Potential Diversification Opportunities for the Land-Based Aquaculture Sector in Northern Ireland
Potential Diversification Opportunities for the Land-Based Aquaculture Sector in Northern Ireland

This project was supported by the European Fisheries Fund 2007-2013 and the Department of Agriculture and Rural Development

Co-financed by DARD and the European Fisheries Fund

Report by AM Consultancy

February 2011
Executive Summary

There is no question that the overall level of wild catches of fish is in decline; this is supported by a vast amount of evidence. This has also coincided with an enormous growth in the number of products produced through aquaculture on a world-wide scale. It is also very clear that Europe is considered to be the most important seafood market globally with a value of £55 billion. Conversely, the level of aquaculture production in the EU lags far behind other markets in the world. The European Union is by far the world's biggest importer of fish, seafood and aquaculture products. To put this into perspective, seafood consumption in Europe represents 12% of the total overall global figure, but it only accounts for 5% of the production. This means that Europe is the leading net importer at 9 million tonnes per annum which is twice as much as the US or Japan.

Speaking at the Aquaculture Europe Conference 2010 held in Portugal, Philippe Paquotte of the European Commission Markets and Trade said that the current situation, “gives rise to a huge and growing market potential for aquaculture products” but warned that “the industry should identify and take into account consumer trends to ensure profitable outlets for products”.

It is against this background and other EU communications, for example, ‘Strategy for the Sustainable Development of European Aquaculture (COM (2002), 511)’ and ‘Building a Sustainable Future for Aquaculture: A New Impetus for the Strategy for the Sustainable Development of European Aquaculture (COM (2009) 162)’, that this report has been commissioned by Aquaculture Initiative and supported by European Fisheries Fund administered through the Department of Agriculture & Rural Development. The research on ‘Diversification Opportunities for the Land-Based Aquaculture Sector in Northern Ireland’ is presented as a discussion document that has been achieved by working in partnership with many different groups to provide the aquaculture sector with some market insight into possible development opportunities.

The first chapter begins by providing an overview of the current global and European profile in terms of fisheries and aquaculture production. There is discussion of the EU strategy documents in relation to the Northern Ireland context and the Fisheries Forum report, developed by the Department of Agriculture & Rural Development in collaboration with the aquaculture sector and forms an overarching strategy. The aim and objectives of this Aquaculture Diversification report are subsequently identified, as is the list of species for preliminary research purposes. The methodology used to conduct the research is described here and a general overview of the Northern Ireland aquaculture sector is provided. The final summary investigates how the other regions such as England, Wales, Scotland and the Republic of Ireland have responded.

Chapter 2 then covers the species research and diversification opportunities. It commences with a profile of European and Northern Ireland trout production. This is followed by an in-depth analysis of the species that were selected in the original remit, namely, perch, turbot, pollan, sea bass, eels and tilapia. This also includes different aspects such as production, market, prices, product specifications and a summary of the key points for each.

The concept of quality is investigated in Chapter 3 and includes some examples of current standards and management systems that are available i.e. EN45011, HACCP, ISO, ECOPACT, GLOBALG.A.P. and the EU Protected Food Name Scheme. The importance of traceability within the supply chain is also explained as well as which quality systems are most recognised by consumers.

Chapter 4 examines some of the issues to be considered by current and potential new aquaculture entrants when investigating the production of a new aquaculture species in Northern Ireland. There is a generic overview of some of the financial, technical and legislative elements to be taken into account, with a focus on operating costs, capital costs, statutory licenses required and site selection.

Chapters 5 and 6 draw conclusions on the viability of establishing production of the candidate species in Northern Ireland along with a number of strategic and species specific recommendations. It is hoped that these recommendations can be used by the public and private sectors to stimulate new investment into aquaculture diversification in Northern Ireland.
Acknowledgements

I would like to thank those in the aquaculture industry and other professionals alike for co-operating with this report, giving up their time and for providing their valuable contributions that have helped to inform and shape this work and helped to make this research as comprehensive as possible.

Producers
Glenoak Fisheries, Otterburn Farm, Silverstream Fisheries, Blue Valley Fish Farm, Rocks Lodge Trout Farm, Sperrin Mountain Spring Hatchery, Island Shellfish and Frank Newell.

Producers
Kelly’s Fish, TH Nicholson and Rooney Fish.

Importers/Exporters
McIlroy’s, Gebr Dil, Comestible Copro, Irish Seafood Producers Group, JPL Shellfish, Shetland Seafood Auctions, Ward’s Fish and Bengate Trading.

Agencies and Industry Professionals
Aquaculture Initiative: Martin Flanigan, Mike Murphy, Damien Toner and Joanne Gaffney; Bord Iascaigh Mhara: Lucy Watson; Seafood: Craig Burton, Lynn Gilmore; IMARES: Edward Schram; University of South Bohemia: Tomas Policar; Aquaculture Consultant: Kees Kloet; Billingsgate Market: Adam Whittle and the Department of Agriculture & Rural Development: Kenny Parker and Ronnie McBride.

Nicola Donnelly
2.3.3 Production Systems
2.3.4 Cost of Producing Juveniles
2.3.5 Logistics and Market Conditions
2.3.6 Prices
2.3.7 Product Specifications
2.3.8 Issues
2.3.9 Summary

2.4 Turbot
2.4.1 Introduction
2.4.2 Habitat and Biology
2.4.3 Production Systems
2.4.4 Cost of Producing Juveniles
2.4.5 Logistics and Market Conditions
2.4.6 Prices
2.4.7 Product Specifications
2.4.8 Issues
2.4.9 Summary

2.5 Pollan
2.5.1 Introduction
2.5.2 Habitat and Biology
2.5.3 Production Systems
2.5.4 Cost of Producing Juveniles
2.5.5 Logistics and Market Conditions
2.5.6 Prices
2.5.7 Product Specifications
2.5.8 Issues
2.5.9 Summary

2.6 Seabass
2.6.1 Introduction
2.6.2 Habitat and Biology
2.6.3 Production Systems
2.6.4 Cost of Producing Juveniles
2.6.5 Logistics and Market Conditions
2.6.6 Prices
2.6.7 Product Specifications
2.6.8 Issues
2.6.9 Summary

2.7 Eels
2.7.1 Introduction
2.7.2 Habitat and Biology
2.7.3 Production Systems
2.7.4 Cost of Producing Juveniles
2.7.5 Logistics and Market Conditions
2.7.6 Prices
2.7.7 Product Specifications
2.7.8 Issues
2.7.9 Summary

2.8 Tilapia
2.8.1 Introduction
2.8.2 Habitat and Biology
2.8.3 Production Systems
2.8.4 Cost of Producing Juveniles
2.8.5 Logistics and Market Conditions
2.8.6 Prices
2.8.7 Product Specifications
2.8.8 Issues
2.8.9 Summary

2.9 Survey Feedback
2.9.1 Introduction
2.9.2 Pike Perch
2.9.3 Multi-species culture
2.9.4 Fry and Fingerling Production
2.9.5 Oyster hatchery
2.9.6 Sea Trout

3.0 Quality, Organic and Environment
3.1 Introduction
3.2 Current Quality Standards
3.2.1 European Standard EN45011
3.2.2 Irish Quality Scheme
3.2.3 International Standards Organisation (ISO)
3.2.4 British Trout Association (BTA)

3.3 Organic Standards
3.3.1 Introduction
3.3.2 European Guidelines
3.3.3 Soil Association

3.4 Traceability Process Quality and Food Safety
3.4.1 Introduction
3.4.2 Hazard Analysis and Critical Control Points HACCP
3.4.3 GlobalG.A.P.
3.4.4 EU Protected Food Name Scheme

3.5 Environmental Quality
3.5.1 Introduction
3.5.2 Legislative Framework
3.5.3 European Eco-Management and Audit Scheme (EMAS)
3.5.4 ECOPACT
3.5.5 Eco-label Europe
3.5.6 Aquaculture Stewardship Council (ASC)

3.6 Recognition of Quality Systems
3.7 Summary

4.0 Financial and Legislative Consideration of RAS
4.1 Financial Elements of RAS
4.2 Technical Considerations
4.3 Statutory Consents
4.4 Future Prospects for RAS

5.0 Conclusions for Candidate Species
5.1 Introduction
5.2 Perch
5.3 Turbot
5.4 Pollan
5.5 Seabass
5.6 Eels
Potential Diversification Opportunities for the Land-Based Aquaculture Sector in Northern Ireland

5.7 Tilapia
5.8 Feed

6.0 Discussion and Recommendations

6.1 Introduction
6.2 Barriers to Diversification
6.3 Recommendations
6.3.1 Species Specific Recommendations
6.3.2 Strategic Recommendations
6.3.3 Proposed Action Points

Appendix 1: European Fisheries Fund Regulations for Aquaculture
Appendix 2: Contact List
Appendix 3: Questionnaire
Appendix 4: References
Appendix 5: Site Survey Format

Glossary

Artemia - Brine shrimp. One of the most commonly used live foods for larval stages of fish.

Benthic- Pertaining to the bottom terrain of water bodies.

Bord Iascaigh Mhara - Irish Sea fisheries Board

Broods - A batch of fish larvae

Extensive - Extensive aquaculture is characterised by a low degree of control, low initial costs, high dependence on local climate and water quality.

DARD - Department of Agriculture and Rural Development

Demersal - Living on or close to the bottom of a pond lake or the sea

EFF - European Fisheries Fund

Elvers - A young eel. A developmental stage of the eel, at which they have the ability to move from marine to freshwaters.

Fecundity - Number of eggs or young produced annually by a female animal or per unit of body weight.

Grading - Separating larger fish from smaller ones.

Grow out - Period of time to raise juvenile fish to a market size.

Heterogeneity - A measure of genetic variance.

Hybrid - Off spring of two fish from different species or varieties

Hybridisation - Crossing of inbred lines or individual organisms of different genetic make-up or species.

Intensive - Aquaculture cultivation is a largely controlled environment, involving a high input of energy to optimise growth and survival.

Milt - Sperm bearing fluid of fish.

Notifiable - A notifiable disease is one that must be immediately reported to the agricultural authorities.

Pelagic - Living or occurring in open water areas of lakes or oceans

Peristaltic pump - Pump often used in hatcheries to deliver fluids periodically to a holding unit.

Perca Tech - European funded project whose main aim was to secure the production of Eurasian perch juveniles in order to sustain the development of European SME’s.

Plankton - Passively drifting or weakly swimming organisms, many microscopic plants (phytoplankton) and animals (zooplankton)
1. Background

1.1 Global Profile

It has been widely accepted that global aquaculture has developed at an enormous rate over the last number of decades and continues to be one the fastest growing food-producing sectors in the world. According to the Food & Agriculture Organisation (FAO), annual Aquaculture production was less than 1 million tonnes in the 1950’s while this figure was estimated to have increased to 51.7 million tonnes by 2006. Today the European Commission states that aquaculture produces nearly half of all the fish that are consumed across the globe.

The largest producer, on a global scale, is the Asia-Pacific region which supplies 89% of total production and generates 77% of the value. FAO also indicates that this situation is, in part, due to the capacity of China which contributes 67% towards global production in terms of volumes and 47% of total global value. Norway and Chile dominate the culture of salmon and account for 33% and 31% of the market respectively while Canada and Britain (primarily Scotland) collectively represent 20% of total market share (Fish Farmer, February 2010).

This development should be understood within the context of fisheries in general, since the availability of wild catches through capture fisheries has been decreasing over time and indeed reached a plateau during the 1980’s, while fish consumption doubled throughout the years 1973-2003 (www.eubusiness.com). In addition, per capita figures demonstrate that consumption has increased from 0.7kg in 1970 to 7.8kg in 2006 and this represents an average growth rate of 6.9% per year. According to FAO, 19% of the major commercial fish stocks are overexploited, 8% are depleted and 1% is recovering from depletion.

If current projections become reality, for example, if population figures continue to rise as they have been expected to do, there is a further opportunity for aquaculture to maximise its potential, however, this would imply that global aquaculture production will have to achieve 80 million tonnes by 2050 in order to sustain the present levels of per capita consumption.

1.2 Local Profile

Northern Ireland is a relatively small area compared to many of the world’s major aquaculture producers, however, the region has the potential to become a significant producer in its own right. The development of land-based aquaculture in Northern Ireland has been limited to date, with the majority of production currently occurring in the sea off the coast of the region. However, there are several potential opportunities for diversification that could be explored in order to increase the region’s production capacity.

RAS (Recirculation Aquaculture System) - A closed or partially-closed system employed in aquaculture production where the effluent water from the system is treated to enable its reuse. Usually a relatively small proportion of the actual water flow is exchanged per unit time.

River Basin - A model for a single system of water management. Where a river basin is the natural geographical and hydrological unit, - as opposed to trying to manage water bodies according to administrative or political boundaries.

Rotifers - Group of microscopic aquatic animals. Important for being used as live food for fish larvae in hatcheries.

Vitelline - Fish egg membrane

Yolk sac - A sac-like organ that encloses the yolk of a fish egg.

Zooplankton - Animal component of plankton. i.e. weakly swimming organisms often microscopic.
significance for the European market and statistics indicate that while global production improved by approximately 9% per year from 1996-2004, production within the EU rose only by 3-4% up until 1999 (www.eubusiness.com). By 2004, EU aquaculture represented approximately 2.3% of total world production and, since then, aquaculture production is considered to have slowed down or, worse still, stagnated altogether. It has been recognised that Europe is at the forefront in terms of research and technological development and it is committed to exemplifying high standards and maintaining sustainable growth, however, this has not translated into a significant increase in production.

This sentiment has been expressed by the then Commissioner for Maritime Affairs and Fisheries, Joe Borg in 2007:

“Aquaculture has a bright future ahead of it in providing Europe's discerning consumers with high quality, healthy fish products. However, today its potential is far from being fully realised. It is time for it to get its full share and to give this strategically important sector an equal voice, and – quite literally – the place it needs to develop” (European Commission).

1.2 European Profile

A large proportion of European aquaculture is derived from freshwater fish farming such as trout and also from marine mollusc farming which predominantly consists of mussels, oysters and clams. The profile of these sectors is typically traditional SME's that either employ less than 10 individuals or are family run enterprises (World Fishing & Aquaculture, January 2010). As Europe expanded so did the amount of additional freshwater production, in particular carp and trout, bringing both benefits and specific issues to the fore.

The lack of significant progress in aquaculture expansion was the impetus for the first Communication from the Commission published in 2002 and entitled ‘Strategy for the Sustainable Development of European Aquaculture’ (COM (2002), 511). The aim of this communication was to assist with the development of conditions that would enable the aquaculture industry to become more sustainable and to realise their potential by improving their competitiveness in the marketplace.

The objectives of the strategy were to:

- Ensure that there are healthy, safe and good quality products available to consumers while promoting high animal health and welfare practices;
- Provide an environmentally sound industry.

There was a lot of emphasis placed on the necessity for research in relation to species diversification and this area was highlighted as one of the key priorities that needed to be addressed specifically for fish and molluscs. Furthermore, it suggested that the identification of new species would need to be consistent with consumer preferences and market trends.

In 2007, it was decided that the initial 2002 objectives had not been achieved completely. Furthermore, it was conveyed that aquaculture was being hindered by its inferior position of not being equal within marine and maritime development.

Therefore, a new strategy was proposed that would incorporate and involve the role of public authorities in future development (World Fish & Aquaculture, January 2010). This strategy is titled ‘Building a Sustainable Future for Aquaculture: A New Impetus for the Strategy for the Sustainable Development of European Aquaculture’ (COM (2009) 162). The vision of this strategy was to elevate European aquaculture production as the future leader of sustainable development. This was supported by organisations such as the Federation of European Aquaculture Producers that went further to say that:

- Europe should be acknowledged through the implementation of certification systems, that demonstrate products have been handled and produced in a safe way and to the highest standards, rather than the current situation that has encouraged imports to be more competitive, but not subject to the same legislation and policies;
- There is a necessity to address the challenges facing the sector including competition for space, complicated licensing and legislative process;
- More effort is required to promote and improve the sector’s competitiveness.

(www.aquamedia.org)

1.3 Northern Ireland Context

1.3.1 Introduction

DARD's records indicate that in 2009 there were 81 licensed fish farms (covering 95 sites), of which 48 are licensed for the cultivation of shellfish and 33 for the cultivation of finfish (31 inland and 2 marine sites).
The sector is characterised by micro-businesses and small to medium sized enterprises which produce species such as salmon, rainbow trout, sea trout, arctic char, rope mussels, bottom mussels, pacific oysters, native oysters, scallops and clams. In 2009, the aquaculture sector produced 8,328 tonnes of shellfish valued at £5.78 million and over 1,120 tonnes of finfish valued at £3.26 million (Source DARD). In total the aquaculture sector directly employs 113 full time and 48 part time employees.

While the sector is considered to be relatively small when compared to Scotland and the Republic of Ireland, it still has a significant role to play in creating and supporting employment in the rural communities of Northern Ireland. These are challenging times for business development with rising costs and decreasing consumer expenditure thus aquaculture expansion will require a measured approach and some innovative thinking.

Similarly, the sea fisheries and processing sectors in Northern Ireland are also facing challenges with external pressures that threaten their sustainability. The major priority for the processing sector at the moment is to address the lack of raw material supply. There is an opportunity for aquaculture to co-operate and work in partnership with processors to provide an alternative, primary resource.

In 2008, an Issues Paper was prepared by the Department of Agriculture & Rural Development in consultation with members of the Fisheries Forum including both the sea fisheries and aquaculture sectors. This communication was used to determine the key areas that each sector would like to see addressed. As regards the aquaculture industry, the following were considered to be the most immediate:

- To determine the potential for significant development/expansion and the means by which this could be achieved;
- To establish if there was a need for a separate strategy within the overarching Fisheries Forum strategy;
- To determine whether the sector can become more cohesive;
- To determine the scope for locally produced aquaculture products to be able to differentiate themselves possibly in terms of regional branding or organic status;

1.3.2 Fisheries Forum Report

In April 2010, the Fisheries Forum produced a report for submission to the Minister for Agriculture & Rural Development, Michelle Gildernew. This report recognised the contribution that aquaculture makes towards the local economy and the potential for further expansion. It emphasised the need for seafood and aquaculture to be more integrated and work on a co-operative basis particularly in relation to inshore fisheries, the environment, processing, branding, marketing, reputation and strategic development. The vision outlined in this document is demonstrated in the statement below:

“A sustainable, profitable and self-reliant seafood and aquaculture industry which maximises its contribution to the coastal communities and the rural economy and which is based on fish stocks managed at sustainable levels and which operates in an environmentally sustainable manner”.

The above paper supports the Communication circulated from the EU and believes that there is an opportunity to develop a cohesive and well represented sector that produces high quality products using sustainable means.

It is against this background that the research conducted in this report has been commissioned by the Aquaculture Initiative and supported by the Department of Agriculture & Rural Development (DARD) through the European Fisheries Fund. In discussions with representatives from the grants and policy section of the Department, they indicated that they would like to see the industry exploiting opportunities and furthering aquaculture development. They feel that this is demonstrated by their response to an industry request for additional funding which has been approved and is currently available.

In terms of changing production to a new species, they advised that the applicant is required to apply to DARD to have their fish culture licence amended. This process will also involve a public consultation exercise. They verified that a producer can apply to have multiple species on a licence, for example, they could add tilapia and still retain authorisation to allow them to continue cultivating trout. In these cases, the Department may seek assurances that the species being produced are kept in separate facilities. In addition, there are specific guidelines concerning the use of alien and locally absent species in aquaculture contained in Council Regulation (EC) No 708/2007.

1.3.3 European Fisheries Fund (EFF)

In August 2009, the Minister for Agriculture & Rural Development, Michelle Gildernew, announced the opening of the first three measures of the European Fisheries Fund (2007-2013) which was proposed and designed by the European Commission to provide support to the fisheries and aquaculture industry with the following aims:
To support the Common Fisheries Policy by exploiting living natural resources in a way that creates the necessary conditions for sustainability in economic, environmental and social terms;

- To strengthen competitiveness and the development of economically viable enterprises in this sector;

- To foster the protection of the environment and natural resources;

- To encourage the sustainable development and the improvement of the quality of life in the marine, lake and coastal areas affected by fishing and aquaculture activities

- To promote equality between men and women in the development of the sector and coastal fishing areas.

Financial support is awarded under four priority axes:

- Adaptation of the community fishing fleet;

- Aquaculture, inland fishing, processing and marketing of fisheries and aquaculture products;

- Measures of collective benefit;

- Sustainable development of fisheries areas.

In relation to EFF, Northern Ireland is categorised as an area with non-convergence status and received approximately €18.1 million of EFF grant aid which was matched by national funding in Northern Ireland bringing the total to over €36 million.

The measures including Collective Actions; Productive Investments in Aquaculture and Investments in Processing and Marketing are currently open to the local industry and funds are available for projects dependent on eligibility. The rules governing the implementation and administration of EFF are contained in the Council Regulation (EC) No 1198/2006 and the Vademecum. Information from the Council Regulation that relates specifically to aquaculture can be found in appendix 1. There are guidance notes available to assist with completing applications for Investments in Aquaculture. Prospective applicants are advised to liaise with the grants section of the Fisheries and Climate Change Division in DARD, Aquaculture Initiative, and EFF Facilitator, Lynn Gilmore.

While there is acknowledgement that aquaculture is extremely important as a sector and this is becoming increasingly so, it is clear that there needs to be more direction and input into how aquaculture can further unlock its potential and grasp the opportunities that are available.

1.4 Aquaculture Diversification Report

Objectives ‘Research and produce a report on the potential diversification opportunities for Northern Ireland’s land-based aquaculture sector’.

The key objectives and criteria for this work are:

- To develop a profile for the local land based aquaculture sector in Northern Ireland looking particularly at how the sector can strategically progress;

- To provide recommendations on how the portfolio of species can possibly be expanded to achieve these objectives;

- To produce a scoping report that will provide a comprehensive profile of land based aquaculture production;

- While doing so, there will be an emphasis on supplying and using information that is as contemporary as possible unless it is relevant to the discussion;

- It is hoped this method will allow the sector to make management decisions based on current market information rather than rely completely on historical trends;

- To conduct some research into species of interest to the land-based aquaculture sector in Northern Ireland. In this instance, there was a number of species identified initially for further investigation and this list included;

  - Perch
  - Pollan
  - Eels
  - Turbot
  - Sea bass
  - Tilapia

- Technical, legislative, environmental and economic framework.

References to the value of the fish species are given primarily in Sterling. Also some species are referred to by their value in Euros, as this is the predominant currency that the species is either produced or marketed. For example, perch are only produced in
the euro zone and there is no home UK market. Many producers discuss fish prices and fish feed prices in Euros.

As strong emphasis was placed on the importance of the report being carried out as a collaborative exercise. This was achieved by consulting with a diverse group of stakeholders including Aquaculture Initiative, DARD, producers, processors, importers/exporters, trade representatives and agencies. This work was also supported by researching industry reports, trade publications and journals, technical requirements, and legislative and economic factors.

1.5 Land-Based Systems

In this report by “land-based systems” we are referring to;

Recirculating Aquaculture Systems (RAS) or flow-through systems. The distinction between these systems is the extent to which water is reused or recirculated.

In RAS either some (Partial re-circulation) or the entire outflow water is treated and subsequently returned to the culture system (Full re-circulation). The level of water recirculated can vary from 50%-99% although a large proportion of farms normally achieve between 95% and 99%. The advantages of such systems include:

- Reduced land and water use;
- Strict water quality control;
- Lower environmental impact;
- Higher biosecurity;
- Better control of waste production.

RAS technologies are used throughout Europe to produce a variety of species and have been successfully applied to one or more stages of development such as the cultivation of fingerlings, on-growing and broodstock. It is also important to note that fish produced for their entire life cycle from recirculation systems cannot at present achieve organic accreditation.

There are a range of technologies available producing a variety of species both on a European and worldwide basis.

1.6 English Aquaculture Sector

1.6.1 Introduction

In April 2009, Department for Environment & Rural Affairs (DEFRA) commissioned ‘A Strategic Review of the Potential for Aquaculture to Contribute to the Future Security of Food and Non-Food Products and Services in the UK and Specifically England’. In this document, it states that it would be significant if the UK and in particular England could:

- Reduce its prospective dependence on aquaculture imports;
- Ensure that seafood is accessible and affordable;
- Produce sustainable species;
- Potentially offer products for export that are healthy and of a relatively high value.

1.6.2 Species Profile

England contributes around 6% to the overall UK production of aquaculture products. This total represents around 11,373 tonnes of all species and the largest proportion of these volumes consists of rainbow trout and mussel culture. In 2006, the farm gate value of fish in England and Wales amounted to approximately £23 million. The figure can be further sub-divided into the following sub-categories:

- £13 million for salmonids;
- £0.5 million other food fish;
- £10 million coarse fish for re-stocking of fisheries and ornamental purposes.

1.6.3 Opportunities

According to James and Slaski (2009), the main species that have potential for ‘reasonable growth’ in the short to medium term is Atlantic salmon and mussels. They believe that trout production has generally levelled off, however there could be some opportunities for further growth within this sector and also in Pacific oyster production. In addition, they suggest that values for some niche products may be enough to inspire further development especially if there is a restriction on imports or sustainable production methods are developed. There has also been a rapid increase in the number of farms producing tilapia.
1.6.4 Production Technologies

The report commissioned by DEFRA highlights the potential for exposed and offshore cage production to assist with expansion of aquaculture in England. They indicate the existence of some pump ashore or re-circulating technologies which may develop further, however, it does warn that economics of using such systems still remain an issue. Furthermore, it states that future aquaculture development is less likely to occur in floating cages due to limitations within the Water Framework Directive. It envisages that the most appropriate technology for the cultivation of finfish is land-based including:

- Freshwater tank and pond farms which combine gravity feed and pumped waters. It is likely to have a high degree of water re-use and some form of effluent treatment;
- Marine land-based tanks or pond / raceway farms based on low-lying coastal ground, involving water re-use and recirculation to a greater or lesser extent.

1.7 Welsh Aquaculture Sector

1.7.1 Introduction

In 2008, the Department of Rural Affairs published ‘Wales Fisheries Strategy’ which was presented as the Welsh Assembly Government’s long term strategy for the management and development of fisheries in Wales across all sectors of aquaculture, commercial fisheries, and recreational fisheries up to 2020.

In this document, there were a number of key objectives highlighted including:

- The development and management of fisheries that contribute sustainably to the environment;
- The development and management of healthy fish stocks;
- Recognising positive community role through the contributions that fishermen have made;
- Maximising economic contribution towards the development of the ‘Wales’ brand;
- Continuing to support existing partnerships.

1.7.2 Species Profile

Aquaculture production in Wales contributes around 6% towards the UK aquaculture total (James and Slaski, 2009). Historically, aquaculture production on a commercial level has involved the cultivation of trout for the table market, stocking and recreational fisheries as well as seabed shellfish production (Welsh Aquaculture Strategy, 2009).

The freshwater production of salmonids includes:

- 500 tonnes of rainbow trout which is supplied to the table market and for recreational purposes valued at an estimated £1 million;
- Brown trout and salmon for re-stocking fisheries worth approximately £0.5 million.

1.7.3 Opportunities

More recent advancements in terms of the development of Welsh aquaculture production are summarised below:

- 1,000 tonnes of land-based marine finfish (sea bass, turbot) produced per year
  - This has been achieved using;
  - Advanced recirculation systems
  - Expertise transferred from the Mediterranean knowledge base
- Land-based marine invertebrate production;
  - ‘King ragworm’ which has been used in the past for angling bait
  - Recent efforts to convert this as high value ‘aqua-feeds’
  - Trails have been performed to use in multi-trophic aquaculture i.e. trout/ragworm
- Other specialty and non-food projects;
  - Genetically improved tilapia for example fry and broodstock for export
  - Pacific oyster cultivation
  - Ornamental fish
  - Medicinal leeches
  - Microalgae exploitation.

The major challenge for the cultivation of marine finfish is the scale of production that would be required to compete effectively in the marketplace and the availability of sites. There is potential opportunity, however, presented in the ‘cluster’ farm approach which involves shared processing.
1.7.4 Production Technologies

In 2003, Wales established a centre of excellence ‘The Centre for Sustainable Aquaculture Research (CSAR) which has helped the region to establish a credible reputation and expertise with Recirculation Aquaculture Systems. This knowledge has also been exported to other regions globally (Welsh Aquaculture Strategy, 2009). It has also experienced industry growth in partnership with companies in relation to systems design and manufacture which has earned them a strong international presence.

1.8 Scottish Aquaculture Sector

1.8.1 Introduction

In 2003, Scotland set out its vision for the future of aquaculture in the region, “Scotland will have a sustainable, diverse, competitive and economically viable aquaculture industry, of which its people can be justifiably proud. It will deliver high quality, healthy food to consumers at home and abroad, and social and economic benefits to communities, particularly in rural and remote areas. It will operate responsibly, working within the carrying capacity of the environment, both locally and nationally and throughout its supply chain” (‘A Strategic Framework for Scottish Aquaculture’, 2003).

In 2009, a new aquaculture framework was issued and was based on six key themes:

- Healthier fish and shellfish;
- Improved systems for licensing aquaculture developments;
- Improved containment;
- Better marketing and improved image;
- Improved access to finance;
- Shellfish forum.


1.8.2 Species Profile

According to The Scottish Government, the total output for the aquaculture sector was estimated to be approximately £367 million annually at farm gate. This figure consists of around £336 million for farmed Atlantic salmon, £15 million for rainbow trout, and £8 million for shellfish. Other species such as brown trout, sea trout, halibut and arctic charr are also cultivated in Scotland (www.scotland.gov.uk). DEFRA's figures show that Scotland has the largest aquaculture sector in the UK is the largest producer of farmed salmon in the EU and the third largest producer globally following Norway and Chile. The region represents around 60% of the total UK production on the basis of value and volume (James and Slaski, 2009). In 2008, there was 128,626 tonnes of Atlantic salmon produced at 257 different marine sites. There was also:

- 7,670 tonnes of rainbow trout;
- 311 tonnes of brown trout / sea trout;
- 206 tonnes of halibut;
- 0.9 tonnes of arctic charr.

The majority of aquaculture is cultivated along the West and North of the region and supports over 6,800 jobs consisting of full-time, part-time and seasonal work for the salmon, finfish and shellfish sectors.

1.8.3 Opportunities

As discussed, farmed production of salmon has been extremely successful both in terms of the domestic and international markets although, there has been some caution expressed in relation to an over-reliance on one dominating species. The Scottish Executive has been eager to encourage diversification and reduce the ‘vulnerability of workforce and communities through the industry’s excessive dependence on one farmed species’.

There have been successful attempts within the industry to produce alternative species. An example of this is Gigha Halibut which began farming in the 1990’s. They produce around 200 tonnes of the species per year which accounts for approximately 80% of halibut directly available to market in Scotland. Their primary market is the UK with the US market accounting for 30% of sales. They use a land-based fish farming system. Ardtoe Marine Laboratory or Viking Fish Farms Ltd have also been involved with the production of breeding stocks for haddock, turbot, sole, whiting, goldsinny wrasse and ballan wrasse (www.ardtoemarine.co.uk). The Scottish Aquaculture Research Forum also indicates that they have recently begun the establishment and development of broodstock for European hake (www.sarf.org.uk).

1.8.4 Production Technologies

Production in Scottish aquaculture is mainly carried out in marine cages; however, there has been some recent growth in the use of land based systems e.g. Gigha Halibut. While there is support for land based aquaculture units there is concern over the space that would be required to achieve required tonnage. Development on land is
subject to planning permission and to suitability for aquaculture, so site selection is important. In addition, the capital and running costs are much higher in such systems. The refinement of recirculation technologies has resulted in a large increase in the amount of freshwater salmon smolt units using such technology, with prospects for juvenile production for halibut, cod and potentially haddock in the future.

1.9 Republic of Ireland Aquaculture Sector

1.9.1 Introduction

In 2006, a report was published by the Seafood Industry Strategy Review Group, ‘Steering a New Course: Strategy for a Restructured, Sustainable and Profitable Irish Seafood Industry 2007-2013’. In this, specific reference was made to the development of the aquaculture industry and outlined in the following statement:

“Significant development and expansion of the aquaculture sector, within the context of clearly defined national policies, output targets and an efficient licensing regime and supported by an Aquaculture Development Programme spearheaded by BIM” (Cawley, 2006)

The key recommendations of this document highlighted:

- A sustained, fact based communications programme run by State Development Agencies with industry support, should be undertaken to engender greater acceptance of aquaculture as a sustainable and legitimate activity by other stakeholders in the coastal zone;
- Review the current licensing and regulatory regime;
- Implement an Aquaculture Industry Development Programme.

1.9.2 Species Profile

The above strategy document was then followed by ‘Status of Irish Aquaculture 2007’, commissioned by BIM, which provided a profile of the aquaculture industry. In 2007, total aquaculture production on the basis of volume for the shellfish and finfish sectors was 48,350 tonnes. The main species cultivated by the shellfish sector were:

- Rope mussels;
- Bottom mussels;
- Native oysters;
- Clams;
- Scallops;
- Novel shellfish including abalone, urchins and lobster.

In terms of finfish, salmon is the main species farmed. This sector also includes:

- Freshwater trout;
- Sea reared trout;
- Salmon ova/smolt;
- Novel finfish including cod, perch, arctic char and ornamental finfish.

1.9.3 Opportunities

BIM also produced a report (Seahorses to Sea Urchins: The next big splash in Irish Aquaculture, 2003) specifically looking at and highlighting species that they considered to have potential for diversification. These species included:

- Cod;
- Perch;
- Seahorses;
- Abalone;
- Sea urchins.

In 2008, a pioneering project on cod, ‘Eircode’, was launched in the Republic of Ireland by the National University of Ireland in Galway and supported by BIM. According to the Marine Institute, Eircode expects to have adult cod at sea for four years and more than 50 unique family groups by 2011 (The Fish Site, July 2010).

The Republic of Ireland has the highest number of perch farms and hatcheries in Europe. In 2000, the Republic of Ireland’s first commercial perch hatchery, PDS Irish Waters Perch Ltd was established, followed by Key Waters Fisheries. There are also three on-growing units including Emlagh Fisheries, Clune Fisheries and Ballybay Perch.

The Republic of Ireland has had six start-up farms producing abalone and the most recent opened in 2009. Within 3-5 years, Tower Aqua Products Ltd is expecting to have a total stock of approximately 2 million abalone, with an average annual harvest of around 500,000, the equivalent of 40 tonnes annually (BIM and IntraFish, 2009).

According to Fish and Information Services (2010), the University College of Cork have been using a new system to cultivate sea urchins. The technology is known as the UrchinPlatter system and allows urchins to be produced quickly and efficiently. The species are only fed with natural seaweed thus mitigating the problems that occur with
other species when using artificial feed. Gourmet Marine recently partnered with Dunmanus Seafoods Ltd to culture the first out of season sea urchins.

### 1.9.4 Production Technologies

Aquaculture production in the Republic of Ireland is characterised by a range of methods due to the diverse nature of this industry. In the case of cod farming, land based facilities have been used to rear juveniles before being transferred to sea cages. With abalone cultivation, there are plans to use a polyculture system which will involve using the output water from the shore-based farm as a source to develop special seaweeds.

### 1.10 Summary

This section demonstrates that while production levels for aquaculture within Europe are behind the global average there are many positive signs that regions, including Northern Ireland, are responding and are trying to develop individual strategies that reflect their strengths, needs, characteristics and exhibit innovative thinking. It can be seen that there is technology and expertise both within the UK and in the Republic of Ireland that can be utilised to assist diversification of land-based systems in Northern Ireland. The following table provides a brief snapshot of the types of activity that regions have been involved with traditionally, and the new areas that they have proposed to develop.

### Figure 1: Overview of Regional Aquaculture Activity in terms of Species

<table>
<thead>
<tr>
<th>England:</th>
<th>Wales:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Species</strong> — rainbow trout, mussels, salmonids, other food fish</td>
<td><strong>Main Species</strong> — trout, seabed shellfish production, blue mussels, freshwater production of salmonids, rainbow trout, brown trout and salmon</td>
</tr>
<tr>
<td><strong>New Species</strong> — Atlantic salmon, mussels, further growth opportunities for trout, pacific oysters</td>
<td><strong>New Species</strong> — land based marine fish inc. turbot and sea bass, land based marine invertebrate production i.e. king ragworm, genetically improved tilapia, pacific oyster, ornamental fish, medicinal leeches, microalgae</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scotland:</th>
<th>Republic of Ireland:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Species</strong> — Atlantic salmon, brown trout, sea trout, halibut, arctic char, mussels, pacific oysters, native oysters, king scallops, queen scallops</td>
<td><strong>Main Species</strong> — salmon, freshwater trout, sea reared trout, salmon ova/smolt, rope mussels, bottom mussels, native oysters, clams, scallops</td>
</tr>
<tr>
<td><strong>New Species</strong> — cod, development of breeding stocks for halibut, turbot, sole, whiting, goldsiline wrasse, ballan wrasse, European hake</td>
<td><strong>New Species</strong> — abalone, urchins, lobster, cod, perch, seahorses, arctic char</td>
</tr>
</tbody>
</table>
2.0 Species Research and Diversification Opportunities

Finfish aquaculture products produced in NI are primarily sold in the UK and to the wider European market. It is for this reason that the following consumption and demand statistics for aquaculture and seafood products concentrates on the European market with only a few general references made to global trends.

2.1 Trout Production

European freshwater aquaculture production is characterised, in part, by the farming of trout and, in particular, rainbow trout. It also includes the cultivation of carp and other species in smaller quantities

This scenario is also similar to the situation in Northern Ireland whereby a large part of the aquaculture sector is in trout farming. In a series of interviews with this target group it became clear that many of these businesses were established as small family run enterprises some decades ago.

In 2003, the average wholesale price for trout was €2.16* or £1.88. This had improved to €2.57 or £2.23 in 2005 although it began declining in 2006.

Unfortunately, companies in NI are finding it increasingly difficult to compete with imports from the EU due to the current economic climate, rising production costs, lack of routes to market and reduced margins. The prices for producers can vary but were quoted, in general, to be between £2.15 (£2.47)* and £2.25 (£2.59) per kg for whole fish 420-480g and £5.45 (£6.27)-£6.00 (£6.90) per kg for filleted fish.

Figure 2: Current Overview of Trout Sizes, Prices and Formats

<table>
<thead>
<tr>
<th>Marketable Size</th>
<th>Price per kg</th>
<th>Product Format</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>420-480g</td>
<td>£2.25</td>
<td>Whole fish</td>
<td>GB</td>
</tr>
<tr>
<td>420-480g</td>
<td>£2.15</td>
<td>Whole fish</td>
<td>NI/ROI</td>
</tr>
<tr>
<td>550-700g</td>
<td>£6.00</td>
<td>Filleted fish</td>
<td>GB</td>
</tr>
<tr>
<td>550-700g</td>
<td>£5.45</td>
<td>Filleted fish</td>
<td>NI/ROI</td>
</tr>
</tbody>
</table>

(Source: Feedback from NI Industry)

The cost of transportation also has an impact on margins and this, on average, is between £0.10 and £0.15 per kg. It is very important to note that the £0.15 freight charge only covers the product as far as Glasgow. For destinations such as the Manchester area, an additional £0.21 per kg is necessary as well as an extra 7% fuel surcharge which brings the total to approximately £0.37 per kg for this journey alone. The price of boxes have increased by 8% since the end of September 2010 and now cost £0.78 or the equivalent of over £0.12 per kg. Subsequently, at this time, producers can be facing total charges for freight and packaging of nearly £0.50 per kg. One producer indicated that the situation is going to become further exacerbated by more increases in overheads, as they have been told by their feed companies that the next container they purchase will cost £60 per ton more. This equates to an increase of €130 since February of 2010 further compounding the difficulties that the Northern Ireland producers are trying to overcome.

The feedback that was received overwhelmingly concurred that prices have remained relatively unchanged over the last number of years despite the fact that other costs have increased significantly, in particular, feed costs. These costs have had a negative impact on profitability and the evidence that has been presented supports that this is a stark reality for SME’s operating in this sector. The onset of the recession may have dissuaded producers further from increasing prices since there had been a widespread reduction in consumer spending.

To illustrate the disparity between the ex-farm price and retail selling point, a brief survey was carried out to determine the range of prices that trout products are sold at in Tesco, Sainsbury’s and ASDA respectively.

Figure 3: Price Comparison of Retail Trout Products

(Source: Review of Supermarket Products)

*Based on conversion rates as of October 2010 i.e. 1 EUR=0.863193 GBP (www.xe.com)
It is clear that the retail price varies significantly from the wholesale price that producers receive. With profit margins becoming increasingly narrow, this makes it extremely difficult for companies, particularly SME’s, to consider inward investment and to have access to funds that could be used to develop their businesses.  

2.2 Diversification Opportunities

In spite of economic difficulties there was, however, a positive response from most survey participants in relation to the potential for and tentative interest in diversification. Future responses are likely to depend heavily on what kind of opportunities will be presented to the sector and the level of commitment in terms of finances, resources and legislation that may be required to implement these. For some small businesses, the concept of diversification will require the introduction of technology such as new production infrastructure or different processing facilities. For others, the reality of introducing a high level of long term diversification would have to include the consideration of a facility that has the capacity and scale of production to compete and to be economically viable. It is also necessary for the farm to have access to an appropriate and effective infrastructure to ensure continuity of supply can be assured and that the quality of the product is not compromised.

The remit for this report was to scope out information on the opportunities that may exist for the existing members and new entrants to land-based aquaculture sector in Northern Ireland; therefore, a primary consideration was recirculation technology.

In preliminary discussions with Aquaculture Initiative and existing producers, there was a list of finfish species selected for further investigation. The primary remit was preferably for native species because of the minimal risk it poses for the natural environment and eco-systems. However, tilapia was also considered because it has features that make it very suitable for aquaculture production such as a high growth rate, and could be used as a contrast with other species.

It should be noted the species discussed are not exhaustive, other possibilities for the aquaculture sector in Northern Ireland and alternative opportunities that were emphasised by producers are highlighted briefly towards the end of the chapter. This does not imply that they are any less important but unfortunately due to the original remit and timescales the same effort cannot be dedicated to these at this stage. Indeed, it was raised in discussions with members of the sector that the idea of diversification should not be limited to a prescriptive list but rather decisions should be based on an evaluation of qualifying features such as market opportunities, fish health regulations, disease free status and the ability to produce juveniles. Others felt that species development and production should be integrated with renewable energy sources that will assist with the reduction of costs.

For the purposes of this project, the species for consideration are as follows:

- Perch;
- Turbot;
- Pollan;
- Sea bass;
- Eels;
- Tilapia.

2.3 Perch

2.3.1 Introduction

Perch or Perca fluviatilis is a common freshwater fish found throughout the island of Ireland, Great Britain and the Baltic countries of Northern Europe including brackish water habitats in the Baltic Sea (Sullivan & Lee, 2002).

Perch is a small fish but can reach sizes in the range of 35-50cms and weigh up to 4.75kg. The meat is white, with a small flake, delicate texture and mild flavour. It was an important food fish in central Europe and the Baltic countries, in particular, the Eastern European countries such as Estonia, Poland, Russia and Germany.

Perch belongs to a family (Percidae) of freshwater fish which are originally derived from the temperate water of the northern hemisphere i.e. North America and Europe but has also been introduced to Australia, New Zealand and South Africa (FAO).

2.3.2 Habitat and Biology

The natural habitat for perch is generally slow-flowing rivers, deep lakes and ponds. It is also typically found in close proximity to or among obstacles in the water. It is described as a predatory species; juveniles feed on zooplankton, bottom invertebrate fauna and other perch fry, while adults tend to feed on both invertebrates and fish, primarily sticklebacks, perch, roach and minnow. In the northern hemisphere,
In terms of aquaculture production, Figure 4 demonstrates that production levels have been improving over the years. In 2002, there was 72 tonnes of perch while this had risen to 332 tonnes in 2007. In 2008, volumes had decreased to 264 tonnes. Again, the value has varied greatly during this period. In 2005, the total value of products sold was $902,000 whereas in 2002 the value generated reached $157,000.

2.3.3 Production Systems

There are many benefits cited in support of producing perch fry in an RAS system, for example, it offers a more stable and controlled environment. It is also much easier to manage the incidence of cannibalism than other production methods. The majority of production in the Republic of Ireland is now done using this method.

Following fertilisation eggs are moved from the hatchery to rearing tanks at the eyed egg stage to counteract the risk of mortalities. Eggs are suspended on trays the day before they hatch at a water temperature that is similar to that of incubation. Within one day, the temperature is increased to 20°C and remains somewhere between 19°C and 23°C depending on the strain being produced.

Following hatching larvae are transferred to larval rearing tanks of different shapes and are made of a variety of materials; sizes can vary from 330L to a few m³. All tanks should be provided with its own water and air supply. When small tanks are used, larvae have a tendency to cling to the tank walls and exhibit a non-feeding behaviour. PVC or fibreglass tanks should have darker walls to help make the distinction between live and inert food against the background.
Preliminary stocking densities normally vary between 20 and 50 larvae/L. Although higher densities can be used, this has to be decreased following the weaning phase due to the risk of cannibalism.

1-2 days following hatching, small Artemia nauplii are fed to the larvae over the course of three days. Fry are then moved onto more regular sized Artemia distributed either by hand or by peristaltic pump during daylight. From the end of week 1 to week 3, the daily feed allowance decreases from 35% to 10% of fish biomass. On day 14, the fish can be taught to respond positively to dry feed and this gradually becomes the normal food source. Another strategy is for larvae to be fed alternative natural first-food sources, in particular, rotifers. This has an advantage in that rotifers are more suitable for the small mouth size of fry, however, it means that an additional step in the production process has to be included and this, in turn, implies an extra cost to the producer.

Ongrowing of perch fry once weaned to dry feed, takes place in larger tanks in the RAS system until they reach market size.

2.3.4 Cost of Producing Juveniles

Another important consideration in relation to any production decisions, whether this is for a hatchery or on-growing facility, are factors such as initial capital costs and investment in terms of land, planning permission, appropriate building and construction, permits/licences, equipment including tanks and water treatment facilities, husbandry and grading equipment. According to Toner and Schram (2008), the capital costs required to establish a perch hatchery is €350,031 which is the equivalent of £303,610* with a capacity to produce 800,000 juveniles in a year. Subsequent operating costs also based on the production of 800,000 juveniles are €142,996 or £124,020*. Obviously the more juveniles that are produced, the smaller the costs per head are in the production process, for example, if 200,000 juveniles are cultured the cost price is €0.60 per unit whereas if a farm produces 1,200,000 juveniles over a year the cost is reduced significantly to €0.13 or £0.11* per unit.

An experiment conducted by the University of Liege compared cost of juvenile production in both extensive and intensive systems. After 4-6 weeks cost per 4cm juvenile was €0.06 in the extensive system and €0.10-0.12 (as a result of 60 – 70% mortality) in the intensive system. As a benchmark comparison to the figures above, a 4cm Rainbow trout fry produced in NI is estimated to cost 2p.

2.3.5 Logistics and Market Conditions

The primary markets for perch are the Alpine regions, in particular, Switzerland, Germany and Italy where it is perceived to be a premium product and is normally consumed on special occasions or in à la carte restaurants. There are around 5,000 tonnes of perch fillets traded in Europe annually. The main suppliers of perch are Poland, Estonia, Russia and Finland. In terms of aquaculture production in ROI, there are 5 licensed farms which consist of 2 hatcheries and 3 on-growing sites. Elsewhere here are 3 farms in France, 2 in Switzerland, 1 in Austria and 1 in Denmark. Sweden also has a number of small on-growing farms.

Wild perch are also caught and processed in both Europe and locally in Lough Neagh. However catches from some established wild fisheries in Europe have recently been documented as declining.

Eurasian perch because of its white flesh, delicate texture and mild flavour, is among the most appreciated and popular freshwater fish in Northern Italy as well as in Central European regions. In spite of this, perch aquaculture production is low when compared to other farmed freshwater fish and is primarily limited to wild capture (Watson, 2008).

Industry feedback from BIM, the Aquaculture Initiative and local producers support the view that there is currently a lot of demand for the product and 90% of this is from Switzerland and Germany. Irish production is currently being sourced by Swiss supermarkets that are keen to develop sustainable and reliable supplies.

There has been some difficulty in the past with logistics as wholesalers are very particular about quality and freshness, delivery dates must coincide with retail requirements and it can take approximately 3 days for the product to be transported by road. Some wild caught product from Northern Ireland has been distributed through Scotland to France, Germany and Italy. In an interview with Swiss importer, Compro Comestible, it became clear that they did try in the past to source perch from the Republic of Ireland, however, the distance from the market posed an issue in relation to the length of delivery times and the subsequent freshness that is demanded. They did indicate that if this difficulty was resolved they may consider supply from Northern Ireland in the future.

There was a positive response received from an exporter in Northern Ireland who stated that there is a demand for farmed perch since there are times of the year when it is not
available from the wild and farmed production could resolve the issue of continuity of supply.

The Irish Seafood Producers Group stated that they found it difficult to penetrate the "whole fish" market with their perch products. They concur that demand is concentrated in Austria, Switzerland and the east of France. There is an additional opportunity in the US, however, it is dominated by a few large, key players making it very difficult to achieve market share. They currently supply 100% of their perch products to the Swiss market in filleted form.

Two processors contacted did not seem confident that there was a domestic market for perch in Northern Ireland.

2.3.6 Prices

The price of perch can vary greatly according to many factors including seasonality. Wild perch can generate €4-5 or £4.61-5.77*/kg for fillets which is the equivalent of £1.60-2.00/kg for whole fish. Farms in the Republic of Ireland can receive €13.50-22.00/kg for filleted fish and the whole fish price is generally €5-7.00/kg. Other market reports demonstrate the massive variability in prices. Recently, a US trader purchased frozen perch fillets for $10.00/kg with another source reporting seeing perch fillets in Manoir, Geneva, for as much as £60/kg.

The market price for wild perch supplied by McIlroy’s exporter in Northern Ireland is £3.00-4.00/kg for whole, fresh fish and £10.00/kg for fresh fillets.

<table>
<thead>
<tr>
<th>Size</th>
<th>Price/Kg</th>
<th>Product Format</th>
<th>Fresh/Frozen</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-40g</td>
<td>€17.95</td>
<td>Filleted fish</td>
<td>Fresh</td>
</tr>
<tr>
<td>20-40g</td>
<td>€13.50-22.00</td>
<td>Filleted fish</td>
<td>Fresh</td>
</tr>
<tr>
<td>20-40g</td>
<td>€8-9.00/Kg</td>
<td>Filleted fish</td>
<td>Frozen</td>
</tr>
<tr>
<td>20-40g</td>
<td>€7-10.00</td>
<td>Filleted fish</td>
<td>Frozen</td>
</tr>
<tr>
<td>20-40g</td>
<td>€11-15.00</td>
<td>Filleted fish</td>
<td>Fresh</td>
</tr>
<tr>
<td>140g</td>
<td>£5-7.00</td>
<td>Whole</td>
<td>Fresh</td>
</tr>
</tbody>
</table>

(Source: Feedback from Industry)

It is not easy for producers to predict prices as they can fluctuate enormously depending on market conditions, for example, Easter is an important occasion for the German speaking region when perch is consumed. If Easter is early the lakes are still frozen in Eastern Europe which limits supply and prices rise whereas if Easter happens later there is more availability and prices will decline.

2.3.7 Product Specifications

The fillet yield for wild perch is normally 38% while the farmed fillet is typically around 45%. The French speaking area of Switzerland wholesalers tend to prefer a market size of 80-100g fish and that produces a 10-20g fillet. In the German speaking area, the preference is for 40-60g fillets which require the whole fish to be 200-250g. The demand in Italy and Sweden is also for larger size fish.

Product characteristics and quality are very important to the Swiss market. In general, the German region likes the fish to be skinned while the French speaking region prefers the skin on.

For the markets that perch is currently being distributed to, the need to identify the perch as being an aquaculture product is not a precondition of sale although there are more MSC and accredited products becoming available. But producers are expected to satisfy customer requirements i.e. if a quality standard is part of the criteria then the product won’t be accepted without this.

2.3.8 Issues

It is clear from the above discussion that there is technical expertise available to be transferred to Northern Ireland. Perch is considered to be a native species; therefore, risk to the environment from escapees is not a major concern.

Poor growth rates are potentially an issue for extensive systems. (Toner et al., 2007; Staffan, 2004). To cite the example of Switzerland, it can take 365 days+ for perch to grow to a market size of 80g-100g and this is applying an optimum temperature of 23°C in recirculation aquaculture systems. In comparison, it can take approximately 800 days under natural water temperature conditions. Growth heterogeneity has a negative impact on production volumes, a number of solutions have been explored and these have included: strain selection, domestication, all female populations, hybridisation and efficient stock management.

Another issue is that due to the smaller size of market size perch, the hatchery costs have a much higher impact than with other species. To produce 1 ton of perch, a farm would need have 10,000 juvenile fish whereas with salmon there only needs to be 1,000.

*Based on conversion rates as of October 2010 i.e. 1 EUR=0.863193 GBP (www.xe.com)
In compiling this report the author visited Gebr. Dil BV, Dil one of the largest processors of freshwater fish in Holland. They process pike perch, perch, pike, carp and eels; these are then distributed to markets within Europe including Belgium and Sweden.

The company has been involved previously with the Aquaculture Initiative and PERCATECH project. In the past, they did receive some sample perch from the Republic of Ireland although there was an issue with the size of the fish. The perch needed to have scales removed but unfortunately the perch were too small to be used in their processing equipment. However Ballybay perch now has the technology in-house to process and add value to the species.

The issue of continuity of supply is extremely important as suppliers need to consistently satisfy market demand. There has been evidence to suggest that a small number of individuals in the fisheries/processor sectors have established partnerships with each other and do work on a co-operative basis to ensure continuity of supply. It is possible that such partnerships could be replicated by producers within the aquaculture sector.

2.3.9 Summary

- The general consensus is that there is a large and current demand for perch;
- This demand is primarily from Switzerland, Germany, Eastern Europe, Italy, US and to a lesser degree Austria. Although, the smaller fish seem to be more suitable to the Swiss rather than German markets;
- There is a range of production methods used to cultivate perch including extensive, semi-intensive and intensive in recirculation systems. The latter is the most expensive system to use; however, it is the most predictable and is easier to achieve successful production. One means of reducing costs is to increase the number of juveniles that are reared;
- The Republic of Ireland has the largest number of perch farms in Europe and includes hatcheries and on-growing units. There are also units in Denmark providing an extensive knowledge base and expertise that can facilitate diversification in Northern Ireland;
- There are two hatcheries and two on-growing units in the South of Ireland, therefore, technical expertise is locally available.

2.4 Turbot

2.4.1 Introduction

According to the Food and Agriculture Organisation (FAO), the first aquaculture of turbot (Psetta maxima) was carried out in Scotland during the 1970’s and was introduced to France and Spain thereafter. At the beginning of the 1990’s, the sector experienced a high level of growth (52%), however, the industry suffered from a lack of a consolidated marketing network. In addition, the farms were small and incurred high production costs. These issues caused some producers to close. Since then, the sector has been re-structured and other countries have become involved.

Turbot has been traditionally regarded as a high-value luxury item. The reason for this is due to its texture and taste, in addition to it being in short supply. The sector has benefited more recently from commercial investment that has helped to improve facilities and develop new farms. There has also been progress made through the introduction of dry feeds and the use of vaccines.

Figures for turbot indicate that wild catches of the species have decreased dramatically, long the EU Atlantic shoreline, the catch has reduced by one third.

Farmed turbot is generally consumed on the home market but the growth of farmed production is deemed to have led to a decline in prices overall. Today, European production of turbot is almost 5,000 tonnes which is nearly the same as the total capture of turbot and around half of the farmed production originates in Spain.

Generally speaking, domestic market prospects are good as the level of consumption of turbot is limited by its supply, and this trend would suggest that consumption rates would rise if availability was resolved (Seafood International, November 2008). There was very little international trade in turbot because of absorption by local/domestic markets.
Current farmed production of turbot has certainly increased since its inception 20 years ago, however, not at the rate that was expected. In some ways, this reflects the stagnation of overall EU aquaculture production volumes.

2.4.2 Habitat and Biology

Turbot is a flat fish that spends most of its time on the sea bed, half buried in the sand, where it feeds. In their natural environment, spawning tends to happen between February and April in the Mediterranean and in the Atlantic it occurs between May and July.

2.4.3 Production Systems

According to FAO, larval culture can be semi-intensive or intensive. In the former, larvae are reared at low density (2-5 larvae/litre) in a large volume (50m³) while in the latter density is higher (15-20/litre). In both systems, the rearing temperature is 18°C-20°C. Larvae that are newly hatched, feed from their vitelline reserves and on day 3 their mouths usually open. The young larvae are fed rotifers, Artemia and phytoplankton which are added to the water. In the majority of hatcheries, juveniles are provided with two types of live prey: rotifers (Brachinus plicatilis) during first feeding moving to the first naupliar stages of Artemia. Once the first feeding stage has been established and the larvae are large enough to catch and ingest Artemia nauplii, they are given both feed forms, until they can be weaned on to larger prey items. The food is enhanced with proteins, vitamins and minerals to ensure that they are provided with a nutritional diet which is essential for normal growth and development (Daniels & Watanabe, 2010).

The weaning stage takes place in round-cornered square tanks (10-30m³) which are supplied with sea water through an open circuit. In order to ensure that the water is kept at the correct levels of saturation, it is generally equipped with an aeration system. Dry pellets are introduced as food which is distributed either manually or automatically. At this stage, the weight range can vary from 5g-10g and 80g-100g throughout the pre-fattening period which can last 4-6 months.

The most common method for on-growing turbot is in on-shore tanks, pump ashore units and recirculation systems. The vast proportion of turbot production is from pump ashore facilities in Spain and Portugal.

This technique involves the use of square or circular cement tanks (25-100m³) and an open circuit that pumps the sea water. Again, there must be the appropriate system in place to ensure that oxygen levels are maintained. Successful productivity is considered to be heavily influenced by temperature and fry quality. The ideal temperature for feeding ranges from 14°C-18°C although the extreme temperature range for the cultivation of turbot is 11°C-23°C.

2.4.4 Cost of Producing Juveniles

In 2008, the main producing countries for juvenile turbot were Spain and France (FEAP). The average European price for juveniles remained static at €1.10 or £0.96 from 1998 to 2004. In 2008, the cost per unit increased quite significantly to €1.25 or £1.08. It should also be noted that on-growers have been able to purchase juveniles for £1.00 per unit in the past which is the equivalent of €1.16.

![Figure 6: Cost per Juvenile Turbot](Source: Federation of European Aquaculture Producers)

Denmark is involved primarily with the production of juveniles which are provided for on-growing farms in the south of Europe. In Turkey, the juveniles tend to be produced for re-stocking purposes (Zengin et al., 2007).
2.4.5 Logistics and Market Conditions

Today, the leading producer of farmed turbot is Spain followed by France and Portugal although the latter has experienced a recent decline in production. Turbot has also had a history of being cultivated in Denmark, the Netherlands, Germany, Iceland, Republic of Ireland, Italy and Norway (FAO, 2008). Spain’s success in turbot cultivation is largely due to the highly suitable oceanographic conditions that it experiences. In contrast, farmers in the North of Europe are compelled to employ a recirculation system with the water recycled, re-oxygenated and reheated or re-cooled. The latter is a more complicated and expensive method. It is also considered to have a negative effect on the turbot’s growth rate.

In 2007, the primary market for turbot farming was the restaurant trade. Stolt Sea Farm sold only 20% of its production to supermarkets, and France Turbot only 5-7%. The hotel and restaurant markets were not showing any signs of saturation either. When two French companies launched Label Rouge in 2002 (a French agricultural label created in 1960 that exemplified that certain products had superior qualities), this had a huge positive effect on demand.

In 2008, Achill Island Turbot was established in Co. Mayo in the Republic of Ireland. Unfortunately, it was not possible to gain concrete information on the price of fish since the farm is still relatively new and hadn’t harvested any fish as yet. Target market price is approximately €10.00 per kg. They have ambitious plans and are in the process of positioning themselves as one of the leading SME’s in their sector. They are aiming to achieve production levels of around 500 tonnes in the medium term and consider this to be essential for a facility to be viable and competitive in the longer term. Their production methods and husbandry techniques are supported by the accreditation from Cleanfish.

A site visit was carried out to Grovisco, an on-growing unit in the Netherlands (www.grovisco.eu). This facility and another turbot farm, Seafarm, both produce around 50-60 tonnes annually although they both have the capacity to produce up to 200 tonnes. In an interview with an aquaculture consultant, he indicated that the market had been experiencing difficulties as demonstrated by the lower prices and other farms have had to close. In terms of Grovisco, the farm sources juveniles from France and Denmark.

In an interview with TH Nicholson, a local processor and wholesaler in Northern Ireland, it transpired that their business recently experienced a change of direction. In the past, they supplied the primary export markets but have now decided to concentrate on the domestic market and currently supply hotels and restaurants throughout the island of Ireland. At this stage, it would be difficult to provide accurate volumes since they are not receiving a consistent supply of farmed turbot as yet but did indicate that they believe there is a market for turbot and they would consider sourcing farmed turbot locally.

In an interview with Rooney Fish, an interest was expressed in processing and exporting local turbot. At this stage, it was difficult to provide accurate prices as this relationship would need to be negotiated between the producer and the processor.

JPL Shellfish, based in Scotland, specialise in the wholesale of live and processed shellfish products as well as wild caught whitefish species to the UK and international markets in Europe. Although, they don’t currently trade in huge quantities of farmed fish, they would consider some local supply in the future for their domestic market and Spanish and French customers.

2.4.6 Prices

Like any aquaculture product, turbot prices are subject to dynamic market conditions and can change from one week to the next. In 2007, the pricing system changed and a distinction was made on the basis of weight, for example, the average price for turbot > 1kg was €7.86, 1kg-2kg turbot were generally sold for €9.21 and the largest weight of 2kg+ tended to be purchased for €13.48.

Figure 7: Comparison of Turbot Prices
In 2010, reports were demonstrating that although volumes had decreased Stolt Sea Farm did achieve a profit and that the turbot sector was slowly recovering although there remained a lot of competition in terms of price.

Figure 8: Wholesale Prices for Turbot, July 2010, in EUR/Kg, Ex Warehouse

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>800-1,100g/Unit</td>
<td>8.20</td>
<td></td>
</tr>
<tr>
<td>1,100-1,400g/Unit</td>
<td>9.60</td>
<td></td>
</tr>
<tr>
<td>1,500-1,800g/Unit</td>
<td>11.80</td>
<td></td>
</tr>
<tr>
<td>1,900-2,300g/Unit</td>
<td>12.50</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Fish and Information Services, 2010)

According to Grovisco, the autumn 2010 price for whole, fresh turbot is €8-8.50/kg with an average marketable size of 0.5-2kg. The market has been more favourable in 2010 compared to 2009 when the average price ex farm was €6.50.

While TH Nicholson indicated that they would possibly be interested in local farmed turbot in the future, the condition of supply would be that the turbot is available at a competitive price. Whole, wild turbot is purchased according to the following weights: for 4kg+, the market price is £9.00-10.00 or €10.57-11.75*/kg. Medium size turbot weigh between 2 and 4kg, their price is £7.00-8.00/kg (€8.22-9.40*) and the smallest size which is 500g-1.5 kg is generally £5.00-6.00/kg (€5.87-7.05*).

For JPL Shellfish in Scotland, their requirement would primarily be for larger sized fish, for example, no less than 1-2kg and up to 2-4kg. The price quoted would be in the region of £7-8.00 per kg and a maximum of £12.00 per kg.

A representative from Billingsgate market in London indicated that there are a large number of merchants supplying turbot and the average price received is normally around £12.00 per kg.

2.4.7 Product Specifications

In Spain, the demand for turbot is generally for whole, fresh fish while the preference in other parts of Europe is for filleted fish. Spain has begun to produce filleted turbot to meet European market demand. Size requirements have changed and smaller portions have become more acceptable. Previously, it was 1.5-2.0kg and now it is 0.7-2.0kg.

- The primary market in France, similar to Spain, is the foodservice sector which is particularly true for wild-caught large size fish (>4kg) which are sold exclusively to restaurants;
- French and Belgian restaurants use turbot both in set menu and à la carte with farmed turbot featuring more predominantly on the set menu;

More than 60% production from France Turbot is supplied to top quality restaurants which require different market sizes ranging from 500g – 3kg or more. This company promotes their products using the brand name of Label Rouge. The brand originates from 2000 and the Turbot Quality Association, providing traceability throughout the supply chain including the hatchery, growth farms, processors and feed manufacturers (www.turbotlabelrouge.com). The Quality system is developed from HACCP and the product formats they offer are based on the following:

Chilled product includes:

- Whole turbot / Label Rouge (500g-3kg), gutted or not gutted;
- Turbot steak / Label Rouge (various sizes).

In addition, FRANCE TURBOT offers the transportation of live turbot which is offered in the following ways:

- Transport by container in water (to most European cities);
- Airfreight transport;
- Delivery without water in watertight boxes with a total immersion time of less than 24 hours (www.adrien.fr).

In 2006, IMARES Wageningen University carried out a ‘Market Study of Farmed Turbot’.

The key findings demonstrated that taste and texture, freshness, packaging, sustainability and fish welfare were all considered to be important qualities. Customers were motivated to purchase farmed fish because there is a general lack of supply from
wild populations. Demand was also encouraged as it was considered to be ‘a new and exciting niche product’ that is considered to be good quality.

In a Quality manual published by BIM (2007), the importance of allowing the fish to bleed after it has been killed was highlighted since it improves the shelf-life and quality in general. The process of bleeding involves making an incision about an inch from the caudal or tail fin. The knife is used to slice down until it reaches the tailbone or backbone. By using this method, the cooling time can be reduced since heat loss occurs as the fish bleeds. The additional advantage is that fish treated in this way are more likely to have light coloured fillets and fewer bruises, blood spots and other defects. Most importantly, it can also extend the shelf-life of farmed turbot by up to nine days.

2.4.8 Issues

An issue affecting the culture of turbot is the incidence of growth retardation. In 2007, a research project into growth retardation of turbot (GRRAS) was carried out by Wageningen UR (University and Research Centre) in the Netherlands funded with €1 million from the Sixth Framework Programme. The turbot project was initiated by members of this aquaculture sector from Germany, Netherlands, France and the UK that were experiencing problems with this issue in the production environment. There were a number of hypotheses proposed as regards the possible causes such as the presence of humic substances in the system, however, it was not easy to replicate a common or standard production environment as the style of the system can vary from one facility to the next.

Controlled experiments were carried out within the research facilities and were used to compare flow through with recirculation systems but it was not possible to demonstrate any negative effects on growth and the findings were inconclusive. It was acknowledged that the issue obviously exists, as it has been experienced by certain farmers. It has been suggested although not proven that some kind of management practice or something in the system that could be at fault. In 2010, research carried out by Gonçalves et al., indicated that high stocking densities in commercial turbot farming may have a negative effect on growth and increase production costs. Furthermore, they suggested that the high levels of waste that accumulates in an intensive system could also have an impact on production. They were interested in establishing whether L-carnitine, a recognised growth enhancer, would have some potential in counteracting the effects of crowding. Disappointingly, the results from the study were inconclusive and the issue remains unresolved.

Grovisco appear to be one of a few turbot farms that hasn’t been affected by the growth retardation issue although the reason for this still remains unclear.

2.4.9 Summary

- There is still a relatively strong demand for turbot and the primary markets are Spain, France, Portugal, Republic of Ireland, Italy, Germany and the Netherlands;
- It is likely that this sector will be subject to increased competition once a proposed production facility in Portugal is fully established;
- Turbot has been primarily sold to the restaurant trade and there has been a reduction in the level of out-of-home consumer expenditure;
- There are two production methods used to culture farmed turbot either pump ashore or recirculation units. The majority of production in the EU is from pump ashore facilities in Spain and Portugal;
- Turbot are carnivorous fish and this does present an issue in terms of sustainable sources of feed;
- The life cycle and production process has been well established for a long time, therefore, there is existing knowledge and expertise available to new producers;
- By applying the appropriate slaughtering methods, the shelf-life of farmed turbot can be improved by up to 9 days;
- Farming of turbot can assist with the improvement of continuity of supply;
- It can take up to three years for turbot to reach maturity and marketable size which can affect the cost of production;
- The cost of producing juveniles is more expensive in comparison with other species.
2.5 Pollan

2.5.1 Introduction

Pollan or Coregonus Autumnalis pollan (Irish) is the only member of the corrogoid whitefish family found on the Island of Ireland and populations are confined to four major lakes – Lough Neagh, Lower Lough Erne, Lough Ree and Lough Derg. The largest density of pollan is in Lough Neagh and this also supports a small scale commercial fishery. Arctic cisco or Coregonus Autumnalis is pollan’s closest relative and is found in Canada, Alaska and Russia.

There is very little in-depth, contemporary information available on this species although, in 2002, the Environment & Heritage Service (now NIEA) provided funding for a project that was aimed at determining “the status and genetics of pollan Coregonus Autumnalis (Pallas) in Ireland”. They also launched the Northern Ireland Biodiversity Strategy which incorporated conservation of pollan as one of the key elements of this plan.

Although there is little comparative information available, accounts and historical studies carried out between 1995 and 2005, support the view that there has been a reduction in the volume of catches and the size of spawning pollan over the last decade which is considered to be a symptom of stress amongst the population. It is difficult to provide accurate figures in terms of volumes of wild populations as little information is extant. Although the Island of Ireland has over 4,000 lakes that are bigger than 5 ha, only Lough Neagh, Lower Lough Erne, Lough Ree and Lough Derg are known to have pollan populations. Over the past 20-30 years, numbers of pollan found in the Erne and Shannon areas have dropped dramatically and only a handful of fish are caught annually. The only place where the availability of pollan is significant enough to support a commercial fishery is in Lough Neagh. The factors that have been identified as contributing to this decrease in population are:

- Levels of eutrophication;
- Introduction of roach which competes with pollan for zooplankton;
- Potential introduction of zebra mussels which cover rocky and gravelly areas, possibly competing with pollan on spawning grounds;
- Although not conclusive, climate change was considered as having a possible effect on pollan. The species have an upper thermal limit at approximately 20°C-22°C.

Pollan is a commercial species although it is highly regulated in Northern Ireland, where there is a closed season in Lough Neagh (October 31st and runs until the 1st of February).

2.5.2 Habitat and Biology

Following the recommendations outlined in the All-Ireland species report, a comprehensive genetic based investigation into pollan was prepared for the Environment & Heritage Service by Quercus (Queen’s University, Belfast). The primary aim of the study was to gain an understanding of the pollan populations that are present in the four lakes and their subsequent inter-relationships.

The findings of this genetic work could have significant bearing on three aquaculture issues namely; the potential source of broodstock for hatchery rearing, the significance of maintaining genetic diversity at a hatchery level and also the potential requirement of any restocking or establishment of ‘Arc’ sites, i.e. transmigrations of fish to safe environments.

The report by Quercus focused on the distinction between pollan and Arctic cisco. In this study, it states that there are key life history differences between the Irish pollan and C. Autumnalis showing how our pollan has adapted to its environment over time: Three of the most salient points were;

- Pollan is much smaller and has a shorter life expectancy. Irish pollan tends to grow to a maximum of 30 cm in length and will live around 4-5 years whereas Arctic cisco can grow to 38 cms in length and usually lives until it is 10 years or more;
- Pollan matures at an earlier age and experiences more rapid growth than its Arctic counterpart;

There have been a number of ecological and behavioural distinctions noted between pollan from different catchments, for example, the pollan from Lough Neagh are present in all habitats, pollan in Lough Erne are not present in shallow areas and are rare at deep water depths (Harrod et al., 2002). There is still no conclusive evidence to explain why the largest population is in Lough Neagh while other areas have suffered the collapse of stocks, however, it is thought that it could, in part, be attributable to a genetic ability to adapt much better to their habitat. Further key findings and recommendations from the study were that;
The difference in terms of genetics between Irish pollan and Arctic cisco is considered to be higher than was previously thought;
- Significant genetic disparities were found to exist between pollan from Shannon lakes and those originating from Lough Neagh;
- The data gathered also suggests that there are two genetically different populations in Lough Neagh. This is possibly the result of adaptive genetic changes with one group five times larger than the other although there was no indication of figures supplied;
- Any conservation / management plan which is aimed at restocking pollan, translocation and / or aquaculture, need to factor in the presence of genetic differences between and among the specific locations;
- There is an immediate need for further investigations that are essential to understanding the spawning areas of the two different groups within Lough Neagh;
- A new pollan population has apparently been observed in Lough Allen (Shannon) which needs to be clarified since if samples from a closer or more genetically similar population can be found, this would provide better broodstock for aquaculture and/or restocking programmes.

2.5.3 Production Systems

In 2004 a small scale pollan hatchery project was conducted by personnel from a number of agencies including Department of Culture Arts and Leisure, Environment & Heritage Service, Department of Agriculture & Rural Development and the Aquaculture Initiative. Ripe adult pollan were selected for translocation from Lough Neagh under licence in November/December 2004. The project accomplished its two preliminary objectives:
- To explore the best fishing methods, as well as temporal and spatial conditions when collecting pollan broodstock;
- To develop on site experience within the Movenagher (DCAL) rearing facility to determine the hatchery 'bottlenecks' that occur with producing pollan fry under controlled culture conditions.

Unfortunately, the Department of the Environment confirmed that the project in partnership with the Movenagher facility is currently on hold due to budget constraints.

2.5.4 Cost of Producing Juveniles

There is no information available on the cost of producing juveniles as attempts have been carried out on an experimental scale only. One local producer indicated that there are similarities between pollan and other whitefish that are produced in countries such as Norway and Poland. These techniques and knowledge could possibly be transferred and applied to future pollan production.

2.5.5 Logistics and Market Conditions

According to industry accounts, the European price for pollan is generally not very high in terms of value. There is a very small quantity of pollan sold in a local NI market although it is categorised generically as whitefish. Wild fish are relatively small, therefore unless a farm could produce pollan of a larger size, high production volumes would be required for a farm to be profitable. In an interview with an academic from the University of South Bohemia, it was estimated that production figures for the Czech Republic of corogenicids are normally around 15 tonnes per annum. A local commercial fisher in Northern Ireland indicated that there is a market in the US for pollan and they are supplying quantities of approximately 20 tonnes each year. In an interview with a NI exporter, there was some indication that there would be interest in farmed pollan. Another producer stated that the primary market for pollan is eastern France and Poland. The demand for pollan is very seasonal and tends to reach its peak during the summer months which would mean that a farm would have to concentrate its production efforts to reflect this.

Overall, this indicates that there may be an opportunity for more concerted marketing of pollan as a table fish. Any production of pollan for restocking purposes would need to take into account the genetic issues outlined in the studies above.

2.5.6 Prices

The general trend suggests that pollan does not tend to have a high market value. A local exporter indicated that wild whole fish (200-300g) prices are approximately £3.00-4.00 per kg, while fillets can be sold for around £6.00 per kg. One industry professional estimated that current prices for pollan are probably around £3.90 per kg.

In the Czech Republic, whole pollan are sold for 150 CZK or €6.14 which is the equivalent of £5.36 per kg. A local NI producer supplies whole, gutted fish which are purchased at €2.50-3.00 per kg or £2.16-2.59 while fresh and frozen fillets have a wholesale price of €5-7.00 per kg or £4.31-6.04.
2.5.7 Product Specifications

Pollan can be sold whole or in filleted form and it is also accepted as fresh or frozen product. They are also a delicacy in Poland where they are salted and consumed in the domestic market although some products are re-distributed back to Northern Ireland and sold in Polish retail independents.

2.5.8 Issues

It is clear that there is a serious concern for wild stocks and the Pollan Action Plan did stipulate that, by 2009, aquaculture and stocking methods would be established to permit reservoir stocks of all four sub-populations of pollan to be created. Unfortunately, the work that has been completed thus far is now in jeopardy due to financial pressures.

2.5.9 Summary

- A gap in the information available on pollan in terms of aquaculture production methods and hatchery techniques has been identified;
- It is a unique species to the Island of Ireland and in particular to Northern Ireland, which provides an interesting Unique Selling Point (USP) for furthering promotional opportunities;
- A bottleneck exists in terms of producing juveniles and there will be little or no research completed in the immediate term;
- There is an opportunity that the lessons from perch hatchery techniques and on-growing would provide a way forward;
- The potential markets for pollan appear to be very limited internationally and, in the main, it is not considered to be a high value species. It may be that flow through rather than recirculation on-growing systems are more suited to the production of this species as a result of cost;
- There is no significant demand in the domestic market. Should the species ever be produced commercially it would be for export or require a promotional campaign to educate consumers;
- There may be an opportunity for restocking and conservation needs of this species to be met through aquaculture.

2.6 Seabass

2.6.1 Introduction

Seabass (Dicentrarchus labrax) was first cultivated in coastal lagoons and reservoirs, prior to the mass production of juveniles which began during the late 1960's in France and Italy. By the 1970's, this had led to the development of successful hatchery techniques which were then adopted by the majority of Mediterranean countries, resulting in the production of hundreds of thousands of larvae. European seabass enjoys the position of being the first marine non-salmonid species to be commercially cultivated in Europe. In current times, it is still the most widely cultivated species in Mediterranean areas (GLOBALGAP, November 2009). The largest producers are Greece, Turkey, Italy, Spain, Croatia and Egypt.

2.6.2 Habitat and Biology

In their natural environment, seabass is a demersal fish, it lives in coastal waters down to about 100m depth but more commonly frequents the inshore waters of estuaries and brackish water lagoons (European Commission Fisheries), they have also been known to move upstream to freshwater sources. In the Mediterranean and Black Sea, reproduction occurs from January to March whereas in the British Isles it is March to June. They are not particularly sensitive to low temperatures, therefore, they can sometimes winter out in coastal lagoons instead of returning to the open sea (The Fish Site, March 2009). According to FAO, seabass are known to be voracious predators, feeding on small fish in shoals and a large selection of invertebrates including shrimps, prawns, crabs, squids and molluscs. In terms of size, they can grow to a maximum size of 100 cm weighing up to 12kg although the average size tends to be 50cm. (European Commission Fisheries).

Reduction in wild seabass catches coincided with an increase in aquaculture production. In 1998, the aquaculture sector in Europe was producing 77,553 tonnes of sea bass products which generated $520,124,000. By 2008, production had increased to 192,861 tonnes with a value of $1,225,715,000.
2.6.3 Production Systems

There are three primary methods used for sea bass farming:

- Extensive cultivation;
- Sea-cage culture;
- Land-based culture.

For the Northern Ireland the only suitable culture method is land-based culture in a recirculation unit. This method allows temperature control while also minimising any impacts on the environment. Using this culture method it is possible to produce sea bass of marketable size within 9-12 months.

Recirculation systems are supplied with fry from hatcheries and a controlled diet is provided. Food is distributed by an automatic feeder every 10-15 min for small fish i.e. 2g-15g, or by hand for larger fish. It is essential to grade at least two or three times per production cycle to avoid growth differentiation and cannibalism. Juveniles mature to 400g-450g within 18-24 months (The Fish Site, March 2009). Although, according to GLOBALgap (November, 2009), the minimum market size is 250g which takes up to two years in a tank and 7 months in a cage. The European Commission states that the fish are generally harvested and slaughtered once they have achieved 300g-500g in weight.

2.6.4 Cost of Producing Juveniles

Data from the Federation of European Aquaculture Producers shows that many countries produce juveniles; therefore, there are a range of suppliers to choose from.

There were a total of 517,507,000 seabass juveniles produced in the Europe in 2008 and the most dominant producers were Greece and Turkey. As technology and knowledge has improved, this has had a positive impact on the cost per unit for producing juveniles which decreased from €0.22 in 1997 to €0.18 in 2008.

2.6.5 Logistics and Market Conditions

The main production area for seabass is the Mediterranean region. Often seabass production is combined with seabream. The Federation of European Aquaculture Producers (Eurofish, June 2009), reported that seabass production increased to 105,900 tonnes in Europe during 2008. This equates to a 10.7% increase from the previous year. What was also interesting was that the prices for the respective markets were reacting quite differently. Sea bream was falling rapidly while sea bass remained relatively constant.

Despite the fact that the information on trade statistics is not fully comprehensive, there has been general trend of increasing production, primarily in Greece, Turkey and to a
Based on conversion rates as of October 2010 i.e. 1 EUR = 0.863193 GBP (www.xe.com)

It was anticipated that this upward trend would not continue into 2009 given the negative economic climate which was having a detrimental impact on sales. The economic climate is of particular importance for these species as they are predominantly sold to the restaurant trade.

Spain is an important market for imports of sea bass and sea bream although it also has relatively large domestic production. In the past, bream production has taken precedence although this situation has been changing. Within the four years (2005-2008), sea bass production has nearly doubled to 11,800 tonnes. Consequently, prices have declined; however, production is still profitable.

In 2008, both volumes and the value of imports for sea bass rose in the French market. The French market is much smaller than Spain and Italy with less internal production, therefore, imports are essential to satisfy any increase in demand.

The UK has been the primary market for seabass produced in Greece for many years and this has been largely due to scale of the introduction of the species into the supermarkets by the major retailers. In 2008, the volume of UK seafood imports from Greece was 8,000 tonnes of which sea bass accounted for 68%.

In 2002, Bluewater Fish Farm was established in Anglesey, Wales. It is owned by the Greek multinational Selonda and was originally set up as a turbot farm. The facility was extended with the plan of cultivating 1,000 tonnes of sea bass annually. The Managing Director, Mr Gatland explained, “At the moment, sea bass is imported, mostly from Greece, which involves a lot of air miles, the whole point here is to supply the local market in the UK” (BBC News, January 2008). The advantage of having a base in the UK is that the product can reach the market on the same day as it is harvested which is 5 days less than product that is imported from Greece and Turkey. In fact, the product is so fresh that it has been described as ‘red-gilled sea bass’ (Intrafish, November 2010). The company intended to promote the products as a local Welsh brand.

The company also introduced some innovative technology which uses the movement of the swimming fish to increase the water temperature. There were two processes employed in retaining a constant water temperature of 20°C-22°C, one involves the reuse of already heated water and the other is a biological method, whereby ammonia produced by the fish as a waste product is converted into heat. In an interview with Bengate Trading it was indicated that demand is and prices are currently high due to low levels of production in the Mediterranean. This situation will persist for the next couple of years but following that it is anticipated that the major players will re-establish a monopoly on the market. This company normally trades approximately 2-3 tonnes of sea bass per month.

TH Nicholson and Rooney Fish also expressed an interest in locally produced sea bass although the companies were unable to provide information on the price and quantities they would offer.

### 2.6.6 Prices

Seabass is very often compared alongside seabream in much of the research as changes with one appears to have an influence over trends for the other. Globefish (2009) reported that the large rise in supply of bream in 2008 from Greece and Turkey (i.e. the two major producing countries, had a significant downward effect on prices). Seabass, however, held its own although the general weakening of demand was causing some lower prices for both species. The outlook for 2009 was not considered to be positive with plenty of supplies remaining coupled with consumer’s reluctance to spend on non-essentials such as eating out. This negative outlook was reflected across all markets.

In Spain, the prices of small to medium size sea bass improved by an average of around €0.05/kg while large fish prices remained the same (Fish and Information Services, October, 2010).*

*Figure 12: Wholesale Prices for Sea Bass, October 2010 (Week 41), in EUR/kg, Ex Warehouse*

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>300-400g</td>
<td>4.40</td>
<td>+</td>
</tr>
<tr>
<td>400-600g</td>
<td>7.10</td>
<td>+</td>
</tr>
<tr>
<td>600-800g</td>
<td>9.80</td>
<td>–</td>
</tr>
</tbody>
</table>

(Source: Fish and Information Services, October 2010)

In 2008, imports of sea bass to Italy declined by 6.1% and sea bream also experienced a decrease of 11% in value. In Italy, bass import volumes declined by almost 20% to 16, 400 tonnes as unit values increased from €4.85 – 5.39/Kg in comparison with 2007. From this analysis, it was apparent that the rising price of bass had a negative effect on sales. Conversely, prices for bream fell from €4.22 to 3.34/Kg with imports increasing approximately 9% to 18, 300 tonnes. Prices are therefore extremely important considerations when producers try to move substantial volumes of product.

By 2010 (Intrafish), the situation appeared to be becoming more positive with prices of €7.00 per kg being reported compared to €5.75 per kg the previous year. Bengate...
Trading in the UK indicated that the size for sea bass can vary from 400-600g, 600-800g and 800g+ and the typical price per kg is £3.50-5.50 or €4.03-6.34*.

Billingsgate market confirmed that there are an exceptionally large number of suppliers for sea bass products. The average price has been as little as £1.50 per fish or £4-5.00 per kg.

2.6.7 Product Specifications

As knowledge of seabass has improved so too has the product offering. As well as wholefish, product lines also include value added filleted fish. Since 2009, Selonda has successfully launched two new added products in Waitrose as headless, gutted and stuffed with fennel butter (Intrafish, March 2009) while Tesco offer boneless sea bass fillets in their premium range.

2.6.8 Issues

In 2009, GLOBALgap reported that the sea bass market was saturated. There was very little processing being applied and more needed to be done to improve the raw product and further develop the markets. It also warned about the over-use of antibiotics was leading to bacterial resistance. In addition, there were some environmental issues with chemical use and pollutants.

In 2009, Dias Aquaculture claimed that there were too many companies involved in the production of sea bass in Europe (Intrafish, September 2009). At that time, consolidation was still happening in Greece, Spain and Turkey. The long term impact of this was expected to decrease production and thus ultimately increase prices. The company which produced 20,000 tonnes in 2009 stated that sales of seabass had risen in the first part of 2009 although low prices had a negative impact. This situation was felt by other members within the sector, Hellenic Fish Farming became another casualty of falling seabass prices and the company collapsed (Intrafish, September 2009). Although, other companies such as Nireus, were reporting that sales had been improving towards the latter end of that year.

There has been some suggestion that the Mediterranean sea bass and bream sector may follow a similar pattern to salmon trends in terms of supply, demand and prices (Intrafish, May 2010).

Also in 2010, private equity firm, Linnaeus Capital Partners BV demonstrated their support by providing financial investment for Dias Aquaculture SA because it sees

‘tremendous opportunity in the aquaculture sector and believe DIAS is well placed in this sector to capitalise on future growth and opportunities’ (Intrafish, July 2010).

2.6.9 Summary

- The primary markets for sea bass are Spain, Italy, the rest of the Mediterranean and the UK;
- The UK is the biggest target market for Greek sea bass production;
- More specifically, one of the trade markets for sea bass is restaurants but it is also widely available through retail multiples;
- It is possible to produce sea bass in recirculation systems within 9-12 months (Seafood) therefore; the production process is shorter in comparison with other species. It should be noted, however, that other sources state it can take up to 2 years for sea bass to reach a marketable size of 250g from cages;
- Sea bass is a carnivorous fish and relies on food sources from wild fish stocks;
- There is a vast amount of expertise available in terms of the production or life cycle and there are a large number of hatcheries to source broodstock;
- The cost of producing juveniles is relatively low at €0.18 or £0.16 per unit;
- As with other species, production difficulties can include growth differentiation and cannibalism if the appropriate husbandry isn’t applied;
- Locally produced sea bass would be in direct competition with established suppliers such as the Greek multi-national Selonda for access to the UK market.

*Based on conversion rates as of October 2010 i.e. 1 EUR=0.863193 GBP (www.xe.com)
2.7 Eels

2.7.1 Introduction

The eel is a culinary specialty of many different cultures across Europe, from the White Sea to the Black Sea. Up until the 1970's, the European Eel (Anguilla anguilla) had been extensively cultivated in ponds in Italy, Germany and Denmark.

Eels are becoming very rare in the wild, so much in fact that they have been placed on the Red List of seriously endangered species which is issued by the International Union for Conservation and Nature (IUCN). A European recovery plan was introduced in 2007 through the Council Regulation (EC) No 1100/2007 establishing measures for the recovery of the stock of European eel. According to the South Western Regional & Fisheries Board, a complete ban on eel fishing in the Republic of Ireland was introduced in January 2010 and will remain in place until 2012 when the situation will be assessed again (The Independent, March 2010). There is also a closed season in Northern Ireland that runs from the last day in February in any year to the 31st May in that year (Eel Fishing Regulations, Northern Ireland 2010, No. 166).

In 2010, The Department of Culture Arts and Leisure (DCAL) through the authority of the Fisheries Act (NI) 1996 announced their plans to introduce a statutory rule which will enforce the conditions of (EC) No. 1100/2007 in Northern Ireland.

The European regulation stipulates that each member state must implement EU Management Plans (EMP) for each eel river basin. In terms of the Northern Ireland region, this applies to the North West, Neagh Bann and North East basins. The implementation of this involves:

- Europe's largest wild eel fishery in the Lough Neagh Bann catchment area will continue to fish at current levels which are considered to be sustainable. However, the fishery will be closely regulated and monitored;

- The fishery based at Lough Erne is deemed to be unsustainable; therefore, there will be no commercial fishing allowed. The fishermen who hold licences will be provided with an opportunity to apply for contracts to catch and transport eels for conservation purposes;

There is no eel population in the North West basin; therefore, there isn't a fishery to be affected.

In summary, the NI regulations state that all eel fishing is not allowed except where it used to conserve stocks in all other areas outside of Lough Neagh and named weirs of the lower River Bann.

Since 1983, the number of eels entering the Northern Ireland's river system has declined dramatically which has led to a reduction in the numbers of adult eels (yellow, brown and silver eels).

According to FAO, total aquaculture production of European eel is approximately 10,500 tonnes and the largest producer is the Netherlands which contributes around 50% towards the total EU production. Italy and Denmark also produce large amounts of eel, followed in terms of production volume by Spain, Greece, Sweden and Germany. Smaller quantities are also produced in other European and African countries.

Figure 13: European Aquaculture Production of Eels

(Source: Food and Agriculture Organisation)

2.7.2 Habitat and Biology

In the wild, young eels inhabit rivers, lakes and ponds until they become sexually mature which is at 6-12 years for males and 9-18 years for females. At this stage, they return to the Sargasso Sea in the Atlantic Ocean where they spawn. The larvae stay in the Sargasso for around 1-2 years until they are transferred by the Gulf Stream
to the coasts of Europe. In the south of Europe, the juveniles tend to arrive early winter while northern Europe can expect to see young eels at the beginning of the following summer. At this stage, they turn into glass eels which are small and transparent, growing to lengths of 6-12 cm. They remain in estuaries where they consume plankton and progressively colonise rivers, lakes and ponds changing into yellow eels.

### 2.7.3 Production Systems

Eel production involves the capture of juveniles or glass eels from wild stocks that are caught in the estuaries of Portugal, Spain, France and the United Kingdom; these are then used for on-growing. Scoop nets and traps are used in Spain and Portugal whereas, in France, small trawlers use wing nets and trawls. Scoop nets are the only fishing method allowed in the UK for legal reasons.

As discussed, this fishery is regulated under the 2007 recovery plan which stipulates that a large proportion of glass eels (60% from 2013) must be set aside for wild ecosystem restocking programmes (Council Regulation (EC) No. 1100/2007).

Within a farm facility, the glass eels (~0.33g each) spend some time quarantined in small tanks of 3-4m² where the density is 10-15 kg/m². Here, they are inspected for any signs of disease and treated accordingly. They are provided with natural food such as fish eggs and are weaned on to a paste consisting of fishmeal and fish oil over a period of time. Once the eels weigh 5g, they are moved to a juvenile production unit where the tanks are 5-8m² with stocking densities of 50-75 kg/m². It is, at this stage of development, that they are given dry pellets (1mm) consisting of fishmeal and vegetable extracts.

Once the eels reach a weight of 50g, they can be moved either to extensive or large intensive breeding tanks using a recirculation system. Both methods use dry pellets based on fishmeal and vegetable sources as food. Unfortunately, eels have a tendency to grow at variable rates, this necessitates grading at regular intervals to ensure that similar sized eels are grouped together. The production cycle takes 2-3 years, with mature eels being sold for food or restocking purposes. Indoor systems began to be utilised on an experimental level at the start of the 1970’s and this was followed by the development of heated systems that were able to cultivate the eel at its optimum temperature of 24°C-26°C. The most common method of producing eels today is in recirculation systems, these systems are used widely in the Netherlands, Denmark and Germany, with producers having success in the creation of highly intensive production systems. The extensive culture of European eels has declined to such a level that it is no longer considered to be commercially important.

### 2.7.4 Cost of Producing Juveniles

Juveniles are sourced in the wild as hatchery technology has not been successfully developed for this species.

### 2.7.5 Logistics and Market Conditions

As discussed, young eels are sourced from around the shores of France, Portugal, Spain and UK then either utilised by the domestic market or exported to producers in other countries.

The demand for glass eels has been documented in the past and this has been particularly high in Asian markets. Indeed, glass eels have been described as more rare and expensive than caviar. Prices were so high in France that eels were being overexploited, this prompted members of the sector to insist on a ban of glass eel fishing. Price quoted reached €700 or £480* per kilo (BBC News, April 2005).

At the beginning of 2009, LEI and IMARES which are both part of Wageningen University in the Netherlands conducted some research on behalf of the World Wildlife Fund (WWF). The purpose of this was to investigate whether stopping the sale of eels in the Netherlands could assist in the recovery of wild stocks. There were four scenarios evaluated, ranging from the partial to the complete closure of the eel fishery and the eel farming sector. In each of these cases, both the economic repercussions for the fishery, aquaculture, processing and retail sectors were considered alongside the biological implications. WWF did not utilise the final report and one explanation for this is that, because there is a closed season in place for the eel fishery in the Netherlands could not assist in the recovery of wild stocks. There were four scenarios evaluated, ranging from the partial to the complete closure of the eel fishery and the eel farming sector. In each of these cases, both the economic repercussions for the fishery, aquaculture, processing and retail sectors were considered alongside the biological implications. WWF did not utilise the final report and one explanation for this is that, because there is a closed season in place for the eel fishery in the Netherlands, many supermarkets have voluntarily removed eels from their shelves (Wageningen University). This has also been corroborated by a processors and an aquaculture consultant.

According to FAO, the technology for eel production is considered to be mature. They also state that the sector is unlikely to experience much further expansion. The main issue facing the sector is the shortage of elvers. There is a genuine fear that future catch will be regulated heavily in order to protect wild stocks, although it can be argued that the on-growing of elvers for restocking purposes can be used to support this very issue. Some members of the local NI sector were in favour of an enhancement programme although with a very carefully management particularly at the release stage. They suggest that the survival levels for eels (5-10g) produced in an aquaculture system can be as much as 50-70%.

*Based on conversion rates as of October 2010 i.e. 1 EUR=0.863193 GBP (www.xe.com)
2.7.6 Prices

The cost of eels can fluctuate quite a lot and is determined by annual catches and Asian eel producers. In 2004, prices were between €300.00 and £750.00/kg. In the past, Denmark reported that the generic production costs for recirculation systems were €6.00/Kg.

Gebr Dil. Bv based in Holland processes eels and its trade volumes can be up to as much as 5,000 tonnes per week. Some of the markets they sell to include Belgium and Sweden and the current price is around €7-7.50 per kg.

There are still significant volumes of live eel sold in Billingsgate market. It is considered to be a high value species that has a typical price of £12-18.00 per kg.

2.7.7 Product Specifications

If the eels are to be consumed fresh, they are chilled and packed into strong oxygenated plastic bags and with just enough water to ensure that the skin is kept moist and they are subsequently transported to market. If they are meant for processing, they are transported live to their destination. Dutch processing plants tend to smoke Danish farmed eels, while smaller quantities are skinned and used for frying.

There are typically two market sizes for eels that are destined to be smoked. The Dutch market prefers the size to be between 120g-180g. Whereas the demand in Germany, is for a larger size of between 300g and 600g. Small quantities of the product are fried, jellied or stewed. The majority or 90% of total eel production is processed as a specialty product, for example, as Japanese ‘kabayaki’ in which the eel is butterflied, skewered, basted and marinated in a thick soy sauce, then steamed or grilled.

2.7.8 Issues

The main challenge is that aquaculture is dependent on catches of juveniles from the wild since it has not been possible to reproduce eel in captivity as yet. In a discussion with Gebr Dil., there was some confidence expressed that the cultivation in terms of controlling the entire life cycle will be successful in the future but it is not expected to happen for another 5-10 years. This is the result of a lack of understanding regarding what the eels consume in the wild and there has been some speculation that young eels feed on shark eggs. If this is the case, the culture of eels could be an even more complicated process than was previously thought.

The explanation for the decline of the eel population is multifactorial however overfishing, poaching, reduction of habitat, water quality and the introduction of dams which have blocked the migration paths are all thought to contribute in some way to the stocks being at such critical levels.

In April 2010, a project called PRO-EEL was launched and will be co-ordinated by a consortium of 15 partners from a range of European research institutes. The aim of this project is to build on the success of recent DTU research initiatives that managed to produce European eel larvae which survived the yolk sac stage and lived for 21 days. The project acknowledges that there is a severe decline in wild stocks and as yet aquaculture has not been able to resolve the issue of the production process becoming completely self-sustainable. The objectives of the research therefore involve:

- The expansion of current knowledge in relation to eel reproduction;
- Development of standardised protocols for the production of high quality gametes;
- Viable embryos and feeding larvae of European eels.

(Source: Wageningen University, Netherlands)

2.7.9 Summary

- There are markets for eels around the world including France, Portugal, Spain, Denmark, the Netherlands, Germany, Italy and Belgium, however, the Eel Recovery Plan has placed heavy restrictions on the fishing of young eels and this has serious implications in terms of production for the foreseeable future with the exception of possibly restocking purposes;
- The production or life cycle has not been successfully completed in an artificial environment, creating a reliance on wild eelers. Further research is taking place on hatchery production, but progress is slow. The opportunity for Eel culture is therefore low;
- It can take eels up to 9 years in their natural habitat to reach the level of maturity this contrasts to the 2-3 years required in an aquaculture pro unit to grow from 50g to marketable size;
- They also require regular grading as they are prone to high variations in growth rates.
2.8 Tilapia

2.8.1 Introduction

Tilapia is a collective common name for a variety of Cichlid fish. There are four main species of tilapia that are used in aquaculture production and these are; Nile tilapia or *Oreochromis niloticus*, Mozambique tilapia or *Oreochromis mossambicus*, blue tilapia or *Oreochromis aureus* and their hybrids including the red tilapia (The Fish Site, 2005) From the 1940's, tilapia was brought to many Asian countries from south central Africa but it wasn’t until the 1960's that it began to be cultivated widely for human consumption. Nowadays, the variant red tilapia is commonly used especially in the West of Europe because of its fast growth rate and calm disposition.

Initially, the production process was extensive which led to over population problems and stunted growth. In the 1970's, however, with the development of hormonal sex reversal, the sector was able to produce male monosex groups which had a huge impact on their ability to create standard marketable sizes. Since the mid-1980’s, the industry has witnessed significant expansion which is attributable to market development and technological advancements.

The following graph demonstrates how tilapia production has developed at an enormous pace. In 1998, total production was 723,970 tonnes while, in 2008, volumes increased over threefold to 2,334,432 tonnes. Likewise, the value of this sub-sector also experienced positive growth throughout this time, increasing from €855,285 to €3,208,561 with the biggest increase occurring between 2006 and 2008.

Figure 14: Global Aquaculture Production for Nile Tilapia

(Source: Food and Agriculture Organisation)

2.8.2 Habitat and Biology

Nile tilapia is described as a tropical species that tends to inhabit shallow water in its natural environment. The temperature range for tilapia is from 11°C to 42°C, although the optimum temperature is normally from 31°C-36°C. Tilapia is an omnivorous fish and consumes food sources such as phytoplankton, aquatic plants, small invertebrates and benthic fauna. Sexual maturity is reached at a very early age (5-6months) and spawning occurs when the water temperature is 24°C. Following fertilisation, the female incubates the eggs and broods the young until the yolk sac is absorbed and the temperature is favourable. The average life span of the Nile tilapia is approximately 10 years and can achieve a weight of 5kg+. Tilapia is referred to as an asynchronous breeder which means that breeding does not take place at a specific time of year. This cycle can happen throughout the year in the tropical regions and during the warm season in the sub-tropics.

Tilapia can be grown to marketable size (400-500g) for whole fish in approximately 8-10 months. For fish that are grown for the purposes of processing fillets, it takes around 11-14 months for them to reach 700-1000g (World Seafood Market, January 2005).
2.8.3 Production Systems

In the Northern Ireland situation, only land-based recirculation culture would be a suitable culture method for tilapia.

Within commercial production of tilapia, male monosex populations tend to be preferred as the growth rate for males is twice that for females. Furthermore, females in populations encourage uncontrolled reproduction, increased numbers of fingerlings and competition for food, resulting in growth retardation. The reversal of female fry to male can be achieved by administering a male hormone several days after the yolk sac has been absorbed.

Once the sex reversal has been successful, fingerlings are grown to a more advanced size prior to being moved to on-growing units. The first growth phase involves stocking rates of 3,000 fish per m³ which are grown for 6 weeks until they reach 10g. Then they can be restocked at 2,500 fish per m³ for 4 weeks until they reach 25-30g. These can be stocked at 1,500 for another 4 weeks until they are 50-60g fingerlings. A recirculation system which stocks fish 1,000 per m³ can grow fingerlings to 50g in 12 weeks.

In a RAS system, production levels can range from 60 to 120 kg/m³ of rearing tank volume, or more. The final crop is not the best way to demonstrate efficiency within the system as the maximum daily feed input to a system may be a better indicator of both productivity and efficiency. Feed input and other factors that promote production are captured by the Production to Capacity ratio (P:C), the ratio of system output to maximum carrying capacity. For tilapia, P:C ratios of >4.5 are possible and ratios of >3 may be necessary for profitability. Intensive stock management practices, such as multiple cohort culture with regular partial harvests and restocking, are needed to reach high P:C ratios.

Tilapia should be given prepared feeds that provide a complete diet consisting of adequate protein, lipids, carbohydrates, vitamins and minerals. Harvesting can be carried on a partial basis in tanks, raceways and recirculation systems using grader bars to remove the largest fish.

The advantages of growing tilapia are that they can be produced using vegetable based feeds which reduces the high cost involved with sourcing animal proteins for fish feed. Tilapia can be used as a substitute for declining whitefish, exhibits good growth rate, is a resilient species and very versatile at being farmed intensively (UK Tilapia Ltd).

Tilapia is less susceptible to viruses, bacterial and fungal diseases in comparison with other species. They are also more likely to tolerate wider variations in terms of salinity but do prefer water temperatures between 29°C and 31°C. Indeed, temperatures below 20°C seem to have an adverse effect on growth and this can be an issue for countries producing the species in more temperate climates. They are not particularly sensitive to lower levels of dissolved oxygen and they consume a variety of food such as plankton, green leaves, benthic organisms, aquatic invertebrates, larval fish and decomposing matter (World Seafood Market, January 2005).

Males tend to exhibit on average a 40% faster growth rate; therefore, there is a preference for male populations.

2.8.4 Cost of Producing Juveniles

Since January 2005 the University of Stirling has been involved in developing small scale, warm water production systems for growing tilapia as a diversification strategy for UK agricultural farmers. Funded by the Research Councils UK Rural Economy and Land Use Programme (RELU) the aim of the project has been to develop an income earning diversification strategy, producing tilapia as a local food and, where possible, using available farm infrastructure and local on-farm feeds. To this end, the project has drawn on extensive research from individuals with expertise in aquaculture, marketing and public health. In a useful handbook produced by the University of Stirling, Scotland, the cost of producing fry or fingerlings is estimated at £0.13.

(Fish Farmer, 2007). Fishing News International quotes “The potential for tilapia is enormous. The only thing you need for tilapia is heat and London and the South East have a lot of heat. So you could grow tilapia in elevator shafts, and then people could buy tilapia grown by local people in the South East” (BBC Inside Out, February 2009).

In 2009, there were around 12 farms producing tilapia in England using recirculation systems. All had varying degrees of production capacity from a few to several hundred tonnes per year.

There have been casualties within the sub-sector too as demonstrated in the case of Vitafish based in Belgium. The company was launched in June 2006 and proclaimed

---

1 The economic analysis presented here is based on nutritionally complete commercial pellets which can achieve high feed conversion ratios while minimising waste. The economic viability of diet formulations using on-farm or local plants sources requires further research.
that it was the biggest closed recirculation system globally, built at a cost of €15 million. The ambition was to produce 3,000 tonnes of tilapia annually (Fish and Information Services, 2009). In 2006, the company reported that the market for their tilapia had already exceeded 1,000 tonnes and they were expecting to use 3,000 tonnes of whole fish to produce 1,000 fillets (Intrafish, March 2006). Their motivation was to exploit the trend towards healthy eating products particularly in light of the meat and protein scares that had damaged consumer confidence at the time. The market they were targeting included Belgium, France, Germany and the Netherlands.

Unfortunately, by 2009, the company was declared bankrupt and the problem was cited as the decline in fish prices particularly cod from the Barents Sea and also the increase in Norwegian and Icelandic quotas. The company, however, was acquired by Joosen-Luyckx which specialises in sturgeon and there were plans to diversify the business to accommodate the production of both species (Fish and Information Services, October 2009).

On a much more positive note, UK based farm, The Fish Co. is currently supplying Tesco with tilapia. The tilapia is produced in four units across Yorkshire and Lincolnshire in the north of England. The facility is based on a recirculation system and sources broodstock from Til-Aqua International based in the Netherlands. The company produces 700 tonnes of tilapia each year and also provides scaled and gutted fish to the foodservice sector clients such as M&J Seafoods as well as Billingsgate and Birmingham markets. There is some contrasting information on this issue as, Finfish News 9 (Cefas) of Winter / Spring 2010, included information that the total production in the UK could be in total 800 tonnes, but this capacity had not been reached due to ‘teething problems’ and was probably closer to 300 tonnes. Tilapia Scotland, which was established in 2008, is a project funded by the Scottish Enterprise for two years and is a partnership between the Institute of Aquaculture and the Department of Marketing at the University of Stirling. This organisation is in place to offer mentoring support to individuals and businesses in Scotland who have an interest in diversifying into warm-water food-fish production using recirculating aquaculture systems. Certainly, interested parties from NI into tilapia could start by contacting Stirling University for information.

According to a Globefish report published in 2008, the US market for tilapia was growing with imports reaching approximately 400,000 tonnes which meant that America was the second largest market for tilapia following China. In 2009, Globefish also reported that tilapia prices were subject to difficult market conditions due to low ground fish prices in all of the major markets.

North America’s two largest tilapia companies were predicting that the European market for tilapia would grow significantly over the next couple of years. Tropical Aquaculture and Regal Springs had witnessed an increase in the number of sales that they were exchanging with Europe. They were very positive about the future potential and prospects available. Regal Springs had been trading within Europe around 4-5 years previously with production levels of 20 tonnes. By 2009, volumes had risen to 500 tonnes on a weekly basis (Globefish, 2008).

2.8.6 Prices

Figure 15 demonstrates the fluctuations in price that tilapia has experienced. In 2003, the average cost per kg for tilapia was $1.75 or £1.51 and by 2006, this had dropped to $1.52 or £1.31/kg.

The market price was low in 2009 because of an increase in availability coupled with the negative economic climate. In 2008, the unit price for tilapia was $3.00 or £1.86/kg and by 2009 this figure had dropped to $2.77 or £1.72/kg.

Contact with Billingsgate market revealed that both red and black tilapia is widely available. The prices tend to be relatively similar to sea bass and ranges between £4-5.00/kg on average.
North America’s two largest tilapia companies were predicting that the European market for tilapia would grow significantly over the next couple of years. Tropical Aquaculture and Regal Springs had witnessed an increase in the number of sales that they were exchanging with Europe. They were very positive about the future potential and prospects available. Regal Springs had been trading within Europe around 4-5 years previously with production levels of 20 tonnes. By 2009, volumes had risen to 500 tonnes on a weekly basis (Globefish, 2008).

### 2.8.6 Prices

Figure 15 demonstrates the fluctuations in price that tilapia has experienced. In 2003, the average cost per kg for tilapia was €1.75 or £1.51 and by 2006, this had dropped to €1.52 or £1.31/kg.

The market price was low in 2009 because of an increase in availability coupled with the negative economic climate. In 2008, the unit price for tilapia was $3.00 or £1.86/kg and by 2009 this figure had dropped to $2.77 or £1.72/kg.

Contact with Billingsgate market revealed that both red and black tilapia is widely available. The prices tend to be relatively similar to sea bass and ranges between £4-5.00/kg on average.

### 2.8.7 Product Specifications

Tilapia products in the form of fresh and frozen fillets, whole and gutted fish have become important commodities (Fitzsimmons, 2001). Products vary greatly with fillets available in different sizes and packages, skin on and skin off, deep skinned, individually quick frozen (IQF), smoked, sashimi grade and as izumi-dai (red coloured tilapia).

### 2.8.8 Issues

The Fish Site (June, 2009) reported that a tilapia farm in England was subject to an outbreak of a bacterial disease thought to be caused by *Franciscella sp* which has been isolated from diseased Asian tilapia. This serves as a warning to producers and identifies a potential risk to stocks from diseases other than those controlled by the aquatic animal health regulations and the statutory health certification requirements. Cefas recommends that special attention needs to be administered when farming new species to ensure that the stock from new suppliers is clear of other non-notifiable pathogens. Producers have also been advised to determine if the supplier has an isolated water source, maintains their own broodstock and employs sound bio-security policies (The Fish Site, 2009).

The ease with which tilapia reproduces can surprisingly be a disadvantage as this can lead to overcrowding, increased competition for food and retardation in terms of growth. This has led one company, Fishgen to develop an innovative technique which is known as the ‘YY male technology and produces Genetically Male Tilapia (GMT®). It
This has led one company, Fishgen to develop an innovative technique which is individually quick frozen (IQF), smoked, sashimi grade and as izumi-dai (red coloured tilapia). Figure 15: Comparison of Tilapia Prices

(Strobe: Federation of European Aquaculture Producers)

2.8.7 Product Specifications

Tilapia products in the form of fresh and frozen fillets, whole and gutted fish have become important commodities (Fitzsimmons, 2001). Products vary greatly with fillets available in different sizes and packages, skin on and skin off, deep skinned, individually quick frozen (IQF), smoked, sashimi grade and as izumi-dai (red coloured tilapia).

2.8.8 Issues

The Fish Site (June, 2009) reported that a tilapia farm in England was subject to an outbreak of a bacterial disease thought to be caused by Francisella sp which has been isolated from diseased Asian tilapia. This serves as warning to producers and identifies a potential risk to stocks from diseases other than those controlled by the aquatic animal health regulations and the statutory health certification requirements. Cefas recommends that special attention needs to be administered when farming new species to ensure that the stock from new suppliers is clear of other non-notifiable pathogens. Producers have also been advised to determine if the supplier has an isolated water source, maintains their own broodstock and employs sound bio-security policies (The Fish Site, 2009)

The ease with which tilapia reproduces can surprisingly be a disadvantage as this can lead to overcrowding, increased competition for food and retardation in terms of growth. This has led one company, Fishgen to develop an innovative technique which is known as the YY male technology and produces Genetically Male Tilapia (GMT®). It is claimed that it has been proven in both extensive and intensive systems involving ponds, raceways, cages or tanks. These males only produce male offspring but without the need for hormone treatments. This helps to increase viability, reduce variations in size, and promote high growth rates and an improved yield.

2.8.9 Summary

- There is a huge market and production of tilapia world-wide; this appears to be continuing to grow. The biggest areas of growth seem to be the UK and US. Tilapia is already being produced in a number of facilities particularly in England;
- Tilapia is an omnivorous fish which doesn’t have to depend on foods that are derived from wild fish stocks, therefore, it can be produced using sustainable sources;
- The species exhibits significant growth rates and can reach mature adult size within six months. Although, more cautious reports estimate that it generally takes 8-10 months to grow whole fish and 11-14 months to produce fish that will be processed for fillets;
- Tilapia is a particularly robust fish that can generally withstand extreme ranges in temperature;
- It has a lower cost than cod and has a mild flavour which is fuelling speculation that it could be a future substitute for other whitefish including haddock and whiting;
- As a result of its similarity to other whitefish, it can also be affected by changes in their market conditions;
- Tilapia is an exotic species, therefore, there is a risk that if any farmed fish escape there could be a detrimental impact on native eco-systems, this will necessitate farming in closed bio-secure recirculation units;
- In general, they do have a resistance to most diseases; however, this does not mean that this threat is removed altogether. The importation of juveniles may be difficult due to environmental concerns and regulations;
- The world-wide supply and independence from fishmeal prices means that there may be an opportunity for processors to use it as a primary source of whitefish and add value to it.
2.9 Survey Feedback

2.9.1 Introduction

In the course of completing this research, respondents were asked to comment on the species that have been discussed in the sections above and they were also invited to volunteer information on further diversification opportunities that they consider to have potential. Some producers in the trout sub-sector felt that the addition of equipment to their business such as filleting machines would improve their efficiency, add value to their products and reduce costs. The Department of Agriculture and Rural Development clarified that the introduction of technology is categorised as a ‘processing and marketing’ function and support for such initiatives is available through the EFF measure under the same name.

A range of species and opportunities for business development that were specifically mentioned by producers included:

2.9.2 Pike perch

A local NI exporter suggested that pike perch is a species that could potentially offer further opportunities. Gebr. Dil. in the Netherlands concurs with this and stated that the current market prices are favourable. A representative from Billingsgate market indicated that high quality, pike perch can receive up to £15.00 per kg.

2.9.3 Multi-species culture

For another local producer, diversification would involve the production of other species such as tench, carp, sturgeon and koi carp, for example, that would have the added benefit of attracting more fishing tourism to Northern Ireland from locations such as the Germany. It was suggested that this concept could be developed whereby different species would be produced in an existing facility and the activity of each would complement the business proposition. For example, while one species would be grown to maturity and supplied for recreational purposes, the hatchery unit would also be able to supply ova, to be processed for consumption.

Erne and Melvin Enhancement Company based in Fermanagh has a modern brown trout fish hatchery which also incorporates the concept of a multi-species culture through a state of the art recirculation coarse fish hatchery. Its aim is to create and promote a sustainable angling product in Co. Fermanagh for the purposes of the tourism market and local angling. Their licence covers coarse and game fish including salmon, trout, pollan, carp, tench, roach and rudd. There could be potential for the previously mentioned companies to liaise with each other.

2.9.4 Fry and Fingerling Production

For two existing producers, the future opportunities for the aquaculture sector are in the production of fry and fingerlings. The advantage that Northern Ireland has over other regions is its disease free status. There were a number of producers that felt that this aspect was and still is very important and has not been promoted properly or exploited to its fullest.

2.9.5 Oyster hatchery

Among opportunities raised by producers was that of a pacific oyster hatchery. Island Shellfish is the only native oyster hatchery in the UK and is only one of a few pacific oyster hatcheries on the island of Ireland. The current market price for 175-200g Native oysters is approximately €8.00 per kg. Island Shellfish's interest is in the establishment of a micro-hatchery which will produce approximately 1 million seeds per season. The benefit of this would be to develop a native broodstock that would assist with the implementation of a high level of biosecurity and could potentially address issues such as continuity of supply. Seed is currently being supplied by French and English hatcheries but the order needs to be placed the year before delivery. If something happens with the hatchery stock as in 2009 when 2 billion seed were lost there are very little alternative resources available. In addition, the cost of purchasing 8mm seed currently is £15.00 per 1,000 units whereas this could be reduced to £5.00 per 1,000 units in a local hatchery facility.

Island Shellfishes contend that 40% grant aid available for a research programme into the establishment of a hatchery in NI isn’t viable for a project of this kind since the majority of the work has to be completed by skilled labour. This is an extremely intensive process and requires the appropriate level of expertise and handling for it to be successful. If the research project can be scaled up to a commercial level it has the potential to attract revenue to the Northern Ireland economy, create additional employment and facilitate the region in gaining a reputation for hatchery expertise.

Once the experimental phase has been completed, there could be a further opportunity to become self-sustainable by supplying modular systems to producers throughout the island of Ireland and abroad or alternatively providing broodstock to countries such as the Far East.
2.9.6 Sea Trout

There was also an expression of interest indicated in relation to the production of indigenous sea trout.

3.0 Quality, Organic and Environment

3.1 Introduction

According to the Federation of European Aquaculture Producers, the visible explanation of quality can be difficult to define. For the consumer, quality is generally perceived as the condition that the fish is bought in and includes such factors as the appearance of skin and eyes, taste and sometimes the presence of bones. Such factors can also reflect how the product has been handled and treated, if it can be seen that a farm has a high standard of care, there is often an assumption that the fish produced are of high quality. The price of products can also be perceived as an indication of quality. To customers, quality can be used to describe the type of service as well as the product.

For the producer, quality can be related to aspects of broodstock, fry and fingerlings, feeds and other items that are utilised within the farming process. Arguably though fillet yield, organoleptic characteristics and the price a product can command, are the most important indicators of quality. Reputation, conditions of sale and a disease free status can also be signs of quality. All of these elements make the clear application of quality extremely complicated and dynamic.

In attempting to both ensure and demonstrate product quality a huge range of mandatory quality standards and voluntary certification schemes have been developed. Voluntary schemes include organic, environmental, ethical and quality management. While mandatory schemes relate more to health and safety concerns such as banning the use of chemicals and setting maximum levels for contaminants and bacteria in food. HACCP and traceability labelling are two examples of such mandatory schemes. The problem is that there is such a diversity and abundance of schemes now available that it has become increasingly confusing for the consumer.

There can also be significant expenses associated with the application and maintenance of standards which can affect farm production costs. Different certifiers have different cost structures for their schemes including an application fee, annual licence fee, inspection costs and member fees. Inevitably, it is the customers within the supply chain that will determine what quality requirements are expected to be fulfilled. The following section provides an overview of some of the schemes that are required or are available for producers.
3.2 Current Quality Standards

3.2.1 European Standard EN45011

EN45011 is the recognised standard for European product certification, the objective of which is to provide confidence in the way that the certification process for is conducted and thus communicate to the consumer that products receiving this satisfy identifiable and consistent quality standards. The standard was initially introduced in 1989 and requires inspection, testing and surveillance to make sure that there is compliance with the standard demonstrated by a certificate, mark of conformity or licence to the supplier. This accreditation is generally regarded as, ‘the international gold standard’ for product certification.

The principle features of EN 45011 are:
- Independence;
- Third party checks;
- Normative documentation against which standards can be measured.

There has been an increasing requirement from retailers and global foodservice chains for quality assurance schemes to be independently audited and this type of accreditation meets this criteria.

3.2.2 Irish Quality Scheme

Bord Iascaigh Mhara has developed a Quality Seafood Programme (QSP) available to producers in Northern Ireland which is accredited to the international standard EN45011/ISO-65. QSP is described as a ‘recognisable assurance scheme for both wild and farmed seafood that allows members to demonstrate their commitment to the environment as well as producing an excellent product’. An accredited scheme for perch has recently been developed whereby producers can use labelling to demonstrate that their product has been farmed using the highest quality standards and environmental practices.

3.2.3 International Standards Organisation (ISO)

In addition, some aquaculture companies have adopted International Standards Organisation or ISO which supports managerial and service quality, the ISO are considered to be the strictest in relation to international approval.

3.2.4 British Trout Association (BTA)

The British Trout Association was established in 1983 and manages the ‘QTUK’; quality assurance scheme. The standards apply to the supply chain and cover all activities associated with the farming, hatchery through to the processor including fish welfare considerations. It is accredited under EN45011 and is consistent with the British Retail Consortium’s Technical Standard, a requirement of retailers. The inspections are conducted by the European Food Safety Inspection Service (EFIS) who have been approved by UK Accreditation Service to carry out this work.

FEAP states that future trends in aquaculture will focus on the further development of and requirement for quality systems. This is expected to coincide with an increased demand for organic or biological products.

3.3 Organic Standards

3.3.1 Introduction

According to INFOish, organic aquaculture has grown by 950% worldwide in the last 20-25 years (Fish and information services, March 2010). In 2015, the total annual production is expected to increase to 500,000 tonnes which will be the equivalent of 1% of aquaculture production world-wide. This sector is currently composed of three primary species namely salmon, shrimp and carp representing 31%, 17% and 14% respectively. The German and Swiss markets have also seen a recent rise in demand for organic pangasius. Furthermore, the report indicates that the value of organic aquaculture has also been increasing. The global market for organic food and beverages is reputed to be worth over €30 billion. At European level, the figure is €20 billion while, in the US, the market is estimated to be worth between €12 and 20 billion. Approximately, 60% of Irish salmon is organic and is considered to be an export success story. However currently in Europe fish grown for greater than 1/3 of their life in recirculation units cannot obtain organic certification.

Approval for receiving organic status on the basis of FAO INFOish standards includes the implementation and demonstration of a decreased protein and fishmeal diet content; absence of inorganic fertilisers, synthetic pesticides or herbicides; lower energy input; use of natural medicines and processing practices that adhere to organic guidelines.
### 3.3.2 European Guidelines

On the 1st July 2010, there was a new set of rules (Regulation 710/2009) issued in relation to the organic production of fish, shellfish and seaweed. More specifically, these conditions are concerned with:

- The aquatic production environment;
- Impacts on other species;
- The distinction between organic and non-organic facilities;
- Animal welfare conditions including maximum stocking densities, for example, it is recommended that salmon is stocked at 10kg/m³ in sea water net pens and 20kg/m³ in freshwater. For sea bass and sea bream, the maximum is 15kg per m³ in the sea while earth ponds and lagoons should be stocked at 4kg per m³.

In addition, the rules state that:

- Biodiversity should be respected;
- The use of artificial hormones to induce spawning should be prohibited;
- Organic feeds should be supplemented by fish feeds originating from sustainably managed fisheries.

The major criticism is that organic aquaculture has typically been regulated by a combination of national rules in member states and various private schemes, only a few of which have been operational and recognized beyond single member states. This has had a detrimental impact on the free movement of goods and the potential for Europe to act as a single market.

Maritime Affairs and Fisheries Commissioner, Maria Damanaki, said,

“European-wide rules for organic aquaculture have become a reality. They will give consumers a better choice and be a boost for sound and environmentally acceptable production and a viable alternative to the more traditional, intensive approach” (Intrafish, July 2010).

In 2008, there were approximately 123 certified organic aquaculture units in Europe which is nearly half of the 225 facilities that have been certified globally (Intrafish, July 2010). It is also close to 50% of the 50,000 tonnes that is produced in the world. The main producers are the UK, Republic of Ireland, Hungary, Greece and France. The demand for organic products is rising in countries such as France, Germany and the UK. Around €17 million worth of organically labeled seafood is purchased in France and this market rose by 220% between 2007 and 2008. In Germany, organic food has become more widely available through discount retailers in addition to specialist organic supermarkets.

### 3.3.3 Soil Association Certification

In the UK, the Soil Association Certification Ltd is the largest certification body and covers over 80% of the total organic products sold in the UK. Their standards for aquaculture include many elements such as:

- Organic aquaculture systems;
- Managing aquaculture systems;
- Managing stock through conversion;
- Eggs and young stock;
- Environmental management;
- Managing holding facilities;
- Managing water quality;
- Feeding organic stock;
- Maintaining high stock welfare;
- Keeping stock healthy;
- Transporting live stock;
- Harvesting and slaughtering;
- Record keeping.

There is some evidence that organic status can improve the price that producers receive by 25-30% and assist with reaching international markets, however, the prevailing issue, again, is that there are other certifying bodies in many different countries with standards that can vary greatly on the basis of guidelines and species.

### 3.4 Traceability Process Quality and Food Safety

#### 3.4.1 Introduction

Evidence of traceability within the production and supply chain has become increasingly important. Within aquaculture this specifically refers to control over the production process and maintenance of records.

Inevitably, traceability and food safety systems require a level of investment and effort to demonstrate compliance. Many of these systems have been introduced by larger companies who have done so on the basis that it would encourage a better return on prices and profitability. Unfortunately, this theoretical advantage has been undermined
by the level of competition that exists and the position that retailers hold. The situation increasingly is that if quality cannot be demonstrated then products will not be purchased.

European and National legislation also controls many aspects of aquaculture product quality such as approved veterinary products and maximum residue levels (i.e. for therapeutic agents). As well as this, supermarkets can have their own criteria that signify quality and will only buy from those suppliers that meet these conditions. Some trout producers in Northern Ireland are part of the British Trout Association. If they supply to supermarkets they are also expected to comply with each retailer’s individual system.

3.4.2 Hazard Analysis and Critical Control Points HACCP

Within the European Union, the standard system for demonstrating an adherence to consumer safety and quality is HACCP which is a system that covers the processes in installations licenced for food production, processing and sales. The purpose of this system is to provide a risk assessment of all procedures in order to ensure a safe production environment and a quality product.

3.4.3 GlobalGAP.

GlobalGAP has established voluntary standards for the certification of agriculture products on a global scale. This is a private sector body and its aim is to implement one standard of ‘Good Agricultural Practice’ i.e. G.A.P. which can be applied to different products. GlobalGAP is described as a pre-farm-gate standard and this means the accreditation system refers to the process of the certified product including farm inputs such as feed or seedlings and the entire farming activity until the product has left the farm. The major drawback is that the label is for business-to-business use and doesn’t have any visible application for consumers. The process of accreditation is conducted by more than 100 independent and accredited certification representatives in more than 100 countries. The application process is also open to all producers and supported by annual inspections.

3.3.4 EU Protected Food Name Scheme

The EU Protected Food Name Scheme was established to assist with the promotion of regional products across Europe. According to the European Commission, products that have received approval for protected name status can fall into one of three categories:

- **Protected Designation of Origin (PDO)**
  For a PDO, the product must have qualities and characteristics which are essentially due to its region of production: it must also be produced, processed and prepared exclusively within that region.

- **Protected Geographical Indication (PGI)**
  For a PGI conditions are slightly less strict; a good reputation of a product from a given region is sufficient (rather than objectively different characteristics) and any of the steps of production, processing and preparation may take place within the region. PGI status is currently being sought for Atlantic salmon by BIM on an all-island basis;

- **Traditional Speciality Guaranteed (TSG)**
  This is open to products that are traditional or have customary names, and have features that differentiate them from other similar products. These features don’t necessarily have to be attributable to the geographical area the product is produced in, nor entirely based on technical advances in the method of production.

In principle, producers in Northern Ireland were fairly open to considering the possibility of applying for schemes such as the EU Protected Food Name Scheme, however, this would depend very much on the costs involved. There was some support for the potential of such schemes to raise the profile of Northern Ireland’s products. There was also a suggestion that existing schemes should be streamlined within overarching systems to reduce the level of investment and bureaucracy that is involved with each application process. This issue has been acknowledged and agreed at European level. This is demonstrated more clearly in the discussion on sustainability and, in particular, eco-labelling whereby new guidelines have been administered to implement a common EU standard.

3.5 Environmental Quality

3.5.1 Introduction

Recirculation units were identified in the Strategy for ‘The Sustainable Development of European Aquaculture’, as being an area for further expansion. “The Commission considers that closed water recirculating systems should be further developed in order to reduce water demand and to transfer farms to areas with less landscape value”.

3.5.2 Legislative Framework

There are a number of Directives originating from the European Commission governing environmental protection and these include:


Environmental schemes are those that are particularly concerned with the impact that the production of goods has on the environment.

### 3.5.3 European Eco-Management and Audit Scheme (EMAS)

This is used as a management tool for companies to evaluate report and improve their environmental performance. It is open to companies that are based in the EU and the European Economic Area (EEA). The aim of this is to recognise and reward companies that exceed the minimum legal requirements. It includes ISO 14001 and companies are also asked to produce a public statement regarding their environmental performance. In 2009, new guidelines were issued and implemented from 11th January 2010 to assist with the optimisation of company production processes, the reduction of environmental impacts and to encourage a more efficient use of resources.

According to the European Parliament, the objectives of EMAS are to:

- Promote continuous improvements in the environmental performance of organisations through the establishment and implementation of environmental management systems by organisations;
- Evaluate the performance of such systems, the provision of information on environmental performance;
- Encourage an open dialogue with the public and other interested parties and the active involvement of employees in organisations and appropriate training.

### 3.5.4 ECOPACT

There has been an increase in the number of independent schemes specific to aquaculture, for example, ECOPACT™. This initiative was developed by Bord Iascaigh Mhara (BIM) and launched in 2003 in partnership with the Irish Shellfish Association, and the Irish Salmon Growers Association. The aim of this scheme was to encourage the widespread adoption of Environmental Management Systems in the Irish Aquaculture industry. This scheme was introduced to Northern Ireland in 2004 for aquaculture producers.

### 3.5.5 Eco-label Europe

The first European Eco-label was established in 1992 with the aim of encouraging businesses to produce and market products and services that are more sympathetic to the needs of the environment. This scheme is voluntary and those products and services that receive approval are allowed to display the logo which identifies them to consumers including public and private buyers.

In order to meet the criteria, products must be in a position to demonstrate that they can satisfy the high environmental and performance standards that have been established at European level, in consultation with a field of experts.

These standards cover a whole range of different elements including the impact that the product has on the environment throughout its life-cycle, beginning with the raw material in the pre-production stage, through to production, distribution and eventually its disposal.

### 3.5.6 Aquaculture Stewardship Council (ASC)

The Aquaculture Stewardship Council is a very recent development which began in 2009. It is an independent body established in partnership with the World Wildlife Fund (WWF) and Dutch Sustainable Trade Initiative (IDH). At present, the organisation is still in its development phase but hopes to be operating fully by 2011. It has aspirations of becoming the world’s leading certification and labelling programme for aquaculture products that can demonstrate they are farmed responsibly. The objectives are to develop standards that are compliant with ISEAL Alliance guidelines (a collaboration of certifying companies including Fairtrade and MSC), a global association for social and environmental standards systems; to minimise the environmental and social footprint of commercial aquaculture by addressing key impacts and; connecting...
the farm to the marketplace by promoting responsible practices through a consumer label.

3.6 Recognition of Quality Systems

In 2007, the European Commission carried out a study, the aim of which was to investigate the perceptions that the aquaculture sector had in relation to quality accreditation systems. Furthermore, the survey intended to determine the potential interest in future European action in this area. Figure 16 demonstrates the level of awareness in relation to the listed quality schemes.

Figure 16: Which Quality Systems Do You Recognise and Understand?

![Quality Systems Graph]

(Source: European Commission)

3.7 Summary

It is clear that the area of quality and sustainability can be extremely complicated and indeed costly due to the sheer number of schemes that are currently on offer. The majority of producers interviewed support the principal of quality and sustainability schemes. Any consideration of a European wide scheme would necessitate streamlining other independent systems with this to reduce the level of resources that are required to achieve approval and maintain the standards that are expected on an individual basis.

4.0 Financial and Legislative Considerations of RAS

4.1 Financial Elements of RAS

Recirculation Aquaculture Systems (RAS) are characterised by high set up and operating costs even with recent advances in energy efficiency. This requires a significant capital outlay, and specifically means that only high value species can be considered for recirculation units. Examples of the type of costs involved are a perch recirculation start-up in the Republic of Ireland which had a total NDP (National Development Plan) investment of €663,708 for a unit with a capacity of less than 100 Tonnes, and the Achill Island Turbot project in the Republic of Ireland which cost over €2m for a startup production of 100t, with plans to expand with further investment.

As capital investment in RAS is greater than other traditional flow through systems, the strategy to achieve profitability requires a high production and high stocking density. RAS by definition are high density grow out units and this means that the water treatment aspect of the system is very important. Failure of the water treatment functions can result in high losses, so back-up systems and alarms are an integral part of the design.

Operating costs are also more expensive in RAS systems when compared to extensive systems. Technically skilled staff are required and energy / fuel consumption contributes significantly to overheads. Energy efficient, reliable systems are required, to attain healthy profit margins. Another aspect to be considered is the duration of the grow out period. For example, perch may only take a year to grow to market size and turbot would take around 18 months.

A relevant study into the operating costs of an RAS system in the EU was carried out in 2008 by Sturrock et al. The study titled ‘Prospective Analysis of the Aquaculture Sector in the EU used turbot as an example to illustrate the type of costs to be considered when looking into RAS.

This report compared turbot in RAS and flow through production units in Europe. Recirculation units were found to have an operating cost of €4.58 / Kilo and a payback time of 6 years, whereas a flow through unit had a cost of €3.98 / Kilo and a payback time of 5 years. However, as a way of illustrating the importance of location for any aquaculture business model, this report’s caveat was that flow through systems in cooler regions of the EU, would need larger energy inputs than those in areas such as Portugal, making RAS the best option for areas such as NI, as flow through is uneconomical for fish species with optimum growth rates at temperatures greater than those in natural water bodies e.g Turbot.
Figures 17 and 18 from Sturrock et al. give a detailed overview of the type and scale of costs to be anticipated in setting up a land based turbot farm. An overall finding of this study was that using their financial feasibility model a 120 ton/year RAS turbot farm should be viable.

**Fig 17: Estimate of Operating Costs for 120T turbot farm (Sturrock et al., 2008)**

<table>
<thead>
<tr>
<th>Operating Costs</th>
<th>€</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>138,600</td>
<td>15%</td>
</tr>
<tr>
<td>Fry</td>
<td>86,842</td>
<td>10%</td>
</tr>
<tr>
<td>Labour</td>
<td>66,000</td>
<td>7%</td>
</tr>
<tr>
<td>Medicines</td>
<td>16,500</td>
<td>2%</td>
</tr>
<tr>
<td>Stock insurance</td>
<td>1,931</td>
<td>0%</td>
</tr>
<tr>
<td>Power/fuel</td>
<td>99,000</td>
<td>11%</td>
</tr>
<tr>
<td>Rep and ren</td>
<td>33,000</td>
<td>4%</td>
</tr>
<tr>
<td>Gen insurance</td>
<td>16,500</td>
<td>2%</td>
</tr>
<tr>
<td>Admin</td>
<td>33,000</td>
<td>4%</td>
</tr>
<tr>
<td>Legal and prof</td>
<td>9,900</td>
<td>1%</td>
</tr>
<tr>
<td>Depreciation</td>
<td>315,506</td>
<td>35%</td>
</tr>
<tr>
<td>Consumables</td>
<td>8,250</td>
<td>1%</td>
</tr>
<tr>
<td>Other 10%</td>
<td>82,503</td>
<td>9%</td>
</tr>
</tbody>
</table>

Total op costs: 907,532 100%

Cost per Kg: 4.58

**Fig 18: Estimate of Capital costs for 120T turbot farm (Sturrock et al., 2008)**

<table>
<thead>
<tr>
<th>Capital costs</th>
<th>No. units</th>
<th>Cost unit, €</th>
<th>total, €</th>
<th>Contingency +20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polytunnel per m²</td>
<td>962</td>
<td>128.7</td>
<td>123809.4</td>
<td>148571.3</td>
</tr>
<tr>
<td>Office</td>
<td>Sum</td>
<td>198000.0</td>
<td>198000.0</td>
<td>237600.0</td>
</tr>
<tr>
<td>building/roads/parking/sewage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6m bio filter housings</td>
<td>4</td>
<td>3135.0</td>
<td>12540.0</td>
<td>15048.0</td>
</tr>
<tr>
<td>2.8m degaser housing</td>
<td>2</td>
<td>165.0</td>
<td>330.0</td>
<td>396.0</td>
</tr>
<tr>
<td>Treatment pumps</td>
<td>4</td>
<td>3451.8</td>
<td>13807.2</td>
<td>16568.6</td>
</tr>
<tr>
<td>Fish return pumps</td>
<td>2</td>
<td>3451.8</td>
<td>6903.6</td>
<td>8284.3</td>
</tr>
<tr>
<td>Biofilters media</td>
<td>116.9</td>
<td>544.5</td>
<td>63639.0</td>
<td>76366.8</td>
</tr>
<tr>
<td>Belt filter / drum filter</td>
<td>1</td>
<td>46200.0</td>
<td>462000.0</td>
<td>55440.0</td>
</tr>
<tr>
<td>Water storage tank 100m³</td>
<td>1</td>
<td>10725.0</td>
<td>10725.0</td>
<td>12870.0</td>
</tr>
<tr>
<td>pH MONITOR</td>
<td>2</td>
<td>1402.5</td>
<td>2805.0</td>
<td>3366.0</td>
</tr>
<tr>
<td>pH buffer</td>
<td>1</td>
<td>2475.0</td>
<td>2475.0</td>
<td>2970.0</td>
</tr>
<tr>
<td>pH pump</td>
<td>1</td>
<td>891.0</td>
<td>891.0</td>
<td>1069.2</td>
</tr>
<tr>
<td>blowers</td>
<td>4</td>
<td>2475.0</td>
<td>9900.0</td>
<td>11880.0</td>
</tr>
<tr>
<td>ozone monitor</td>
<td>2</td>
<td>1072.5</td>
<td>2145.0</td>
<td>2574.0</td>
</tr>
<tr>
<td>control panels</td>
<td>2</td>
<td>8250.0</td>
<td>16500.0</td>
<td>19800.0</td>
</tr>
<tr>
<td>oxygen monit. 8 channels</td>
<td>3</td>
<td>1072.5</td>
<td>3217.5</td>
<td>3861.0</td>
</tr>
<tr>
<td>probes</td>
<td>30</td>
<td>222.8</td>
<td>6682.5</td>
<td>8019.0</td>
</tr>
<tr>
<td>flow meter</td>
<td>1</td>
<td>1650.0</td>
<td>1650.0</td>
<td>1980.0</td>
</tr>
<tr>
<td>containers</td>
<td>2</td>
<td>2805.0</td>
<td>5610.0</td>
<td>6732.0</td>
</tr>
<tr>
<td>ozone generator</td>
<td>1</td>
<td>11550.0</td>
<td>11550.0</td>
<td>13860.0</td>
</tr>
<tr>
<td>contact columns</td>
<td>1</td>
<td>2887.5</td>
<td>2887.5</td>
<td>3483.0</td>
</tr>
<tr>
<td>engineering</td>
<td>18</td>
<td>577.5</td>
<td>10395.0</td>
<td>12474.0</td>
</tr>
<tr>
<td>Transport of equip</td>
<td>Sum</td>
<td>1980.0</td>
<td>1980.0</td>
<td>2376.0</td>
</tr>
<tr>
<td>Fitting biofilters (fluidised)</td>
<td>10</td>
<td>577.5</td>
<td>5775.0</td>
<td>6930.0</td>
</tr>
<tr>
<td>Screens</td>
<td>8</td>
<td>363.0</td>
<td>2904.0</td>
<td>3484.8</td>
</tr>
<tr>
<td>Labour</td>
<td>30</td>
<td>577.5</td>
<td>17325.0</td>
<td>20790.0</td>
</tr>
<tr>
<td>Trickle and submerged filter</td>
<td>Pipework</td>
<td>2</td>
<td>825.0</td>
<td>1650.0</td>
</tr>
<tr>
<td>Screen and supports</td>
<td>Pipework</td>
<td>2</td>
<td>1419.0</td>
<td>2838.0</td>
</tr>
<tr>
<td>Labour</td>
<td>20</td>
<td>577.5</td>
<td>11550.0</td>
<td>13860.0</td>
</tr>
<tr>
<td>Standby generator</td>
<td>1</td>
<td>2145.0</td>
<td>2145.0</td>
<td>25740.0</td>
</tr>
<tr>
<td>Feeders (small tanks)</td>
<td>7</td>
<td>412.5</td>
<td>2887.5</td>
<td>3465.0</td>
</tr>
<tr>
<td>Ongrowing feeders</td>
<td>23</td>
<td>1320.0</td>
<td>30360.0</td>
<td>36432.0</td>
</tr>
<tr>
<td>Fish tank assemble labour</td>
<td>30</td>
<td>577.5</td>
<td>17325.0</td>
<td>20790.0</td>
</tr>
<tr>
<td>Mechanical filter installation</td>
<td>6</td>
<td>577.5</td>
<td>3465.0</td>
<td>4158.0</td>
</tr>
<tr>
<td>Tanks in GRP and circular</td>
<td>Fry tank</td>
<td>7</td>
<td>1320.0</td>
<td>9240.0</td>
</tr>
<tr>
<td>Grow out tank</td>
<td>Grow out tank</td>
<td>23</td>
<td>13200.0</td>
<td>303600.0</td>
</tr>
<tr>
<td>Screens stand pipes etc sum</td>
<td>Screens stand pipes etc sum</td>
<td>60</td>
<td>33.0</td>
<td>1980.0</td>
</tr>
</tbody>
</table>

Total, €: 1912160.3
4.2 Technical Considerations
Recirculation Aquaculture Systems are in essence, units that treat and reuse effluent water following suitable treatment. This water treatment is made up of biological and mechanical filtration elements. There are four types of solids generated in recirculation systems: settleable, suspended, floatable and dissolved. Different designs of the different components are used by the main suppliers and these differences can affect operating costs.

4.3 Statutory Consents
For a land based recirculation unit to be established in Northern Ireland a number of statutory consents need to be received. Depending on the site and species under consideration, these could include;

- An Abstraction License (NIEA)
- A Discharge consent (NIEA)
- Planning Permission (Planning Service)
- A Fish Culture Licence. (DARD)

If a marine construction such as a pipe to sea is required this will require a FEPA or marine construction license (NIEA).

In addition, Aquatic Animal Health Regulations require aquaculture production businesses to be authorised and produce a biosecurity plan. A business plan is also required as part of the fish culture licensing process.

Within each statutory consent difficulties can arise, and the first stages of site selection and site survey are fundamental in the success of an aquaculture project. Clearly all of these consents take time, money and a lot of effort to receive. The Aquaculture Initiative’s role is to be on hand to offer their experience and support to clients in order assist with the consenting process.

4.4 Future Prospects for RAS
It is quite likely that recirculation units will become more commonplace, although the cost-effectiveness of systems will be dependent on using the best technology available. It is interesting to note that in Holland, unlike anywhere else in Europe, finfish aquaculture production takes place almost exclusively in recirculation systems.

In terms of the prospects for development for RAS in Northern Ireland, this report has identified some species with good prospects however again site characteristics are of paramount importance and it is only through a thorough site analysis that a clear picture will emerge of what is possible.
5.0 Conclusions for Candidate Species

5.1 Introduction

Under Measures for productive investments in aquaculture, EFF grants administrated by DARD offers support of 40% of the capital expenditure on Aquaculture projects and that can help off-set the initial costs. A SWOT Analysis in Figures 19-24 and a summary table in figure 25 helps to give a comprehensive overview of the diversification opportunities provided by the candidate species in this report.

A key point to make is that the set up costs and scale of unit are very much dependent on the site which is under consideration. In many ways the site characteristics are the most significant factor in determining the level of capital outlay that will be required. For example, a comprehensive analysis of the available water source for an RAS fish farm would be undertaken when designing the system. The results of the water analysis could influence the system and the species that would be best grown.

Anyone considering the suitability of a site for land based recirculation aquaculture would need to consider the suitability of their site and how it would affect the costs of operation on site. Some of the key information required to assess the suitability of a site can be seen in the Site Survey Form in Appendix 5. This illustrates that the site’s relationship to water resources, infrastructure and environmentally sensitive issues are key points for consideration when establishing an aquaculture facility.

5.2 Perch

Fig. 19: SWOT analysis - Perch

<table>
<thead>
<tr>
<th>Strengths:</th>
<th>Weaknesses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Delicate flavour, therefore, it can potentially have appeal for different target markets;</td>
<td>- Limited market appeal and channels at present therefore NI perch would be competing for the same markets as others;</td>
</tr>
<tr>
<td>- An established market exists in Switzerland, France, Germany, Austria and US;</td>
<td>- Species produced is relatively small and will have a niche market;</td>
</tr>
<tr>
<td>- Perch products from ROI have a good reputation for quality;</td>
<td>- Carnivorous fish that depends on feeds derived from wild fish stocks</td>
</tr>
<tr>
<td>- In terms of species production, perch can tolerate a wide range of temperatures;</td>
<td></td>
</tr>
<tr>
<td>- Perch can be grown in approximately 1 year;</td>
<td></td>
</tr>
<tr>
<td>- There are a range of proven, successful production methods;</td>
<td></td>
</tr>
<tr>
<td>- Higher yield produced from farmed perch compared to wild fish</td>
<td></td>
</tr>
</tbody>
</table>

Progress being developed in relation using vegetable oils in fish feeds

<table>
<thead>
<tr>
<th>Opportunities:</th>
<th>Threats:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Industry feedback indicates that there is a demand for more perch products;</td>
<td>- Distance from the markets can pose an issue in terms of delivery requirements and fresh product;</td>
</tr>
<tr>
<td>- There is an opportunity for producers to ‘piggyback’ with each other to reduce or share transportation costs;</td>
<td>- Major issue with accessing alternative markets such as US due to competition with major players;</td>
</tr>
<tr>
<td>- Use existing networks and contacts to penetrate new markets;</td>
<td>- Cost of transportation to more niche markets could be prohibitive for some producers.</td>
</tr>
<tr>
<td>- Possibility of growing perch to a larger size.</td>
<td></td>
</tr>
</tbody>
</table>

The life cycle of perch is well known and there is a wide range of expertise available in relation to hatchery and on-growing techniques including the use of recirculation systems. There are facilities already established in the Republic of Ireland and the Aquaculture Initiative possesses know-how within this area as well. There is a great deal of expertise in relation to the feed requirements of juveniles and adult fish, therefore, the husbandry is considered to be well developed. Increasingly, recirculation
systems are becoming more popular in the production of perch. The major
disadvantage is that such systems are still relatively expensive, however, technology is
continually improving and this should reduce expenses over time. The information
from this study suggests that there is an export market for locally produced perch,
although any decisions should consider the size of the fish produced and future
logistical arrangements.

5.3 Turbot SWOT

Fig. 20: SWOT analysis – Turbot

**Strengths:**
- Turbot is traditionally regarded as a high-value, luxury item, suitable for broad pan-European markets;
- Sector has benefited from commercial investment improving facilities and developing new farms;
- Progress made in relation to dry feeds and the use of vaccines;
- Established markets particularly in Spain, France and Portugal but also including Denmark, the Netherlands, Germany, Iceland, Rep. of Ireland, Italy and Norway;
- Turbot has been produced successfully on a commercial basis, therefore, there is expertise available in relation to hatchery and production techniques;
- In October 2010, prices in Spain reached a maximum of €20.00/Kg but averaged between €8.00-12.00 per kg;
- The shelf-life of turbot can be increased by up to nine days by applying the appropriate post-harvest methods;
- Progress has been made in relation to the use of vegetable based feed

**Weaknesses:**
- Less international trade in comparison with other species as volumes are generally absorbed by domestic markets of each producing country;
- Turbot is susceptible to slow growth rates;
- Cost of producing juveniles is still relatively high when compared to other species;
- Turbot is vulnerable to dynamic market conditions and prices can change dramatically from one week to the next. At its lowest reported levels, it has been €6.50/kg;
- Demand in the domestic market would need to be supplemented with supply to export markets;
- It can take up to three years to produce turbot;
- Turbot is a carnivorous fish and relies on fish from wild stocks as a food source.

**Opportunities:**
- Turbot is in short supply as wild catches have decreased significantly;
- Consumption levels could therefore improve if availability was resolved;
- Demand expressed from local processors for domestic market;
- Establish new markets.

**Threats:**
- Persistent development of farmed turbot has had a negative impact on prices;
- Market is controlled primarily by a number of large multinationals;
- It is likely that this competition will intensify once the facility in Portugal has achieved its full capacity.

At present, the life cycle of turbot has been researched and expertise within this field has been gathered from a variety of different sources. Turbot has been successfully reproduced and grown in recirculation systems although it should be noted that the species may be prone to growth retardation. There is professional experience available
regarding the feeding and husbandry that turbot requires to grow successfully. There are also farms that have actively sought accreditation to promote quality products. It is a high value, niche product which, according to the information gathered, does have quite an extensive market throughout Europe, however as with perch the startup costs are currently very expensive.

5.4 Pollan

**Fig. 21: SWOT analysis – Pollan**

**Strengths:**
- Pollan is an indigenous species to the island of Ireland.
- Pollan has been a traditional fish exported to European markets.
- Innovative preliminary R&D has previously taken place.
- Existing technology could be applied to Pollan production.
- Pollan may be more suited to flow through systems.
- Wild fishing is unlikely to expand

**Weaknesses:**
- The market value for pollan is not very high;
- The market demand for pollan is limited to a few countries;
- The demand for pollan is also very seasonal and peaks during the summer months;
- There is no existing demand in the domestic market and would require a promotional campaign to educate consumers

**Opportunities:**
- Pollan’s unique selling point, of being the only species of its kind native to the Island of Ireland, can offer potential provenance and promotional opportunities;
- The availability of pollan is significant enough to support a small fishery in Lough Neagh;
- There is a need to conserve existing stocks therefore aquaculture could assist with the re-stocking of populations;
- There has been some interest expressed for farmed pollan from producers and an exporter.

**Threats:**
- Pollan is a commercial species in Northern Ireland although it is subject to strict regulations;
- Experimental hatchery has been deferred indefinitely due to budget restrictions;

At present, the life cycle of pollan has not been fully completed on a commercial aquaculture scale. Therefore, this requires expertise and understanding to be developed in this area. Currently, there is little knowledge of the nutritional and behavioral habits of pollan and consequently the husbandry required for rearing and handling this species remains to be fully determined. Until, further R&D initiatives are continued, this issue will remain unresolved. There does appear to be a market for pollan although at the moment it is much smaller than the demand that is evident for other species such as perch. An important aspect with pollan is that there is only one substantial pollan population on the Island of Ireland and this is in Lough Neagh. The Lough Neagh pollan populations are believed to be discrete breeding populations. Therefore, genetic and other conservation considerations would need to be taken into account when looking into hatchery matters.

5.5 Seabass

**Fig. 22: SWOT analysis – Seabass**

**Strengths:**
- Reports suggest that sea bass is still the most widely cultivated non-salmonid finfish species. It is recognised and available through a variety of outlets;
- Demand for sea bass is spread throughout Europe and there are a range of countries producing juveniles;
- The cost of producing juveniles is low. In 2008, it was €0.18 per unit;
- It is possible to produce sea bass in recirculation units within 1-2 years;
- There is a vast amount of knowledge available for the entire production process;
- The implementation of the correct husbandry can help to resolve production difficulties associated with poor growth and cannibalism.

**Weaknesses:**
- One of the markets for sea bass is the restaurant trade and sales in this area have been negatively affected during the recession;
- Demand for sea bass in Spain has declined late;
- There is little or no differentiation in terms of premium quality sea bass products;
- Sea bass is a carnivorous fish and therefore subject to fishmeal pricing;
- Production difficulties can include growth differentiation and cannibalism.

**Opportunities:**
- Sea bass could be produced using certification for example to differentiate quality and local products;
- The UK has been the primary market for Greek production for many years and is considered to have growing potential;
- France has less internal production of sea bass than Spain and Italy therefore imports are necessary to satisfy any increases in demand;
- Currently, there are less volumes available from the Mediterranean;

**Threats:**
- The multinational company, Selonda, has established a production facility in Wales to satisfy UK demand and are hoping to reach their optimum capacity of 1,000 tonnes annually;
- Once the production issue is resolved in the Mediterranean, the major players will have a monopoly on the market again which will mean intense competition for locally based companies;
- Domestic demand alone would be unprofitable therefore new export markets
The cultivation of sea bass has been established for a number of years therefore the methods used are well established. There has been in-depth knowledge gathered in relation to its behavioral and nutritional requirements. It is however a carnivorous fish therefore it is sensitive to the price of fish meal. There is demand for sea bass throughout Europe; however, there has been some speculation that the existing market is saturated.

5.6 Eels

Fig 23: SWOT analysis – Eels

**Strengths:**
- Eel is considered to be a speciality in many cultures;
- The markets include France, Portugal, Spain, Denmark, Germany, Italy and Belgium;
- Lough Neagh Bann has Europe's largest wild eel fishery;
- The application of regular grading can identify and resolve growth differentiations.

**Weaknesses:**
- The market for eels is becoming increasingly limited;
- Retailers in the Netherlands have removed eel products from their shelves;
- Eels tend to be prone to high variations in terms of growth;
- The life cycle of the eel has not been successfully completed;
- It can take 2-3 years for eels to grow from 50g to marketable size.

**Opportunities:**
- The EMP for Northern Ireland recommends that the eel fishery in the Lough Neagh Bann catchment area can continue to fish at current levels as they are deemed to be sustainable;
- There is a rationale for producing eels and satisfying the issue of conservation;
- There is research currently being conducted into the reproduction of eels however the findings will remain unknown for the next couple of years;

**Threats:**
- Some members of the NI industry were supportive of an enhancement programme but emphasised that this would need to be very carefully co-ordinated;
- Netherlands and not offer eel products;
- It has not been possible juvenile to breed eels in captivity as yet.

The production of eels is increasingly controversial due to environmental concerns. A further outstanding issue is that the life cycle of the eel has never been completed within aquaculture. The EU Eel Recovery Plan is imposing heavy restrictions on the capture of elvers from the wild thus there is a bottleneck in the system. The nutritional and behavioural characteristics are still unclear given the above difficulties. Current research initiatives will hopefully resolve these problems but the results will not available in the short term. While there has been a demand for eel in markets across Europe, this sub-sector has experienced added complications in that some retailers have responded to the Eel Recovery Plan and voluntarily removed eel products from their shelves. Perhaps the only current viable opportunity is to produce eels purely for restocking programs.
## 5.7 Tilapia

**Fig 24: SWOT analysis – Tilapia**

<table>
<thead>
<tr>
<th>Strengths:</th>
<th>Weaknesses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Production of the species has developed at an enormous rate;</td>
<td>- Their high breeding rate can cause overcrowding and growth retardation therefore all male populations are necessary;</td>
</tr>
<tr>
<td>- The variant red tilapia is commonly used in the West of Europe because of its fast growth and calm disposition;</td>
<td>- Tilapia is susceptible to bacterial infections from species such as Francisella sp;</td>
</tr>
<tr>
<td>- There have been major developments with the production of red tilapia in the UK;</td>
<td>- Tilapia is considered to be an alien species and therefore importation would be subject to the compliance with regulations.</td>
</tr>
<tr>
<td>- Tilapia can tolerate extreme ranges in temperature;</td>
<td></td>
</tr>
<tr>
<td>- Tilapia is an omnivorous fish and can therefore be produced without a dependence on wild fish as a food source;</td>
<td></td>
</tr>
<tr>
<td>- Recirculation systems are widely used in temperate climates;</td>
<td></td>
</tr>
<tr>
<td>- Use of vegetarian feeds can reduce costs normally involved with animal proteins;</td>
<td></td>
</tr>
<tr>
<td>- Tilapia is a robust species and is very versatile at being farmed intensively;</td>
<td></td>
</tr>
<tr>
<td>- They are also less susceptible to viruses, bacterial and fungal diseases;</td>
<td></td>
</tr>
<tr>
<td>- The fish are not treated with hormones and are GM free.</td>
<td></td>
</tr>
</tbody>
</table>

### Opportunities:

- The species can be produced using sustainable means to create a point of differentiation;
- Local tilapia could be actively promoted as an alternative to whitefish;
- Tilapia can be grown to marketable size within 8-10 months for whole fish and, 11-14 months for fish that are used for fillets;
- In 2008, Globefish reported that the US market for tilapia was growing and they were the largest importer;
- There is also demand in the UK and throughout the rest of Europe;
- Could be used by local processors as a primary source of whitefish and add value to it.

### Threats:

- Production of the species has developed at an enormous rate and there is a danger that there could be over capacity in the marketplace;
- There are currently 12 farms in England already producing tilapia;
- The decline in groundfish prices can have a detrimental effect on the value of tilapia;
- There is competition from major players in the industry;
- Tilapia is in direct competition with species such as pangasius.

On a global level, tilapia is perhaps the most suitable fish in terms of aquaculture production since it is not as sensitive as other species and can tolerate a wide range of temperatures and water quality. The cultivation of this species has been established over a couple of decades therefore there is a high degree of expertise available for new producers to review. Information on the life cycle from hatchery production to marketable size is also available as is information of their nutritional and behavioral requirements. There is current market demand for tilapia and this appears to be rising particularly within the UK and US. While there is no existing farming of tilapia on the island of Ireland there are quite a number of facilities producing the species throughout Great Britain. The value of tilapia can be influenced heavily by changes in the volumes and price of wild caught fish (e.g. cod). With the importation by processors of new species like tilapia, there can be uncertainty regarding what quality to expect and how it will be processed and packaged to customers. Tilapia is also more appealing to different market segments based on ethnicity. In addition, this demand would inevitably be larger in mainland Great Britain than in Northern Ireland or the Republic of Ireland. There would obviously be a limited domestic market for tilapia in NI but the species could potentially offer opportunities to the local processing sector. However tilapia is, of course, a non-native species and it would be challenging to get production in NI approved. Also, another issue would be the cost involved with local production compared to other sources such as overseas and outside of Europe.

### 5.8 Feed

One major drawback associated with the production of the species mentioned above, with the exception of tilapia, is the dependence on fish oil and fishmeal in feeds. In the near future, these costs are expected to increase. This is an area of intense R&D being carried out by feed companies. An example of this research is Skretting which has carried out a series of studies investigating the use of vegetable oils in feeds for trout. This research demonstrated that feeds consisting of half fish oil blended with either soya, corn or rapeseed oil did not have an impact on the generic performance and quality of the trout. In addition, there were no major effects on growth, feed conversion, condition factor, flesh color or carcass and fillet yields (Finfish News, 2009).
6.0 Discussion and Recommendations

6.1 Introduction

It is clear from the evidence that seafood caught through wild fisheries are on the decrease while aquaculture production globally is increasing. Unfortunately, Europe has not been following world-wide upward trends in aquaculture production and is finding it particularly difficult to compete with cheap imports and rising internal costs for items such as water extraction and energy. There has been recognition that the European Union needs to develop new and innovative ways to encourage further expansion within the aquaculture sector.

Throughout the UK, there has been positive regional response to the EU communications of 2002 and 2009 and the process of implementing strategic plans for the aquaculture sector is progressing. This is being achieved through co-ordinated effort and partnerships that have been established between producers, SME’s, processors, academic institutions, industry professionals and agencies. There is a strong emphasis on the production of species supported by environmentally and economically sustainable techniques and practices. In addition, the importance of producing products for niche markets, adoption of organic accreditation, high welfare standards and regional initiatives for the purposes of differentiation have all been highlighted.

The findings from this report suggest that producers within the NI industry are, in principle, supportive of diversification within the sector. The future outcome, however, will depend on the consideration of many factors including the consideration of the information that has been presented in this report and investment required. Given the levels of investment required it is important that each diversification proposal be supported by a detailed business study. The sector also felt that the adoption of some form of accreditation and/or organic status could benefit products being exported from Northern Ireland. This would need to be assessed in terms of the costs involved with participating in such schemes and the new framework for organic certification established by Regulation 710/2009. In addition, there could be a ‘green label’ for Northern Ireland that provides provenance and traceability for products produced here.

According to the Federation of European Aquaculture Producers (FEAP), aquaculture can only be considered as a sustainable activity once four basic criteria has been satisfied:

1. The life cycle has been mastered which means that the methods to breed adult fish are known, as is the ability to rear eggs to adulthood.
2. The growing process is controlled, which means that there is professional knowledge available as regards the nutritional and behavioral needs of species. This is essential to ensure that the appropriate husbandry techniques are employed.

3. Respect for the environment indicates that the farming of species can only be successful if it is completed in a clean and hygienic environment otherwise it is not sustainable.

4. Marketing of the final product involves the ability of the producer to sell products for a profit otherwise it is unsustainable.

For some producers, the discussion about new opportunities was less about a predetermined list of species but rather it about whether aquaculture operations will have the necessary capacity and access to financial resources that will be required to ensure that the business is viable and can survive in the long term.

Of the six candidate species looked into in this report, none are currently produced in Northern Ireland. However, four are currently cultured commercially in recirculation units in either Great Britain or the Republic of Ireland i.e. turbot, perch, tilapia and seabass. Eel farming is practiced in Holland.

Site selection is a key step in any new aquaculture project, and a huge subject in itself. Appendix 5 of this report contains a standard Site Survey Form used by the Aquaculture Initiative. This provides an initial overview of some of the factors that should be considered when selecting a site for an aquaculture.

### 6.2 Barriers to Diversification

The aquaculture sector has historically found it difficult to access bank loans due to the perceived risks associated with aquaculture ventures and the length of time it takes to generate a return on investment. The current economic climate has placed additional limitations on the ability of the sector to access funds, and new costs such as those associated with environmental compliance and inspections are placing an extra burden on the limited financial resources available.

While the industry respects that it is necessary to follow and implement environmental regulations, they do feel that local approaches to implementation have become overwhelming to the point that it completely stifles innovation and diversification.

In terms of the implementation of certain aspects of legislation, for example, water abstraction, the aquaculture sector is critical of the way in which this has been enforced. As a region, Northern Ireland has been likened to the South of England and it was proposed that a similar abstraction assessment system to that region be administered here. Such a proposal ignored certain key factors that distinguish Northern Ireland from the South of England including the density of the population and the level of rainfall that each area typically experiences. There is a case for ensuring that the abstraction control directed by Europe is applied on a regional basis to ensure that the system is practical and adequately reflects the characteristics of the area.

The sector is aware that there are strict policies in place governing the aquaculture sector and the importation of foreign or exotic species. They feel that this level of surveillance is not replicated for other sectors importing life fish and fish products, which could pose serious environmental and fish health problems. For example, the regulations are much weaker in relation to the movement of species provided that they can prove that they are for recreational / aquarium use.

While the sector understands that the process of applying for funds has to meet EU requirements, it does believe that it is an extremely lengthy, complicated and unnecessarily bureaucratic, which would benefit from some form of simplification.

The industry would like to suggest that more support is available to farms subject to water pollution from external sources.

DARD would suggest that the challenges to progress include the level of capital costs that are necessary to diversify, lack of support from financial institutions, issues regarding the cultivation of non-indigenous species, limited marketing opportunities, competition from other countries and a lack of suitable sites.

### 6.3 Recommendations

From the information received through the literature review, and contacts made with industry during the project, the following is recommended;

#### 6.3.1 Species Specific Recommendations

- This report recommends that from marketing, aquaculture and environmental perspective, perch and turbot have a high development potential for Northern Ireland. Furthermore, pollan could represent a unique aquaculture species for Northern Ireland following some concerted R&D.

- To a lesser extent seabass has some strong development potential however, with a market background of high competition within the UK and also from Mediterranean countries this would be very difficult.

- The cultivation of tilapia worldwide is booming. UK production is also developing, although the market is largely untested. In NI there is a lack of an ethnic market and this may make it difficult to establish a premium price for fresh product.

- Eel farming is of little immediate development potential. The dependence on elvers from the wild and with the background of eels becoming increasingly considered as an endangered species makes this species very problematic.
6.3.2 Strategic Recommendations

- In order for existing license holders to move further into diversifying their farming operations, they should consider collective and cooperative initiatives to maximise the value of any research or marketing initiatives. This could be best achieved through the establishment of a producer representative body.
- The issue of the burden of bureaucracy has already been highlighted in the Fisheries Forum Report. Efforts to promote private sector involvement, through removing ‘red tape’ are definitely encouraged.
- The Private Sector needs to improve its access to financial investment. The key to this has been identified by the Scottish authorities as looking at government and investor confidence to encourage investment. NI could follow in this direction.
- The Aquaculture sector should maximise the opportunity offered by the EFF funds, these funds are there to encourage productive investments in Aquaculture. This significant funding is now available to help modernise and develop farms.
- The EFF budget for Aquaculture until 2013 is substantial and does help to encourage investment from existing and new producers. It is recommended that the budget stays at this level.
- New sites with new producers and new species is the another avenue for the further diversification of aquaculture in Northern Ireland. Although a challenge, this is an area that organisations such as the Aquaculture Initiative and industry led R&D is an essential element to be promoted.
- For existing producers and new entrants to research diversification ideas, travel to existing facilities and markets in other countries is required.
- In order to reach out to new producers and new sites, a workshop should be organised to promote the concept of aquaculture and for existing and potential producers to work on how to make progress in this area.

6.3.3 Proposed Action Points

The Aquaculture Initiative should work with new and existing producers in finding ways to minimise costs associated with diversification.

To change a species on a license requires a new license application to be made, producers find this a daunting prospect. The Aquaculture Initiative will work with producers in an effort to assist with the licencing process.

There is a need identified for R&D into the pollan species. Aquaculture Initiative should look into how a project consortium could be put together and for programmes such as Framework Programme 7 could be applied to for funds for an NI pollan based project.

Perch has been identified as a strong candidate species. Full facilitation of cross-border knowledge transfer to interested parties from NI such as site visits, should be promoted by the Aquaculture Initiative.

The sector requests the continuation of the Aquaculture Sub-group to the Fisheries Forum as this group provides important opportunities for interaction with regulators.

The establishment of a producer representative body be investigated by the Aquaculture Initiative.
Appendix 1: European Fisheries Fund, (EFF)

**Council Regulation (EC) No 1198/2006 on the European Fisheries Fund.**

**Article 28 - Scope of intervention in aquaculture production**

1. Support for targeting aquaculture production may be granted for the following:
   (a) Measures for productive investments in aquaculture;
   (b) aqua-environmental measures;
   (c) Public health measures;
   (d) Animal health measures.

2. Transfer of ownership of a business shall not be eligible for Community aid.

3. Support under paragraph 1 may contribute to lifelong learning.

4. With regard to operations provided for under Articles 29, 31 and 32 when realised for the purpose of guaranteeing compliance with standards under Community law on the environment, human or animal health, hygiene or animal welfare, aid may be granted until the date on which the standards become mandatory for the enterprises.

5. Member States shall ensure that adequate mechanisms exist to avoid counterproductive effects, particularly the risk of creating surplus production capacity or adversely affecting the policy for conservation of fishing resources.

6. For operations provided for in Annex II of Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (1), aid shall be granted only when the information laid down in Annex IV of that Directive has been provided.

**Article 29 - Measures for productive investments in aquaculture**

1. The EFF may support investments in the construction, extension, equipment and modernisation of production installations, in particular with a view to improving working conditions, hygiene, human or animal health and product quality, reducing negative impact or enhancing positive effects on the environment.

Investments shall contribute to one or more of the following objectives:

(a) Diversification towards new species and production of species with good market prospects;

(b) Implementation of aquaculture methods substantially reducing negative impact or enhancing positive effects on the environment when compared with normal practice in the aquaculture sector;

(c) Support for traditional aquaculture activities important for preserving and developing both the economic and social fabric and the environment;

(d) Support for the purchase of equipment aiming at protecting the farms from wild predators;

(e) Improvement of the working and safety conditions of aquaculture workers.

2. Investment aid shall be limited to:

(a) Micro, small and medium-sized enterprises, and

(b) Enterprises that are not covered by the definition in Article 3(f), with less than 750 employees or with a turnover of less than EUR 200 million.


3. By way of derogation from paragraph 2, in the outermost regions and the outlying Greek islands, aid may be granted to all enterprises.

4. Member States shall ensure that priority is given to micro and small-sized enterprises.

**Article 30 - Aqua-environmental measures**

1. The EFF may support granting compensation for the use of aquaculture production methods helping to protect and improve the environment and to conserve nature.

2. The purpose of the support is to promote:

(a) Forms of aquaculture comprising protection and enhancement of the environment, natural resources, genetic diversity, and management of the landscape and traditional features of aquaculture zones;

(b) Participation in the Community eco-management and audit scheme created by Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS) (1);
(c) organic aquaculture within the meaning of Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs (2);


3. In order to receive compensation under this Article, beneficiaries of compensation must commit themselves for a minimum of five years to aqua-environmental requirements which go beyond the mere application of normal good aquaculture practice.

For the support provided for under paragraph 2(a), the environmental benefits of such commitments must be demonstrated by a prior assessment conducted by competent bodies designated by the Member State.

4. Member States shall calculate compensation on the basis of one or more of the following criteria:

(a) The loss of revenue incurred;

(b) The additional cost which may result from the application of aqua-environmental methods;

(c) The need to provide financial support for carrying out the project;

(d) The specific disadvantages or investment costs for units located inside or near NATURA 2000 areas.

5. A one-off compensation shall be allocated:

(a) under paragraph 2(a), on the basis of a maximum amount per hectare of the area of the enterprise to which aqua-environmental commitments apply;

(b) under paragraph 2(c), for a maximum of two years during the period of the conversion of the enterprise to organic production;

(c) under paragraph 2(d), for a maximum of two years subsequent to the date of the decision establishing the NATURA 2000 area and only for aquaculture units existing prior to that decision.

### Appendix 2: Contact List

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Address</th>
<th>Town</th>
<th>County</th>
<th>Postcode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Producers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tadhg Kelly</td>
<td>Kelly’s Fish</td>
<td>64 Ardboe Road</td>
<td>Cookstown</td>
<td>Co. Tyrone</td>
<td>BT80 0HT</td>
</tr>
<tr>
<td>Raymond Mairs</td>
<td>Glenoak Fisheries</td>
<td>1 Nuts Corner Road</td>
<td>Crumlin</td>
<td>Co. Antrim</td>
<td>BT29 4BW</td>
</tr>
<tr>
<td>Lee Beverland</td>
<td>Otterburn Farm</td>
<td>31 Caddy Road</td>
<td>Randalstown</td>
<td>Co. Antrim</td>
<td>BT41 3DL</td>
</tr>
<tr>
<td>Ian McGrath</td>
<td>Silverstream Fisheries</td>
<td>Old Corby Road, Limnavallaghn Road</td>
<td>Clough, Martinstown</td>
<td>Co. Antrim</td>
<td>BT44 9RX</td>
</tr>
<tr>
<td>Mark McAlister</td>
<td>Blue Valley Fish Farm</td>
<td>14 Upper Kildress Road</td>
<td>Cookstown</td>
<td>Co. Tyrone</td>
<td>BT80 9RS</td>
</tr>
<tr>
<td>Brian Johnston</td>
<td>Rocks Lodge Trout Farm</td>
<td>24 Bunberg Road, Lisnaturanny</td>
<td>Newtownstewart</td>
<td>Co. Tyrone</td>
<td>BT78 4NQ</td>
</tr>
<tr>
<td>Wilfred Mitchell</td>
<td>Sperrin Mountain Spring Hatchery</td>
<td>22 Loughfea Road</td>
<td>Cookstown</td>
<td>Co. Tyrone</td>
<td>BT80 9QL</td>
</tr>
<tr>
<td>Frank Newell</td>
<td></td>
<td>23 Ballinahatten Road</td>
<td>Kilkeel</td>
<td>Co. Down</td>
<td></td>
</tr>
<tr>
<td>Billy Johnston</td>
<td>Island Shellfish</td>
<td>68 Millbay Road</td>
<td>Lame</td>
<td>Co. Antrim</td>
<td>BT40 3RG</td>
</tr>
<tr>
<td><strong>Importers/Exporters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joe McIlroy</td>
<td>Exporter</td>
<td>Lough Neagh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hein Dil</td>
<td>Gebr Dil</td>
<td>Kerklaan 40</td>
<td>Akersloot</td>
<td>The Netherlands</td>
<td>1920 AA</td>
</tr>
<tr>
<td>Hanspeter Tschumpe</td>
<td>Comestible Copro</td>
<td>Sommeristrasse 37a</td>
<td>Amriswil</td>
<td>Switzerland</td>
<td>CH-8580</td>
</tr>
<tr>
<td>Name</td>
<td>Company/Role</td>
<td>Address</td>
<td>City</td>
<td>Postcode</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Valerie Cooke</td>
<td>Irish Seafood Producers Group</td>
<td>Kilkieran, Connemara, Rep. of Ireland, Co Galway</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>John Logie</td>
<td>JPL Shellfish</td>
<td>Unit 1, Seafood Park, Scrabster Harbour, Caithness, Scotland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martin Leyland</td>
<td>Shetland Seafood Auctions</td>
<td>1st Floor, Lerwick Fishmarket, Lerwick, Shetland, ZE1 0NS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simon Buckmaster</td>
<td>Ward’s Fish</td>
<td>Birkenhead Market, Birkenhead, Wirral, England, CH41 2YN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edward Schram</td>
<td>IMARES, University of Wageningen</td>
<td>Unit 7B, PO BOX 67, Ijmuiden, The Netherlands</td>
<td>1990 AB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craig Burton</td>
<td>Sea Fish Industry Authority</td>
<td>18 Logie Mill, Logie Green Road, Edinburgh, EH7 4HS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomas Policar</td>
<td>University of Bohemia</td>
<td>Branišovská 31a, České Budějovice, 370 05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Processors**

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Role</th>
<th>Address</th>
<th>City</th>
<th>Postcode</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Rooney</td>
<td>Rooney Fish</td>
<td>The Harbour, Killeel, Newry</td>
<td>BT34 4AX</td>
<td></td>
</tr>
<tr>
<td>Harold Nicholson</td>
<td>TH Nicholson</td>
<td>The Harbour, Killeel, Newry</td>
<td>BT34 4AX</td>
<td></td>
</tr>
</tbody>
</table>

**Agencies**

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Role</th>
<th>Address</th>
<th>City</th>
<th>Postcode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenny Parker</td>
<td>DARD Fisheries Division</td>
<td>Dundonald House, Upper Newtownards Road, Belfast</td>
<td>BT4 3SB</td>
<td></td>
</tr>
<tr>
<td>Ronnie McBride</td>
<td>DARD Fisheries Division</td>
<td>Dundonald House, Upper Newtownards Road, Belfast</td>
<td>BT4 3SB</td>
<td></td>
</tr>
<tr>
<td>Damien Toner</td>
<td>Aquaculture Initiative</td>
<td>14-15 Gray's Lane, Park Street, Dundalk, Co Louth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3: Questionnaire

Introduction

The purpose of this work is to carry out research on behalf of the Aquaculture Initiative looking specifically at potential diversification opportunities for the land based aquaculture sector in Northern Ireland including species such as perch, pollan, eels, turbot, sea bass and tilapia. It is hoped that the implementation and administration of this questionnaire will be used by way of consulting with the industry to determine their views and perspective in relation to this which will be included in this process and be used to compliment additional research that will occur. It is also important to note that there are funds available through European Fisheries Fund that can assist with diversification and strategic development of the sector.

1) In your experience, do you feel that there are further opportunities for the aquaculture sector and/or your business to develop and diversify?

2) If you agree, could you please highlight which areas and/or species you consider to have the most potential or may be interested in?

3) Are you aware of what the price per kg for this species is? (This question can also be applied to receive information on existing species)

4) Are you aware of what the marketable size for this species is?

5) Are you aware of what would be required if you decided to change production to another species?

6) In your experience, are there any barriers that you can see that could have an impact on the future development of the aquaculture sector?

7) Are there any biological constraints that you feel should be highlighted in relation to species development?

8) Are there any environmental constraints that you feel should be highlighted?

9) How important do you feel an initiative such as EU Protected Food Name Scheme is? (explain where necessary) Is this something you could be interested in?

10) There have been recent discussions about the introduction of a European eco-labelling scheme which relates to sustainability, do you feel this could be beneficial and something you could potentially be interested in?

11) Can you provide some indication of the logistics and/or costs involved in transporting your products to market?

Thank you for your time!

Appendix 4: References


BBC News, April 2005, “Asia Demand Threatens French Eels”.

BBC News, January 2008, "Warmer Waters at Island Fish Farm".


Cefas, Number 9, Winter/Spring 2010, “Finfish News (incorporating Trout News)”.


DEFRA, 2009, ‘A Strategic Review of the Potential for Aquaculture to Contribute to the Future Security of Food and Non-Food Products and Services in the UK and Specifically England’


Environment & Heritage Service and Queen’s University Belfast (Quercus), 2005, “Population Structure and Conservation Genetics of Irish Pollan Coregonus autumnalis pollan Thompson 1856”.


Fish Farmer, August 2007, “Tilapia Offers Diversification Opportunity for UK Farmers”.

Fish and Information Services, May 2009, “Pescanova Shelves Tourinian Farm Project”.

Fish and Information Services, June 2009, “Pescanova Kicks Off Mega Plant’s Turbot Production”.

Fish and Information Services, October 2009, “VitaFish Empties its Tanks for Good”.

Fish and Information Services, October 2009, “Tilapia Offers Diversification Opportunity for UK Farmers”.

Fish and Information Services, May 2009, “Pescanova Shelves Tourinian Farm Project”.

Fish and Information Services, May 2010, “Global Organic Aquaculture Booming”.

Fisheries and Aquaculture Technical Paper, 2009, “Impact of Rising Feed Ingredient Prices on Aquafeeds and Aquaculture Production”.


Globefish, June 2009, “Sea Bass and Sea Bream”.

IntraFish, October 2010, “Ireland’s First Turbot Farm Set for Market Launch”.

IntraFish, March 2006, “Fish Farming on Land Heats Up”.

IntraFish, October 2006, “Strong Turbot, Bluefin Tuna Prices Lift Stolt Q3”.

IntraFish, November 2006, “China Tightens Inspections at Turbot Farms After Contamination Reports”.

IntraFish, October 2007, “Galicians Bristle at Exodus of Spanish Seafood Firms”.


IntraFish, August 2009, “Irish Abalone Farm Opens”.

IntraFish, September 2009, “Too Many Players in European Bass, Bream”.

IntraFish, September 2009, “ Bail Out for Bass, Bream Farmer”.

IntraFish, July 2010, “Greek Sea Bass Farm Receives Private Equity Backing”.

IntraFish, October 2010, “Stolt Sea Farm Sees ‘Slow’ Recovery in Turbot Market”.


Potential Diversification Opportunities for the Land-Based Aquaculture Sector in Northern Ireland


Northern Ireland Fisheries Forum, April 2010, “Report to the Minister for Agriculture and Rural Development”.


Organisation for Economic Co-operation and Development, 2009, “Round Table on Eco-labelling and Certification in the Fisheries Sector”.


Seafish, June 2009, “Responsible Sourcing Guide: Sea bass”.

Seafish, February 2010, “Guide to Aquaculture”.


Seafood Source, February 2009, “Tilapia Production to Rebound in 2009”.

Seafood Source, July 2009, “Halibut Farming’s Uncertain Future”.

Seafood Source, March 2010, “Can Europe’s Aquaculture Industry Grow?”.

Seafood Source, April 2010, “Seafood Production, Consumption Hits New Heights”.

Seafood Source, July 2010, “Galicia Leads Spain in Aquaculture Production”.

Seafood Source, September 2010, “Ireland Seafood Exports Reach EUR 730 Million”.

Seafood Source, September 2010, “FAO: Fish Feed Costs to Remain High”.

Seafood Source, September 2010, “Tesco Starts Selling British Tilapia”.

Seafood Source, October 2010, “Cracking Europe’s ‘Highly Complex’ Market”.


Stirling University, 2006, “Warm Water Fish Production as a Niche Market and Diversification Strategy for UK Farmers”.


TheFishSite, January 2005, “A Fish Called Tilapia”.

TheFishSite, October 2008, “Farmed Fish Takes a Bite at Booming Organic Market”.
TheFishSite, March 2009, “Risks and Solution to Feeding Fish with Fish”.
TheFishSite, June 2009, “Potential Disease Problems for the UK Tilapia Industry”.
TheFishSite, July 2010, “Minister Visits Sea Change-Funded Cod Farming Project”.
TheFishSite, August 2010, “France Fishery Products”.
TheFishSite, September 2010, “Local Fishing Industry Receives £2.5 Million”.
The Guardian, November 2009, “BBC’s TV Chefs Attacked for Putting Eel on the Menu”.
The Independent, April 2003, “Britain’s First Commercial Cod Farm Could Save Wild Stocks From Global Decline”.
The Independent, November 2010, “Incomes Can Adapt Despite Eel Fishing Being Reeled In”.
The Shetland Times, June 2009, “Halibut Firm Winds Up Owing £200,000”.
Til-Aqua International, May 2010, “Til-Aqua’s Tilapia Hatchery Products and Services”.
Wageningen IMARES, 2006, “Market Study for Farmed Turbot”.

Generic References:

www.achillislandturbot.ie
www.aquacultuur.wur.nl
www.ec.europa.eu
www.eurofish.dk
www.eea.europa.eu

www.europarl.europa.eu
www.europeche.net
www.fao.org
www.gighahalibut.co.uk
www.ifremer.fr
www.imares.wur.nl
www.marine.ie
www.pro-eel.eu
www.selonda.gr
www.tilapiascotland.org
Appendix 5: Site Survey Format

**Date**

**Technical Survey and Report**

**Ref**

**Site Location:**
E.g. OS map. Irish Grid Reference

**Site Elevation:**
E.g. Direct recordings/ readings taken from a theodolite

**Planning Zone Status:**
Refer to the Planning Service area plan

**Source of water:**
See OS map

**Fish Species Present:**
Refer to designated status (i.e. salmonid or cyprinid)

**Water Quality Information:**
Primary source of data from EHS (surface water department) and to a lesser extent the Rivers Agency

**Water Quantity Information:**
Some direct data may be required for this. Some idea of the level of flows may be obtained through EHS (surface waters). Actual measurements of flows can be sourced from WMU on some rivers. Direct recordings may have to be obtained.

---

**Other factors relevant to the site**

E.g. size of site, topography / layout, Deprivation Index of the local area, closeness of site to industrial activities or closeness of site to potential pollution events.

**Discussion**

Fish Production Options

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>W</th>
<th>O</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Through</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recirculation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow through</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cage Culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alternative Species Options Considered

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>W</th>
<th>O</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/W or S/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Overview of Site**

<table>
<thead>
<tr>
<th>Criteria (Environmental)</th>
<th>Key Considerations</th>
<th>Site Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Character</td>
<td>General appearance of existing site</td>
<td></td>
</tr>
<tr>
<td>Elements</td>
<td>Effect on trees, landform, streams and field boundaries</td>
<td></td>
</tr>
<tr>
<td>Intrusion (visual)</td>
<td>How visually intrusive the project would be at this location</td>
<td></td>
</tr>
<tr>
<td>Proximity to Properties</td>
<td>Number of properties within</td>
<td></td>
</tr>
<tr>
<td>Criteria (Technical)</td>
<td>Key Considerations</td>
<td>Site Comment</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Proximity to ASSI area</td>
<td>How close the site is to Area of Special Scientific Interest (ASSI)</td>
<td></td>
</tr>
<tr>
<td>Proximity to good quality freshwater</td>
<td>Water quality, volume of water</td>
<td></td>
</tr>
<tr>
<td>Proximity to Electrical Grid</td>
<td>Ease of access to electrical grid</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Ease of access</td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Ease and reliability of operation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria (Financial)</th>
<th>Key Considerations</th>
<th>Site Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>Cost to construct the project on the site</td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>Appropriate access to water</td>
<td></td>
</tr>
<tr>
<td>Biological</td>
<td>Species to be grown</td>
<td></td>
</tr>
</tbody>
</table>

Map

Site Potential Head

Alternative Site Potential Head

Map of Site