supplies of good quality raw materials are a clear prerequisite.

3.3 Cultivation of marine algae

Traditionally used as a fertiliser in the agriculture of coastal communities on the western seaboard, and for human consumption, **seaweed (marine algae)** has been commercially harvested for alginate production since 1947. *Laminaria* stems were the principle harvest at first, but since 1960 *Ascophyllum* meal has been produced (*Ascophyllum* now accounts for 94%, by wet weight, of the total seaweed harvest).

The main activities in recent years are shown below, together with the approximate percentage of total industry turnover which they account for:

Seaweed meal for alginates	57%
Fertilisers and animal feeds; agrochemicals & hortichemicals	27%
Body-care products	13%
Sea vegetables for human food	3%

Annual harvests in 1993-94 were around 34,400 tonnes, representing £0.9m (1.08 mECU) first sale value. Of this production, exports account for 95% of the weight and 87% of the value.

Although seaweeds have not yet been cultivated in Ireland, there are clear opportunities for developing the aquaculture of native species, especially in view of the increasing imports of seaweed products into Ireland and other EU Member States. The potential economic benefits of algal cultivation are viewed as being considerable, and the following species have been identified as being the most suitable:

- *Alaria spp*: suitable substitute for *Undaria pinnatifida* in the preparation of Wakame products.
- *Porphyra spp.:* intensively cultivated in Japan and other Asian countries for human consumption as Nori.
- *Laminaria saccharina:* good substitute for *L.japonica* (Kombu), the main species cultivated in China (about 3 million tonnes annually).
- *Palmaria palmata* (also known as Dulse): commonly eaten world-wide as a snack food, also has potential in a range of value-added applications.
- *Ulva spp.* and *Enteromorpha spp.:* biofilters and food for macroalgivores.

The potential benefits of shellfish and seaweed cultivation in countering the effects of excessive nutrient inputs (whether from sewage, land-based agriculture or from aquaculture) should be investigated through research on the natural recycling of such wastes.

3.4 . Priorities for EU research policy in the future

In reviewing the document "European Aquaculture Research: current position and prospects" (COM(94) 258 final), the group of Irish aquaculture experts noted that DG XIV identified (on pages 12-13 of the document) eight subject areas as being appropriate for Community support, and two as being more suitable for national support.

Favoured for Community support:

1. Innovative & high risk programmes
2. Disciplines requiring mobility of highly specialised scientists
3. Transnational problems
4. Co-ordination of national research, and sharing of large-scale equipment or facilities
5. Disease
6. Environmental aspects
7. Genetics
8. Socioeconomics

For national support:

1. Rearing techniques for new species
2. Optimisation of husbandry for established species

The meeting expressed the strong and unanimous view that it was not justifiable to recommend, as the DG XIV document does, that the last two items should be mainly addressed at national level. Although rearing techniques for new species will vary between wide geographic areas, their specificity will be at the *regional* level, not the country level. The combined experience of those involved in aquaculture in northern and southern Europe, for example, has a sufficient number of common elements for the scientists, farmers and entrepreneurs to learn from one another in the different regions of the Union. This should be recognised and encouraged, by making the subject eligible for Community support.

Similarly, the optimisation of husbandry for established aquaculture species is an appropriate subject for *Community* support. Attention to improved nutrition, for example, could be expected to have a significant impact on the rate of return on investment capital, thereby reducing or even removing some of the economic constraints facing European aquaculture.

In the opinion of the group of Irish experts, the following nine items are priorities for the future development of European aquaculture. The list is in no particular order of importance; they are presented as the items which should appear as the top nine in any larger listing.

- Aquaculture resource assessment
  - alternative uses of resources
  - new resources (thermal groundwater, for example)
  - new species (including macro-algae and macro-algivores)
- Diseases
- Environmental interactions
- Genetics
- Intermediate culture, wild stock enhancement and ranching
- New engineering technologies
  - biofilters
  - biopurification
  - recirculation
  - submerged structures
- Optimisation of husbandry
  (including nutrition and intermediate culture)
- Product development and quality
  (including non-food products)
- Socioeconomics

3.5 Recommended actions for the Commission Services

Thematic groups should be established to address the above items, together with appropriate networking arrangements. Responsibility for the thematic groups should be spread among the Member States of the European Union.

Noting that the DG XIV document "European Aquaculture Research: current position and prospects" states (Section 5.1, page 15) that ".... in genetics and environmental sciences, research is limited and inadequate", we would point out that both these scientific disciplines are among those which have been given considerable attention in Ireland. We would therefore like to put our facilities at the disposal of the Commission

Services and our colleagues in other European research institutes, by offering to lead any thematic groups, workshops or co-ordinated networking in these subject areas.

4. Main research programmes

The following list attempts to summarise current Irish activities and interests under a number of species/group headings:

4.1 Finfish

4.1.1 Salmon *(Salmo salar)*: This is the largest single sector within the Irish industry, and, clearly, the area of greatest research effort. The activities have been further divided into a number of themes, viz. genetics, health, environment and product quality.

Genetics:

- Mechanisms of gene expression
- Ploidy and hybridisation studies
- Broodstock management and stock enhancement programmes
- Farmed escapees and genetic interaction with wild populations
- General biology of wild populations: sea age and run timing

Health & disease:

- Epidemiology and pathology of Pancreas Disease
- Furunculosis studies and diagnostic techniques
- Biology of sea lice and monitoring programmes
- Elucidation of immune defence mechanisms
- Development of oral vaccines
- Studies on various parasite/disease spp. including *Vibrio*, PKX

Environment:

- Benthic impacts and sediment monitoring
- Development of fallowing strategies
- Cage design and site location

Product quality:

- General quality control
- Monitoring of product quality and compositional analyses
- Routine residue testing

4.1.2 Rainbow trout *(Oncorhynchus mykiss)*: Currently, very little research underway.

- Effluent discharges and loading in freshwater environments
- Study of PKX disease in Rainbow trout culture

4.1.3 Sea trout *(Salmo trutta)*: A number of research projects are ongoing with wild populations.

- Culture for rehabilitation programmes and enhancement
- Broodstock management and genetics
- Kelt reconditioning and nursery diets
- Growth trials of hatchery reared *S.trutta* in the sea

(discontinued because of marketing difficulties)

4.1.4 Other fish species: There is a general desire to expand and diversify the range of species under culture in Ireland, but at present only three native species are being evaluated:

Eel *(Anguilla anguilla)*:

- General biology, ecology and physiology of eel populations, particularly juveniles) to underpin culture initiatives

Arctic char *(Salvelinus alpinus)*:

- Growth trials - continuing studies at a number of centres

Turbot *(Scophthalmus maximus)*:

- Studies on growth and performance at a number of locations
- Development of feeding strategies and improvement of feed formulations
- Minor studies on disease, genetics and flesh quality

Ornamental fish:

- Trial cultivation

4.2 *Molluscs*

4.2.1 Mussels *(Mytilus spp.)*:

- Evaluation of new culture techniques, systems and sites (e.g. offshore/deep water)
- Production strategies and carrying capacity of water bodies
- Product quality (particularly, fouling)
- Genetic studies on *Mytilus edulis* and *M. galloprovincialis*
- Market research and development of value added products

4.2.2. Oysters:

Ostrea edulis:

- Studies on the aetiology, control and management of *Bonamia*
- Intermediate culture

Crassostrea gigas:

- Mass (summer) mortalities in *C.gigas* stocks
- Quality of imports and exotic introductions
- Various studies on pests and parasites e.g. *Polydora, Mytilicola*
- Preliminary investigations on the identification of suitable nursery sites

4.2.3 Clams *(Ruditapes phillipinarum)*:

- Early hatchery trials (gamete production and larval survival)

4.2.4 Scallop *(Pecten maximus)*:

- Evaluation of on-growing techniques and systems
- Hatchery techniques and wild spat collection programmes
- Larval/spat quality and stress testing
- Enhancement strategies
- Predator control

4.2.5 Abalone *(Haliotis tuberculata, H.discus hannai)*:

- General growth trials and culture systems
- Hatchery, nursery, security of seed supply, ongrowing, nutrition techniques

4.2.6 Periwinkles *(Littorina littorea)*:

- Preliminary growth and feeding trials

4.2.7 Sea urchin *(Paracentrotus lividus, Psammechinus miliaris)*:

- Security of seed production, growth trials and culture methods, nutrition and enhancement
- Hatchery techniques, larval rearing and enhancement

4.3 Crustacea

4.3.1 Lobster *(Homarus gammarus)*:

- Basic biology and behaviour of juveniles
- Growth studies and juvenile recruitment
- Enhancement strategies

4.3.2 Freshwater crayfish *(Austropotamobius pallipes)*

- breeding, incubation and ongrowing trials

4.4 Algae (Alaria esculenta, Ulva spp., Graciliaria spp.)

- Evaluation and trials of algal culture techniques
- Spore production for macro-algivore feeding

4.5 General aquaculture

In addition to the specific topics listed above, there are more diffuse actions under a number of general headings. These include:

- Monitoring the occurrence of algal blooms and composition of the plankton community
- Detection of biotoxins in mariculture
- General interactions of aquaculture activities with the environment (e.g. birds, mammals, parasite cycles, aesthetics)
- Phytodepuration
- New engineering technologies including recirculation systems and biofilters
- Development of coastal zone management strategies
- Socio-economic studies
- Legislative and regulatory framework
- Marketing and market surveys
- Training initiatives

Table 1 IRELAND: Aquaculture production, 1980-1994

Year	Mussels (bottom)		Mussels (rope)		Oysters (C.gigas)		Oysters (O.edulis)		Clams		Total molluscs	
	Tonnes	£	Tonnes	£	Tonnes	£	Tonnes	£	Tonnes	£	Tonnes	£
1980	4,557	400,000	175	70,000	60	59,000	422	534,030			5,214	1,063,030
1981	4,658	410,000	200	84,000	58	58,000	400	553,659			5,316	1,105,659
1982	5,282	465,972	300	124,000	49	49,000	861	1,759,063			6,492	2,398,035
1983	5,739	658,722	584	263,000	35	35,000	316	578,624			6,674	1,535,346
1984	12,640	1,350,808	1,077	506,190	110	111,320	398	845,926			14,225	2,814,244
1985	8,722	544,957	1,636	695,300	101	101,000	216	514,085			10,675	1,855,342
1986	9,572	754,000	1,003	427,000	113	177,000	275	760,000			10,963	2,118,000
1987	13,393	1,187,892	1,500	675,237	104	123,250	477	1,326,839			15,474	3,313,218
1988	11,048	1,253,000	1,600	675,000	160	192,000	414	1,115,000			13,222	3,235,000
1989	10,760	1,274,000	2,800	1,000,000	380	400,000	400	1,075,000			14,340	3,749,000
1990	15,000	1,800,000	3,380	1,352,000	361	509,000	420	1,660,000	60	240,000	19,221	5,561,000
1991	11,200	1,351,000	4,100	1,845,000	1,278	1,086,000	366	1,464,000	50	142,000	16,994	5,888,000
1992	8,731	1,430,000	5,091	2,342,000	1,750	2,363,000	334	783,000	79	198,000	15,985	7,116,000
1993	8,884	1,456,976	4,773	2,147,850	2,014	2,517,500	450	1,200,000	84	193,200	16,205	7,515,526
1994	9,260	2,129,000	3,707	1,666,000	1,862	2,234,000	590	1,455,000	110	253,000	15,529	7,737,000

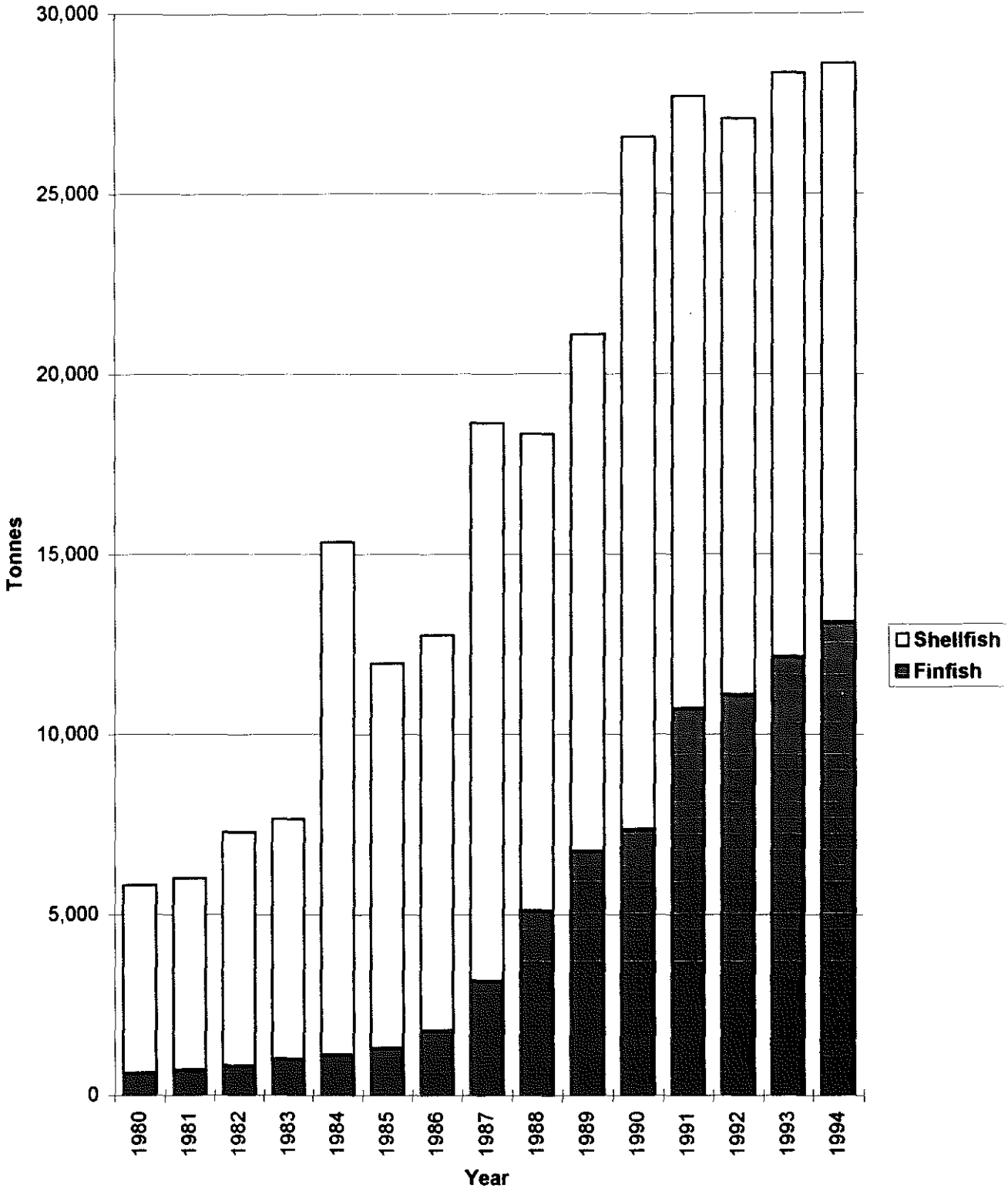
Year	Salmon		Rainbow trout (sea)		Rainbow trout (freshwater)		Turbot		Total finfish		TOTAL (fish + molluscs)	
	Tonnes	£	Tonnes	£	Tonnes	£	Tonnes	£	Tonnes	£	Tonnes	£
1980	21	73,000	160	317,000	420	504,000			601	894,000	5,815	1,957,030
1981	35	122,500	170	340,850	490	735,000			695	1,198,350	6,011	2,304,009
1982	100	350,400	230	461,150	470	705,000			800	1,516,550	7,292	3,914,585
1983	257	1,042,135	248	545,600	483	724,500			988	2,312,235	7,662	3,847,581
1984	385	1,798,720	130	286,000	582	1,024,320			1,097	3,109,040	15,322	5,923,284
1985	700	3,150,000	60	158,700	529	1,058,000			1,289	4,366,700	11,964	6,222,042
1986	1,215	4,540,000	93	240,000	470	930,000			1,778	5,710,000	12,741	7,828,000
1987	2,232	10,122,120	320	691,000	600	1,150,000			3,152	11,963,120	18,626	15,276,338
1988	4,075	19,500,000	400	920,000	630	1,260,000			5,105	21,680,000	18,327	24,915,000
1989	5,800	21,750,000	300	800,000	650	1,300,000			6,750	23,850,000	21,090	27,599,000
1990	6,323	21,056,000	324	891,000	705	1,800,000			7,352	23,747,000	26,573	29,308,000
1991	9,300	30,253,255	560	1,316,000	845	1,859,000			10,705	33,428,255	27,699	39,316,255
1992	9,696	30,407,000	432	1,080,000	965	1,834,000	3		11,096	33,321,000	27,081	40,437,000
1993	10,556	33,141,419	677	1,692,500	906	2,029,440	4	24,000	12,143	36,887,359	28,348	44,402,885
1994	11,616	37,404,000	613	1,533,000	854	1,836,100	3	15,000	13,086	40,788,100	28,615	48,525,100

Turbot 1994 figures are preliminary

£1 (IEP) = 1.2246 ECU

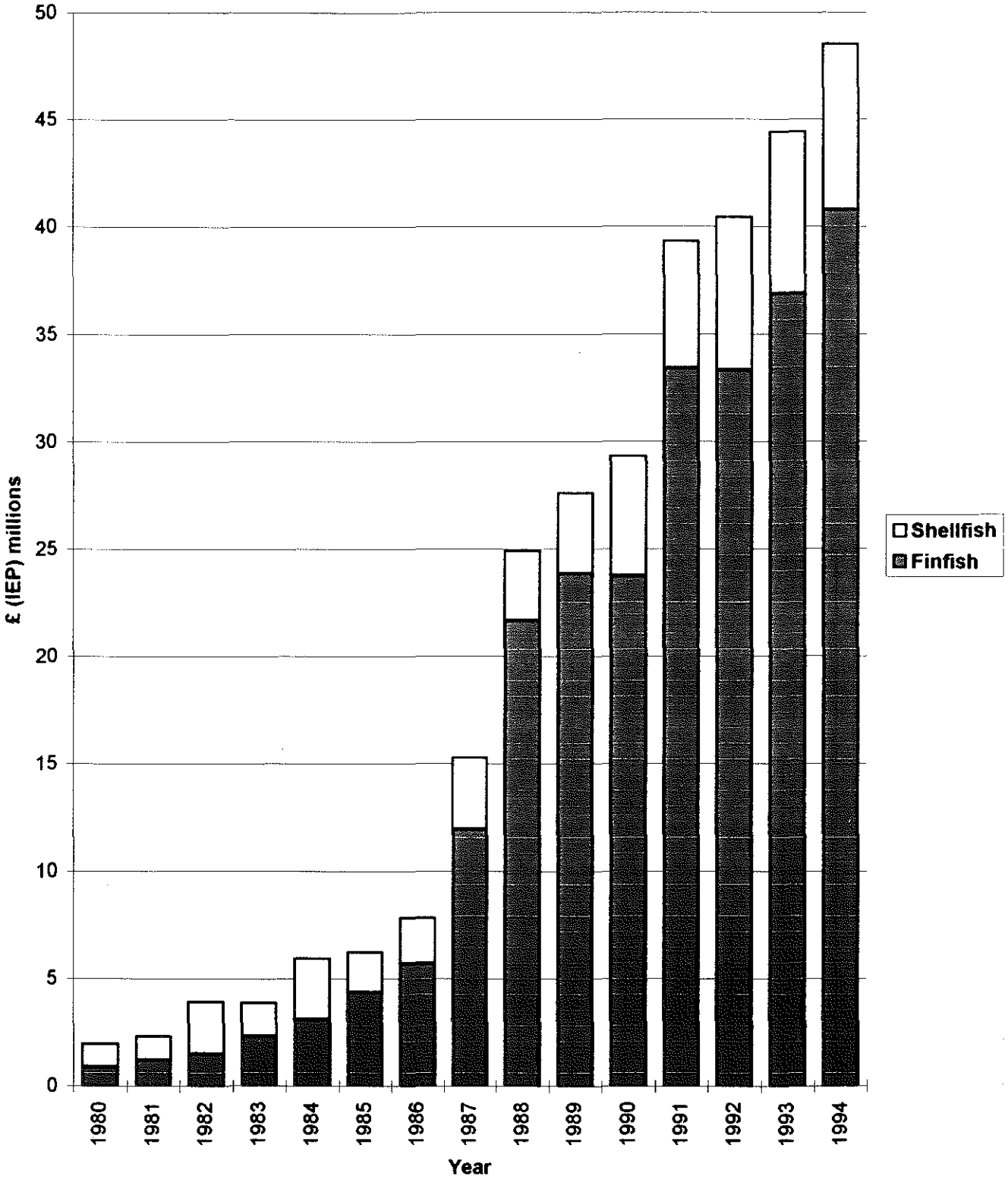
Source: An Bord Iascaigh Mhara

Fig.1 IRELAND: Aquaculture production (tonnes)



Source: An Bord Iascaigh Mhar

Fig.2 IRELAND: Aquaculture production (value)



£1 (IEP) = 1.2246 ECU

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