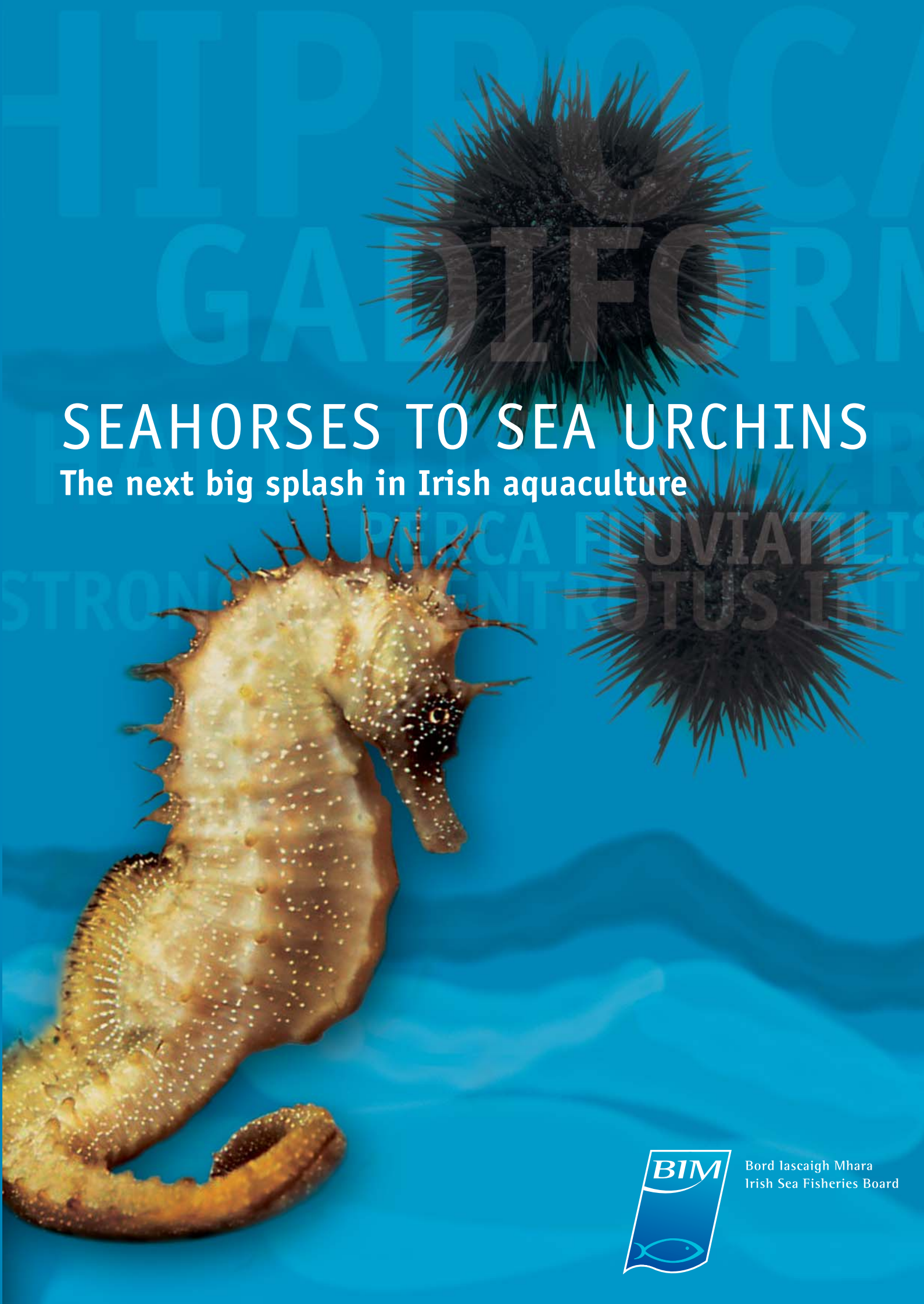
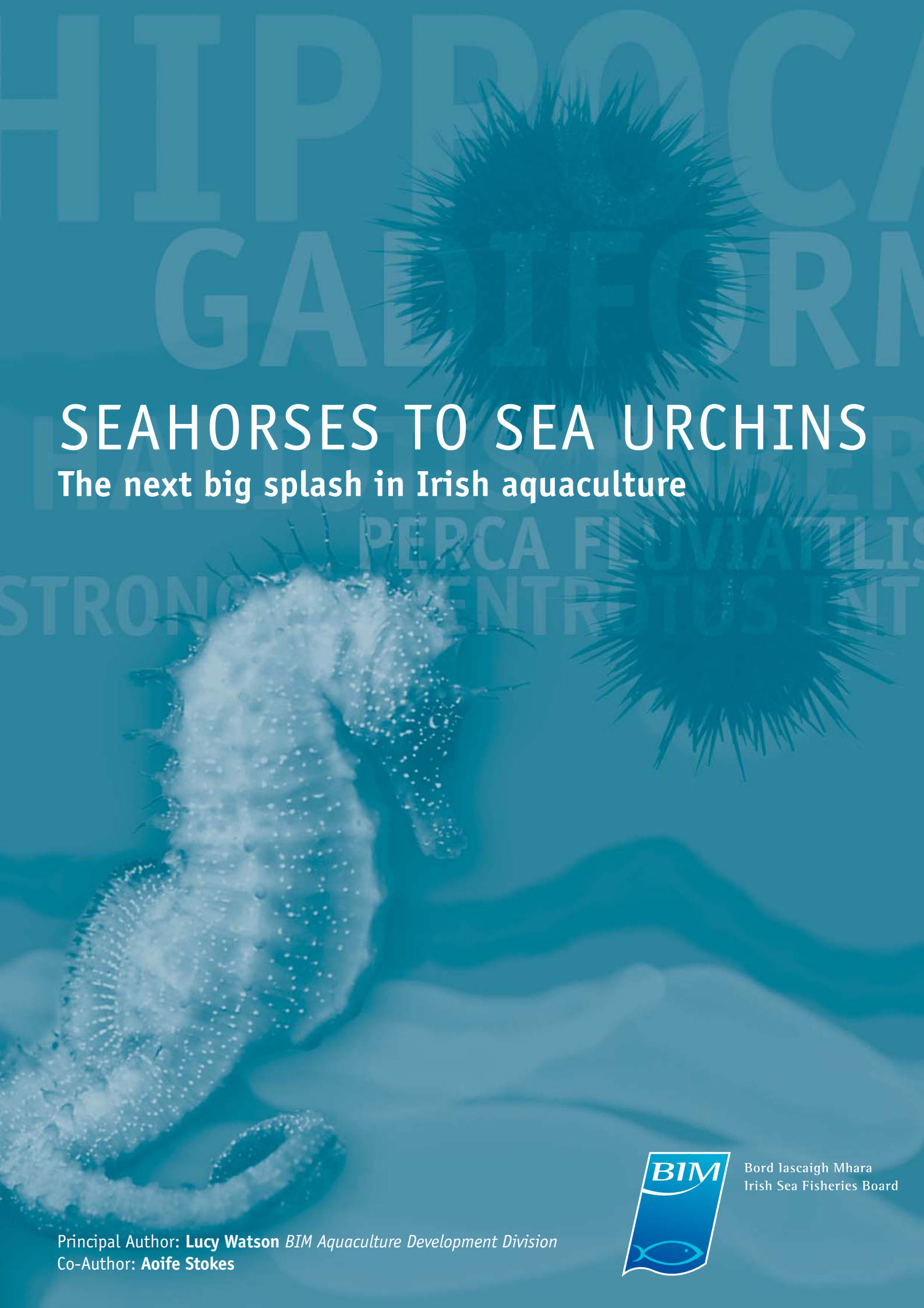


SEAHORSES TO SEA URCHINS

The next big splash in Irish aquaculture

Bord Iascaigh Mhara
Irish Sea Fisheries Board



SEAHORSES TO SEA URCHINS

The next big splash in Irish aquaculture

Principal Author: **Lucy Watson** *BIM Aquaculture Development Division*
Co-Author: **Aoife Stokes**

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Executive summary

Fish farming: the fundamentals

Globally, the average fish consumption per person has almost doubled in less than half a century, despite the fact that the wild supply has declined over the same period. This increase in consumption has been made possible by a dramatic rise in farmed fish production. Moreover, it is widely accepted that sustainably-practiced aquaculture has the potential to alleviate poverty through the provision of steady employment and, over the next three decades, will expand to produce the greater part of the world's seafood supply. Further, fish farming can help to safeguard key marine resources for future generations by alleviating pressure on wild stocks.

For its part, aquaculture in Ireland is playing a key part in wealth and employment generation in otherwise economically-marginalised coastal communities. BIM and Údarás na Gaeltachta in Ireland's Gaeltacht regions have steadfastly supported the sustainable development of this industry, through a uniquely integrated suite of development services. The last decade has seen the Irish aquaculture sector steadily increase in terms of; value and output volume, jobs created, the diversity of sites used and the range of species farmed. The sector has grown in value from €51 million in 1994 to some €117 million in 2002, and now employs more than 2,500 people on a full- and part-time basis.

Today, fish farming in Ireland is entering a new era with new challenges and rewards. As the more established markets in species such as salmon, trout, bottom mussels, rope mussels and oysters show signs of maturing, it is time for Ireland's fish farmers to expand and diversify to meet the ever-increasing consumer demand for fish. In addition to the species already mentioned, the cultivation of King scallops, Manila clams and Arctic charr has been supported by BIM. Comparatively new species to European culture, they are gradually gaining in popularity amongst producers. For various reasons, however, it is not considered likely that any of these fish will be produced in large volumes in the short term in Ireland.

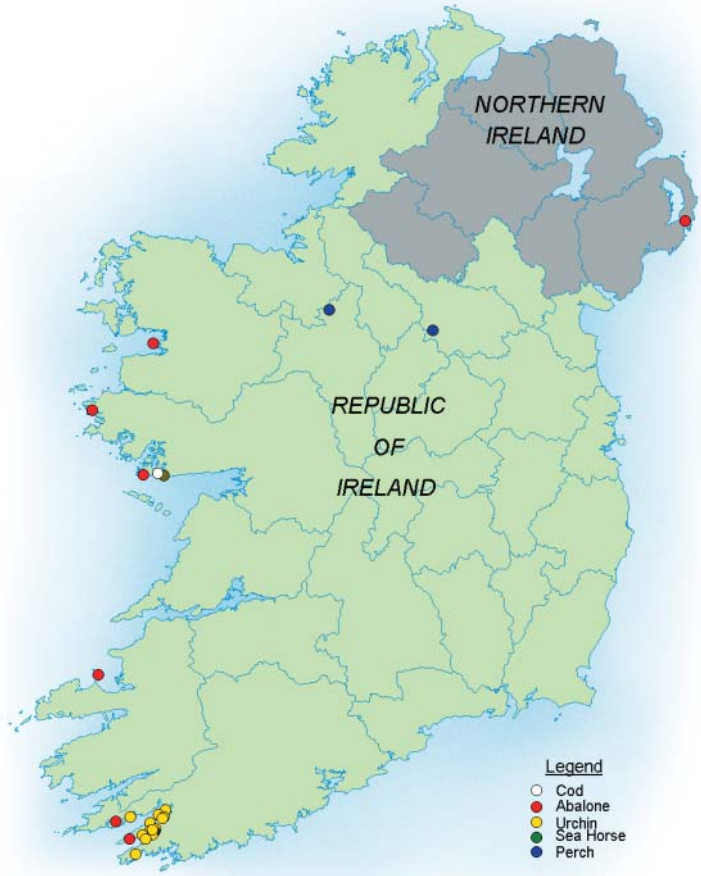
Undoubtedly farmed Atlantic salmon has been the great success story of modern aquaculture with production output rising from nothing in the early 1970s to its current level of 1,500,000 tonnes per annum. To some extent, farmed salmon has become a victim of its own success and it is now seen as something of a commodity product, Clearly the race to diversify is well and truly on.

So what will the next big splash in the ocean be after farmed salmon, and of more direct interest, what species will be the next *big thing* in Irish fish farming? This document will examine the current state of the art and assess the commercial viability of five new species: cod, abalone, urchins, perch and seahorses.

Because of the decline in wild cod stocks and its abiding popularity with the consumer, cod is being heavily touted internationally as the next big thing in fish farming, particularly by the Scots and the Norwegians. We examine whether prioritising cod would be such a wise move for Ireland.

Supporting sustainable aquaculture

BIM has always taken an integrated approach to the development of new species aquaculture, and as a standard proceedure closely examines both the production and market opportunities for any new species being considered. Marketing, technical, environmental and financial support are then made available to prospective or established producers via BIM's unique, vertically-integrated, one stop shop approach to sustainable aquaculture development in Ireland.



In addition aquaculture in Ireland is supported through the Co-ordinated Local Aquaculture Management System (CLAMS) which creates localised development plans for fish farming. This unique and very progressive collective management approach accomodates an individual company's development aspirations within the framework of an overall area development plan and has been designed to harmonise with Integrated Coastal Zone Management (ICZM) and County Development Plans.

Recently the CLAMS process has been enhanced by the addition of the ECOPACT initiative which further assures the environmental sustainability of the sector. It should be stressed as a matter of reassurance to the general public that the development of any further new species in Irish aquaculture would be carried out in this context.

What about turbot and flatfish?

Some might consider that turbot and flatfish should find a place in this document, but it is BIM's contention that these should now be seen as well-understood species of farmed fish. Turbot is currently farmed extensively in France, Spain, Portugal and Chile and significantly the farmed tonnage now exceeds the wild catch. In Europe, official 2002 figures for turbot production are given by the Federation of European Aquaculture Producers (FEAP) at 5,240 tonnes, which consists of some 4,000 tonnes in Spain, 700 tonnes in France and 540 tonnes in Portugal. Other countries such as Ireland, Wales, Belgium, Holland and Germany are also producing turbot but these amounts are not recorded by FEAP. It is likely that the total annual European production of farmed turbot is now approaching some 7,000 tonnes.

Turbot farming is not new to Ireland. Experimental and small-scale turbot ongrowing trials have been carried out over the last decade with assistance from BIM and Údarás na Gaeltachta. There is one commercial farm in the west of Ireland which reported a harvest of 60 tonnes in 2003. Turbot juveniles are readily available on the open European market, and the cost of juveniles has decreased in line with their increasing availability in recent years. Irish ambient temperatures are suitable for turbot ongrowing, except in the winter when colder water temperatures cause a slowdown in growth. Conventional flow through systems can be augmented to ameliorate this growth reduction with the addition of recirculation technology whereby water is heated, cleaned and re-circulated through the tanks.

The market for turbot and other marine finfish species was extensively investigated in 2000 in a joint study undertaken by BIM, the British Marine Finfish Association and the UK Seafish Industry Authority. The document, 'The Market Potential for Marine Finfish Species from British and Irish Aquaculture', found turbot to be one of the most prized and high-value farmed marine species in Europe. Further, the report showed that the market price was increasing at a rate of seven per cent per annum until 1999, and in light of that, good opportunities for entrepreneurial producers of turbot still exist.

Thus this document has not concentrated on farmed flatfish but will look at which *new* farmed fish may be the next big splash in the ocean after farmed salmon in Ireland. Will it be cod, abalone, urchins, perch or seahorses?

Waiting for cod

In 2001 BIM held a conference, Irish Cod – Capture/Culture: The Way Forward, to explore the potential for farming cod in Ireland. The two-day conference incorporated much debate on the topic but to date the jury has remained out on the merits of embarking on the farming of the species in Ireland. This is despite the fact that much has been reported on the potential of cod aquaculture to fill the gap created by falling wild catches. To this end, substantial investment has been made in Norway and to a lesser extent in Scotland to fast-track the farming of this species. The cost of juveniles and reliability of stock performance are still major considerations in the cod farming equation. Given the head start that our competitors already have, our studies indicate that production costs will have to be significantly reduced to make the cod farming sector commercially viable in the longer term, particularly if there is any recovery in the volume of the wild catch.

The potential for perch, seahorses, abalone and urchins

While it is acknowledged that there is still work to be done on the opportunity for cod farming in the major marine fish farming countries, Norway and Scotland, other species have been identified as offering greater potential in Ireland. To this end BIM has been supporting a number of diversification opportunities.

The **perch** market is one that is currently undersupplied and that has demonstrable potential, particularly within Europe. Although there are only two perch farms in Ireland at present, there is a large natural resource of wet and marshy lands which have been exploited commercially for peat extraction and these offer a unique potential for perch farming.

Seahorses have been exploited for years for their medicinal and ornamental properties. Demand for these beautiful and unusual animals far outstrips supply. The majority of sea horses are harvested from the wild to supply these markets and in some areas the threat of extinction is now very real. Seahorses now feature on the Convention on the International Trade in Endangered Species (CITES). The cultivation of seahorses is imperative to sustain the wild population. Ireland is in a unique position in Europe in having a team of experts in seahorse cultivation techniques. This team has established a successful breeding programme at a hatchery in the west of Ireland. The products of this company are primarily aimed at the highly-lucrative aquarium trade.

Abalone and urchins are two of the most prized and highly-priced seafood delicacies worldwide. Wild landings of both species have shown significant reductions since the mid 1990s. Ireland does have some very significant competitive advantages with regard to these two species of seaweed-eating shellfish.

The most recent Fishtech figures for abalone (1999) show that nearly half of the total global abalone production of 19,000 tonnes was farmed in that year. This is compared with 1968 figures

when total global abalone production of 35,000 tonnes came purely from wild fisheries. Similarly, between 1995 and 2001, there was a reported 27 per cent drop in wild urchin landings. This is a more serious development as the world production of urchins essentially comes from the wild. Ireland is in an unrivalled position in Europe in having two species of abalone – the European and Japanese abalone – in culture systems. BIM's market intelligence statistics predict a potential shortfall in abalone supply of up to 5,000 tonnes in 2004.

Ireland is home to Europe's only urchin hatchery. Spawning of our native urchins is achieved using the most up-to-date techniques deduced from fact-finding trips to centres of excellence in Japan and elsewhere. To date several million urchin juveniles have been planted out in intertidal and subtidal rock pools at sites in the south-west. This will replenish the wild urchin fishery. Ireland used to have a very lucrative urchin fishery with a reported 500 tonnes of urchins exported annually in the 1970s. This fishery has all but collapsed due to overfishing and mismanagement and in 2001 just five tonnes of urchins were landed. The urchin hatchery offers a unique opportunity for reinstating the wild fishery and already harvested product is being sold to market.

The study

This study focuses on the technical, economic and market potential for these new finfish and shellfish species which are currently being cultured in Ireland: **perch, seahorses, abalone and urchins**. In addition, this document looks at the current state of cod farming, seen by some as *the* new aquaculture opportunity. A similar approach is followed in the examination of each of the five key species. The study places Ireland's aquaculture production in the global context, and also looks at the state of the wild fishery. It examines the technology to ongrow the species, assesses the economics of culture and, finally, it analyses the available market data.

GADIFORMES

1.0 Cod

Introducing: Cod

Cod is the common name for nearly 60 species of the family Gadidae, order Gadiformes. Other families in the order are also known as cod, such as the deep-sea cod of the family Moridae, but the best-known and most commercially important cod is the Atlantic cod, *Gadus morhua*, of the Gadidae.

The Atlantic cod has three dorsal fins, two anal fins, an unforked tail, and a small barbel on its lower jaw. It is generally moderate in size but can weigh as much as 90 kilograms (200 pounds) and be as long as 1.8 metres (six feet). Greenish-gray to blackish-brown and sometimes red in colour, Atlantic cod has a marbled pattern on its head, back, and sides. It is a voracious predator, eating herring, sand eel, and other shoaling fish.

Chiefly inhabiting cold or temperate northern seas, at depths of 180 to 360 metres (600 to 1,200 feet), cod undertake long migrations. They gather in large numbers during the winter months to spawn, and each female lays four to seven million eggs. Every egg has a droplet of oil so that it floats, and the larval cod become part of the plankton for about 10 weeks. They sink to the bottom when they are about two centimetres (one inch) long, begin to migrate in the second year, and spawn in five years.

Cod are valued both as food and as the source of cod-liver oil. They form the basis of a historically-profitable fishery in the North Atlantic, to which England, France and Portugal began to send boats in the 16th century. Stocks of this popular fish are now in serious decline as a result of years of overexploitation, and conservation measures are being taken to protect cod into the future. The global catch of cod at its height, in 1969, totalled some four million tonnes. This level of wild capture was unsustainable. Even if wild stocks do recover it is thought unlikely that they will ever achieve these types of figures again for a variety of reasons including environmental degradation and loss of breeding grounds.

Cod farming is the latest aquaculture phenomenon, and it may be that there is potential for farmed cod and managed wild fisheries to operate together to supply the market. Farmed cod have the potential to ease the pressure on wild catch and reduce the risk of further over-fishing.

Table 1.1 Atlantic cod landings (tonnes)

	1996	1997	1998	1999	2000
World catch	1,340,774	1,367,977	1,207,978	1,094,062	734,028
EU catch	318,684	292,599	260,771	214,661	179,234
UK catch	78,362	74,636	77,182	51,695	41,750
Irish catch	7,259	5,702	5,290	3,846	2,923

Cod stocks in Ireland and the EU

In Ireland, there has been a recovery programme in place for cod in the Irish Sea since 2000. In 1999 the Irish Sea cod stock was deemed to be at serious risk of collapse, and as a result the European Commission, with the assistance of industry members, put forward the first emergency recovery measures for cod in European waters – The Irish Sea Recovery Programme. These measures include a closure every year from February to April and net modifications, which allow the release of juvenile cod from the nets. The programme is agreed on an annual basis.

With the reform of the Common Fisheries Policy in 2003, it was decided that it was necessary to put in place more recovery programmes for fish stocks considered to be close to collapse or outside of safe biological limits. Unlike the Irish Sea Recovery Programme, they will be taken within the framework of a long-term strategy that aims to rebuild stocks to sustainable levels. The estimated time frame for achieving the recovery objectives is five to ten years.

In May 2003, the European Commission proposed the establishment of a long-term recovery plan for Cod stocks in European waters including those in the Irish Sea. These measures involve low catch quotas, limits on fishing effort and specific control and monitoring rules to ensure their implementation. At present the Commission is negotiating these with Member States and it is hoped that an effective and practical programme, which takes into account progress in the Irish Sea Recovery Programme, will be put in place early in 2004.

To farm or not to farm

The Norwegian Institute of Marine Science recently reported that the cod farming industry has a window of five to 10 years until wild stocks have recovered, however Norwegian cod farming plans are currently accelerating towards a target of at least 100,000 tonnes of farmed cod by 2010 (Kontali 2002), with a reported 400,000 tonnes by 2015 if expected juvenile production is realised. The Norwegian wild cod quota for 2002 is some 200,000 tonnes. If wild stocks do recover it is surely a question of economics: the cost of fishing for cod versus the cost of farming cod. The arrival on the cod market of generic substitutes, such as hoki, should also be considered.

The proposed cod farming model is completely at variance with the farmed Atlantic salmon model where the peak wild catch of just 12,000 tonnes per annum has been completely surpassed by production of nearly one million tonnes of farmed salmon worldwide. Also unlike farmed salmon, which was launched into the luxury market and yielded high returns to the early investors, cod is a staple fish, well known to the fish-eating public, which has never commanded a similar price premium. This is the first time that we have started with a cheap aquaculture product in the developed world (€2-2.50 per kilogram, compared with salmon: €10 per kilogram, seabass, gilthead bream: €14-16 per kilogram, turbot and halibut: €25+ per kilogram). Looking at the salmon model, salmon farmers have been able to maintain a margin with volume increases by improving production efficiencies, although prices have dropped very significantly with increased availability.

Cod farmers may find it more difficult to keep production costs down initially as juvenile production is still a technical bottleneck (problems include early survival, physiology, nutrition and aggression) and is costly. However, one must assume that these problems will be overcome with increasing knowledge and economies of scale. Comparing cod to salmon faming, it is reasonable to expect all other factors to be broadly similar. For instance feed costs and Feed Conversion Ratio also known as FCR (food for cod is slightly cheaper than salmon food but FCR is slightly higher), similar survival rates, cost of vaccinations and manpower per unit output will tend to converge the cost of growing cod to that of salmon.

Speaking at the BIM Whitefish Capture/ Culture Conference in 2001, Richard Slaski of the British Marine Finfish Association (BMFA) said that cod production costs can match salmon production costs. However, comparative production models of salmon and cod farming demonstrate that on a gross margin basis (assuming 1,000 tonne production and a cod price of £1.58 per kilogram) there is still a better margin in producing salmon only, rather than salmon and cod or cod only. Running a sensitivity analysis on the core model demonstrated that at a juvenile price of £0.70 for 50 gram

fish and a sales price of £1.90 per kilogram ex-farm, the gross margin was slightly better for cod. So the prospect of growing cod in cages at similar market values to salmon looks reasonably good.

A study by KPMG Norway in 2001 shows that between 1993 and 1998, production costs for salmon were cut by 25 per cent to 16.58 Norwegian Krone (NOK) per kilogram. The comparative cost of production for cod is estimated at 21.46 NOK per kilogram, with the cost of juveniles, manpower and finance contributing to the higher cost. KPMG advise that significant time will be needed before cod farmers achieve the same type of reduction in production costs. Cod farmers will have to achieve this 25 per cent cost reduction in order to compete with other more profitable species.

The Norwegians are concentrating on volume production with 25 hatcheries set to come on stream with a total volume capacity of 85 million juveniles. Some 50 million of those will come from the Cod Culture Norway (CCN) hatchery, in which Nutreco is the major shareholder. Of the 17 facilities which produced juveniles in 2002, CCN is one of the biggest.

Already 280 cod farming licences have been issued in Norway and the Norwegians have the UK market in their sights. That market is the largest in Europe totalling 170,000 tonnes annually, with over 100,000 tonnes being imported.

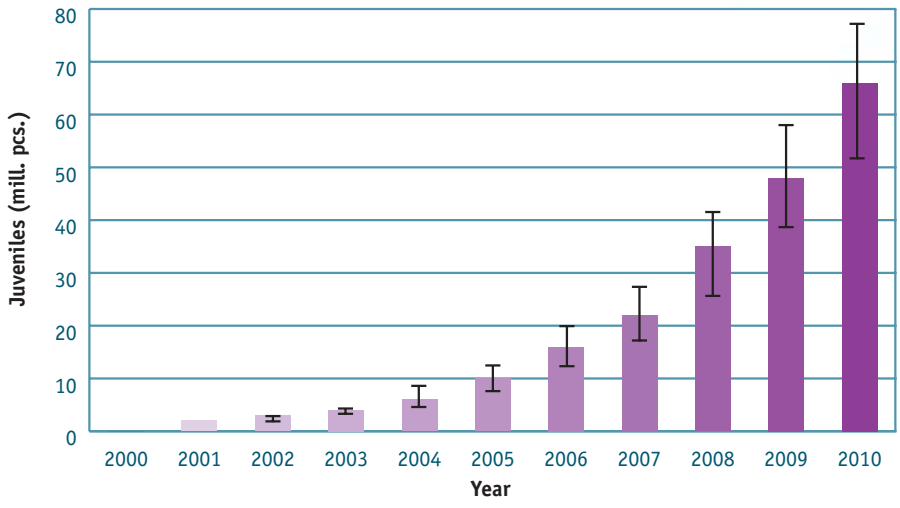
Ireland's cod project

A Marine Institute funded project is currently underway at the NUI Galway marine station in Carna, Co Galway. The project, entitled Investigations into hatchery rearing of cod *(Gadus morhua)* in Irish conditions, aims to establish an experimental hatchery to rear cod to 5 grams.

Norwegian ambition

From initial figures of some 600,000 juveniles in 2000, Kontali estimates juvenile cod production in Norway will increase to between seven and 13 million in 2005 and 52 to 78 million in 2010.

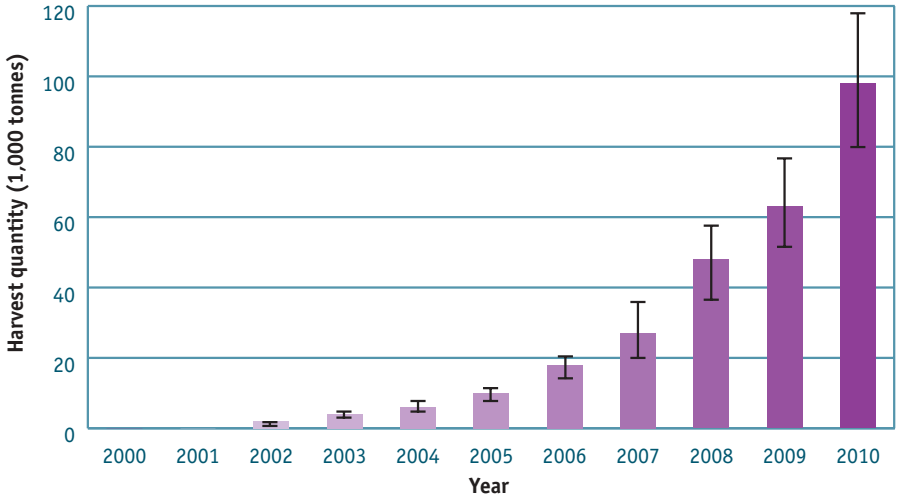
Figure 1.1 Juvenile cod production in Norway (2000-2010)



Kontali 2002

In line with this, Kontali estimate grow-out production to increase from 200 tonnes in 2000 to between five and 10 thousand tonnes in 2005, and to between 77,000 and 118,000 tonnes in 2010.

Figure 1.2 Ongrowing cod production in Norway (2000-2010)



Kontali 2002

By combining the graphs in a matrix Kontali demonstrates the time lag between juvenile output and marketable fish.

Figure 1.3

Year	Juveniles (mill.)	Ongrowing production - 1,000 tonnes harvest quantity								
		2002	2003	2004	2005	2006	2007	2008	2009	2010
2000	0.6	2								
2001	1		3							
2002	2			5						
2003	3				8					
2004	6					16				
2005	10						27			
2006	16							46		
2007	22								64	
2008	33									98
2009	48									
2010	65									

Kontali 2002

Scottish caution

The Scottish are taking a more cautious approach to the farming of cod. British Marine Finfish Association figures target production of 25,000 tonnes of cod, 5,000 tonnes of haddock and 10,000 tonnes of halibut per annum by 2010, with a total first sale value of £100 million. To make this a reality requires the production of 15 million cod, two million haddock and three million halibut juveniles. A new hatchery in Shetland is set to take on some of these production targets. In addition 70 marine-finfish cage sites, 10 land-based sites, three halibut hatcheries and nine cod and haddock hatcheries will be needed.

Norwegian predictions of viable farming costs, as low as £1.40 per kilogram ex farm, are setting a target for the Scottish who will have to achieve a similar figure in large-scale production.

Economics

A driving factor of major concern in the economics of farming cod is the yield from cod which, at 44 to 45 per cent for fillet, skin on, is substantially less than the 60 per cent yield from salmon. This did not matter when wild caught cod was common and cheap but it certainly matters now. This reduction of 15 per cent for fillet or useable flesh represents a significant cost in the market place. Assuming a similar production cost and percentage margin, cod fillet is considerably more expensive than salmon.

Early indications are that farmed cod give a slightly better fillet yield (five per cent) compared to wild cod. While cod was once a staple at the height of its historical catch curve, stock collapses coupled with the inevitable costs of culture (which will show cost reductions paralleled by salmon) and its fillet yield, are likely to push cod products into a smaller market place, (the Scottish plan is to niche market to top-end restaurants) or, as a worst case, could render its mass appeal or mass culture a non-viable objective. Opportunities may therefore present for farming similar fish using the same technologies but with a better fillet yield.

To this end, the Chileans are investigating the farming of hake and are reporting good results so far. Gustavo Parada, Aquaculture and Fisheries Industries Manager at Fundacion Chile, predicts that hake could become as important a product for Chile as salmon. Austral hake *(merluza; Merluccis australis)* broadly matches the characteristics of a cod generic, however the fillet yield is thought to be considerably higher. Hake farming is only being progressed by Chile, and considerably less investment is being made in hake: only US$1.5 million compared to US$200 million spent by Europe on cod thus far. Nonetheless the Chileans have a production target of 500,000 tonnes by 2015 – 2020.

The market

The Association des Industries du Poisson de l'UE (AIPCE) Whitefish study 2003 documents the sourcing of the major white fish species used within the EU fish processing sector. It reports that cod continues to be the major fish species in demand, accounting for almost 38 per cent of major white fish species. Some 87 per cent of cod had to be imported in 2002, and this is expected to rise over the coming years until the cod recovery plan benefits can be seen. The document looks at EU published statistics of EU fish quotas and landings plus imports and exports of all fish and seafood species for human consumption. It concentrates, however, on the seven most important white fish species which are cod (87 per cent imported), alaska-pollack (100 per cent imported), hake (95 per cent imported), saithe (87 per cent imported), haddock (62 per cent imported), hoki (100 per cent imported) and redfish. The estimated outcome for 2003 is a further decline of 4.2 per cent in the domestic catch and an increase of 10 per cent in third country imports which will rise to 63 per cent of the total community supply. While it may be beyond the scope of the AIPCE study it is still worth noting that no mention is made of the likelihood of farmed cod coming into the European marketplace, and in particular filling the gap between supply and demand, thereby reducing the dependence on third country imports.

The cod market is characterised by a decline in the catch of wild fish and a rise in prices with a simultaneous increase in the production of farmed whitefish such as seabass, bream, catfish and tilapia. The EU is the largest market for Norwegian cod products, and will become the most significant for farmed cod. With volume production, the Norwegian farming sector will have to be prepared to lower its prices in line with wild catch. Higher prices may be obtained providing there is volume, stable delivery, focused marketing, product development and quality assurance.

The rush to support the falling catches of cod with farmed production is without doubt of major concern to fishermen. Only recently Danish fishermen have voiced their concerns saying that the quantities projected over the next 10 years will put pressure on prices and create disturbance in the market. They say that Norway will have to accept an agreement for farmed cod that is modelled on the EU-Norway Salmon Agreement, with a minimum import price (MIP) and regulation of quantity.

Richard Slaski of the BMFA suggests a modest market for species such as cod on the basis of cost, hence the BMFA's cautious approach. Slaski predicts that if costs can be reduced further (eg feed and juveniles) then cod and haddock will move into the consumer price range of salmon today and only then can it compete in a volume market.

Exports of farmed cod from Norway to date have been low, totalling some 258 tonnes in 2002 with a total export value of NOK 9.4 million. The largest importers of farmed cod were France (129 tonnes), Denmark (82 tonnes) and Belgium (37 tonnes). Statistics from the Norwegian Seafood Export Council (NSEC) reveal an average price for exported farmed cod of 36.51 NOK per kilogram, compared with 46.30 NOK per kilogram in 2001.

A successful three-year demonstration project carried out by Sea Fish Aquaculture at Ardtoe was completed in 2000, resulting in the first 10 tonnes of UK farmed cod going on sale in Marks and Spencer. A further 35 tonnes of ongrown cod from the project was then sold over the following months.

Market size

Although larger fish are expected to have a relatively higher market value, growth beyond two to three kilograms is limited by the high incidence of maturation in the 1+ year class. This is a biological consideration at production level that needs to be resolved. Market size for farmed cod is in the region of two to four kilograms, like that of wild cod. Currently this is taking some 20 to 22 months in culture, however this needs to be reduced to a maximum of 18 months. Andrew Mallison of Marks & Spencer warns that flesh quality must not be compromised in pushing for faster growth rates. Customer perception is increasingly important. Given the decline in wild stocks and the resulting media attention, he believes that labelling farmed cod as farmed may act as a positive selling point. Sustainable methods of supplementing wild supplies are regarded positively by the environmentally-aware, fish-eating public.

Quality

The quality of farmed cod will be significantly influenced by variations in feed composition and maintenance. Pelleted diets for cod need to have much lower lipid contents than salmon diets. This is because cod store lipid in their livers, which can account for up to 15 per cent of the total body weight in farmed fish. Cod tend to accumulate water-soluble protein in the meat which escapes on cooking to give a hard, dry texture. It is thought that this may, to some extent, be feed-related, but stress is also considered a factor. This again represents a reduction in flesh yields. Although cod liver oil is a valuable bi-product, the quality of oil will need to be carefully assessed. The feed companies have already started addressing this problem and commercially-viable diets are now available for cod, with lipid contents of 11 to13 per cent. On a positive note, it is reported that farmed cod will be fresher to the market than wild cod which has had to be transported from fishing grounds. Farmed cod will also have a longer shelf life than its wild counterpart, an important quality criteria.

Farmed cod and the market

The largest cod fishing nations are Iceland, Norway and Russia. Norwegian farmed cod will compete with both wild-caught cod and other wild-caught and farmed whitefish species on the European market. This is a market where prices, to a large extent, are influenced by quota restrictions and resultant supply of wild-caught fish.

Predicting a market price for farmed cod is somewhat uncertain. The Norwegian investment group SND is itself unsure as to which market price can be used as a basis for financing. In relation to SND, reduced fund allocation to the group has represented a setback to the Norwegian cod farming initiative.

The price of farmed cod will not only be affected by the production volume, but also by the status of the wild fishery. In fact, it is also complicated by the interaction of other competitor species, such as hoki, which the market has grown accustomed to in order to fill the vacuum created by declining wild cod catches. One school of thought is that, in the short term, small volumes of farmed cod reaching the market can be marketed as a high-quality or high-value product, but as production volume increases and as the wild fishery may recover, hatcheries and ongrowers will need to achieve greater efficiencies to remain viable in the long term. Cod will be competing with both wild fish and farmed whitefish such as sea bass, seabream, catfish and tilapia. As production increases, the fish will be going increasingly onto a price-sensitive market.

Norway will undoubtedly have the advantage of well-established cod processing and marketing infrastructure, but it remains to be seen what price the market will bear for the farmed product. Supplying the market when the market demands, for instance when wild fish are in short supply in the winter months and during closed seasons, should secure good prices without destabilising the market in the short term. In this regard the aquaculture industry will need to co-operate with the fisheries industry.

Because wild cod has a longer biological cycle than farmed species, there is a resultant price cycle. This will result in long periods above or below the production price of farmed cod, before the price changes direction again.

The 'Kontali Analyse 2002' report agrees that farmed cod will not steer price developments but will be dependent on the natural long term price cycles of the cod market – both in a positive and negative way. It may face long periods of good prices, as well as long periods where prices are below production cost. It is essential that farmers work toward lowering production costs so that the industry can survive such price fluctuations.

UK fishermen have been assured that the cod farming industry there is not going to compete with them, but rather will complement commercial fishing. Farmed cod will reduce Icelandic and Norwegian imports into the UK. The first target for the farming industry is to substitute the 9,000 tonnes of high quality, fresh cod fillets that are imported into the UK from Iceland every year. These Icelandic fillets are sold by Waitrose who have stated that Scottish farm-reared cod is £1 per kilogram more expensive than air-freighted Icelandic cod (£9.29 per kilogram). Waitrose is waiting for the first Scottish farmed cod to come on line but stress that it must be of the same quality as the Icelandic fillets they currently sell. They see little scope for a "premium" cod line. Cod constitutes 9.5 per cent of all Waitrose's wet/chilled fish sales while 10 per cent of Tesco's fish counter sales are cod, with fresh fillets selling at £6.59 per kilogram.

UK retailers stress that unless farmed cod production prices reduce to a level that competes with wild caught fish imported frozen into the UK, farmed cod will not be able to compete on the mass market and farmed product will be confined to small quantities, destined for niche markets. The BMFA is market-led, aiming to supply the top eight per cent of the current cod market. Carrefour in France intends to treat farmed cod in the same way as farmed salmon, but say they want 1.5 kilogram cod for 400 gram fillets.

The industry will need to be prepared to start steering price developments as volume tonnage comes on stream. Efforts to increase fillet yield and to improve FCR and survival must be increased in line with greater marketing effort to secure the future of farmed cod.

In particular, it is envisaged that as production technologies improve, increased harvest weight will be achieved in a shorter time frame. Initial achieved weights of up to three kilograms in 24 months are predicted to increase to average Norwegian harvest weight of 3.5 kilograms by 2010.

The UK objective is to produce mainly fish in the 2 – 3.5 kilogram size range, with some at size 3.5 – 5.5 kilogram with only the smallest at size 1 – 1.5 kilograms. It is reasonable to assume that Norway is aiming for a similar size breakdown, and given plans to produce juveniles year round, harvest of fish will ultimately be year round.

European cod markets

Table 1.2 Cod supply (tonnes) per European auction per quarter since 2001

Source PEFA

Auction	01/01	04/01	07/01	10/01	Total tonnes 2001	01/02	04/02	07/02	10/02	Total tonnes 2002	01/03
Zb	369	210	447	392	**1,418**	447	333	473	637	**1,890**	190
Sl	149	73	29	74	**325**	124	49	61	146	**380**	107
Lw	48	49	5	26	**128**	15	16	4	10	**45**	29
Ag	31	33	84	82	**230**	15	19	7	4	**45**	14
Mf	10	18	14	24	**66**	20	9	-	-	**29**	-
Tf	7	4	2	3	**16**	24	17	4	2	**47**	17
Sc	-	-	115	548	**663**	307	172	104	517	**1,100**	135
Th	-	-	82	1,166	**1,248**	1,159	895	657	581	**3,292**	807
Cp	-	-	2	36	**38**	14	12	11	202	**239**	21
Lc	-	-	-	-	**-**	4	-	-	-	**4**	-
Ch	-	-	-	-	**-**	-	2	8	6	**16**	4
Fa	-	-	-	-	**-**	-	-	-	-	**-**	4
Total tonnes	**614**	**387**	**780**	**2,351**	**4,132**	**2,129**	**1,524**	**1,329**	**2,105**	**7,087**	**1,328**

Table 1.3 Cod prices (€/T) per European auction per quarter since 2001

Source PEFA

Auction	01/01	04/01	07/01	10/01	Average price/ tonne 2001	01/02	04/02	07/02	10/02	Average price/ tonne 2002	01/03
Zb	2,530	2,573	2,722	2,731	**2,653**	2,367	2,479	2,586	2,281	**2,413**	2,572
Sl	2,850	2,898	3,301	2,836	**2,898**	2,989	2,921	2,466	2,165	**2,580**	2,455
Lw	3,226	3,699	3,462	3,750	**3,523**	3,642	4,014	2,712	2,951	**3,538**	2,388
Ag	2,350	2,501	3,067	2,804	**2,795**	2,971	1,946	2,401	3,245	**2,119**	1,874
Mf	2,730	3,058	2,468	2,317	**2,613**	1,716	2,205	-	-	**1,868**	-
Tf	1,462	1,527	1,713	1,990	**1,609**	1,633	1,820	1,839	1,328	**1,705**	1,319
Sc	-	-	2,600	2,507	**2,523**	3,050	3,085	3,690	2,420	**2,815**	3,024
Th	-	-	3,287	2,686	**2,725**	2,430	2,987	3,894	3,113	**2,994**	2,359
Cp	-	-	3,134	2,800	**2,817**	2,971	2,995	2,710	2,250	**2,327**	2,830
Lc	-	-	-	-	**-**	3,571	-	-	-	**3,571**	-
Ch	-	-	-	-	**-**	-	1,886	2,247	2,318	**2,181**	2,047
Fa	-	-	-	-	**-**	-	-	-	-	**-**	1,701
Average price/tonne	**2,639**	**2,784**	**2,814**	**2,668**	**2,705**	**2,531**	**2,861**	**3,305**	**2,537**	**2,750**	**2,450**

Key

Zb	Zeebrugge	**Sl**	Stellendamn	**Lw**	Lowestoft	**Ag**	Halster
Mf	Milford	**Tf**	Troon	**Pe**	Pefa	**Sc**	Scheveningen
Th	Thyboren	**Cp**	Colignsplaat	**Ch**	Cuxhaven	**Fa**	Fiskeauktion

Figure 1.4 European cod auctions 2001-2003: tonnage landed by quarter and port

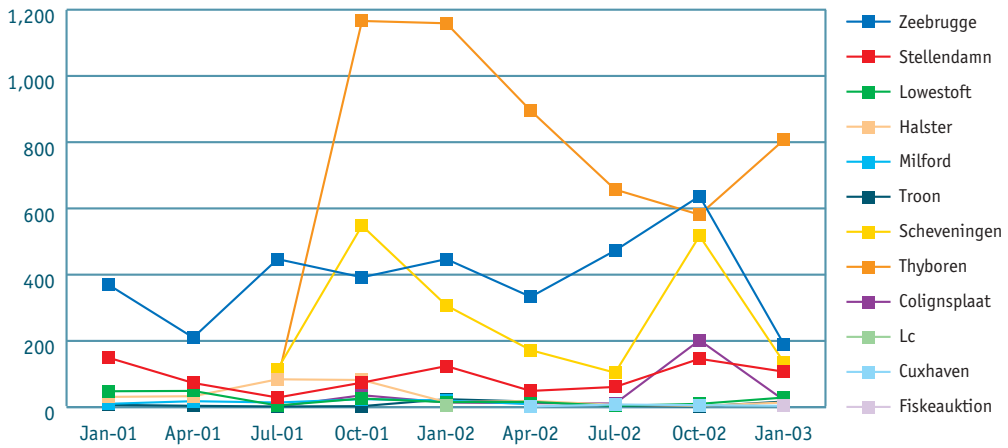


Figure 1.5 European cod auctions 2001-2003: average value, (euro per tonne) by quarter and port

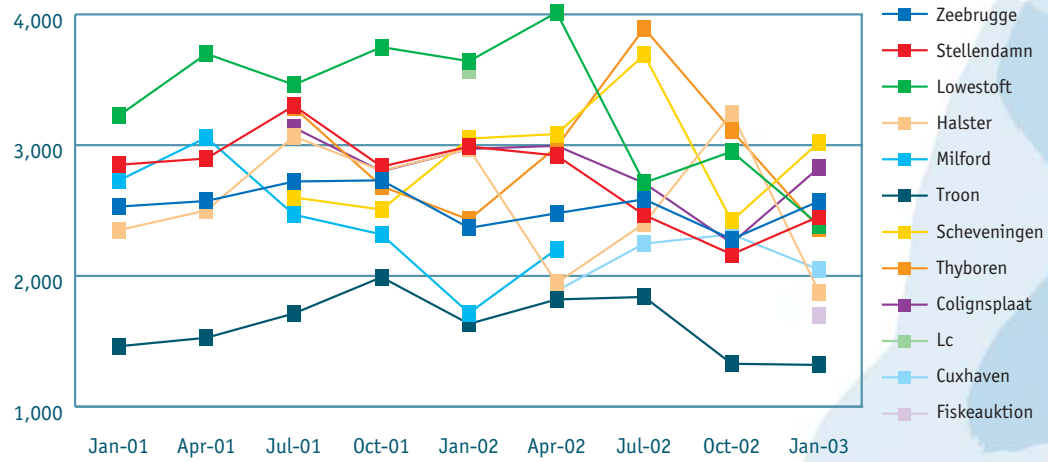
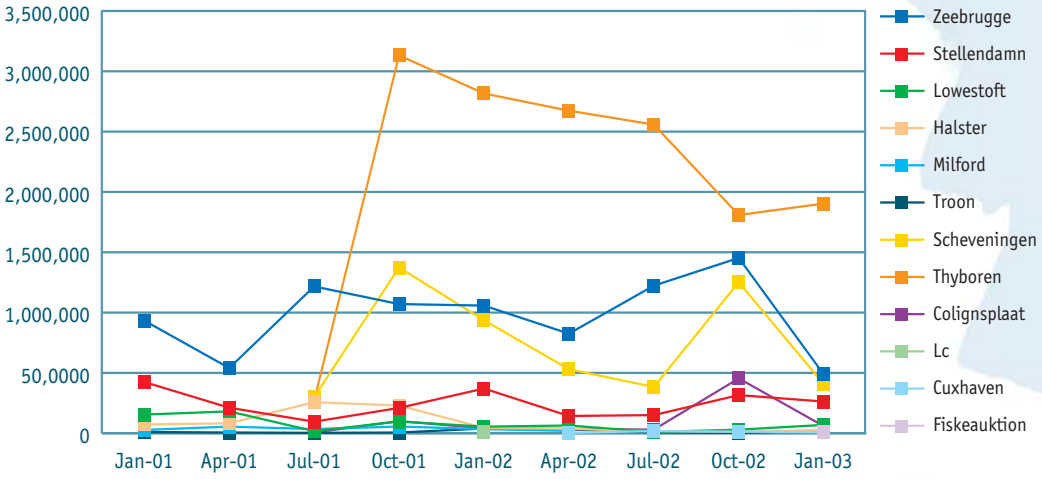


Figure 1.6 European cod auctions 2001-2003: total value of cod landings (euro), by quarter and port



From tables 1.2 and 1.3 and figures 1.4, 1.5 and 1.6, it is apparent that the dominant ports are Thyboren, Zeebrugge and Scheveningen. The tonnage landed appears to vary seasonally but not consistently within ports or between ports. Equally price does not vary consistently with season, nor, in fact, does it vary with tonnage, however price is more consistent within a port than between ports. The maximum variation within port is roughly two-fold. The maximum variation between ports is greater than three-fold. In value terms, the ports with increased tonnage also dominate in total value. Both in tonnage landed by quarter and in total value, the majority of the eight ports, other than Zeebrugge, Schevingen, Thyboren and Stellendamn, are insignificant in relative value. For example for the October quarter of 2001, the landings in Thyboren were worth over €3 million whereas in eight other ports, landings were less than €100,000 or there were no landings at all.

In summary in all cases tonnages are inconsistent year on year and quarter by quarter. Price is more consistent by port than landings. It is reasonable to expect that farmed cod available on regular basis would find value.

Conclusion

Two opposing directions are being taken by the major players – the Scottish and Norwegians – on cod farming. The Norwegians are going for volume production and are rolling out a very ambitious ten-year programme. The Scottish, on the other hand, are taking a more cautions approach on the basis that the returns will not be there for volume production and the only way to make a margin is to niche market a differenciated cod product.

Undoubtedly farmed cod from Norway is going to come onto the market in increasing quantities, but what volume this will constitute is unclear. The biggest problem facing Norway is achieving the same cost efficiencies as the pioneering salmon farmers have early enough to have a margin on cod. Salmon farmers took five years to cut the cost of production by 25 per cent. Cod farmers will have to fast track the learning curve, overcome juvenile production availability problems and others, including early maturation, in order to achieve the target volumes predicted and not go out of business in the meantime. Should it take five years to achieve these same efficiencies, in order to make cod viable, it may prove too long, particularly if cod stocks show recovery.

Norwegian volume production may, without a marketing plan, get lost on the volume market (it may in fact have restrictive pricing applied to it) and as such will be a price taker. In the event that the NSEC comes up with and executes an effective well-funded marketing plan that places the product in the marketplace as a price maker, then one can assume that it may well impact the market whether in processed form, which farmed cod lends itself well to, and/or as “fresh farmed cod from pure Norwegian waters”. Creating and selling the marketing plan without achieving the production could, however, be problematic, and the two programmes will need careful orchestration.

PERCA FLUVIATILIS

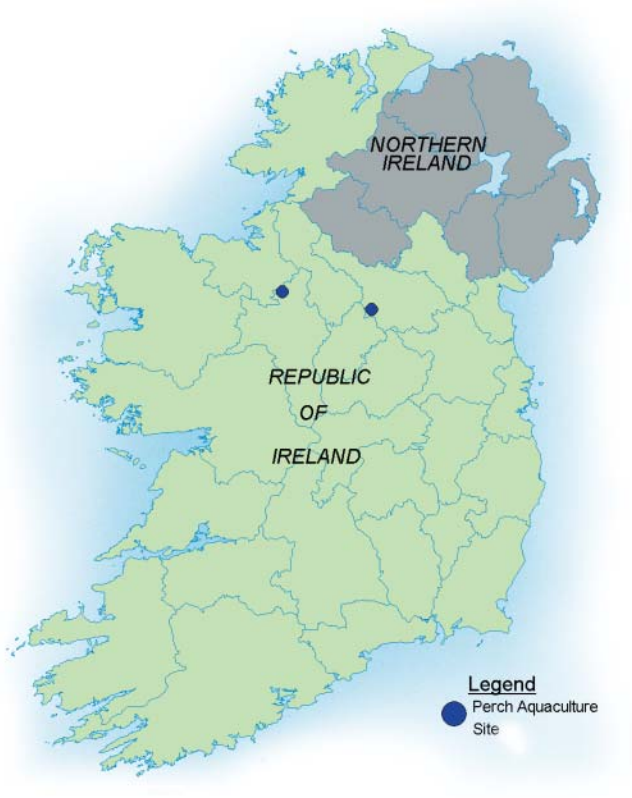
2.0 Perch

Introducing: Perch

The European perch *Perca fluviatilis* is a common freshwater fish found throughout Ireland, Great Britain and the Baltic countries of northern Europe including brackish water habitats in the Baltic Sea. The species has been introduced to Asia and is found across Russia as far as eastern Siberia. It has also been introduced to southern European countries as well as Australia, New Zealand and South Africa. A very adaptable species, it has prospered and bred in many varying habitats far from its original range. It is closely related to the American yellow perch *P. flavescens*.

Ireland and perch

A coolwater species, their preferred temperature range lies between 4 –24˚C with an optimum of 21˚C, higher than the Irish seasonal maximum (17.5˚C). Growth in Irish conditions is quite satisfactory. Historically in Ireland perch have, at times, been seen as a pest species given their negative impact on salmonid fisheries. To this end many perch were often netted and discarded to improve local fisheries. The perch, however, is particularly adaptable and thus the long term effect on populations is negligible. Some areas of the country, particularly Lough Neagh and the Galway lakes, have traditionally been fished commercially for perch which was sold on to dealers in continental Europe. Again this practice, with the exception of Lough Neagh, has largely died out and commercial netting of perch in Ireland is scarce or non-existent, with no new licences being issued.



Perch generally live in lakes and slow moving rivers. They can tolerate mild to moderate pollution but as with most fish prefer clearer waters. In the wild, each spawning female is attended by shoals of males who immediately fertilise the eggs. Subsequent fertilisation rates would appear to be far higher than with other species. Eggs are produced in a characteristic ribbon of material which is, in fact, a cylinder of fabric wherein each egg is attached to six others in a polygonal pattern. In the wild these ribbons can be seen in April/May draped on submerged branches and leaves. The average female produces up to 120,000 eggs. The period of incubation before hatch is dependent on temperature with eggs taking 18 days at 12˚C. Newly-hatched larvae absorb their yolk sac within days and very quickly begin to feed on rotifers and other small zooplankton present in the water column. Perch is a small fish but can reach sizes in the range 35-50 centimetres and weigh up to 4.75 kilograms. The meat is white with a small flake, delicate texture and mild flavour. They are an extremely predatory fish and although naturally shoaling display cannibalistic tendencies at an early age. Perch's natural diet includes other fish such as roach, sticklebacks and minnows. It is this predatory nature that has historically marked them out as a threat to salmonid fisheries.

Worldwide fisheries production

There is no commercial fishery for perch in the Republic of Ireland and only a small number of licences remain in existence for the Shannon. These were issued during the electrification scheme and are rarely used today. The policy of the Central Fisheries Board is that commercial fishing will not be allowed and no further licences will be issued.

According to FAO estimates, perch production in Europe (including Belarus, Ukraine and Kazakhstan) amounted to 23,200 tonnes in 1999. This figure represents a decline of almost five per cent on 1998, and a decline of just over five per cent on the 1995 level. The FAO data given in Table 2.1, which also includes landings of sea or brackish water perch, underlines the importance of production in Eastern European countries. These countries, and in particular Estonia, Poland and the Russian Federation, are now the leading suppliers of perch to European markets. Although Finland is by far the largest perch producer in Europe, Finnish product plays a relatively minor role in European markets. Excluding Finnish production leaves a balance of between 8,000 and 10,000 tonnes of perch landings a year.

Table 2.1 Perch landings 1994 – 1999 (tonnes)

	1994	1995	1996	1997	1998	1999
Finland (sea)	3670	3848	5013	5226	5251	5224
Finland (inland)	13043	13028	12634	12634	9470	9470
Russian Federation	1976	2234	2628	3527	4459	3455
Poland (sea)	744	728	568	1405	1009	938
Poland (inland)	120	224	601	179	163	186
Estonia (sea)	551	384	396	315	237	296
Estonia (inland)	672	623	634	887	815	680
Germany (sea)	672	733	549	567	607	499
Germany (inland)	215	215	215	215	215	215
Switzerland	396	373	475	364	422	491
Kazakhstan	728	736	670	480	350	400
Sweden (sea)	145	127	94	108	120	130
Sweden (inland)	211	216	173	278	251	171
Ireland	-	-	-	-	200	200
Netherlands	136	219	376	336	155	177
Denmark (sea)	72	63	42	67	65	78
Denmark (inland)	32	27	21	16	35	41
Lithuania	115	114	83	114	104	116
Bulgaria	-	-	-	63	81	102
Latvia (sea)	34	37	34	27	21	53
Latvia (inland)	20	27	22	29	34	34
Ukraine	288	319	126	80	107	79
Romania	-	39	38	8	40	60
Belarus	98	93	101	75	45	40
Czech Republic	38	31	33	34	36	37
Belgium	25	25	25	25	25	15
Slovakia	30	32	18	12	13	13
Slovenia	2	2	1	1	1	< 0.5
Norway	-	-	-	9	3	-
Czech Republic	-	-	-	-	-	-
Moldova Republic	-	-	-	-	-	-
TOTAL	**24,033**	**24,497**	**25,570**	**27,081**	**24,334**	**23,200**
TOTAL (excluding Finland)	**7,320**	**7,621**	**7,923**	**9,221**	**9,613**	**8,506**
TOTAL (excluding Finland & Russian Fed.)	**5,344**	**5,387**	**5,295**	**5,694**	**5,154**	**5,051**

FAO

Figure 2.1 Total perch production: Finland, sea and inland fisheries, 1994-1999

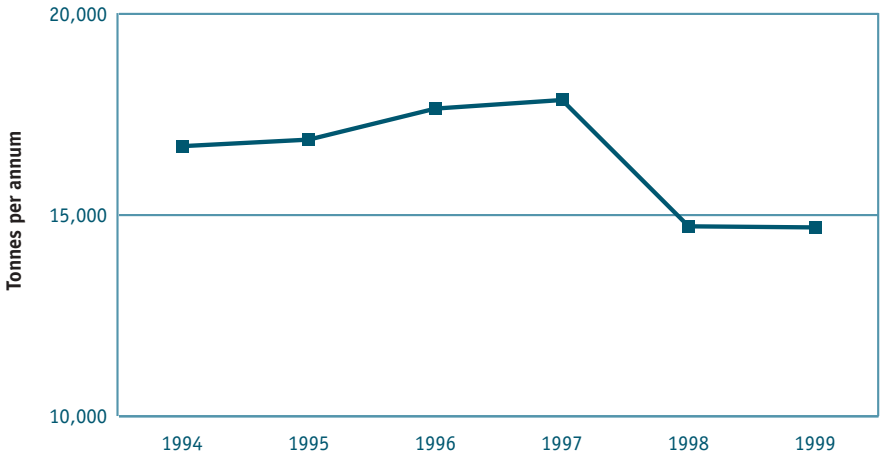


Figure 2.2 Total perch production: major fisheries excluding Finland, sea and inland fisheries where applicable, 1994-1999

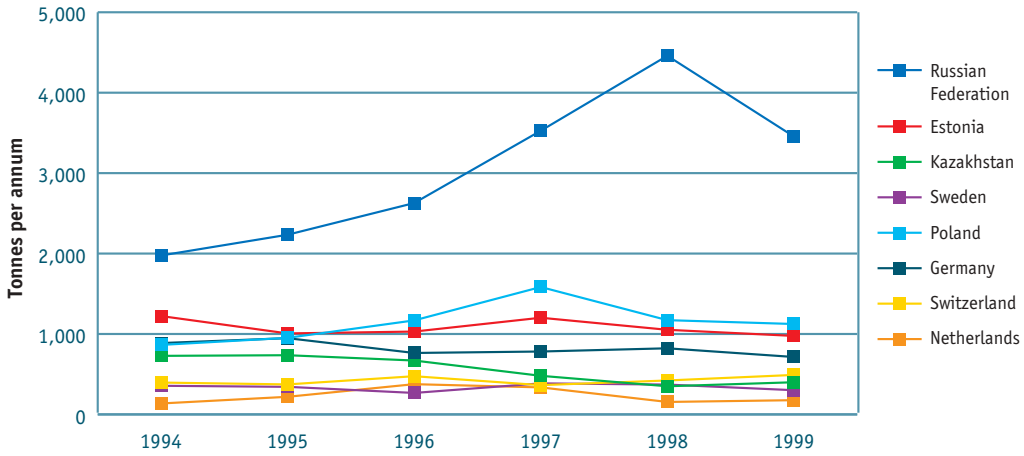
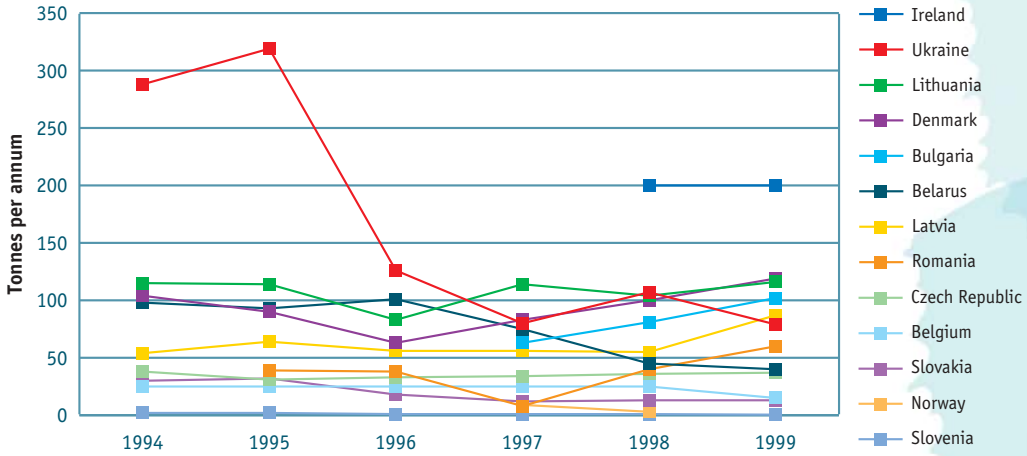


Figure 2.3 Total perch production: minor fisheries; sea and inland fisheries where applicable (Denmark); 1994-1999



Lough Neagh

There is a long tradition of perch exports from Lough Neagh to Switzerland. Northern Ireland perch is positioned in terms of taste and consistency at the top end of the range, just under perch from Lake Geneva. According to Swiss statistics, the country imported 99 tonnes of chilled freshwater fillets and 75 tonnes of frozen fillets from Great Britain in 2000. For the same year imports of fresh and frozen freshwater fish fillets from Ireland amounted to 78 and 38 tonnes respectively. It is difficult to know what percentage of these figures relate to Lough Neagh perch. Swiss importers suggest that sales of perch from Lough Neagh to Switzerland have declined significantly in recent years due to supply availability and also as a result of price competition from Estonian perch.

The technology to farm perch

Perch aquaculture was identified as having potential in Ireland in a BIM review of the options for non-salmonid aquaculture carried out in 1995 and subsequently in BIM's 'Aquaculture Explained manual – Cultivating Perch' (1997). It has taken until now for the full potential of this species to become apparent and for commercial rearing of perch in Ireland to begin in earnest. The recent establishment of Ireland's first commercial hatchery and farm, together with numerous other planned perch projects, is the result of intensive preparation and research by BIM and the cross-border Aquaculture Initiative (AI).

Perch aquaculture has been suggested as a diversification for Ireland's agricultural sector. In particular, the potential of the species in marginalised rural areas is in line with EU and Irish stated policy for social and economic development. Perch farming has the potential to be a low-cost, high-value sector of Ireland's aquaculture and agriculture sectors offering real opportunities for rural communities to fully harness local natural resources.

Perch aquaculture has been confined to the Czech Republic, Poland and Hungary with recent interest in Switzerland, Belgium and France. Production in eastern European countries has tended to be extensive with perch grown in large pond systems alongside other fish including carp, catfish and pike. This extensive method of cultivation means that production is variable from year to year. The perch are not fed artificial diets but feeding is supplemented with grain. These perch are generally sold to local markets. Perch farming in Switzerland, Belgium and France is more recent and in later years has tended to focus on cultivation in recirculation systems. Belgium, which has a history of pond cultivation, has done much of the pioneering work on perch production.

Aquaculture perch production in Europe was recorded by FAO at 148 tonnes in 1999, a reduction of 10 per cent on the previous year. As Table 2.2 indicates, production in certain eastern European countries has developed at a low rate in recent years. Although there are no figures provided for Switzerland, it is evident from trade contacts in the country that some limited production exists. As will be seen in relation to marketing, Switzerland is the most important market in Europe for perch.

Table 2.2 European farmed perch production 1995-1999 (tonnes)

	1995	1996	1997	1998	1999
France	-	251	251	101	101
Czech Republic	15	15	27	17	21
Russian Federation	-	-	-	23	19
Romania	-	-	7	21	4
Macedonia	-	-	2	2	2
Ukraine	-	-	-	-	1
Total	**15**	**266**	**287**	**164**	**148**

FAO

Further abroad, a close relative of our native perch, the North American Yellow perch *(Percas flavescens)*, is grown commercially in the northern states of America. Perch farming here is to supplement the decline in catches from the Great Lakes and has largely concentrated on pond cultivation.

Ongrowing units

Farming of perch can take place in intensive reared systems (recirculation units) or in more extensive pond-based systems. Preliminary data from Irish trials suggests that while both methods may be feasible each entails an entirely different approach. Perch farming in Ireland is currently undertaken on a pond-based farm in Co. Cavan which was set up with BIM support. The farm, which was built from a green field site, is situated beside a stream tributary of the Erne river from which the farm sources its water. The ponds are earthen construction lined with grey clay to prevent leakage. Pond size varies from 400 metres^3 to 1,200 metres^3 with a total pond volume of 9,000 metres^3. Water is pumped from the stream into the ponds from where it flows by gravity down through the pond system before entering a reedbed system, which cleans the water before it enters the polishing pond. Thereafter, the clean water is pumped by windmill back into the pond system. The total water usage on site is less than five per cent per week. This simple pond system has the capacity to rear 10 tonnes of market-size perch per annum. A small hatchery on site provides the juvenile perch, which are stocked on to the farm in April. The juvenile perch feed naturally on zooplankton in the ponds. Growth is rapid and by week five the perch are placed on an artificial diet. The system is designed around the natural ecosystem and makes full use of local plant life to encourage food in the ponds for the juvenile perch.

The production cycle

Perch farmers often allow spawning to occur naturally, collecting ribbons from open waters or from spawning ponds where broodstock are held. Farmers will also leave ribbons in the ponds to allow hatching to occur naturally, however a far higher hatch rate is achieved by hatching in controlled conditions such as spawning troughs. Farmers may further achieve a higher spawning rate by induced spawning. Induced spawning of European perch has been carried out in Ireland with varied success rates. The Czech Republic has pioneered methods of induced spawning using various hormonal treatments. Whilst the use of hormonal treatments in perch brings a higher level of controlled spawning, the resultant survival of larvae is varied. It is, however, a useful tool for the commercial farmer to allow predictable production.

Generally the sperm from one male is sufficient to fertilise the ribbons from up to three females. Fertilisation rates are generally high. It is important that any broodstock brought into tanks are acclimatised to temperature first to reduce stress. Similarly fertilised ribbons should be kept at constant temperature. In Ireland, fertilised eggs are placed in troughs supported on wire racks and incubated at 16˚C. Perch fry hatch after 20 degree days (14 days @ 16˚C).

Hatching

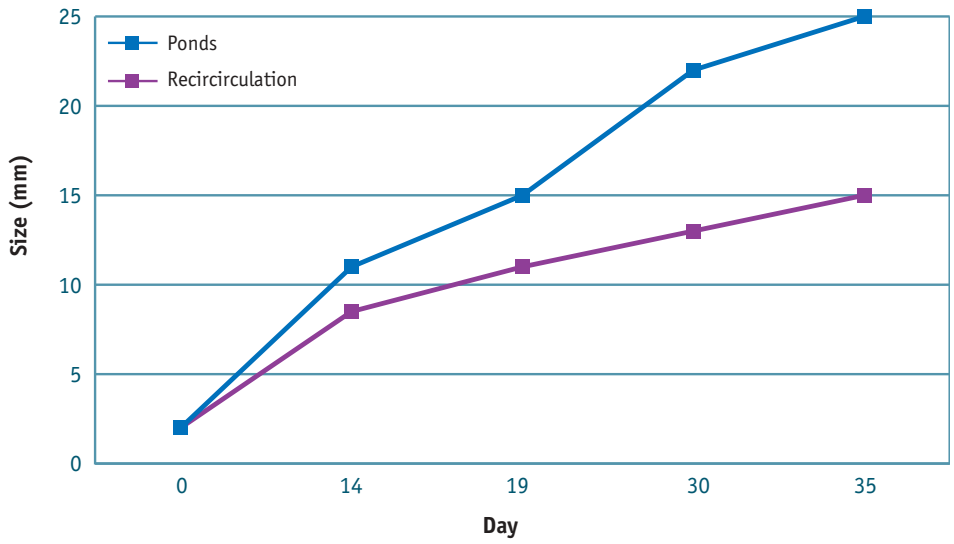
The larvae eyes turn a distinctive gold colour prior to hatching, and vigorous shaking of ribbons can help achieve greater than a 90 per cent hatch. The majority of eggs in a ribbon hatch over a three-day period and are allowed swim in the troughs for a number of days before feeding.

Feeding

Feeding of juvenile perch can be extremely difficult and labour intensive. The mouthparts of newly hatched perch are unable to handle large zooplankton and therefore a food supply of rotifers must be initially provided. Two methods of feeding juvenile perch have been tried in Ireland: natural pond production and intensive feeding in a recirculation unit. Newly hatched larvae can be released into ponds with controlled populations of natural rotifers, or rotifers and artemia can be produced in the hatchery for feeding. The production of rotifers and artemia in hatcheries, whilst achievable, requires a lot of patience and time. Results are variable with an average 20 per cent slower growth rate than larvae released into bloomed ponds. This discrepancy is largely due to the wide range of food availability in ponds. Whilst resultant survival rates in ponds may be lower, the overall health of the fry is far superior to that achieved thus far on cohorts kept indoors and fed artificially.

Larvae released into ponds are harvested when the average size is greater than 17 millimetres. At this size the perch fry are fully-formed and are capable of being trained on to artificial pellet diets.

Figure 2.4 Growth of perch in ponds and recirculation at a farm in Cavan



Perch are trained on to diets in tanks over a period of two weeks before being re-released into ponds. Whilst it is possible to feed train juveniles in ponds, practically it is more difficult given the abundance of natural food available.

Growth

The European perch grows at a faster rate than its American counterpart and initial results indicate that a harvest size of 100 gram weight can be achieved in ponds in 12 months. A natural phenomenon is that female perch tend to grow faster than their male counterparts and thus efforts are being made to have all female stocks available for aquaculture purposes. Perch are reared in ponds or tanks on pellet diets similar to salmon and trout feed but with a lower protein and fat content. The diet is a floating feed so that the farmer can accurately assess the fish performance. Generally water is replaced at a rate of five per cent per week, with a close check kept on oxygen rates. Aeration may be necessary in ponds during the summer months if dissolved oxygen falls to low levels (<5 milligrams/litre). Perch are fed up to 10 per cent of body weight per day.

The economics of perch farming

Table 2.5 indicates an estimated ex-farm gate price of between €3 and 4/kilogram, based on a) current market prices and, b) fillet yield and processing cost assumptions. A 30 per cent yield figure will bring the bottom end of the range below the €3/kg level. The end figures achieved obviously depend on a range of factors including product quality.

Table 2.5 Estimated FOB price range for Irish perch (€/kg)

Current fresh fillet import prices (Switzerland)	11.50 - 13.50
less transport costs	0.60 – 0.60
FOB estimate	10.90 – 12.90
Whole fish price equivalent based on a 35% Yield	3.81 - 5.51
less filleting/processing costs	0.60 – 0.60
FOB estimate for whole perch	3.21 - 3.91

The market for perch

A BIM/Aquaculture Initiative-commissioned market report for perch was carried out in January 2002. A number of points were made:

- The European market for perch is essentially a fillet market, whether in chilled or frozen form. Markets for whole fish, including perch fry, exist but these are marginal in comparison.
- Compared to other fish species, perch markets are poorly documented. The following estimates of market size are therefore very approximate.

Table 2.3 Estimated market size for perch fillets (tonnes)

Switzerland	ca. 2,000
Germany	< 1,000
France	500 – 1000
Austria	< 250

Markets are currently stable due to supply constraints. The Swiss market, however, has the capacity to expand to over 3,000 tonnes. The German market could also absorb increased volumes providing a) increased supplies are regular and, b) prices are competitive with freshwater fillet imports from Eastern Europe.

The main trade flows in perch fillets are from Eastern European countries (notably Estonia, Poland and the Russian Federation) to Switzerland and Germany and, to a much lesser extent, to France and Austria. There is also a flow from Scandinavia to Switzerland and Germany, but passing via the Netherlands (probably for filleting and repackaging), and to a small extent via France. The East/West flow is likely to continue and, according to trade comments in Germany, to intensify over time. It is possible that supplies from Russia will increase, a development which could have implications for future price levels. Trade from North America has been reversed in recent years, with a market now in the U.S. for European perch.

Production specifications and prices vary both between markets and within markets. The main requirements are summarised in Table 2.4.

Table 2.4 Summary of product specifications and import prices by country/region

Country/Region	Main specification	Approximate buying price (per kilo)
Switzerland, French-speaking	fillets: 10-20g, skin-on 20-30g, skin-off	fresh €12 + frozen €9-10 +
Switzerland, German-speaking	fillets: 20-40g, skin off/on	
Germany, Alpine region	fillets: 40-60g	€8-11
Germany, other regions	fillets: 60-100g	
France, eastern region	fry: 3-5g whole fish: 200-400g	€4.50-5
Austria, Alpine region	20-40g, skin on	

Market dynamics and future potential

In general, the main substitute products for perch are other freshwater species, notably pike perch. The degree of substitution is weaker in Switzerland, where the small size of perch fillets and the almost national character of the species make it more difficult to replace. In Germany, substitution with other freshwater species is more pronounced, which means that the perch market there is more vulnerable to the strong competition from supplies of East European pike perch.

With one or two exceptions, importers in the four countries surveyed by BIM were open to the market potential for farmed Irish perch. The perch market is essentially a fillet market, and it is felt that any differences between farmed and wild fillets will not be obvious in the marketplace.

Conclusion

The market for perch in the Alpine regions of Europe is currently under supplied. In particular, market intelligence suggests that the Swiss market has the capacity to take another 1,000 tonnes of perch. This represents a terrific opportunity for Ireland's developing perch farming sector with the first commercial harvest of farmed perch set to come on stream in 2004. Ireland is well placed to become a significant player in supplying this market and must capitalise on the large areas of available suitable land that can be put to use for pond aquaculture.

SYNGNATHIDAE

3.0 Seahorses

Introducing: Seahorses

Seahorses are teleosts (bony fish), complete with gills, fins and a swim bladder. Some of the early natural historians classified them wrongly as insects or shellfish. Seahorses belong to the family Syngnathidae (from the Greek words “syn” meaning together or fused and “gnathus” meaning jaws). This family also includes pipefish, pipehorses and seadragons. Seahorses belong to the Genus Hippocampus, of which there are at least 35 species. The word Hippocampus translates directly from Greek meaning horse and monster.

The Seahorse is a fish which is in great demand worldwide for use in the making of Traditional Chinese Medicine (TCM), for the aquarium market and for sale as curios. Despite this great demand, very little is known about the behaviour, ecology and population of seahorses and today these fish are in serious decline as a result of overexploitation and habitat degradation. Seahorse populations have experienced between 50-70 per cent declines in different areas worldwide. They now feature on the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) although some countries, namely Indonesia, Japan, Norway and South Korea, have withdrawn from the international trade rules for seahorses as set out by CITES.

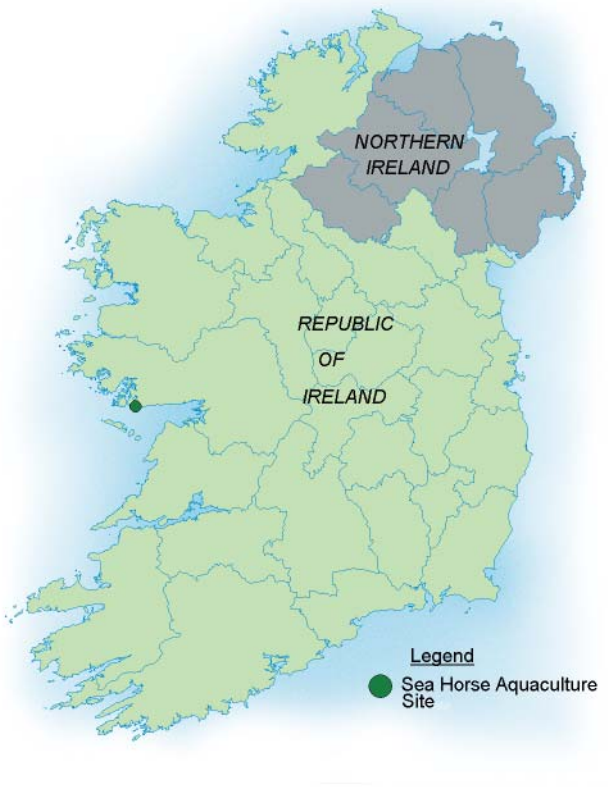
Today, demand far outstrips supply, and with the majority of seahorses being harvested from the wild to supply the above-mentioned markets, the threat of extinction for these unique and fascinating creatures is very real. The cultivation of seahorses is imperative to sustain the wild population.

Seahorse populations in the wild

Seahorses are particularly susceptible to over-exploitation because of their behaviour and ecology. Their low mobility and smaller home ranges make them particularly vulnerable to fishermen taking them either by diving or through trawling. Faithful pair bonds mean that social structure is easily disrupted through the loss of a mate with consequent reduced reproduction. Lengthy parental care combined with small brood sizes limit reproductive rates. Also, should a pregnant male be removed, it also means that his brood is removed with him. Typically seahorses live in coastal areas which regularly receive human disturbance through dredging, degrading and destruction of the seahorses seagrass, mangrove, coral and estuarine habitats. International conservation priorities are the maintenance of coastal zone habitats, developing community-based seahorse fisheries management plans and aquaculture.

Table 3.1 Change in the demand and supply of seahorses (Vincent, 1996)

	Change in Demand	Change in no. caught	Change in no. wild seahorses	Decline in sample seahorse populations	Change in size/quality	Change in no. seahorses per kg
Net exporters						
India	+	-	-	Palk Bay 1992-1995: <75%	-	250 (1993) 500 (1995)
Indonesia	+	-	-	Bali & E. Java 1990-1994:<50% 1993-1994:<30%	-	
Philippines	+	-	-	Bohol 1985-1994: 70% 1990-1994: 54% 1993-1994: 40%	-	250 (1993) 450 (1995)
Thailand	+	-	-	Chon Buri 1993-1995: 50%	-	
Vietnam	+	-	-	Cua Be 1991-1995: 80%	-	
Net importers						
China	+	-			-	
Hong Kong	+	-			-	
Taiwan	+	-			-	



Ireland and seahorses

Seahorses are found in all seas around the world except the cold temperate seas of the Arctic and Antarctic. They are commonly found in shallow, coastal tropical and temperate water habitats such as estuaries, coral reefs and coastal sea grasses. Two of these species, although not plentiful, are indigenous to the coast of Ireland: *Hippocampus guttulatus* formerly called *Hippocampus ramulosus*, (the many-branched seahorse) and *Hippocampus hippocampus* (the short-snouted seahorse). Both these species are classified as endangered.

The technology to farm seahorses

Some seven years ago, research began into the possibility of cultivating seahorses in Ireland. This culminated in the setting up of a small-scale unit in Carna, Co Galway in 2001 with assistance from Udárás na Gaeltachta and the Marine Institute. More recently, in 2003, BIM was instrumental in supporting the development of live feed production systems for the seahorse unit.

The company itself has had a very successful year being outright winners of the Coca Cola National Enterprise Awards 2003, and also winning in the Most Innovative category of the Livewire 2003 Young Business Start Up Awards

Ongrowing unit

This unique custom-built Irish production unit has the potential to produce some 200,000 fish per annum. However, the company intend operating at 75 per cent capacity in order to maintain a healthy, stress-free culture environment. With the help of grant aid from BIM, the farm has installed the latest equipment in hatchery technology, which allows complete control over live feed production, a critical part of successful seahorse ongrowing.

The seahorse growth cycle is broken into a number of separate stages and each stage has an independent re-circulation system. This is an effective tool in the management of the health and husbandry of the animals. All seahorse broodstock entering the production unit are isolated for eight weeks. During this period, the seahorses undergo bacterial analysis to ensure that no harmful bacteria enter the system. Samples of new seahorses are also sent away for detailed laboratory analysis. Health and husbandry protocols are strict and under the control of leading fish veterinarians. They visit the facility on a bi-monthly basis to ensure health standards are maintained.

All the culture systems are linked to an alarm system which monitors power, water temperature, depth, flow and oxygen. This is connected to a 24-hour phone system.

Water quality analysis is undertaken on a daily basis to ensure the seahorses are kept in the optimum culture environment. In the event of breeding stock mortalities, the Company has secured international permits to replace any losses.

Food

Sourcing a viable and sustainable food source to rear seahorses has long posed a problem to those involved in cultivation around the world. All seahorse aquaculture ventures rely on intensive live food production of organisms such as brine shrimp. This adds considerable expense to a culture operation in terms of material cost, space and labour commitment. Some 90 per cent of the world's supply of brine shrimp comes from the lakes in Utah, USA, however excessive harvesting and adverse climatic conditions such as El Niño and global warming have resulted in the decimation of the wild brine shrimp stocks causing a 500 per cent price rise over the last two years.

Brine shrimp (Artemia) are also nutritionally inadequate as a food for seahorses and it is now realised that that this food source is not a viable option for the commercial cultivation of seahorses.

The Irish work over the past years has concentrated on methods to overcome these problems by means of innovative tank design, hygiene and the type and quantity of food, which all have a significant bearing on survival. They have developed a protocol to successfully cultivate seahorses with foods containing the correct amount and proportion of nutrients, namely copepods which are also naturally-occurring microscopic animals living in the sea.

Reproduction

In seahorse couples, it is the male seahorse which becomes pregnant, incubates the developing embryos and endures the labour of birth. In the mating ritual, the male and female engage in a series of colour changes, displays and a series of short bursts of swimming together with tails entwined. When the pair is ready to mate the climax of this courtship ritual is with the egg transfer. The male will inflate his pouch and dilate the opening to facilitate the female. She then inserts her ovipositor into the brood pouch of the male and transfers the eggs. The male will then repeatedly contort his body until the eggs are placed comfortably in the placental wall for the duration of the gestation period. The gestation period for the native species is between 21 and 24 days.

Within the male brood pouch there is a jelly lining of tissue supplied with blood vessels, like a placenta. As the eggs settle, the blood vessels of the pouch lining enlarge, and gradually swell, gently surrounding each individual egg. The egg yolk provides nutrients for the developing embryo with the father contributing calcium for skeletal development as well as providing gaseous exchange, osmoregulation and waste removal for the developing young. Prolactin (the hormone that controls lactation in human females) governs the male seahorse pregnancy. As the male nears the end of the gestation period, he changes the environmental conditions within the pouch to similar to that of the surrounding water.

Juvenile seahorses hatch from their eggs within the pouch but are not expelled until they have completely absorbed their yolk sac. As soon as the juveniles are expelled from the pouch, they are completely independent of their father. Newborn seahorses are effectively miniature replicas of their parents, although there are differences in body proportions. For the first two to four weeks of their lives, they congregate near the surface, hunting for food among the zooplankton. During this pelagic phase, currents may carry the juveniles away from their point of first release - this is the main dispersal mechanism in seahorses. As they grow larger and heavier, the young seahorses start to descend lower in the water column and become more sedentary in nature. Their bodies start to fill out and like their parents, they spend more of their time among seaweed and sea grass.

Seahorse longevity varies according to the species, but one to seven years (barring predation and human fishing pressure), are common estimates. In fact, predation is thought to be a relatively minor cause of mortality among adult seahorses, of far more importance, especially in recent years is fishing pressure and habitat destruction subjected to seahorse populations by humans.

Seahorse markets

The volume of seahorses harvested for Traditional Chinese Medicine (TCM) is considerable and at present unsustainable. The annual export of seahorses to markets in Asia is well in excess of 40 million animals per year, wild populations are unknown and the survival rate of young is less than one in 1,000. Most of these animals are destined for the TCM market and its derivatives such as kanpo (Japan), hanyak (Korea) and jamu (Indonesia). Dried seahorses are a highly-prized ingredient in the world's oldest form of medicine. Retail value ranges from US$900 – $2,000 per kilogram. Pound for pound dead, dried and bleached seahorses are more valuable than silver and almost that of gold on the Asian market.

TCM is a viable healthcare option recognised by the World Health Organisation. It is credited with increasing energy flows within the body and decreasing cholesterol levels. It is also said to have a curative role in such diverse ailments as asthma, impotence, goitre, kidney disorders and skin afflictions such as severe acne.

Regional variations exist in the use of seahorses, for example, in Hong Kong consumers buy seahorses primarily for respiratory ailments, while Taiwanese and mainland Chinese often rely on them to treat sexual disorders and as aphrodisiacs. Economic change is prompting a greater willingness to accept pre-packaged TCM. Approximately 30 per cent of all seahorses now sold in China are sold as proprietary medicine. Juveniles and less desirable species are now becoming the focus of direct exploitation. As affluence levels in many Asian countries continue to rise, and Western societies seek out alternative forms of medicine to promote general health and well-being, the demand for seahorses is likely to rise.

Fish keeping today is the second most popular hobby worldwide after photography and the market for seahorses as aquaria pets is growing. Currently the marine sector accounts for only 10 per cent of the aquarium market with freshwater the remainder. According to many experts, the marine aquarium with live coral reefs is the trend for the 21st Century. Syngnathidae are listed as being one of the species most rapidly increasing in popularity.

The problem lies in the fact that the vast majority of seahorses currently being supplied to the aquarium trade are wild-caught. More often than not, they are mishandled and stressed during shipment, and die within a short space of time from disease or being fed common varieties of fish food when they eat only live food in the wild. Of the five million sold each year, fewer than 1,000 survive the first six weeks.

The curio market consumes more than one million animals per year. While there are those that die of natural causes and are washed up on the beach, these numbers are few. Most meet a far more tragic death, captured and hung or laid out in the sun to die and dry. The appeal of these creatures appears to be so great that people lose sight of how they actually came to be mounted on a frame or hanging from a pendant.

The benefits of seahorse cultivation

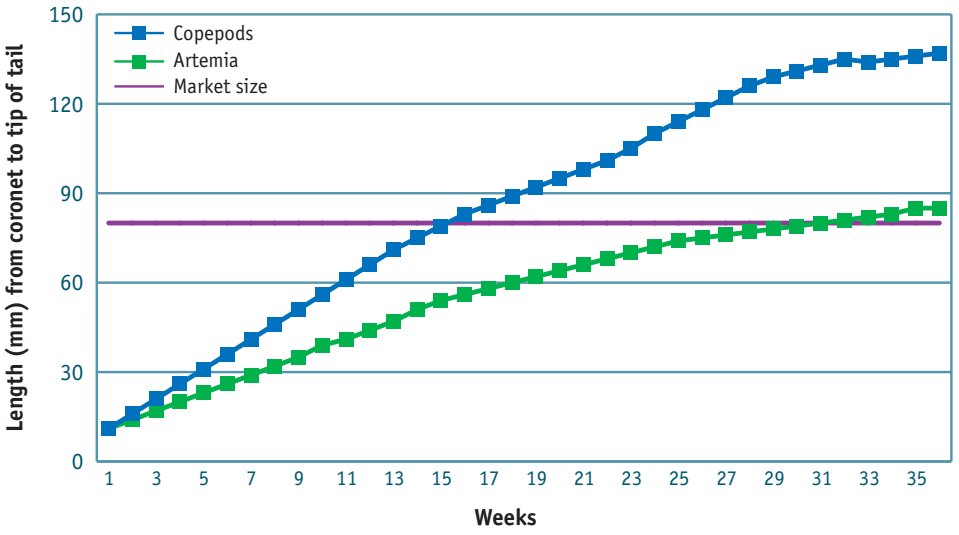
Cultured seahorses ensure a far superior animal in terms of quality, feeding and ability to survive and, as such, it is envisaged that consumer trends may alter in time such that cultured animals are demanded thereby reducing pressure on wild-caught animals. It is hoped that a low-technology method of culturing seahorses will be developed which will have application in areas where seahorses are traditionally fished. Subsistence fishers may earn money from the culture and ranching of seahorses as opposed to exerting continuous pressures on a fishery already in trouble. The Irish Seahorse ongrowing unit is closely linked to the National University of Ireland, Galway and the Galway/Mayo Institute of Technology and is currently conducting research in the biology, ecology, feeding, health and husbandry of seahorses. The information garnered from this research will have a positive effect on developing protocols for the culture of seahorses. The current deficit of information on seahorses is one of the major stumbling blocks in the conservation of the species.

How long to market

In the conditions existing in Ireland's only seahorse cultivation unit a combination of synergistic factors (the location, expertise, captive bred product and a unique feeding process), results in seahorses reaching a market size in just three months. At present the farm is working with a number of seahorse species in order to be able to offer as much variety as possible to the aquarium market. They also intend cultivating other boutique ornamental fish species, i.e. sea dragons which can retail at up to $1,900 per fish.

Food choice dramatically affects the time it takes for the fish to reach market size. Using copepods, the Irish operation is growing seahorses to market size in just 12-14 weeks compared to nine months when using Artemia (Fig 3.1.). Using copepods, the survival rates of juveniles also increase from five per cent to 96 per cent. Copepods cover the nutritional requirements of seahorses, ensure good growth rates and ensure the availability of optimal sizes of prey.

Figure 3.1 Growth of *H. subelongatus* fed on copepods vs. artemia (Doyle, in preparation)



The economics of seahorse cultivation

Estimates put the annual export of seahorses to markets in Asia in excess of 40 million animals, or some 120 tonnes (Forteath, 2000). China, Hong Kong and Taiwan remain the largest consumers however the list of countries trading seahorses is rapidly increasing and includes Australia, New Zealand, India, Indonesia, Singapore, Japan and the USA. Dried seahorses retail from US$900-$1900 per kilogram with larger, paler and smoother animals commanding the highest prices. In terms of the aquaria market, the animals in high demand are bright in colour, of a large size, and possess ornate features. The Philippines and Vietnam are among the largest suppliers of seahorses to the aquarium trade, with those from the Philippines retailing at US$80 per animal in Canada and the USA. Captive-bred seahorses command higher prices. One successful US company is selling animals for up to US$170 by direct selling on the web.

One third of the Irish production will be supplied to aquarium wholesalers at €35 per seahorse while the remainder are to be directly sold through their web site at €150 per seahorse. Any natural mortalities will be sold to TCM outlets at €20 per seahorse. It is projected that the price will increase in line with the increase in demand and diminishing wild populations, even considering possible future competition. The Irish operation will concentrate almost completely on the export market and the value of the euro will undoubtedly affect pricing.

Market trends

Current predictions put the annual increase in demand for seahorses in Asia at 10 per cent for the TCM market (Fig. 3.2 and Fig. 3.3). TCM is in part based on a belief system, which is inherent to the culture. This, combined with high population growth rates and economic development, will see the demand for seahorses continue to expand. TCM is becoming increasingly prevalent in the West. The aquarium trade represents 1/1000 of the food fish harvest, and while the average retail price of food fish is approximately $14,500-$16 500 per tonne, for ornamental fish it is $1.8 million per tonne (Dawes, 2001). Fish keeping is an increasingly popular hobby worth $1.8 billion in the USA alone. The Marine Aquarium Council (MAC) estimates that five million seahorses are currently utilised in the aquarium market. Experts agree that this figure will increase significantly once captive-bred seahorses are available on the market. The potential of the aquarium trade is enormous. Cultivated animals that have been bred in aquaria are a new and far superior product. People will be able to enjoy these magnificent creatures content in the knowledge that they are playing their part in protecting a species from extinction.

Figure 3.2 Global volume of dried seahorse sales from 1986 to 2000 (source Vincent, 2001)

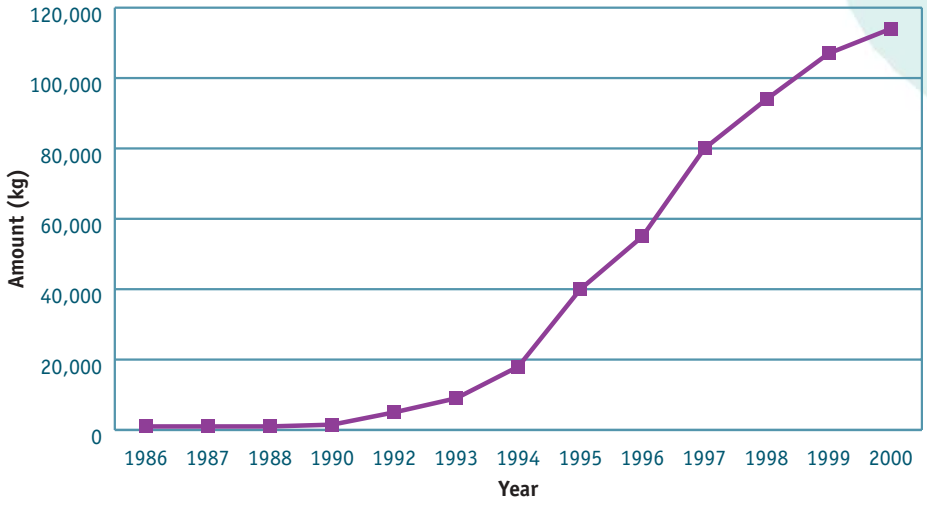
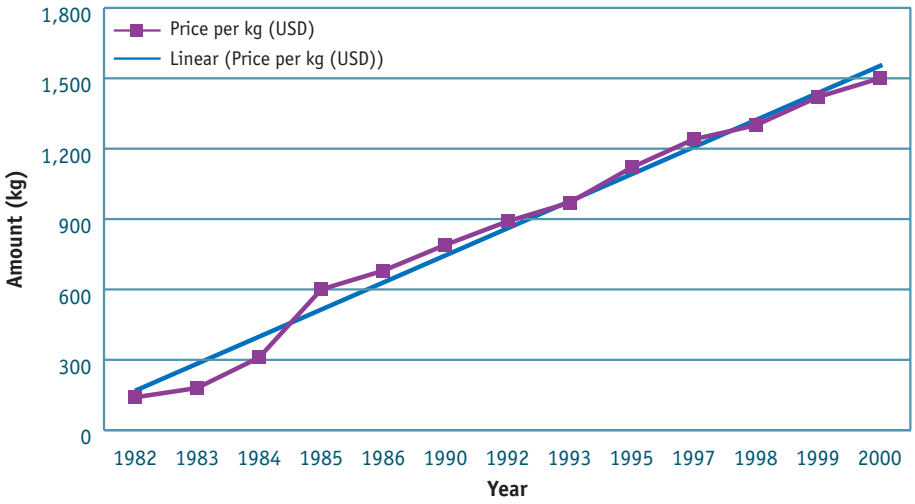


Figure 3.3 Value of dried seahorses US$ per kg between 1983 and 2000 (source Vincent, 2001)



Competition and competitive analysis

There is no known supplier of captive-bred seahorses for the TCM market. The majority of suppliers are in developing Asian countries and the fish are all wild-caught. The gap between demand and supply is steadily increasing as wild-stocks are decimated. TCM prefers large, pale and smooth seahorses, which are the main characteristics of Ireland's native seahorse. While this appears to be a significant competitive advantage, there are many challenges to surmount in order to become a serious market contender. Seahorse cultivation has, and is being, attempted in many parts of the world. New Zealand and China have both developed large-scale hatcheries without success. There are several public and private aquariums around the world culturing these animals on a small scale and research and experimentation is being carried out in many university marine laboratories and by the home aquarist-hobbyist.

One significant US supplier sells captive bred seahorses to the aquarium trade. Their focus is the US, with animals also being sold directly on the web for between $50 and $170. The company supplies approximately 97 per cent of captive bred seahorses to the market however sub-optimum feed types and massive market demand ensure that they supply less than 0.5 per cent of the market demand for seahorses.

Existing competition from farmed animals is insignificant, and that from wild-caught seahorses is waning as more countries ban their exploitation and wild breeding stocks dwindle. The advantages of cultivating these fish in Ireland are many and varied. For the aquarium trade the species suit market demand in terms of size, colouring and general aesthetic beauty. Unlike seahorses taken from the wild, those bred in captivity will be trained to feed on non-living food and will survive and thrive in home aquaria.

Logistically Ireland is well placed to service the main markets which are the USA and Europe.

Marketing challenges

Although a highly lucrative market, there are many challenges in attempting to penetrate the aquaria and TCM markets. Market demand in terms of size, colour, shape, packaging and quantity are being thoroughly analysed in order that customer requirements are met. Knowledge of not just the industry but the people, language, cultures, economies, politics and business etiquette of other countries, in particular for the TCM market, will be paramount. The challenge in supplying the aquarium trade will be in re-educating people that it is now possible to keep seahorses in home aquaria without them rapidly succumbing to disease and starvation.

Market research for Irish captive bred seahorses

TCM markets exist both abroad in countries such as China, Japan, Hong Kong, Malaysia, Taiwan and Singapore, and also at home in Ireland. There are now 40,000 Asian people living in Ireland and five TCM outlets in Dublin alone. TCM outlets in Ireland and Europe are very interested in this new Irish product. In October 2002, the Irish seahorse operation test-marketed seahorses to aquarium wholesalers, public aquaria and pet stores. All customers have reported being extremely satisfied with the product.

Conclusion

The collective experience of the existing Irish operation is 20 years and the promoters have worked with seahorses all over the world. In this regard Ireland is well placed to become a player in the supply of captive bred seahorses to the aquaria and TCM markets. Significantly a ban in the wild fishing of seahorses is being proposed by CITES, which will ultimately result in permitted trade in captive-bred animals only.

GASTROPODS

4.0 Abalone

Introducing: Abalone

Abalone are marine gastropods that graze on seaweeds and are one of the most prized sea delicacies worldwide. The total world production was estimated at circa 18,000 tonnes in 1999, of which nearly 8,000 tonnes was farmed. The culture of abalone began in the late 1950s and early 1960s in Japan and China. A very rapid development of abalone cultivation took place in the 1990s and abalone culture is now widespread in many countries including the USA, Mexico, South Africa, Australia, Japan, China, Taiwan, Iceland and others. The largest cultured abalone producer in the world is China, with over 300 farms and a total production of approximately 3,500 tonnes. Worldwide, the harvest from wild fisheries is declining through overfishing and poaching.

Table 4.1 Total world abalone production (tonnes) 1990-2001

Source FAO

Country	Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Australia	Blacklip abalone	5,132	5,152	5,029	4,668	4,673	5,208	5,425	5,240	5,247	5,318	5,244	5,354
Canada	Abalones nei	50	40	30									
Channel Is.	Tuberculate abalone	1									1	5	4
Chile	Abalones nei							8	1	1	48	66	73
Chile	False abalone	227	218	5	8,574	8,111	2,670	2,541	3,154	2,564	2,294	1,274	828
France	Tuberculate abalone			3	11	3	49	62	75	36	37	61	60
Iceland	Abalones nei									1	8	15	23
Japan	Giant abalone	3,353	3,066	2,496	2,353	2,164	1,980	1,941	2,218	2,269	2,109	2,146	1,982
Korea, Republic	Abalones nei	344	376	320	361	281	260	272	214	71	79	133	133
Mexico	Abalones nei	3,655	2,849	3,132	2,180	1,536	1,227	1,076	924	713	576	544	498
New Zealand	Abalones nei	1,228	1,294	1,481	1,099	1,080	1,280	1,020	1,180	1,300	1,170	1,265	1,064
Oman	Abalones nei	116	49	42	34	36	43	43	40	1,540	1,886	1,945	2,051
Peru	False abalone	7,788	6,018	5,632	2,919	2,557	1,361	2,728	4,366	830	2,289	1,250	544
Philippines	Abalones nei	61	63	73	122	240	483	448	183	347	282	241	250
Solomon Is.	Abalones nei	28	25	5	2					1			
Solomon Is.	Blacklip abalone	31	43	28	26	0.5							
South Africa	Perlemoen abalone	624	573	738	562	588	616	742	340	546	508	590	5,485
Taiwan PC	Abalones nei	1,144	1,324	1,370	1,065	1,063	1,596	1,822	2,214	2,314	1,801	2,500	2,497
USA	Abalones nei	403	267	325	223	213	179	392	367	-	8	-	3
TOTAL		**24,185**	**21,357**	**20,709**	**24,199**	**22,545**	**16,952**	**18,520**	**20,516**	**17,780**	**18,414**	**17,279**	**20,849**

Figure 4.1 Abalone production (tonnes) in main producing countries 1990-2001

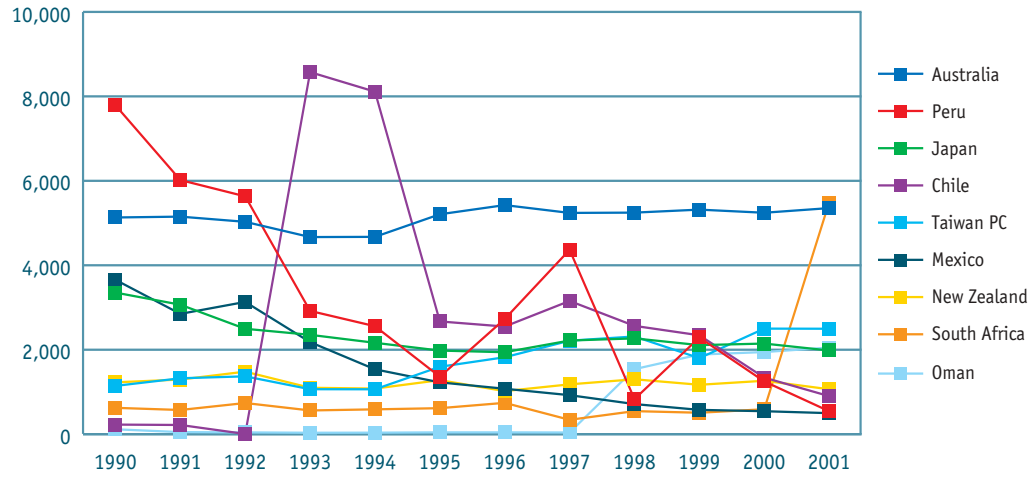


Figure 4.2 Abalone production (tonnes) in other producing countries 1990-2001

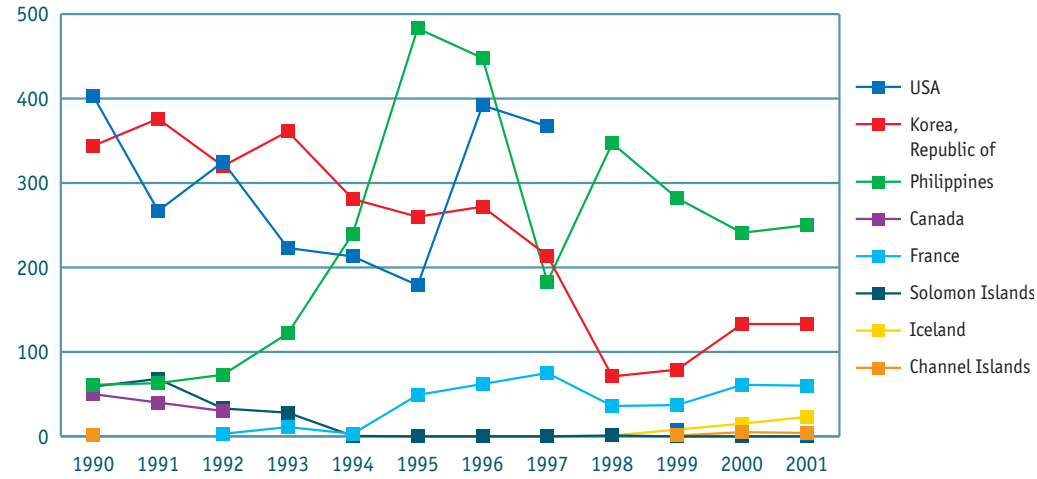


Table 4.2 Fishtech estimates of global abalone production (metric tonnes) from wild catch and aquaculture.

Year	Fisheries	Aquaculture	Total	% from culture
1968	35,000*	0	35,000	0
1989	15,000	1,220	16,220	7.5
1999	10,150	7,775	17,925	43.0

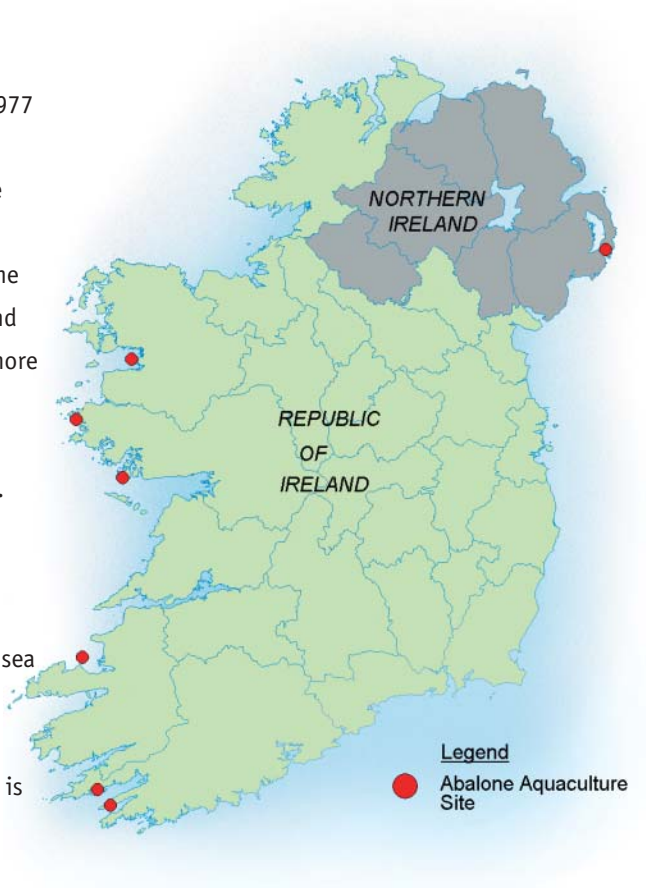
**figures adjusted to include China and Mexico*

Source Fishtech, USA

Generally the majority of wild abalone fisheries are severely restricted or are indeed closed for the foreseeable future. The market for this sea delicacy is still increasing and supplies are being augmented by aquaculture. There are approximately 75 species of abalone in the world of which 22 are either currently farmed or have potential for cultivation. Many species are farmed in countries other than the countries in which they are naturally occurring. Commercially important species can live in water temperatures ranging from 2˚C to 30˚C.

Ireland and abalone – the background

The European abalone, *Haliotis tuberculata*, commonly called ormer, was introduced into Ireland in 1976 and 1977 from Guernsey. Strict quarantine conditions at Carna Laboratory were applied and seed was released from the quarantined broodstock one year after the initial introduction. The main challenge facing the early abalone farmers was the ormer's preference for red seaweeds, and the fact that the species does not particularly like the more common Irish brown seaweeds or kelps. Both BIM and Taighde Mara Teo supported this early work. It was then decided to investigate the potential of a second species. Consequently the Japanese cold water abalone *Haliotis discus hannai*, also called ezo awabi, was introduced to Ireland in 1986 under strict quarantine conditions. The Japanese species prefers kelps and can withstand lower sea temperatures than the European abalone. It has been found to grow 10 per cent faster than the European abalone in Irish ongrowing trials. The Japanese abalone is much sought after by Japanese communities in Europe. This market-led introduction was to offer a great opportunity to Irish abalone farmers to supply this market.



The technology to farm abalone

To realise the full potential of the cultivation of this valuable sea snail, BIM embarked upon an intensive technology transfer programme. This programme involved the importation of ongrowing techniques, food and equipment, predominantly from Australia, China, Taiwan and USA to Irish abalone hatcheries. Amongst the initial challenges faced by the industry were the early survival of animals through the hatchery weaning stage. At this stage the animals switch diet from benthic diatoms to seaweeds. The ethos of the Taiwanese is to mass-produce at spawning stage, therefore allowing for greater success rates. This new way of thinking, along with their advanced settlement techniques, changed the production of seed into a commercial reality, stimulating interest and investment in abalone ongrowing.

The ongrowing systems employed in China, Taiwan and Australia were also more advanced than those employed in Ireland, and a sample of each was introduced and modified where appropriate to local conditions. Now there are three Irish abalone hatcheries, with more at the planning stage, employing a variety of advanced techniques to produce abalone.

Ongrowing units

Currently in the Republic of Ireland there are six abalone ongrowing units. Three of these include hatchery facilities. Spat output from these hatcheries is now fast approaching one million (at 10 millimetres +) animals per annum. Another hatchery/ land-based production unit is set to come on stream in 2004, while the overall production of marketable animals for the country is set to reach 25 tonnes by 2005.

The units are land-based, coastal and offer little visual impact. Due to the high value of the species the volumes cultivated are small and so facilities in turn can be small. Abalone prefer warm water in the region of 15˚C – 20˚C so the ongrowing units are housed in a specially-insulated building with animals growing optimally at elevated temperatures using recirculation technology. Ongrowing is the term used by the industry for the process which involves growing juvenile fish to market size.

The discharge or waste from a farm of this nature is also limited and unlikely to cause any impact on local ecology or habitat. As both species do not occur here naturally due to temperature limitations, there is no risk of populations establishing in the wild.

Food

Feeding abalone and urchins (see chapter five) has always posed a challenge to Irish farmers. Although there are some 500 species of seaweed distributed along the Irish coastline their spatial distribution limits their availability for aquaculture. It has long been established that a mix of weed is preferable and that this weed should be fresh. This posed logistical problems and an alternative was sought. Long-line cultivation of seaweed was pioneered in Ireland as a food for macroalgivores.

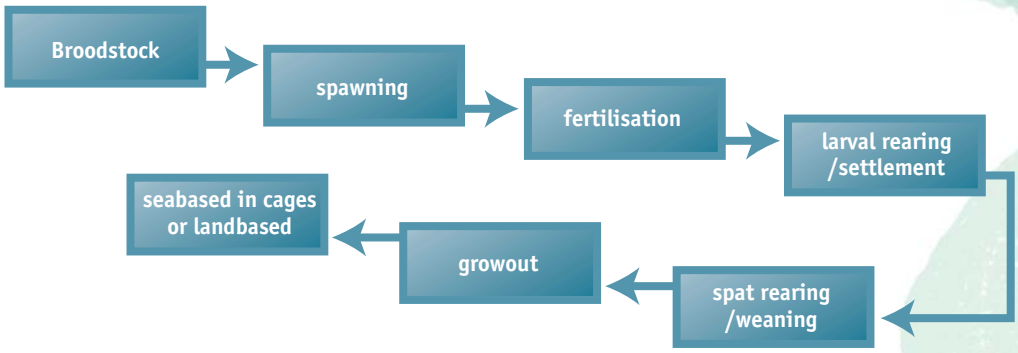
In the mid 1990s trials were carried out using the French technique of long-line cultivation of *Alaria esculenta* and *Laminaria* spp. The culture trials were carried out in various locations and were successful in the supply of seasonal weeds to both sea urchins and abalone. Seaweed is now being farmed in Ireland as a valuable product in its own right. Juvenile abalone begin to eat macroalage at about 10 millimetres and will eat 10 to 30 per cent of their whole body weight in algae each day. The high feeding rate of macroalgae is due to the high water content and relative low protein content of fresh macroalgae.

Developments in artificial diets

Developments in the production of artificial diets have also offered an attractive and reliable food source. Following the technology transfer programme it was apparent that despite the expense involved in importing food from abroad, artificial diets also offer potential as an abalone food source. Initial industry feed trials were run in 1999/ 2000, comparing natural seaweed diets, an Australian diet and a new Irish prototype. Interestingly, the colour banding on many abalone shells results from the different types of algae eaten.

The production cycle

Figure 4.3 Abalone production cycle



Spawning of adult abalone broodstock is induced by chemical or thermal stimulus in a controlled environment with the aim of having a simultaneous release of the eggs and spermatozoids. After fertilisation of the egg there are two larval stages: pelagic and benthic. During the larval phase the young abalone must be fed a live feed which is itself grown in the hatchery. When ready to settle, the larvae are transferred to tanks containing collectors covered with a layer of benthic diatoms, microalgae and bacteria. *Navicula* spp and *Nitzschia* spp are the usual diatom species given to juveniles for food. These diatoms occur naturally in the rearing tanks and produce good growth rates.

These organisms of the diatom layer act as a signal for settlement and are the food source for newly-settled juveniles. When the settled abalone reach 6-7 millimetres, they are transferred to nursery tanks. Once safely in the nursery tanks, the diet of the young abalone is changed and they progressively switch from microalgae to macroalgae. Once the abalone are big enough they are transferred to specialised structures in ongrowing units and fed a diet of artificial food.

Settlement may be onto white plastic Chinese settlement baskets. They are slightly flexible and 20 settlement plates fit into the basket. The settlement plates are made of a supple corrugated transparent plastic. Alternatively, glass collectors in plastic boxes are used to settle animals. Abalone are ongrown to market size in tanks or raceways.

How long to market

In optimal ongrowing conditions abalone grow at a rate of 15 to 20 millimetres per year. Depending on the market accessed, the first abalone can be sold to market in roughly three years from settlement in artificially-elevated temperatures. Growth rates in Irish ambient waters are significantly lower with animals taking four to five years to reach market size. The Irish operations take a flexible approach to this, switching to summer ambient temperature water as necessary to reduce heating and recirculation costs.

The economics of abalone farming

The market for these shellfish is undersupplied. However the cost of production, which remains comparatively high including a long growout period of at least three years, must be borne in mind when considering the potential profitability of farming abalone. *H. discus hannai* is the most commercially-valuable abalone in Japan and makes up to 46 per cent of the wild catch and the majority of cultured abalone seed in that country. Ireland is in the unrivalled position in the European context of having commercial abalone farms capable of supplying this product to the European market place.

Economies on expensive capital construction can be achieved if existing properties are identified for possible conversion and if expensive land purchase is not required. Switching to Irish ambient summer water temperature will reduce current pumping and heating costs. Obviously it is desirable to offset costs and ensure a more regular income. This could be achieved by farming abalone in association with other shellfish that have a shorter production cycle for example oysters or mussels which will show return within 18 months.

Two possible income opportunities can be exploited by the abalone farmer. Once juveniles have settled, the hatchery is in a position to offer these for sale to other potential ongrowers. Settled abalone of 20 millimetres in size are worth in the region of 50 cents each. Subject to its availability, seed can be purchased for ongrowing purposes which bypasses the expensive, and often risky, hatchery side of production. Alternatively market-size abalone of between 75 and 90 millimetres are worth €2.50 - €3.80 each at the farm gate.

The market for abalone

Abalone continues to be a premium-priced luxury product although it has been fished and traded in a variety of forms for centuries. There is significant trade in Asia and Australia and this trade is undoubtedly affected by economic cycles and currency fluctuations. The market price for abalone represents the volatility of these markets.

It is reasonably difficult to get accurate figures on abalone since the species is very often combined with other similar shellfish for trade purposes. It is, however, very apparent that abalone fisheries worldwide have declined significantly in recent decades. According to Fishtech statistics, nearly 10,150 tonnes of wild abalone were harvested in 1999. In the period from 1968 to 1999, abalone fisheries declined by over 30 per cent while farmed abalone production came from nothing in 1968 to an incredible 7,775 tonnes, representing 43 per cent of total abalone on the market. Prices to the fishermen reflect this decreased availability with one 20 year analysis of Australian beach prices recording a price increase from €2.50/kilogram in 1980 to €45/kilogram in 2000.

Over 75 per cent of farmed abalone comes from China and Taiwan, with Australia supplying more than half the wild abalone sold on the market. According to Tony Johnston, General Manager of Tasmanian Seafoods, about 20 per cent of Australia's abalone catch is exported live, with 60 per cent going out as canned product. Abalone get onto the market in a variety of forms: live, fresh, frozen, canned and dried. It is reported that 90 per cent of all abalone is consumed in restaurants with the balance sold through retail, mostly as canned, frozen or dried product. The top-class restaurants tend to offer live abalone from their own display aquaria. These are purchased directly from the local markets. Other restaurants would tend to purchase abalone less frequently, on the basis of its cost and availability.

Much of this wild abalone finds its way onto the Asian markets, particularly Japan. The domestic supply of abalone has fallen steadily in Japan since 1970 which further augments the market potential for abalone there. The Japanese preference is reported to be for an 80-100 gram, in-shell animal.

Table 4.2 Japanese abalone production

1970s	5,000 tonnes
1980s	4,000-5,000 tonnes
post 1992	2,000-3,000 tonnes

Source Enterprise Ireland

Table 4.3 Details of Japanese abalone imports 2000

Item	Abalone
Import	800 tonnes (up 5.3%) value $30.77m
Custom tariff	7%
Import price/kg	$38.47 (live, fresh, chilled, frozen)
Countries of origin/Market share	Australia (56.8%), Republic of South Africa (10.5%)

Source Enterprise Ireland

Table 4.4 Abalone imports to Japan

Year	1998	1999	2000
Value (1,000 US$)	22,102	25,443	30,774
Quantity (tonnes)	680	760	800
US$/kg			
Live, fresh, chilled, frozen	32.5	33.48	38.47

Source Trade Statistics, the Japanese Minstry of Finance

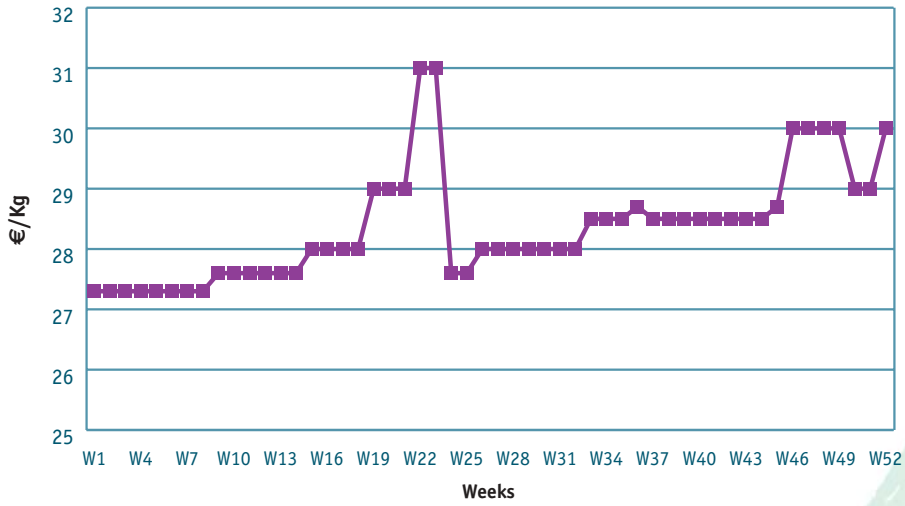
Abalone supply and demand

Fishtech statistics predict a potential demand of in excess of 20,000 tonnes in 2004 representing a potential shortfall of 5,000 tonnes.

The European abalone market and fishery

The amount of abalone moving through the European market place is difficult to quantify. Abalone is, however, moving through the Rungis market and figure 4.5 shows the trend of product movement in 2002. Some wild abalone *(Haliotis tuberculata)* is fished in Guernsey, Normandy, Portugal and Spain, but again centralised official figures are not available to quantify all these fisheries. As an example of an artisanal fishery, the French abalone fishery is limited with quotas attributed to certain areas. Only the fishing area between Brest and Cherbourg is authorised for commercial fishing. In each area fishermen are given an annual fishing quota. In Morlaix, for example, the quota is for 1.5 tonnes per fisherman. In North Brittany a total of 30 fishing licenses have been allocated. The fishing is done by scuba diving, and the minimum capture size is 90 millimetres. Each captured abalone must be tagged. The commercial fishery is closed during the summer season. The fishery is managed locally either by the Comité Régional des Pêches or by the Affaires Maritimes. The total amount of abalone landed is estimated at 40-50 tonnes and the stocks are considered to be sustainable. The fishermen receive in the region of €15-20/kilogram for wild abalone. In addition to this there is a leisure fishery where the capture is limited to 20 abalone with a minimum landed size of 90 millimetres. Abalone can only be taken “on foot”, no diving is permitted. There is no information regarding the amount of abalone taken by this method.

Figure 4.4 2002 Rungis selling prices for abalone



There is one abalone farm in France, located in Normandy. This farm plans to take abalone up to a size of 45 millimetres for sale as "cocktail" abalone.

Conclusion

The abalone market has remained much the same for years, and has been substantially driven by Asia. An opportunity exists for the developing Irish abalone sector to differentiate its product and essentially break away from the traditional way of marketing abalone.

Irish abalone farmers have much to aim for, in that their production is coming into a market that has had its roots firmly in a wild fishery, with a long established history. Abalone farmers need to optimise profitability by entering the market with a differentiated product that matches customer needs. Opportunities exist to value-add for the food service sector and brand name product. More importantly, the farmer can also look to move down the distribution chain dealing in a more direct fashion with the end buyers, cutting out the middle man and offering a tailor-made, quality-assured product.

From an Irish perspective it is reasonable to expect that production will remain comparatively small and that any product will go direct to restaurants. Price premium is achievable if needs are met. Good quality, size-matched animals, well-presented and carefully-packaged will undoubtedly impress. Establishing good contacts, one-to-one relationships and a record of personal service with the Asian restaurant sector is vital in getting a foothold in the European market at that level.

PHYLUM ECHINODERMATA

5.0 Sea Urchins

Introducing: Sea Urchins

Urchins belong to the phylum Echinodermata. They live on the sea floor and move around by means of tiny tube feet. Sea urchin roe has long been considered a delicacy and urchins have been extensively fished for decades. The world production of urchins comes essentially from the wild, and this production is relatively small in comparison with most other seafoods. Landings of wild urchins peaked in 1995 with a reported 108,974 tonnes of urchins landed. By 2001 this had dropped by 27 per cent with only 79,997 tonnes landed that year, a massive drop of 28,977 tonnes. Figure 5.1 shows the rise in landings from 1990 to 1995 and the subsequent serious decline from 1995 to 2001.

Table 5.1 Total world urchin production (tonnes) 1990-2001

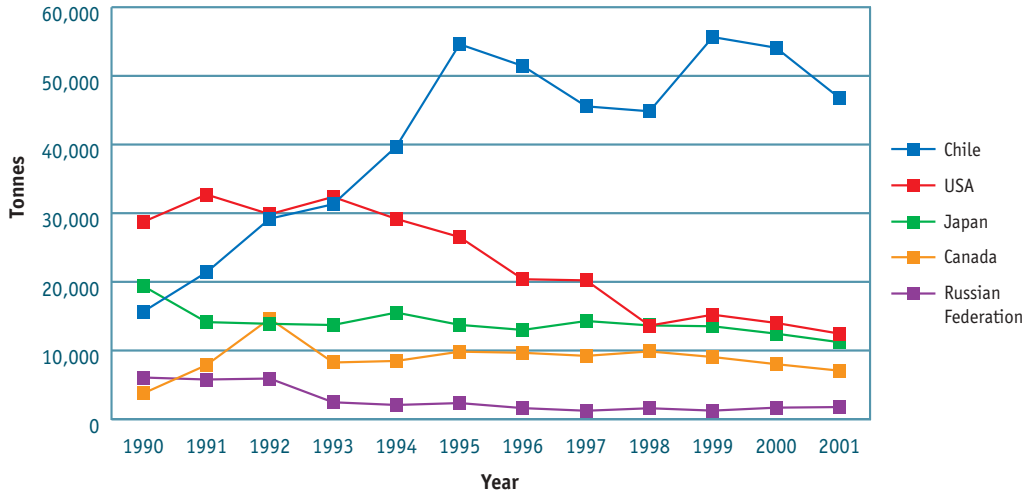
Source FAO

Country	Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Canada	Sea urchins nei	3,748	7,877	14,640	8,255	8,479	9,833	9,665	9,221	9,867	9,052	8,012	7,063
Chile	Chilean	15,648	21,382	29,197	31,300	39,705	54,609	51,437	45,560	44,843	55,654	54,096	46,794
China	Sea urchins nei	30	30	50	100	150	150	200	200	200	200	200	200
Cook Islands	Sea urchins nei	30	28	25	26	25	25	20	20	20	20	20	20
Denmark	European edible	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	<0.5	<0.5
Ecuador	Sea urchins nei	1	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Faeroe Is.	Sea urchins nei	-	-	-	14	-	-	-	-	-	-	-	
Fiji Islands	Sea urchins nei	12	11	14	55	56	59	40	95	103	100	90	96
France	Stony sea urchin	301	218	401	257	159	78	63	48	59	84	198	101
Grenada	Sea urchins nei	5	1	5	36	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	
Iceland	European edible	-	-	713	1,409	923	423	20	-	10	-	-	
Ireland	European edible	95	104	89	26	34	10	2	5	1	2	1	5
Japan	Sea urchins nei	19,398	14,136	13,889	13,713	15,525	13,735	12,996	14,297	13,653	13,530	12,455	11,208
Korean Rep	Sea urchins nei	100	100	100	100	100	140	150	150	100	100	100	100
Martinique	Sea urchins nei	25	13	18	16	15	15	10	15	15	15	10	10
Philippines	Sea urchins nei	48	62	40	74	151	466	452	296	161	143	125	127
Russian Fed.	Sea urchins nei	6,065	5,777	5,917	2,460	2,069	2,344	1,608	1,227	1,590	1,245	1,677	1,763
St.Pierre/Miquelon	Sea urchins nei	-	-	-	-	1	1	-	-	-	<0.5	<0.5	
Taiwan Prov.China	Sea urchins nei	134	123	65	31	51	63	59	61	39	33	41	50
Un.Sov.Soc.Rep.	Sea urchins nei	-	-	-	-	-	-	-	-	-	-	-	
UK	Sea urchins nei	-	-	-	-	-	1	<0.5	-	-	-	-	
USA	Sea urchins nei	28,726	32,722	29,848	32,369	29,167	26,523	20,381	20,216	13,626	15,218	14,014	12,460
TOTAL		**74,360**	**82,589**	**94,295**	**89,500**	**97,145**	**108,974**	**97,508**	**91,431**	**84,277**	**95,407**	**91,039**	**79,997**

This drop in production came on top of significant increase in landings in the 1980s when landings increased by 96 per cent between 1981 and 1989. This increase was a result of two countries, Chile and the USA which both greatly increased landings in that time surpassing Japan in production in 1988. Japan remains the third biggest producer of urchins in the world but is today the major consumer. Over-fishing, pollution and lack of proper fisheries management have led to a drop in world urchin landings.

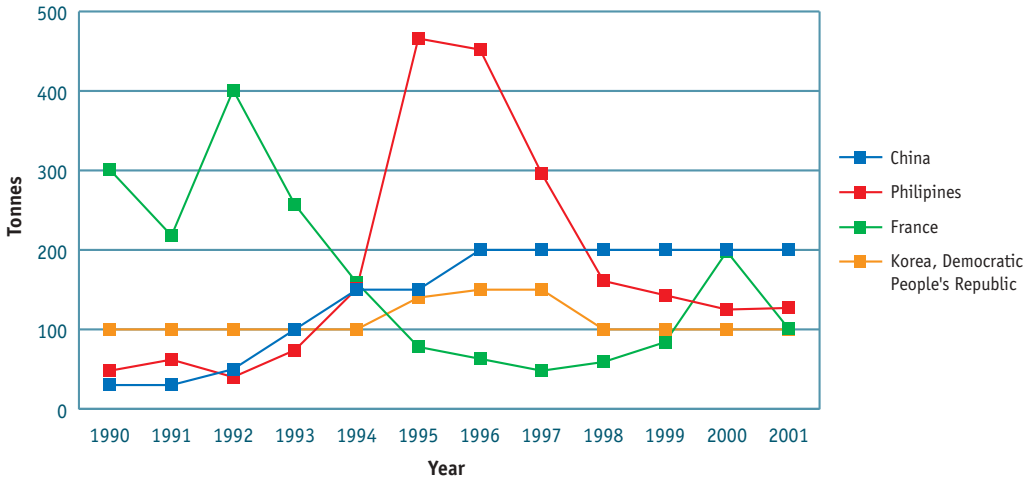
The main species of fished urchins in the world are *Strongylocentrotus intermedius*, *Strongylocentrotus franciscanus* and *Loxechinus albus*. *L. albus* now accounts for 50 per cent of total world landings. The Chilean fishery is based entirely on this species. The major producing counties are Chile, USA, Japan, Canada and Russia. Chile produces over half the world's supply of urchins, and is the only important world producer that has shown an increase in its production in the past 10 years.

Figure 5.1 Urchin landings in main producing countries 1990-2001



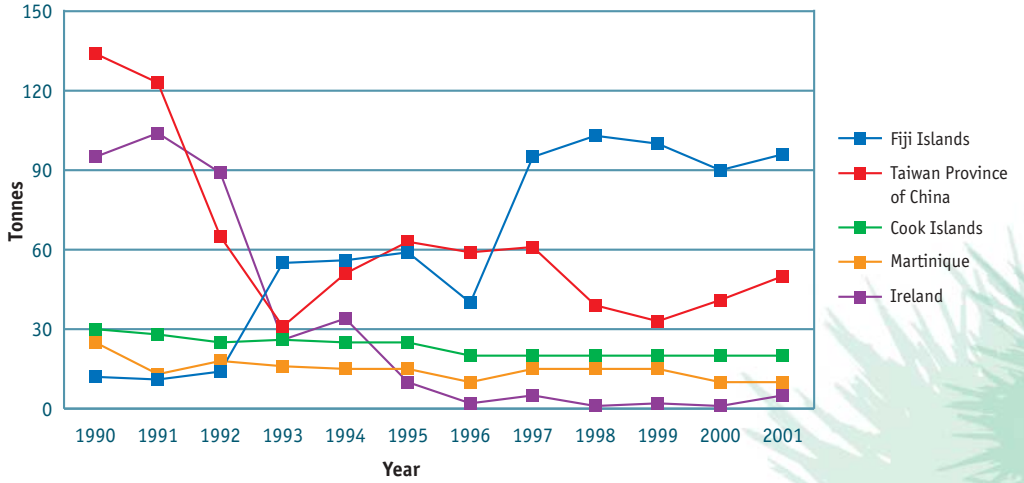
FAO

Figure 5.2a Urchin landings in other producing countries 1990-2001



FAO

Figure 5.2b Urchin landings in other producing countries, including Ireland, 1990-2001



FAO

Irish exports of urchins

Official FAO statistics for Irish urchin production make sobering reading. Figure 5.2b shows a significant overall decrease in production since the 1990s, with only a very slight upturn in production in 2001 compared to 2000. What is important to note, however, is that in the 1970s Irish urchin landings were in the region of 500 tonnes per annum.

Table 5.2 Irish urchin production (tonnes) 1990 to 2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	95	104	89	26	34	10	2	5	1	2	1	5

Source FAO

A traditional Irish fishery

It is reported that the price of air cargo in the 1980s was determined by Aer Lingus on the amount of urchins going out. At the time this was 50 – 60p/kilogram. The fishery was largely unregulated and exploited by Scuba divers operating out of 20-foot rowing boats. Metal baskets with a 3 kilogram capacity were used by the gatherers and, on average, each diver could gather a tonne of urchins a day. These were graded on board with only the quality product being retained. The poorer quality product was dumped overboard. No minimum landing size was required. The fishing season typically lasted from October to February, and all the Irish landings went to the Rungis market. This fishery is reported to have lasted for 15 years although official statistics are impossible to find. It is reported that at least 500 tonnes per year were fished in the more productive years. The reported price for urchins fished in 1983 is £3.50/kilogram to the divers. Urchins were graded 10 pieces/kilogram, 12 pieces/kilogram and 15 pieces/kilogram for the Rungis market. It is hardly surprising that the fishery became severely depleted. Female urchins produce in the region of eight million eggs each. Species that produce such massive amounts do so because of the huge juvenile mortalities encountered. Producing vast quantities of eggs is a safeguard, at least some will survive to adulthood. The vulnerability of the species to overfishing and over-exploitation cannot be stressed enough, in particular the taking of spawning stock. Unfortunately Ireland's urchin fishery is all but fished out now.

The Galician urchin fishery, an example of a regulated fishery

The wild urchin fishery is heavily regulated in Galicia and is a good example of sustainable management. The regulation of the fishery is set out in the Diario Oficial de Galicia (Official State Bulletin of the local Government in Galicia). At the beginning of each year all the measures regarding all fishery types are set. The fishing measures for sea urchins vary depending on the area of fishing and the Cofradia or fishing association in that area. Each measure will set out the following information:

- Name of the Cofradia
- Working area (Zone de traballo)
- Maximum days allowed for fishing (Dias maximos de extraccion)
- Points of control and points of sale (auctions) (Puntos de control/Lonxas)
- Probable periods of fishing (Epocas probables de extraccion)

The technology to farm urchins

International attempts to cultivate urchins started in the late 1970s when work began on *Strongylocentrotus*, and in the early 1980s when the first culture work began on *Paracentrotus lividus*. Today it is reported that some hatchery success has been achieved with *Strongylocentrotus, Psammechinus, Paracentrotus, Loxechinus, Arbacia* and others at different scales of production.

The potential of the native Irish species of sea urchin, namely *Paracentrotus lividus* or the purple urchin, as a candidate for aquaculture in Ireland has been investigated since the late 1980s. Broodstock conditioning, hatchery and early nursery ongrowing requirements of the purple urchin were assessed at the Shellfish Research Laboratory, UCG, Carna, Co Galway during the 1980s and 1990s. As a direct result, the first commercial hatchery in the country was established in Dunmanus, Co Cork during the early 1990s with BIM support. The hatchery has expanded rapidly with its main focus being on the production of juveniles and its current capacity is nearing one million juveniles per year. In tandem with the development of the hatchery, aquaculture licences were aquired by several individuals from the area for the purposes of ongrowing these juveniles in intertidal and subtidal pools. To date several million juveniles have been planted out and five tonnes of urchins were harvested in 2001. This figure is expected to rise to between 50 and 80 tonnes by 2006.

Ongrowing units

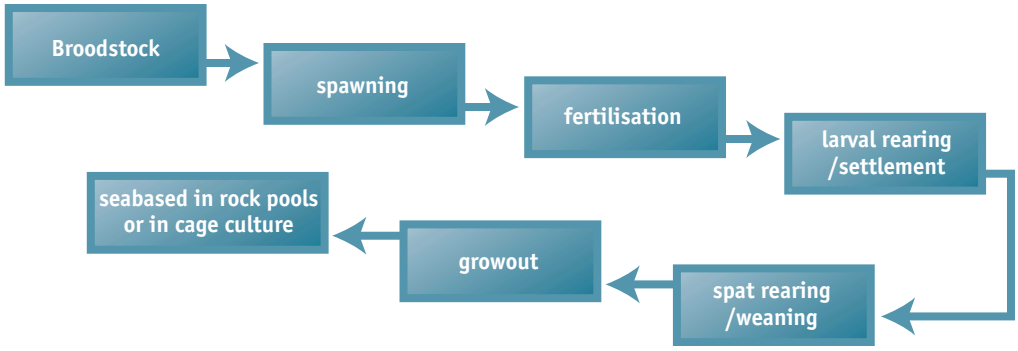
Currently the Irish hatchery has the capacity to produce one million urchin spat at 10 millimetres. It is proposed to upscale production capacity to five million over the next three years. The hatchery comprises 88 conical tanks, with additional tank capacity in the algae room for algal production. In addition, the hatchery has a 24 metre x 9 metre polytunnel with the capacity to hold 150 tanks, each with a capacity of 350 litres. The flow through the hatchery is 350 litres/minute.

Developments in artificial diets

Four diets have been tested internationally over the last number of years, involving several urchin species including the Irish purple urchin, *Paracentrotus lividus*. A number of research teams based in the US/Chile, Canada, Norway and New Zealand have evaluated these diets. In terms of roe enhancement, all the available diets give good results however problems remain especially in relation to colour. The colour of urchin roe is of prime importance especially in relation to the Japanese market. Although one of these trial diets is now commercially available and produced by a US company, it is generally accepted that optimal diets, including feeding strategies and nutritional requirements, are not yet fully established.

The production cycle

Figure 5.3 Urchin production cycle



Wild urchins are collected from the wild and held in tanks in the hatchery prior to spawning. Spawning is induced by chemical or thermal stimulus in the hatchery with the aim of having simultaneous release of eggs and spermatozoids. The cycle is very similar to that for abalone. After fertilisation of the egg there are two larval stages, the pelagic and benthic stages. During the larval phase the young urchins are fed a live feed, which is itself grown in the hatchery. When ready to settle, the larvae are transferred to tanks containing collectors covered with a layer of benthic diatoms, microalgae and bacteria. *Tetraselmis marina* is a commonly-used food species for urchins. Other diatom species occur naturally in the rearing tanks and produce good growth rates.

These organisms of the diatom layer act as a signal for settlement and are the food source for newly-settled juveniles. When the settled urchins reach five millimetres, they are transferred to nursery/ongrowing tanks, and macroalgae is added as the primary food source. Urchins grown in such a system should reach 15 millimetres in one year. At 15 millimetres the urchins are ready to go to sea for growout to market size.

Technical challenges

Technical bottlenecks still pose a challenge in the development of successful urchin hatchery techniques. The dietary needs of the different stages of juvenile development are still not known. Post larval survival rates still remain unacceptably low, and larval settlement rate is still variable. It is difficult to produce sufficient numbers of viable animals of 10 millimetres. The larger the animal, the better its survival rate, in particular when ongrown in intermediate culture. Optimum ongrowing conditions including water flows, water quality and tank design are still not fully understood. Disease identification and treatment is a particularly difficult area with little work done to determine prevention methods and possible treatments.

Urchin growout in Ireland

Urchins that have been planted out in intertidal and subtidal rockpools are expected to reach a market size in four years. This extensive ongrowing system offers the most natural ongrowing environment for urchins but is not without its drawbacks. A level of loss is to be expected through predation and natural losses as the urchins are not contained and are free to move around. Anything up to 80 per cent return has been experienced.

Developments in Japan, Chile and Norway

The wild fisheries of Japan, California, British Columbia and North Western Canada have all been heavily exploited in the past and efforts to manage the fisheries in a sustainable manner have been implemented.

Due to the fact that 80 per cent of the world's sea urchin roe production is consumed in Japan, Japanese efforts to manage and enhance their own fishery is the most advanced. They utilise six species of sea urchins, with the main fishery concentrated on the northern end of Hokkaido. Their enhancement programmes include several options such as: reseeding using hatchery spat, habitat modifications, transplantations, open and closed seasons, maximum landing size and total allowable catch. Their reseeding programme is very well organised and heavily backed by Central Government. In 2000 alone over 84 million was seeded out with *Strongylocentrotus intermedius* accounting for 84 per cent. In tandem with this, extensive studies have also been undertaken to ascertain the value of reseeding urchin grounds. In two separate studies it was estimated that reseeded sea urchins accounted for 62 – 80 per cent of total landings.

The Chileans and Norwegians are both looking at alternative methods of growout cage culture. The Norwegian system is more complex. A new type of cage for ongrowing urchins has been developed by a Norwegian equipment manufacturer, on the basis of research conducted at Fiskeriforskning. A full-scale sea-based prototype has been developed and trialled. The system comprises three main sections: a raft, a ladder cage and crates where the urchins are housed. The unit looks like a ladder lying in the sea and is called a "ladder cage". Stacks of crates holding the urchins are placed within a frame placed in the ladder's spaces. The frame is raised with a winch, and individual crates can be manipulated one at a time. According to the manufacturer, this makes it possible to efficiently handle large quantities of sea urchins with ease.

The Chilean Instituto De Fomento Pesquero (IFOP) is investigating a much simpler system. Two types of cages are being looked at. The first type is made of metal lined with a plastic mesh and suspended from a single head rope mussel line. They are deployed at a depth of 2 metres at intervals of 1.5 metres. The lines are about 80 metres long, and can accommodate about 50 cages. The cage mesh has a plastic zipper for ease of access to the urchins. The cages dimensions are 1 metre x 1 metre x 0.25 metre. Initial stocking density is 5,000-10,000 per cage depending on sizes. Generally sizes range 5 millimetres – 15 millimetres.

A bottom cage is also being developed by IFOP. It is made out of plastic and covered with a mesh with an internal area of 13 metres square. The cages are weighted down and deployed at a depth of 4 metres.

How long to market

Current trials indicate that it takes at least four years to ongrow relayed hatchery-reared urchin spat to market size in natural rockpools. Indications are that urchins will grow faster in cages, taking only three years to attain market size.

The economics of urchin farming

Definitive information is hard to come by, particularly because all the extensive reseeding trials have been undertaken in the Far East, and much of this type of work is still in its infancy. Reseeding efforts are reported to have shown mixed economic results. However, one extensive analysis of sixty sites in Northern Japan indicated that 58 demonstrated a positive economic return with an average $2 in revenue being earned for every $1 invested.

The market for urchins

The sea urchin is considered a delicacy and has a high commercial value. The edible part of the animal are its gonads, and urchins are sold either live or the gonads are removed and sold separately for instance as vacuum packed or canned product. It is estimated that 80 per cent of the world's supply of urchins is consumed in Japan, and Japan imports from at least 13 countries on five continents. France is the main market for sea urchins in Europe.

The French market

France has experienced a rapid decline in its sea urchin fishery dropping from a peak production of 400 tonnes in 1992 to a low of 50 tonnes in 1997/1998. Landings recovered somewhat in 2000/2001 when in the region 200 of tonnes were fished, however recent indications are that the fishery is now in serious decline again.

Three main species of urchins are found on the French market: the Green urchin, *Psammechins miliaris*, Blue urchin, *Sphaerechinus granularis* and the Purple urchin, *Paracentrorus lividus*. In France, urchins are considered a luxury and are not widely consumed by the public.

There are three markets in France for urchins which are broadly independent of each other. The Paris market is dominated by expensive restaurants. The market in Marseilles, the Mediterranean market is for cheaper and what might be considered poorer-quality urchins. The market in Brittany is for traditionally-fished, good-quality urchins.

The Mediterranean market

The urchins from the Mediterranean have specific characteristics in terms of presentation and taste. The main commercial species are the purple urchin. The green urchin from the Sete area is marginal. These urchins are generally sold by the dozen (20-24 urchins/kilogram) and the majority are sold direct. Because the urchins are of a very similar quality and the market is seen to be "closed" it is very difficult for a seller with urchins with different characteristics to break into the market.

The Parisian market

The Parisian market is dominated by the restaurant trade. The wholesale market, Rungis, is the main distribution centre for urchins in Paris. 80 per cent of sales of urchins through Rungis go directly to Restaurants, with the remaining 20 per cent going to fish shops.

Purple urchins for the Parisian market have traditionally been supplied from the Mediterranean area. Seeing this opportunity, fishermen in Brittany started to exploit their local urchin resources but have been rapidly faced with declining catches with overexploitation of urchin stocks. It was at this stage that France started to import urchins. Ireland's urchins are considered by the French to be very similar to Brittany's Purple urchin, and they are therefore well received in the market place. On the contrary, urchins from Spain are considered poor quality and are often badly graded, and so cannot command a premium price on the market. The green urchin, *Psammechinus miliaris*, used to be the most popular urchin, but an unrealistic price has led this species to almost disappear from the market. At present, the most preferred urchin is the purple one. In 2002, Rungis wholesale average selling prices ranged from €11.7 to €13.7/kilogram, however good-quality product can be purchased by wholesalers at around €12 to €15/kilogram. Rungis market imports urchins from Ireland, Norway, Turkey, Spain, Portugal and Greece.

French market potential

As yet the market for canned or preserved urchin gonad has not yet been established in France. The market still remains traditional and specialised. The gonad index, homogeneity in gonad level in the batch and freshness of product still remain key elements in the pricing of urchins. The distribution channel is small, specialised and confidential. The opportunity exists for Irish urchin exporters to penetrate the Rungis market. Because Irish urchins are considered to be similar to the Brittany urchin there is a ready market for them. Given past French production figures and their import requirements, French needs can be expected to be in the region 400 tonnes per annum, and that market is presently undersupplied.

The Japanese market

Table 5.3 Details of Japanese sea urchin imports for year 2000

Item	Sea Urchin
Import	13,774 tonnes (up 6.2%) value $267.11m
Custom tariff	7%
Import price per kg	€19.39
Market share	The US (19.4%), Chile (15.9%)

Table 5.4 Sea urchin imports in Japan

Year	1998	1999	2000
Value (1,000 US$)	235,268	255,719	267,114
Quantity (mt)	12,409	12,971	13,774
US$/kg	18.96	19.71	19.39

Source Trade Statistics, The Japanese Ministry of Finance

Conclusion

Ireland had an important and valuable urchin fishery, and Irish urchins are still comparable with the very best of product coming from the traditional fishery in Brittany. The opportunity exists to re-establish this fishery with hatchery-reared spat from Ireland's only urchin hatchery. There is no expensive capital outlay for ongrowers who simply place juveniles in licensed intertidal and subtidal pools, and wait for the animals to grow to market size.

Conclusions

At BIM, we're taking a slightly different view to the farming of novel species and not following the general stampede in the direction of cod farming. While it may prove a viable proposition for some operators, production costs remain stubbornly high, fillet yields are comparatively low and the market may flood quite quickly with the rapidly increasing output from farms in Norway and, to a lesser extent, Scotland.

The best cod farmers in the best locations will probably make money, but it will be a challenge to maintain an adequate return. In our view it is unlikely that there will be a prolonged "honeymoon" period with high prices for farmed cod, thus new producers feeling their way are likely to be at a disadvantage unless they can get their production efficiencies up to a competitive level very quickly. The window of opportunity for cod will not stay open very long and those countries and companies that have a head start are likely to emerge as the winners in the longer term.

Our market-led research tells us that other novel species, in particular perch, for which there is strong market demand but short supply, may offer more attractive economic possibilities in the diversification of Ireland's fish farming industry. Ireland has some unique natural advantages with regard to perch farming, which would give our farmers a position of competitive advantage on a long-term basis if the sector were to take off in Ireland.

The novel shellfish species, abalone and urchins also present their own opportunities. With the long-term supply shortfall in the market for abalone, Irish abalone farmers, could profitably exploit certain niche markets and, for example, aim to supply the high-priced Asian restaurant sector in Europe with a quality-assured, differentiated product.

Urchins from Ireland have a long history in the European marketplace and Irish-grown urchins compare favourably with the very best of product coming from the traditional fishery in Brittany, France. Extensive farming of sea urchins represents a low capital investment option for Irish fish farmers. Not only does this have the potential to produce a supply of marketable urchins, but it also provides an opportunity to re-establish Ireland's natural urchin fishery in selected areas based on hatchery-reared spat from Europe's only commercial hatchery.

Looking at aquaculture from a different perspective, market research shows the seahorse to be a species in great demand, particularly for the aquarium market as opposed to the seafood or traditional remedy markets.

So, what advice is BIM giving on investing in these "new to culture" fish species?

Be positive, but cautious, with cod and why not look carefully into the interesting possibilities in perch, abalone, seahorses and urchins. Potentially there are great prospects for these species in Ireland and the indications are that there will be continuing good demand in the marketplace in the medium-term with associated high prices.

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