Draft for Public Consultation

National Strategic Plan for Sustainable Aquaculture Development

June 2015

Department of Agriculture, Food and the Marine

An Roinn Talmhaíochta, Bia agus Mara

Chapter 6

Chapter 6
Ensuring Sustainability

Vision for 2020

"An aquaculture industry that develops in harmony with nature, and with the confidence of stakeholders".

Actions to achieve the vision

The following actions are proposed to be undertaken in order to progress towards the vision outlined above. These actions may be undertaken by the State, by private actors, or a combination as appropriate, and some may be financially supported through the Seafood Development Programme, co-funded by the Exchequer and European Maritime and Fisheries Fund.

Action 11	***Application of Guiding Principles for the Sustainable Development of Aquaculture.***
Action 12	***Application of scale limits and phasing in relation to the development of individual offshore salmon farms.***
Action 13	***Development of an industry Code of Practice for Invasive Alien Species.***
Action 14	***Continuation of Invasive Species Ireland Project in relation to aquaculture.***
Action 15	***Quantify the environmental contribution of aquaculture.***
Action 16	***Ensure that aquaculture monitoring is consistent with the requirements of the Marine Strategy Framework Directive.***

Guiding Principles for the Sustainable Development of Aquaculture

The following six high-level principles, recommended by the Marine Institute, are intended to provide a broad direction to guide the ongoing development of sustainable aquaculture in Ireland and instil confidence in all stakeholders in the commitment to appropriate development of the industry.

Principle 1 - Responsible Planning

Responsible planning ensures that the overall development of aquaculture and the siting of individual farms are compatible with other uses and the responsible management of the marine environment. Such an approach, within a wider marine spatial planning framework, ensures a comprehensive consideration of constraints and synergies, and appropriate siting of fish farms, and reduces the uncertainty and administrative burden for developers.

Principle 2 - Ecosystem Protection

Licensing and ongoing regulation of aquaculture operations ensures compatibility with the goal of maintaining healthy, productive and resilient marine ecosystems. This ensures that we maintain good water quality and healthy populations of wild species, prevent escapes and accidental discharges into the environment, and avoid harmful interactions with wild fish stocks, protected habitats and species.

Principle 3 - Science-based Approach

Planning, licensing and regulation of the sector are founded on the best available, impartial and objective science, as delivered by the national and international science community. This provides the highest level of confidence in the decision-making process and allows for the adoption of a risk and evidence-based approach to determining monitoring requirements that are subject to continuous improvement.

Principle 4 - Compliance

Planning, licensing and regulation of the sector ensures full compliance with relevant European and National legislation, including SEA and EIA legislation, nature conservation legislation (Birds and Habitats Directives), and legislation seeking to achieve and maintain good environmental status of coastal and marine waters (Water Framework Directive, Marine Strategy Framework Directive).

Principle 5 - Openness, Transparency and Accountability

Openness, transparency and accountability are core considerations in the licensing and regulatory framework for aquaculture. Seeking public and local knowledge inputs during the process increases confidence in the decision-making process. Likewise, accountability and openness on the part of the industry will help to educate stakeholders on the social and economic benefits of the industry and ensure an accurate understanding of its potential environmental interactions.

Principle 6 - Industry Best Practice

Aquaculture operators should strive to adopt, maintain and improve best practice in all aspects of farm operations, including fish health and welfare, feed utilisation and sustainability, use of medication, abstraction of water, and cage design and maintenance. Additionally, industry should be supported / encouraged to implement Codes of Best Practice and independent certification schemes.

Scaling and Phasing of the Development of Offshore Salmon Farms

The future growth of salmon farming is limited by spatial and environmental constraints in inshore bays. The use of larger, more exposed, offshore sites is increasingly a feature of the development of the sector globally and the environmental benefits of such sites, compared to inshore sites, are clear.

Environmental impacts are predicted to decrease in offshore sites, where stronger currents and greater depths increase the dispersal of waste products and interactions with wild fish are lessened. In addition, competition for space with other users is likely to be less of an issue in sites further removed from the coast.

Despite these potential benefits, no assumptions can be made as to the suitability of locations and individual sites for salmon farms, which can only be considered following rigorous assessment of potential environmental interactions.

Any consideration of the scaling and phasing of individual farms should seek to build regulatory confidence. A key factor in determining the scale of potential developments using ecosystem-based management is the concept of *carrying capacity*, which considers environmental limits aimed at avoiding 'unacceptable change' to the natural ecosystems.

In general terms, carrying capacity for any sector can be defined as the level of resource use both by humans or animals that can be sustained over the long term by the natural regenerative power of the environment.

In considering the appropriate scaling and phasing of individual offshore salmon farms, it is useful to consider international experiences.

- In Norway, where annual production is in the order of 1.2 million tonnes, the maximum allowable biomass per licence is 780 tonnes (except in two counties, where the maximum allowable is 900 tonnes). Farms typically hold several licences for a single location, with the largest farms licensed for just over 7,000 tonnes (maximum allowable biomass).
- Scotland categorises sea lochs using predictive modelling to estimate nutrient enrichment and benthic impacts and sets total biomass limits for individual lochs. Individual licences are in a range of up to 2,600 tonnes (peak biomass).
- In British Columbia, the largest individual farms have a peak biomass of approximately 5,200 tonnes.
- The largest site in Ireland is licensed for a biomass of just under 3,200 tonnes.

It is not possible, however, to make direct comparisons either on a regional or individual site basis. For example, many of the Scottish sea lochs are relatively small, well-defined waterbodies that would not be considered offshore.

Scale limits and phasing

Taking consideration of the above, the following scale limits and phasing, as recommended by the Marine Institute, will be applied in relation to the development of individual offshore salmon farms.

1. Licences for individual sites should be issued on the basis of approval for an initial maximum allowable biomass and, where sought, a provision for a gradual, phased build-up.

2. An appropriate maximum for new individual offshore salmon farms is considered to be 5,000 tonnes (peak biomass). The allowable peak biomass will be site specific and will rely upon a full assessment of environmental considerations, e.g. site characteristics, carrying capacity and separation distance from adjacent operations.

3. Following establishment of a farm, permission for additional tonnage beyond the initial licensed peak biomass may be sought, subject to a total maximum of 7,000 tonnes (peak biomass). Such a request could be considered subject to the following:

   (a) The EIS accompanying the licence application shall include all of the relevant information to describe the physical characteristics of the project, the production processes, expected residues and emissions and the likely significant effects of the proposed project through the various phases;

   (b) The phasing and timing for permission to scale-up beyond the initial allowable biomass should be set at the licensing stage, taking into consideration, for example, site characteristics, stocking strategies and production cycle issues;

   (c) Approval to increase the capacity above the initial allowable biomass should only be considered following a rigorous assessment of monitoring outcomes;

   (d) Monitoring requirements should be included as a licence condition.

The thresholds outlined above (2 and 3) shall be reviewed on a regular basis.

Biodiversity and Sustainable Development

Ireland's marine and terrestrial environment supports a wide variety of species and habitats, many of which are of international importance. While many species are doing well in conservation terms, there are a significant number of habitats and species that are not and which are under threat from unsustainable activities. Progress has been made in the designation of EU-protected areas in Ireland, and Ireland's second National Biodiversity Plan (2011–2016) includes a programme of measures aimed at meeting Ireland's biodiversity obligations including a commitment to halt biodiversity loss by 2020. Protection of biodiversity within and outside protected areas is therefore necessary and requires greater integration of biodiversity concerns in sectoral policy development and implementation, at local and national levels.

Sustainable development means meeting current needs without compromising the ability of future generations to meet their own needs. This encompasses economic, social and environmental factors to provide viable livelihoods for current and future populations.

Actions concerning biodiversity

(A) Continuation of Invasive Species Ireland Project in relation to Aquaculture

Control of invasive species is a major challenge, and involves cross-sectoral and cross-border co-operation by a range of responsible bodies and sectoral interests. In response to this issue, a joint approach was undertaken by the relevant Departments in Ireland and Northern Ireland to establish the Invasive Species Ireland project. This project acts as a co-ordination mechanism and provides advice and resources for stakeholders, in addition to carrying out risk assessment, policy development, education and awareness activities, research and development of invasive alien species action plans.

Both BIM and the Marine Institute have worked closely with Invasive Species Ireland and participate in its marine working groups

The Invasive Species Ireland project is currently on hold but BIM continues to liaise with interested parties in the UK via a project called Marine Pathways.

Invasive Species Ireland can act as a co-ordination mechanism and provide advice and resources for stakeholders, in addition to carrying out risk assessment, policy development, education and awareness activities and research and development of invasive species action plans.

(B) Development of an industry Code of Practice for Invasive Alien Species

Non-indigenous Species (NIS) is an important component of the Marine Strategy Framework Directive and is one of the 11 descriptors upon which Good Environmental Status Targets are based. The recently published Article 19 report states: "The majority of the known initial introductions of NIS to Irish waters have occurred via shipping (commercial and recreational) or through aquaculture."

The project actions include research into prevention and control of NIS, promoting opportunities for the aquaculture sector to learn about and take appropriate action to reduce the risks of invasive species introduction and spread, of species both impacting upon and impacted by existing and new operations in line with MSFD targets.

(C) Quantify the Environmental contribution of Aquaculture

In the National Biodiversity Plan there are objectives and targets related to raising awareness and appreciation of biodiversity and ecosystem services and to conserve and restore these in the wider countryside. One of the targets is to optimise use of opportunities under agricultural, rural development and forest policy to benefit biodiversity.

Although these objectives and targets are primarily concerned with agriculture and forestry, the overall themes are cross-cutting over other sectors, including aquaculture.

The recent trend towards development of Integrated Multi-Trophic Aquaculture, combining fed fish with extractive aquaculture (seaweed and shellfish), appears to be a promising approach to reduce environmental impacts and make farms more profitable through the provision of secondary crops.

Climate Change and biodiversity are inextricably linked. Climate change may be a driver for loss of biodiversity, conversely biodiversity may support the reduction of negative effects of climate change.

Shellfish and seaweed production may contribute, albeit marginally, to control of carbon emissions through carbon sequestration in shell production and seaweed photosynthesis and therefore assist in climate change mitigation. Life cycle analysis is required to confirm the tangible benefits of this.

(D) Ensure that aquaculture monitoring is consistent with the requirements of the Marine Strategy Framework Directive

The marine environment forms the largest part of Ireland's territory, encompassing an area ten times greater than the country's land area. The Marine Strategy Framework Directive (MSFD) establishes a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status (GES) in the marine environment by 2020. Ireland has undertaken the Initial Assessment stage, which was submitted to the European Commission in 2013. The current on-going work is the development of a monitoring programme and Programmes of Measures. Aquaculture monitoring must be consistent with MSFD requirements and be reflected in MSFD assessment and reporting.

The three main pressures exerted on the environment as a result of the activities associated with aquaculture are the introduction of non-indigenous species (NIS), physical loss of habitat and nutrient and organic enrichment. [14]

The SWOT analysis in Chapter 2 identifies several areas of consistency with progress to achieve GES. [15]

Non-Indigenous Species: Monitoring programme with risk assessment by NPWS for pathways and vectors. SWOT identifies reliance on foreign seed. This could be a vector for NIS.

Sea bed integrity: Generally considered good for Ireland. The use of licensing and consents infrastructure could be used to determine pressure footprints and inform management action.

[14] Ireland's Marine Strategy Framework Directive Article 19 Report Initial Assessment, GES and Targets and Indicators
October 2013

[15] Marine Strategy Framework Directive Article 11 Monitoring Programmes Public Consultation Document
July 2014

Eutrophication: This is both an effect by aquaculture and also an effect on aquaculture. The main activities contributing to eutrophication in Ireland's Marine Waters are agriculture, wastewater treatment and discharges from unsewered areas and industry. Eutrophication can have large effects on aquaculture in the form of toxic algal blooms and reduction of oxygen in the water.

Climate Change

Climate change impacts on the marine environment (e.g. rising sea temperatures and increases frequency/intensity of winter storms) and increased ocean acidification present a number of challenges for the global and Irish aquaculture industry. These challenges are set out below.

The timing (short, medium or long-term) and scale of these impacts is difficult to predict and may be of limited significance over the life-span of this plan.

From a Marine perspective

- Sea level rise leading to problems with site suitability, access and general site management
- Increase in storm frequency and intensity leading to structural damage, associated financial losses and burdens, also potential escapes of farmed fish and its consequences for biodiversity
- Increase in water temperature leading to -
    - Changes in seasonality, resulting in changes in typical growth patterns, affecting timing of spawning and harvesting
    - New/different disease challenges
    - Expansion in range of alien invasive species
- Increased frequency/severity of harmful algal bloom events as a result of changes in ocean and coastal stratification and increasing temperatures

From a freshwater perspective

- Increase in storm frequency and intensity - increased flood risk
- Changes in seasonality

- Freshwater availability

In contrast, increased water temperature may also result in benefits for the Irish aquaculture industry, e.g. faster growth rates, resulting in decreased costs and conditions more conducive to the growth of new species.

Actions under Chapter 5 concerning Knowledge Innovation and Technology, supported by funding under the proposed Seafood Development Programme, may be relevant to climate change adaptation by the aquaculture sector, e.g. study, development and trialling of cages that are adapted to withstand greater storm intensity, or studies concerning impacts of raised water temperature on fish health etc.

Chapter 7
Co-ordinated Spatial Planning

Vision for 2020

"Aquaculture incorporated into an effective and equitable marine spatial planning system".

Actions to achieve the vision

The following actions are proposed to be undertaken in order to progress towards the vision outlined above. These actions may be undertaken by the State, by private actors, or a combination as appropriate, and some may be financially supported through the Seafood Development Programme, co-funded by the Exchequer and European Maritime and Fisheries Fund.

Action 17	***Develop opportunities and constraints mapping for aquaculture taking specific account of environmental issues, Natura 2000 sites and inshore fisheries.***
Action 18	***Identify marine tourism opportunities from aquaculture.***
Action 19	***Study on integrated multi-trophic aquaculture and possible synergies with offshore wind farms or other marine renewable energy.***
Action 20	***Study on how aquaculture contributes to communities in rural areas.***

Marine Spatial Planning

The European Marine Spatial Planning (MSP) Directive (2014/89/EU) seeks to establish a framework for maritime spatial planning aimed at promoting the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources. It aims to ensure that growth of marine and coastal activities, as well as the use of resources at sea and on coasts, remain sustainable.

The National Context

Co-ordinated Spatial Planning is more relevant than ever before given the increasing demands on the coastal resource. Emerging growth areas such as offshore energy added to increasing demand from existing sectors and acknowledging the need to protect the environment means that planning is essential. Utilising marine resources efficiently requires careful planning to ensure Ireland manages human use of the marine environment sustainably and that different demands and uses are appropriately sited within Ireland's waters and along its coastline.

Existing Framework for Maritime Spatial Planning in Ireland

Currently, the majority of planning, licensing and regulation in the marine environment is carried out on a sectoral and demand-driven basis. Strategic Environmental Assessment, Environmental Impact Assessment and Appropriate Assessment are applicable cross-sectorally and are undertaken in accordance regulatory requirements.

Marine spatial planning and management of land-sea interactions involve a strategic, forward looking planning approach. It requires stakeholder involvement at an early stage of plan making. It analyses and plans best use of the seas and where and when human activity should take place.

Ecosystem-based, marine spatial planning focuses on marine spaces in which the boundaries are ecologically meaningful and ensures integration with coastal and inland areas. *Harnessing Our Ocean Wealth (HOOW)*, Ireland's integrated marine plan, acknowledges this and establishes a roadmap for the Government's vision, high-level goals and integrated actions across policy, governance and business to enable our marine potential to be realised. Implementation of this Plan will see Ireland evolve an integrated system of policy and programme planning for our marine affairs.

Under Key Action No. 2 of *Harnessing Our Ocean Wealth* an Enablers Task Force was convened to make recommendations on the establishment of an appropriate MSP framework for Ireland, taking into account:

- Emerging EU policy in relation to maritime spatial planning;
- The need for any further legislative changes that may be required to support a national maritime spatial planning framework;
- International best practice on developing integrated marine planning and licensing – benchmarking Ireland's marine regulatory framework; and

- A national maritime spatial planning capacity and responsibility for data coordination and exchange.

Implementation of the recommendations arising from this work is currently being considered by Government in accordance with the European MSP Directive.

The Aquaculture Perspective

From an Aquaculture perspective, Co-ordinated Local Aquaculture Management Systems (CLAMS) is a long established voluntary process which enables co-ordination among existing aquaculture operators and this process will undoubtedly provide important bottom-up information for policy and strategy formation

In order to inform the MSP process and ensure aquaculture spatial needs are properly considered in developing marine spatial plans, a constraints and opportunities mapping project for aquaculture will be carried out.

Marine Spatial Planning & Aquaculture

Food security is an important policy objective and aquaculture makes an important and growing contribution to this [globally]. Aquaculture is an important, and in coming years a potentially more significant, contributor to employment and economic activity in coastal communities. These factors will be important considerations in the development of integrated marine plans.

The majority of marine aquaculture is currently related to Atlantic salmon and shellfish. The farming of seaweed as a food or fuel is a growing part of this sector, including as a part of polyculture processes such as sea fish production. The majority (>85%) of existing marine based finfish aquaculture activity has organic certification. Ireland is the largest producer of organic farmed salmon in the EU, and in the world. Shellfish production is evenly spread throughout Ireland and is a potentially expanding activity. Trends in the industry are closely tied in with changes in wild fisheries, the availability of investment, and site availability. More intensive types of aquaculture can use space and resources more efficiently if they are carefully planned and managed. The overall outlook is dependent on site availability and environmental carrying capacity. Future development of high-energy sites for finfish production could lead to large scale offshore production.

Potential impacts

Increased aquaculture production could help to contribute to increased food security and local production as a means of securing future supply in a way which is carbon efficient and fits local economies. Finfish aquaculture can alleviate fishing pressure on some wild stocks, while providing additional nutrients for shellfish production when well sited. Reduction of pollution of shellfish waters will help provide a sustainable base for development of the inshore aquaculture sector, as well as reducing public health risks. The health benefits of fish consumption remain clear, with increased consumption in the Irish population advised.

Actions proposed to support integration of aquaculture into marine spatial planning framework

(A) Develop opportunities and constraints mapping for aquaculture

These constraints and opportunities may be economic, social and environmental in nature. The mapping study will assess the spatial constraints and opportunities and should provide maps showing specific areas suitable for specific aquaculture activities and areas where there are constraints to specific aquaculture activities. These may be identified as anticipated benefits, including the contribution that the proposals would make to policy objectives, or anticipated adverse effects.

(B) Identify marine tourism opportunities from aquaculture

Aquaculture presents significant opportunities for marine tourism that can supplement farmers' income. The coastal nature of aquaculture complements the tourism products promoted through the Wild Atlantic Way strategy. Aquaculture tourism also offers the opportunity to improve public knowledge of the industry. A study will be initiated to identify marine tourism opportunities for the aquaculture sector and to provide guidance to farmers wishing to become involved.

(C) Conduct studies on how aquaculture contributes to communities in rural areas [to inform decision-making and trade-off considerations]

These studies would outline how aquaculture contributes to the societal benefits in the marine area, including the sustainable use of marine resources to address local social and economic issues, including:

- How properly planned aquaculture developments in the marine area can provide environmental and social benefits as well as drive economic development, provide opportunities for investment, employment and generate export and tax revenues.
- To provide data and information and methodology to assess the economic and social influences and benefits of aquaculture activities to inform decision making and trade off decisions.

(D) Study on integrated multi-trophic aquaculture (IMTA) and possible synergies with offshore wind farms or other marine renewables

A significant part of the renewable energy required to meet low carbon energy targets and objectives will come from marine sources. Offshore wind is expected to provide the largest single renewable electricity contribution as we move towards 2020 and beyond. Wave and tidal stream technologies also have significant potential in the medium to long-term. A study or studies into possible synergies between these renewables and aquaculture activities would yield valuable planning information.

In addition, it will be important to explore what role IMTA could play in Ireland. If, as anticipated, the farming of seaweed becomes more established and prevalent then a study or studies into possible mutually beneficial interactions between seaweed aquaculture and other aquaculture forms would be most beneficial.

Chapter 8
Aquaculture Licensing

Vision for 2020

"A streamlined and efficient licensing system that provides greater business certainty to applicants, and transparency to the general public."

Actions to achieve the vision

The following actions are proposed to be undertaken in order to progress towards the vision outlined above. These actions may be undertaken by the State, by private actors, or a combination as appropriate, and some may be financially supported through the Seafood Development Programme, co-funded by the Exchequer and European Maritime and Fisheries Fund.

Action 21	***Progressively remove the current aquaculture licensing backlog.***
Action 22	***Review and revision of the aquaculture licensing process, including the applicable legal framework.***
Action 23	***In the context of a reviewed process and revised legal framework, consider the phased introduction of appropriate timescales for licence determination.***
Action 24	***Develop a data management and information system, with online aquaculture licence application and tracking functionality, and spatial mapping of aquaculture sites.***

Overview of current legal framework for licensing of aquaculture

The main piece of aquaculture licensing legislation is the Fisheries (Amendment) Act of 1997.

Other key legislation includes

- Sections 2,3 and 4 of the Fisheries and Foreshore (Amendment) Act 1998, No. 54
- Section 101 of the Sea-Fisheries and Maritime Jurisdiction Act 2006, No. 8
- Aquaculture (Licence Application) Regulations, 1998 S.I. NO. 236 of 1998, as amended by S.I. No. 145 of 2001 and S.I. No. 197 of 2006 and S.I. No. 301 of 2012 and S.I. No 410 of 2012.

Aquaculture licensing in Ireland is administered by the Aquaculture Foreshore Management Division of the Department of Agriculture, Food and the Marine on behalf of the Minister.

In conjunction with the Fisheries Amendment Act, the Foreshore Act of 1933 is also required for the licensing of aquaculture sites in Ireland and allows the Minister to grant leases/ licences and regulates the placement of structures on the foreshore associated with the carrying out of licensed aquaculture.

The Foreshore Acts 1933 - 2011 require that a lease or licence must be obtained from the Minister for Agriculture, Food and the Marine for works undertaken on the foreshore which are deemed to be:

- any function in relation to a fishery harbour centre;
- any function in respect of—

    (i) an activity which is wholly or primarily for the use, development or support of aquaculture, or

    (ii) an activity which is wholly or primarily for the use, development or support of sea-fishing including the processing and sale of sea-fish and manufacture of products derived from sea-fish.

The foreshore is classed as the land and seabed between the high water of ordinary or medium tides (shown HWM on Ordnance Survey maps) and the twelve mile limit (12 nautical miles equals approximately 22.24 kilometres).

The Foreshore Acts 1933 to 2011 include the following.

- Foreshore Act 1933
- Foreshore (Amendment) Act 1992.
- Section 5 of the Fisheries and Foreshore (Amendment) Act 1998
- Fisheries (Amendment) Act 2003 (Part 5)
- Maritime Safety Act 2005 No. 11 (Part 6)
- Foyle and Carlingford Fisheries Act 2007
- Foreshore and Dumping at Sea (Amendment) Act 2009
- Foreshore (Amendment) Act 2011

These pieces of legislation form the legal basis for licensing marine aquaculture. For freshwater aquaculture, the foreshore act is replaced by the Planning and Development Act of 2000 for land-based operations.

The appeals procedure of aquaculture licensing is handled by the independent Aquaculture Licences Appeals Board, the legal basis for which is included in the Fisheries (Amendment) Act 1997. Customers, the public or environmental organisations aggrieved by a decision of the Minister for Agriculture, Food and the Marine on an aquaculture licence application, or by the revocation or amendment of an aquaculture licence, may make an appeal within one month of publication of the decision.

The procedural steps relating to aquaculture licensing, including public and statutory consultation, are set out in the Aquaculture (Licence Application) Regulations, 1998 (S.I. No. 236 of 1998). Notice of aquaculture licence applications are published in a newspaper circulating in the vicinity of the proposed aquaculture. This notice specifies where the documentation relating to the application may be inspected. A person may make written submissions or observations within a prescribed time period (as set out in the Statutory Instrument). In addition, aquaculture licence applications are sent to statutory consultees (as prescribed in regulation 10 of S.I. No. 236 of 1998).

Habitats and Birds Directives

Appropriate Assessment (AA) is a legal requirement under Article 6 of Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive) and of Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the Conservation of Wild Birds (Birds Directive). The obligations under the Directives are transposed into Irish law primarily through the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011). The Regulations require that the Minister as the licensing authority for aquaculture satisfy himself before making a licence determination that the proposed activities will not adversely affect the integrity of the designated area, by reference to its Conservation Objectives. AA thus forms an integral part of the decision-making process for aquaculture licensing. The AA process requires very considerable data on protected habitats and species within the designated area.

In December 2007, the Court of Justice of the European Union[16] delivered judgment on Ireland's implementation of the Birds Directive in case C418/04. The Judgment referred to six separate complaints, with one relating to aquaculture. The Court found that Ireland did not meet the required standard regarding the level of protection being

[16] Previously referred to as the European Court of Justice

achieved in SPAs or in areas that should be designated as SPAs, as set out in Article 4 of the Birds Directive or Article 6 of the Habitats Directive, in particular by failing to take all reasonable measures, including targeted action to prevent their deterioration, and by not requiring appropriate assessment for certain types of activities including aquaculture.

Since 2009, Ireland has been addressing the judgement as a whole through a *Programme of Measures* (POM) published by the Minister for Arts, Heritage and the Gaeltacht. As part of that POM, in relation to Natura 2000 areas relevant to aquaculture, the Minister for Agriculture, Food and the Marine, together with the Minister for Arts, Heritage and the Gaeltacht and the Marine Institute, has engaged in a comprehensive multi-annual work programme. All of the baseline data on habitats and species for these areas has been acquired, allowing for Conservation Objectives to be set by the Minister for Arts, Heritage and the Gaeltacht. In addition, targeted research (e.g. specific activity-species-habitat interaction studies) to support the AA process has been commissioned. The POM, and in particular the work carried out in relation to aquaculture, has entailed a very significant financial, administrative and scientific investment by the State in resolving the CJEU judgement in case C418/04.

During the course of the POM work programme, the ability of the Minister for Agriculture Food and the Marine to process aquaculture license determinations was significantly curtailed by law. However, following the above investment of resources, the Minister is now in a position to progress licence determinations in full compliance with the 2011 Regulations. Licence determinations for Natura 2000 areas are being progressed by the Minister on a bay-by-bay basis. By mid-April 2015, 12 bay level appropriate assessments have been carried out. In a number of instances these have triggered the need to commission additional surveys to complete the knowledge-base.

In tandem with the ongoing availability of further completed Appropriate Assessments, this will facilitate the processing of aquaculture licenses currently on hand. The tables below show the number of licence applications determined by the Minister over the period 2007-2014. It can be seen that as the AA process becomes more streamlined, the number of licence determinations is increasing significantly year on year. Completion of bay-level appropriate assessment reports by the Marine Institute is targeted for 2016, with an interim target for delivery of up to an additional 14 reports in 2015.

The publication by the Marine Institute of the AA report does not, in itself, conclude the overall AA Process. This process can only be considered closed following the approval by the Minister of an “Appropriate Assessment Conclusion Statement” (a statement by the

Minister that the proposed aquaculture licensing conforms with the relevant EU Directives.)

	2007	2008	2009	2010	2011	2012	2013	2014	Total
Applications Received	57	24	106	106	123	62	99	140	717
Licences Issued	11	2	4	3	6	16	108	94	244
Licences Refused	1	1	0	0	0	0	0	2	4

Present average application process period

The average timeframe for processing each particular application varies depending on location, species, scale and intensity of production, statutory status of sites, potential visual impact etc. Other factors include consideration of any submissions or observations raised during the public consultation period.

The table below sets out in detail the steps in the licence consideration process, including the AA Process. The table also provides indicative timelines for those actions under the full or partial control of the Minister, including, but not limited to, issues arising as part of the public and statutory consultation process. Definitive timelines are not possible under the constraints of current legislation, multiple external inputs to the process and limited staffing resources both within the Department and available to other parties providing essential inputs.

STEPS	DESCRIPTION OF PROCESS	INDICATIVE TIMELINES
Step 1	Aquaculture licence application received and dated	
Step 2	The application form is checked to determine if the proposed area is located within a 'Natura 2000' site - if so, an Appropriate Assessment needs to be carried out	
Step 3	Appropriate Assessment carried out, which involves: • Detailed analysis of raw data collected (this is substantially complete in all bays) • The setting of Conservation Objectives by the National Parks and Wildlife Service (NPWS) • Preparation of shape files by DAFM and BIM (including profiling of aquaculture activity in the relevant Natura site) to allow the Marine Institute to spatially overlap the aquaculture	

	activity over the protected habitats in the Natura site • Appropriate Assessment carried out by the Marine Institute • Broad agreement between the Marine Institute and NPWS on the outcomes of the Appropriate Assessment	
Step 4	DAFM meets with its scientific and technical advisors to discuss the findings of the Appropriate Assessment, with particular reference to ensuring scientific agreement and translating the findings into practical licensing decisions - this can include an informal meeting with NPWS (who are also Statutory Consultees)	
Step 5	If DAFM has a serviceable Appropriate Assessment, it can proceed to carry out Environmental Impact Assessment (EIA) pre-screening on all licence applications to ensure compliance with EU Environmental Directives	4 weeks minimum
Step 6	Submission to Minister on requirement for Environmental Impact Statement (EIS) for each application	2-3 weeks
Step 7	Submission of set of policy recommendations for entire bay or Natura site for Ministerial approval	1 week
Step 8	All applications accompanied by the Appropriate Assessment and EIA pre-screening (or EIS) are sent to Statutory Consultees (this includes NPWS, An Taisce, County Councils, Department of Environment etc)	9 weeks (includes 6 week statutory consultation period)
Step 9	All applications accompanied by the Appropriate Assessment and EIA pre-screening (or EIS) are sent to Public consultation - allowing members of the public to comment	Runs parallel to Step 8
Step10	All information received is evaluated by DAFM. An Appropriate Assessment Conclusion Statement is finalised indicating how the bay will be licensed in accordance with Natura requirements. Individual recommendations are prepared and sent for	3-6 weeks depending on the size of the bay

	Ministerial approval	
Step 11	Ministerial Decision to either grant or refuse the application	1-2 weeks
Step 12	Publication of Ministerial Decision and the reasons for such determinations are placed on DAFM website	1 week
Step 13	Decision may be appealed to the Aquaculture Licences Appeals Board (ALAB) - the independent appeals body	4 weeks

It will be seen from the above table that a period of time in the order of 30 weeks is required to finalise licence determinations, after publication of each Appropriate Assessment Report.

In addition to the above constraints, enhanced requirements from other authorising agencies have emerged, for example in the case of underwater archaeology. The requirements set down by the Minister for Arts, Heritage and the Gaeltacht in respect of underwater archaeology reflect applicable legislation. However, they will impact the timelines indicated above. It is not possible at this stage to quantify this pending the completion of initial archaeological surveys currently underway in respect of Dungarvan Bay.

Based on the information currently available to the Minister, the expected outturn for 2015 in respect of licence determinations is in the order of 150. This estimation is the subject of an ongoing review for the reasons outlined above.

Licence Fees

Details of the present licence fees are set out in Appendix 3.

Actions proposed

(A) Progressively remove the current aquaculture licensing backlog.

Implementation of a more streamlined process, within a revised legal framework, should allow for the phased introduction of significantly reduced timescales for licence determination. While the overall process will continue to need to reflect the engineering, scientific, environmental, legal and public policy aspects of all applications, the incremental availability and ultimate completion in 2016 by the Marine Institute of Appropriate Assessments will facilitate the processing of aquaculture licence applications currently on hand. As the Appropriate Assessment process becomes more refined, the number of licence determinations should increase significantly year on year.

(B) Review and revision of the aquaculture licensing process, including the applicable legal framework.

(C) In the context of a reviewed process and revised legal framework, consider the phased introduction of appropriate timescales for licence determination.

A full review of the procedures and processes involved in the consideration of aquaculture licence applications including, of necessity, the legislative framework is proposed. Implementation of a more streamlined process, within a revised legal framework, together with completion of appropriate assessment, will allow for the phased introduction of appropriate timescales for licence determination.

(D) Develop a data management and information system, with online aquaculture licence application and tracking functionality, and spatial mapping of aquaculture sites

The development of a data management and online system for aquaculture licence application and tracking is envisaged. The system envisaged will also provide a management tool for aquaculture licence processing, reporting and file sharing. The system will provide a mechanism for reducing the administrative burden for both the applicant and the administrators. The key features and benefits of the system would be as follows:

- Real time reporting and monitoring of the aquaculture industry;
- Potential to improve processing efficiency by the introduction of Registered Aquaculture Agents to assist clients to prepare aquaculture licence applications to the required standard of completeness and accuracy;
- A standardised reporting and input process to the aquaculture licensing process from internal and external consultees;
- Improved efficiencies in processing time of applications such as instant on-screen accessibility and two-way electronic delivery of internal, statutory and public consultation material;
- Public Viewer will deliver transparency for the aquaculture industry and the public;
- Enhanced efficiencies, arising from improved levels of reliability and predictability with consequent cost reduction to applicants, DAFM and other agencies by the use of a standardised paperless system.
- Secure web based system with controlled levels of access (DAFM, agency and public) managed by DAFM.

- Improved efficiency in information accuracy and decision-making by central file sharing and single on-screen viewer.

The system will reduce the administrative burden for the applicant, the administrators, and wider stakeholders.

An Chomhairle Náisiúnta Eacnamaíoch agus Shóisialta
National Economic & Social Council

NESC

The Dynamics of Environmental Sustainability and Local Development: Aquaculture

A study for NESC by Dr Patrick Bresnihan

Assistant Professor of Environmental Geography

No. 143 April 2016

An Oifig Náisiúnta um Fhorbairt Eacnamaíoch agus Shóisialta
National Economic & Social Development Office NESDO

National Economic and Social Council

Constitution and Terms of Reference

1. The main tasks of the National Economic and Social Council shall be to analyse and report on strategic issues relating to the efficient development of the economy and the achievement of social justice.

2. The Council may consider such matters either on its own initiative or at the request of the Government.

3. Any reports which the Council may produce shall be submitted to the Government, and shall be laid before each House of the Oireachtas and published.

4. The membership of the Council shall comprise a Chairperson appointed by the Government in consultation with the interests represented on the Council, and

    - Four persons nominated by agricultural and farming organisations;
    - Four persons nominated by business and employers' organisations;
    - Four persons nominated by the Irish Congress of Trade Unions;
    - Four persons nominated by community and voluntary organisations;
    - Four persons nominated by environment organisations;
    - Twelve other persons nominated by the Government, including the Secretaries General of the Department of Finance, the Department of Jobs, Enterprise and Innovation, the Department of Environment, Community and Local Government, the Department of Education and Skills.

5. Any other Government Department shall have the right of audience at Council meetings if warranted by the Council's agenda, subject to the right of the Chairperson to regulate the numbers attending.

6. The term of office of members shall be for three years. Casual vacancies shall be filled by the Government or by the nominating body as appropriate. Members filling casual vacancies may hold office until the expiry of the other members' current term of office.

7. The numbers, remuneration and conditions of service of staff are subject to the approval of the Taoiseach.

8. The Council shall regulate its own procedure.

An Chomhairle Náisiúnta Eacnamaíoch agus Shóisialta
National Economic & Social Council

The Dynamics of Environmental Sustainability and Local Development: Aquaculture

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Secretary General, Department of the Taoiseach and Secretary General to the Government

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Friends of the Earth Ireland

Mr Michael Ewing,
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Environmental Pillar

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Secretariat to Project
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Mr Noel Cahill,
Economist

A full list of the NESC Secretariat can be found at www.nesc.ie

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Abbreviations

AGD
Amoebic Gill Disease

ALAB
Aquaculture Licensing Appeals Board

ASC
Aquaculture Stewardship Council

ASP
Amnesic Shellfish Poisoning

AZP
Azaspiracid Poisoning

BBS
Bantry Bay Seafoods

BIM
Bord Iascaigh Mhara

CBRM
Community-Based Resource Management

CFP
Common Fisheries Policy

CMO
Common Market Organisation

DAFF
Department of Agriculture, Fisheries and Food

DAFM
Department of Agriculture, Food and the Marine

DCENR
Department of Communications, Energy and Natural Resources

DECLG
Department of Environment, Community and Local Government

DOMMRC
Daithi O'Murchú Marine Research Station

DSP
Diarrhetic Shellfish Poisoning

EAA
Ecosystems-based Approach to Aquaculture

ECJ
European Court of Justice

EIA
Environmental Impact Assessment

EIS
Environmental Impact Statement

EMFF
European Maritime and Fisheries Fund

EU
European Union

FAO
Food and Agricultural Organization

FLAGs
Fisheries Local Action Groups

FOs
Fishery Orders

GES
Good Environmental Status

HABs
Harmful Algal Blooms

HACCP
Hazard Analysis & Critical Control Point

HOOW
Harnessing Our Ocean Wealth

IFI
Inland Fisheries Ireland

IMP
Integrated Marine Plan for Ireland

IMTA
Integrated Multi-Trophic Aquaculture

ISGA
Irish Salmon Growers Association

ISA
Infectious Salmon Anaemia

MCG
Marine Co-ordination Group

MHI
Marine Harvest Ireland

MIP
Minimum Import Price

MSC
Marine Stewardship Council

MSFD
Marine Strategy Framework Directive

MSP
Marine Spatial Planning

MSY
Maximum Sustainable Yield

NGO
Non-governmental Organisations

NPWS
National Parks and Wildlife Service

NSP
National Strategic Plan for Sustainable Aquaculture Development

OsHv1
Oyster Herpes Virus

PD
Pancreas Disease

PSP
Paralytic Shellfish Poisoning

SAC
Special Areas of Conservation

SBM
Single Bay Management

SDC
Seafood Development Centre

SDP
Seafood Development Programme

SFPA
Sea-Fisheries Protection Authority

SPA
Special Protected Areas

Part One
Sustainable Development in Irish Aquaculture: Council Comments

Introduction

Increasing attention is being focused on the aquaculture[1] sector so as to deepen and extend its sustainable growth in Ireland and across the EU. In Ireland, this is part of an increased focus on national resource sectors as a potential source of employment and prosperity. Across the world, it is also part of greater concern about how economic activity can be made consistent with environmental sustainability. In his research paper, Dr Patrick Bresnihan examines how the dynamics of environmental sustainability have been experienced and managed in Irish aquaculture. This research was commissioned as part of NESC's work on sustainability.[2]

The purpose of these Council Comments is to introduce the paper and make some observations, both in relation to the aquaculture sector and to local and regional development more broadly. The focus of current sustainable development work in NESC is to examine pertinent areas on two levels: first, where environment, society and economy meet and interact at a high policy level and, second, in specific contexts such as aquaculture, farms, housing and communities where matters of sustainable development are locally contextualised or where 'the rubber meets the road'. Looking in detail at particular contexts provides narratives of how these dimensions of environment, economy and social meet each other.

The paper is structured as follows. The first section provides an introduction to the aquaculture sector in Ireland and the current policy context. It also outlines the development of a more integrated approach at EU and national levels. This is followed by a short summary of the key research findings and the Council's

1 Aquaculture is the cultivation of any aquatic organism such as fish, crustaceans, molluscs and aquatic plants. Aquaculture in Ireland is generally divided into shellfish and finfish, though there is a burgeoning seaweed farming sector that has good potential for growth.

2 The Department of the Environment, Community and Local Government provides NESC with resources to assist it in integrating a sustainable development perspective into its work.

reflections. The paper concludes by identifying a key question for aquaculture's future: what needs to be put in place to enable forms of aquaculture that are ecologically sensitive *and* sustain employment, enterprise and social cohesion in Ireland's coastal areas?

Aquaculture Goals and the Wider Policy Context

Introduction

In undertaking this work, NESC set out to examine the challenge of Irish aquaculture development that balances economic, environmental and social goals (OECD, 2014: 5). The complex pursuit of local job creation and enterprise, development/growth, and strengthening of exports, while at the same time deepening environmental protection and sustainable development, is not easy to achieve. It is made more complex by challenging and unpredictable natural and environmental conditions. Aquaculture and its future development must achieve a balance between sustainable growth, marine conservation and productive employment in coastal communities while responding to the effects of climate change. These too are reflected in the Global Sustainable Development Goals (SDGs).[3]

Overview of Aquaculture

Aquaculture is considered to have important future food potential and is central in addressing food-security concerns in many countries (OECD, 2014: 25). The OECD points to the jobs that can be created in rural areas from aquaculture, noting that it has better growth potential than capture fisheries (*ibid.* 30).

In Ireland, aquaculture in the form of shellfish (oysters and mussels) and finfish (mostly salmon) has been in operation since the 1970s, along the Atlantic coast but also to a lesser extent in freshwater sites.

The aquaculture sector in Ireland is small in scale, relative to Scotland or Norway for example. Indeed, it has been in decline somewhat over the last decade; the entire volume of farmed salmon produced in Ireland in a year (12,000 tonnes) is covered by three days of production in Norway. Ireland's global market share in salmon production is less than one per cent (FAO, 2014). Nearly all of the salmon farmed in Ireland is now organic, with Ireland supplying 50 per cent of the organic farmed salmon market in Europe (BIM, 2015).

There are currently 850 licensed operations in Ireland, covering 2,000 sites. These are predominantly relatively small shellfish producers. One company, Norwegian

3 https://sustainabledevelopment.un.org/

Marine Harvest, the largest aquaculture company in the world, controls about 80 per cent of the total production of farmed salmon in Ireland. This is the result of considerable commercialisation and regulation of the salmon farming sector in recent years. Technological and regulatory developments have transformed practice.

There are limits to growth within the sector across Europe where aquaculture production has been stagnating for the past decade (European Commission, 2013). However, Ireland does have potential to develop in the coming decade, with a rich and varied marine landscape, and a long coastline, although one which is very exposed. This lack of natural shelters such as loughs or fjords brings both benefits and risks to Irish aquaculture. Combined with Ireland's green image and reputation for quality foods, the opportunities are evident for developing the sector. Bord Iascaigh Mhara (BIM) has estimated that by 2025 total seafood value to the Irish economy will be €1.25bn per annum and that it will employ an extra 250 full-time equivalent jobs. Recent national policies include the Seafood Development Programme and a National Strategic Plan for Aquaculture (NSP).

Aquaculture EU and Irish Policy Context

The National Strategic Plan, the first multi-annual plan for Irish aquaculture, is a requirement of the Common Fisheries Policy Regulation. The plan is intended to inform investment priorities and €28m has recently been allocated to two Sustainable Aquaculture Schemes under the European Maritime and Fisheries Fund (EMFF) Seafood Development Programme for the period up to 2020. The primary aim of the plan is to sustainably grow the production of the aquaculture industry by 45,000 tonnes across all species (DAFM, 2015a). The plan commits to achieving aquaculture growth sustainably, underpinning the broader vision of the green economy.[4]

The ecosystems approach has emerged as a fundamental delivery mechanism for achieving sustainable development, based on maintaining fully functioning ecosystems (Marine Institute, 2009).[5] This approach strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties of ecosystems, including their interactions, flows and processes, and applying an integrated approach within ecologically and operationally meaningful boundaries.[6]

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4 A green economy is one that is low-carbon, resource-efficient and inclusive. The United Nations Environment Programme defines it as resulting in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). The green growth concept has been further developed recently by the OECD. They outline it as fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies (OECD, 2014: 5).

5 Current Environmental Issues in the Marine Sector for 2020. Downloaded May 2015 from https://www.agriculture.gov.ie/media/migration/agri-foodindustry/foodharvest2020/foodharvest2020/2020strategy/2020MarineEnvIssues1.doc

6 http://www.fao.org/fishery/topic/16035/en

However, the implementation of such an integrated approach presents challenges to all stakeholders.

The Government's strategy for aquaculture operates within a context of European environmental directives, such as the Marine Strategy Framework Directive (MSFD). MSFD required an initial assessment of the marine environment, a monitoring programme and a programme of measures in general terms, which Ireland has undertaken (DECLG, 2013, 2014). The sustainability of aquaculture will have to be determined by its impact on the Good Environmental Status (GES) of Irish waters (as determined under MSFD).7 MSFD defines an iterative process; as more knowledge is gained about the Irish marine environment, and as new issues emerge, this assessment is likely to be revised, along with the targets and indicators (DECLG). The obligation on Ireland under the MSFD is to have in place the necessary measures to achieve or maintain GES by 2020. The licensing and regulation of all activities affecting GES, including aquaculture, will be subjected to these requirements.[8]

Creating an Integrated Approach to the Development of Aquaculture

Developing an integrated approach to meeting the MFSD goals will be critical and provides the context for this research. Balancing environmental protection for the marine with economic and social commitments is a challenging policy task. The management of these commitments has not been without problems in Ireland. One key challenge has been difficulties regarding licensing, as a result of which very few licences were issued or renewed for a number of years.[9] A key factor in this was a ruling by the European Court of Justice (ECJ) in 2007 that Ireland had failed its obligations under the Birds Directive by not conducting appropriate assessments before granting aquaculture programmes in Special Protection Areas for birds (Natura areas) in coastal areas.

Aquaculture licensing is currently administered through the Aquaculture and Foreshore Management Division of the Department of Agriculture, Food and the Marine (DAFM). The Minister for Agriculture, Food and the Marine provides the final determination on applications, after they have gone through an in-house technical examination and been put out to consultation with up to 14 statutory

7 The Directive defines what constitutes good environmental status: 'ecologically diverse and dynamic oceans and seas which are clean, healthy and productive'… where '... the structure, functions and processes of the constituent marine ecosystems ... allow those ecosystems to function fully'; 'human-induced decline of biodiversity is prevented' and 'Anthropogenic inputs ... into the marine environment do not cause pollution effects'. It also sets out a list of 11 qualitative descriptors on which the determination of GES is to be based: biological diversity; levels of non-indigenous species; commercially exploited fish and shellfish; food webs; eutrophication; sea-floor integrity; hydrographical conditions; contaminants; contaminants in fish and seafood for human consumption; marine litter, and the levels of energy including underwater noise (SWAN, 2015).

8 http://www.environ.ie/sites/default/files/migrated-files/en/Publications/Environment/Water/FileDownLoad%2C43583%2Cen.pdf

9 Work is now ongoing to provide the necessary baseline data from which conservation objectives and the criteria for appropriate assessments could be established for all new and existing developments within Natura areas (including aquaculture).

agencies.[10] Depending on the type of aquaculture (finfish or shellfish) and where the development is to be located (inside a Special Area of Conservation or Special Protected Areas), there may be a requirement for an Environmental Impact Assessment (EIA) (compulsory in the case of applications for salmon farms).[11] Critics of the current licensing system, both in the industry and among NGOs, point to lengthy delays in some cases as well as limited public consultation. Public notices are only required to be published in one local paper, and the appeals process is costly. There are currently government commitments to review and reform the licensing process, which is recognised by the industry as a critical area for the future progress of the sector.

Regulation, therefore, clearly has an important role for a sector such as aquaculture. EU directives and their transposition into national legislation have had a significant impact. In particular, the MFSD and the criteria for GES are important, along with the targets and indicators by which GES can be measured. The environmental sustainability of all maritime activities will be determined with reference to GES, and it is a prime factor influencing any EIA. In addition, the actions of legislators, regulators and judicial actors, such as the ECJ, are all relevant, while other spheres of regulation—including competition, internal market and EU trade law—also have some influence.

An important issue is the potential environmental impacts from aquaculture, including the risk of escaped salmon, disease and effects on marine life, water pollution, GHG emissions and resource use. Concerns have been raised in these areas, and evidence is cited in the research. In some areas, evidence does not seem to be at a sufficient scale and depth yet to be used as evidence in policy-making. For example, there is a lack of data on the carbon footprint of different types of aquaculture and in the varied approaches to its production, but research is under way elsewhere in Europe. This is in the context of what are argued to be substantial data gaps and a low level of baseline information on many aspects of the marine environment, especially in relation to ecosystem functioning and cumulative impacts (SWAN, 2015). Such research will be important in the progress of any strategic approach to the sustainable development of aquaculture, based on the sound monitoring of environmental effects (Bird Watch Ireland).[12]

Mandatory EIA was an important step in strengthening the focus on environmental issues in Irish public governance and, as the paper makes clear, EIA has a major role in the story of Irish aquaculture. A key feature of the current approach is that, in

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10 These include: Department of Agriculture, Food and the Marine, BIM, the Marine Institute, the Sea Fisheries Protection Authority, National Parks and Wildlife Service, Údarás na Gaeltachta, Bord Fáilte, Commissioners of Irish Lights, Department of Transport, Department of Communications and Natural Resources, Department of Arts, Heritage and the Gaeltacht, Marine Survey Office, Inland Fisheries Ireland, Environmental Protection Agency, An Taisce, and the relevant local authority and harbour authority.

11 The licence decision-making and oversight of the EIA process is managed by DAFM and its agencies, the Marine Institute and BIM. The current licensing process for aquaculture includes a window of one month for public consultation after the licence has gone through the EIA and statutory consultation.

12 http://www.environ.ie/sites/default/files/migrated-files/en/Publications/Environment/Water/FileDownLoad%2C43583%2Cen.pdf

general, each proposed development is considered separately, on a case-by-case basis, rather than in the context of a broader bay area or the wider marine environment. In addition, opportunities for local engagement are limited, and often opposition has to be posed in through the discussion of particular technical, environmental or scientific evidence.

In commissioning the research, NESC posed a number of questions. Can Ireland have green aquaculture, in the sense of being sustainable to the receiving environment and sustainable for aquaculture farms? Is it possible for aquaculture to be environmentally responsible, profitable and sustainable, given that these need not be mutually exclusive? (SWAN & Coastwatch, 2013). In what way would diverse goals relate to each other in practice and be reflected in Irish public policy? The research should explore the relative significance of key drivers and constraints, and how they bear on the way the main goals are prioritised and pursued, drawing on local exploration.

This paper comes at an important time for Irish aquaculture; the new plan and funding programme are in place, and work is being undertaken to develop and roll out Regional Enterprise Strategies (DJEI, 2013: 36). In addition, a planning application for a large salmon farm in Galway Bay, outlined in the paper, has recently been withdrawn by BIM, stating reason of scale. The 15,000 tonnes proposed in the application would have likely exceeded expected guidelines on maximum limits for offshore farms. While this will be regarded by many as a setback for the expansion of the sector in the short term, it provides an opportunity to reflect on possible future directions in the longer term.

Sustainable Development in Aquaculture: Three Research Findings and Council Reflections

The research was undertaken in the second half of 2015 and included over thirty interviews with fish farmers, seafood processors, marine scientists, public sector and policy representatives, NGOs and local stakeholders. The resulting paper provides a fresh and probing exploration of a sector in transition. It achieves this by providing insights on how sustainable development is experienced by the range of stakeholders involved, while also setting out key policy drivers and environmental considerations. It shows clearly how the local is shaped by global market dynamics and by EU and national regulatory frameworks and policies. The paper presents a reflection of the sector as it is currently, as well as outlining and suggesting potential ways forward.

It is clear from the paper that aquaculture is a highly contested sector, with different perspectives on both recent history and future ambition. Some of the examples discussed in the paper, such as the proposals for an oyster farm on Linsfort Beach in Donegal and the Galway Bay Salmon Farm, reflect some of the tensions experienced within specific sites. While these cases may not be typical in all respects, they do provide insight into the complexity of modern aquaculture development and environmental protection. These cases of contestation have not been helped by broader contributing factors, including the difficulties over licensing, concerns over the incidence of disease in oysters and sea lice in salmon, and the consolidation of the sector which has reduced the number of small farmers.[13]

The paper examines, through three central themes, the key challenges that have shaped and will continue to shape the development of aquaculture in Ireland. These themes provide much food for thought concerning the aquaculture sector specifically, but also in relation to wider issues of regional development and environmental protection and enhancement. The paper provides a balanced account that will be useful as the sector moves forward, and also offers thoughtful analysis concerning its future direction. This analysis has brought to the surface a number of different possible paths of aquaculture development, exemplified by the Wild Atlantic Way Seafood Trail and the Asia Oyster Group, both guided by BIM, and their role in local employment and environmental management (outlined further below).

The three key themes identified are:

(i) Diverse Economies for Development;
(ii) Environmental Risk and Resilience, and
(iii) Conflict Resolution, Engagement and Decision-Making.

Each of these themes is now briefly outlined, followed by Council reflections.

Diverse Economies for Development

The paper outlines how the aquaculture industry in Ireland has depended on large, continental buyers who control access to European retail markets. More recently, the green credentials of salmon farming in particular has been part of a strategy to gain added-value within the global seafood market. While Marine Harvest has been the dominant player in relation to farmed salmon, other initiatives to support greater exports for other aquaculture sectors have been undertaken by BIM, such as the supports provided to oyster producers to export to Asian markets (Asia Oyster Group).

The challenges and limitations of the dominant model of development for the sector are outlined; the paper concludes that the long-term sustainability of aquaculture in Ireland will involve the valuing and fostering of more diverse, local economies that perform vital social and ecological functions. Examples of supports to local economies are outlined in Box 1.

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13 The prevalence of disease and sea lice is fully discussed in the research paper.

Box 1: Examples of Supports to Local Economies

Údarás na Gaeltachta

In Connemara Údarás na Gaeltachta encouraged local involvement in the salmon industry by financing the acquisition of cages and smolts. Small producers were paired with larger producers to help them access export markets and ensure a balance between local, family-owned salmon farms and the larger investors who brought the necessary economies of scale and financial investment. Údarás na Gaeltachta also helped develop the Irish Salmon Producers Group (ISPG), which became the largest exporter of farmed salmon in Ireland in the 1990s.

'Taste the Atlantic' Seafood Trail

The Seafood Trail links seafood farmers and small producers based in counties Mayo and Galway with a broader tourist initiative, the Wild Atlantic Way. BIM and Fáilte Ireland collaborated to map out local producers and integrate the provenance of food with local restaurants and businesses. The first pilot project of the Wild Atlantic Way Seafood Trail took place in summer 2015; a number of small producers, retailers and restaurants were chosen in an area that stretched from Achill Island down to South Galway. The producers were mostly oyster and mussel farmers, several artisan smokehouses and a couple of lobster fishermen. As well as producing a map and a guide for the trail, BIM made a short film showcasing the producers and the area in which they work. The aim was to communicate to tourists and visitors that these are 'real' people producing 'real' food and artisan products. The pilot Seafood Trail was a success: after only one summer, there was an estimated sales increase for each producer of 30 per cent (BIM).

Council Reflection: Broadening Economic Development in Aquaculture

The Council, in its discussion of this paper, identified what it considered to be missed opportunities, on the one hand, and opportunities waiting to be seized, on the other. This related to different strands of the sector's recent history, including a sense of missing out on an opportunity for deeper reflection on the potential for diverse economies at a national policy level. The salmon farming industry is now largely dominated by one international company, and the type of production would seem more suited to the dominant large-scale, export-focused economic model. The recent policy development process is now complete for the time being with the publication of the National Strategic Plan for Sustainable Aquaculture Development.

Other Council members felt that the lack of growth in the industry is regrettable, reflecting a broader European challenge. However, for others the development that is not being cultivated sufficiently did not relate to one of scale, but rather to the lack of supports for locally developed, indigenous seafood and seaweed production. It was noted by some that there needs to be greater understanding of the needs of modern food businesses and the complex relationship between farmers, the environment, regulation, markets and the macro-economy. Some of the challenges facing farmers include the need to protect stocks from natural events, disease and environmental hazards and pollution, and being able to situate farms for optimal protection of stocks away from land and sea pollution.

This relates to a perennial challenge facing the Irish food industry: the ability to generate higher returns from sustainable production earlier in the value chain. For smaller producers, along with the important priority of producing safe, high-quality food, access to local and national markets may be the most critical objective. For those with exporting in mind, good access to roads and airports can also be a factor. The Council felt that another economic model, linked to eco-tourism, native species and local skill, is an opportunity that could be developed now. This model features in some of the Regional Action Plans for Jobs, but has yet to be as fully developed at a national level. For example, the Action Plan for Jobs: West Region identifies as an action the development of 'a range of new tourism products and food offerings to link aquaculture and fisheries producers with tourism interests and food businesses in the region'.[14]

The environmental quality of Ireland's coastal waters, combined with its indented coastline, creates enormous opportunities. The importance of community resilience, rural development and the use of local knowledge and skills for a sustainable economy was emphasised in the research. A model of development which integrates and builds on local enterprise has potential. This could have a role for rural co-operatives and other collaborative models such as highlighted in the Seafood Trail. One example from Scotland is the Loch Ryan Oyster Fishery Company, which illustrates the potential for specialist produce to be successful. It sells its produce of wild native oysters to Harrods and the Ritz Hotel in London, as well as exporting to France and Spain.[15] However, in this instance, the success has been underpinned by large investment in marketing and branding, not available to many small producers.

Aquaculture undoubtedly has potential to provide safe, nutritious food and other materials to sustain livelihoods in coastal areas, and to ensure and even enhance the quality of the marine environment. The Council considered that there are opportunities to be grasped for the future in relation to the quality of Ireland's marine environment, both in terms of its protection and preservation, and also as a unique selling point for the industry. The pristine waters and quality land would need to be front and centre of any development for aquaculture. The marketing of Irish food and aquaculture increasingly relies on its environmental credentials. The long-term viability of continuing to do this in a context in which those most focused on, and able to care for specific local environments are not sufficiently rewarded for their efforts, also needs to be considered. There is also the challenge of operating within a carbon-constrained world.

There is a broader challenge in finding a way to promote and support all aquaculture-sector models in a way that allows them to develop in parallel. There

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14 https://www.djei.ie/en/Publications/Publication-files/Action-Plan-for-Jobs-West-Region-2015-2017.pdf

15 http://www.scotsman.com/news/meet-the-men-fishing-scotland-s-last-wild-oyster-bed-1-2555426

may be potential in exploring how niche areas or 'protected spaces' can be supported by the policy system so that innovations can be nurtured and resourced. Seaweed production and research would seem to be an area where such an approach would be valuable as it seems to have clear economic and environmental potential. The research points to the need for a supportive licensing system for smaller farmers, R&D and technical assistance, start-up grants and links with processing units and commercial applications for aquaculture to develop sustainably. There is also further potential for growing a wider support base within the local community, in terms of goods and services, as well as anchoring young people so as to sustain wider social infrastructure such as schools and other local services.

In considering how policy can support the growth of local enterprise and employment based on ecologically sensitive use of natural resources, the Council poses some necessary questions which it believes merit further deliberation. The overarching question for further consideration is: what needs to be put in place to enable forms of aquaculture that are ecologically sensitive *and* sustain employment, enterprise and social cohesion in Ireland's coastal areas?

As more is understood of the interconnectedness of ecosystems and aquaculture practices, achieving a sustainable industry requires a heightened sensitivity to balancing care for the environment with employment, and local opportunity with economic growth. A key question applicable to both agri-foods and aquaculture is: how can the environmental performance of Irish farmers be adequately rewarded?

It is worth reflecting on ways to support different growth models to complement and reinforce each other in a way that helps to build resilient local industry and employment. There is a developmental role for state agencies, such as BIM, which helps to promote smaller producers. Will more of this kind of support be sufficient to boost local aquaculture industry, or is a further suite of guidance, incentives and capacity-building required? Finally, in relation to market-led strategies, how can these capture more value for Irish sea-food producers?

Environmental Risk and Resilience

The research identifies many of the environmental risks and problems that aquaculture faces, and these have a direct impact on production (see Box 2). Aquaculture is both a relatively new activity and one that is fraught with risk and uncertainty—from the point of production (weather, sea lice, disease) to the point of consumption (biotoxins, contamination). These environmental risks have contributed to limiting production volume and reducing certainty of supply to buyers and retailers who increasingly demand consistency of product. The paper argues that, in addition, fish farming generates risks and problems that didn't exist previously as the practice is a relational one between the dynamic marine environment and the farming itself.

Box 2: Common Risks in Aquaculture

While the mussel and oyster sectors have experienced considerable setbacks in production due to the occurrence of toxic algal blooms and the spread of diseases, the salmon industry has suffered more varied, persistent and significant challenges. These include weather, disease, sea lice, jellyfish, Harmful Algal Blooms (HABs) and unexpected changes in environmental conditions.

The problem of sea lice was identified by Marine Harvest as the biggest challenge to the salmon farming industry, in 2015.[16] Beyond the everyday challenges of weather, there are also extreme weather events that pose a risk to the salmon farm infrastructure itself, raising the risk of escapes. While Ireland's record on escaped salmon is good compared to Scotland or Norway, there have been significant occurrences.

These risks have been approached in particular ways by the industry and the State. However, local fish farmers have developed innovative approaches to and skills for managing and negotiating these environmental risks and changes. The research points out that it is in their interests to care for and sustain their environments, but it is not always possible for them to do so, due, for the most part, to economic constraints. The full value of coastal waters and surrounds and their ecosystem services is starting to be recognised in policy in Ireland and the EU, in terms of both their intrinsic value and their economic, social, cultural and environmental value. There are implications arising from this study for the industry but also for the policy-making process. These include ways of managing risk and environmental regulation, planning for future development, environmental regulation and stakeholder engagement. They address both short-term challenges and the development of long-term resilience so that those involved can respond to and absorb disturbance.

Underpinning these environmental risks and how they are managed are the multiple goals of environmental protection, local job creation and protection, sectoral growth nationally and within the EU, global markets, regional development, and social sustainability and resilience. This is in the context of continued uncertainty over environmental outcomes and futures, which is not unique to Ireland. Regulation of the sector is framed by EU directives and policies, as well as national and local plans.

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16 https://www.undercurrentnews.com/2015/10/28/marine-harvest-q3-earnings-exceed-expectations-despite-drag-from-americas/

Council Reflection: The Role of Regulation in Managing Risk and Promoting Resilience

The Council reflected on the achievements and challenges in three spheres of activities regarding aquaculture in Ireland: policy, regulation and deliberation.

At the level of policy, as conducted by both government and its agencies, there has been significant development of the aquaculture sector in recent decades, and the sector now has its first multi-annual plan in place. But the story of aquaculture also exemplifies some policy difficulties. The delay in issuing and renewing licences has been one factor in limiting the business opportunities for small-scale producers. This contributed to something of a slow-down in the development of the industry in recent years. There has also been a lack of clarity over the future development plans for the sector, compounding the challengers for smaller producers. However, the National Strategic Plan and planned improvements of the licensing for the sector, once implemented, will help to bring greater stability and direction. Another factor has been the growth of the large-scale, export-driven approach to salmon farming and its reflection in policy ambition for the future of the sector. As the research observes, while this policy is largely imposed on Ireland because of the small, internal market and the growing international demand for seafood, it is important to recognise that other models of economic development can and do exist alongside this.

In terms of regulation, there have been considerable challenges, given the deep uncertainty and complexity relating to diseases and pests and to climatic changes. The business of aquaculture depends in a fundamental way on an ability to manage environmental risks; these can have a particularly detrimental impact on production and the viability of a business. One means of coping with this risk is to develop large-scale production that has both the financial scale to cope with serious setbacks and that is diversified geographically. However, this view of environmental risk runs the danger of underestimating the ability of local actors to identify and avoid risk more effectively. By contrast, small-scale local producers are more focused on early identification and avoidance of risks as they simply cannot cope when these risks materialise. For these producers, sustainable livelihoods, quality of life and environmental integrity are inseparable.

The paper raises interesting issues for the process of regulation and how difficulties arise where a 'distant' model is used. A more responsive regulatory model would be one that could play a developmental role: taking bad practice and less developmental strategies off the table while supporting the progress of projects and business models that yield good environmental and social outcomes. In other words, regulation that takes out the bad practice and helps make the good strategies better.

Regulation for aquaculture has many different aspects, from the licensing process and EIA, discussed above, to the day-to-day minimisation of risk through disease and pest control such as the national sea-lice monitoring programme, run by the Marine Institute. However, a responsive regulatory system, which is also 'close'—actively works to encourage and support best practice in the high and middle-performing producers, as much as to sanction the worst.

Previous NESC work on quality and standards in human services drew on international trends and thinking on 'responsive regulation' and 'experimentalist' approaches (NESC, 2011). This is useful for this context in two ways: first, in relation to highlighting the value of supporting and developing the industry—through information-sharing, enabling self-monitoring and benchmarking standards, and also through fostering a learning and problem-solving approach when things go wrong. Such an approach emphasises learning and reflection by regulators, in which the story of how problems are solved and approached is as important as the end result of minimising risk or achieving quality standards. This has been the missing piece in the story of regulatory effectiveness (Sparrow, 2008). The key question here is: can the current approach to regulation be developed so that it works to promote resilience and local knowledge, rather than displacing it?

The challenges of deliberation are discussed in the following section.

Conflict Resolution, Engagement and Decision-Making

The research identifies local contestation over proposed aquaculture developments as one key feature of the sector's recent history. The paper identifies the different perspectives that can exist concerning local places. Examples presented illustrate some of the difficulties experienced by key stakeholders and local communities. For example, a beach which is appreciated for its natural beauty, amenity and tourism value may also be recognised as potentially significant for aquaculture development and local employment.

The challenge is to incorporate these different perspectives in any decision-making process. Deliberation is seen as critical, but particularly deliberation with a purpose and a direct influence on decision-making. The sector is characterised by pervasive uncertainty and risk, and the relevant knowledge and capabilities are distributed across local producers and other local actors, national agencies, scientists and market actors. Different degrees and kinds of engagement and deliberation occur within the regulatory and evaluation process (such as EIA) and in local or regional initiatives. The views expressed by diverse stakeholders can be flattened to some extent to conform with the regulatory and planning process. It can become an adversarial and sometimes disappointing process for the parties involved. While the regulatory process (including the EIA) is a critically important one, the research highlights aspects of the process that could be strengthened.

In some instances, there would seem to be insufficient or ineffective engagement and deliberation. The paper points to examples of enhanced participation for aquaculture development in Ireland such as Cairde na Mara (see Box 3) and wider engagement involving local fishermen, communities, state agencies and international actors, such as the Bantry Bay Charter (see Box 4).

Box 3: Cairde na Mara

Cairde na Mara (Friends of the Sea) was established in the Connemara Gaeltacht in 1991 to provide a more consultative approach to dispute resolution. An association of 600 fishers and fish-farm workers, Cairde na Mara conducted surveys of coastal communities in conjunction with Údarás na Gaeltachta (the Gaeltacht Authority).

The purpose of these surveys was to evaluate the impact of salmon aquaculture in a way that extended analysis beyond environmental impact statements and licensing processes which were found to exclude the community from coastal management. The idea was that resource users should be more engaged in the aquaculture planning process.

The research also points to the way scientific expertise is used in addressing the concerns and differences that people may have regarding a proposed development and the challenges this presents where there is no consensus. Where there is insufficient emphasis on deliberation for decision-making, too much responsibility can be placed on scientific knowledge and academics to provide judgements. While noting this, the research emphasises that science and scientific knowledge are important in aquaculture and, indeed, in all spheres of public policy in which there are interactions between technology, society and environment. The role of science—and its interaction with society, technology and public policy in democratic societies—has become the subject of much research and reflection internationally (Bijker *et al.*, 2009; Jasanoff, 2012; Owens, 2015). As highlighted in earlier NESC work on climate change, it is important to reflect on this role, and to structure its contribution to public policy appropriately, in order to avoid both a scientisation of policy and politics and a politicisation of science (Pielke, 2007; NESC Secretariat, 2013: 34-7).

Box 4: The Bantry Bay Charter

The Bantry Bay Charter[17] is an example of how different interests and stakeholders in an area (Bantry Bay, Co Cork) come together to agree a common set of principles and strategies for guiding their own social, economic and environmental development. As with the rationale for single bay management (SBM), the Bantry Bay Charter starts with the recognition that people and the environment in which they live are inter-related. For example, the charter's proposal on Water Quality Information & Monitoring cuts across a range of interests within the area, both on land and at sea: the tourism sector requires water quality that meets bathing-water standards; the aquaculture and wild fisheries sectors require high water quality for fish reproduction, and local residents and visitors require clean water for consumption, which is looked at under the Waste Management proposal.

A notable feature of how the question of water management is discussed in this context is the involvement of local knowledge and experience as well as engineering and scientific expertise, which includes representatives from both natural and social science. Fostering links between the biological and social-science communities, local stakeholders, economists and policy advisors to better understand the role of socio-cultural issues in conflicts, their management within legal frameworks, and efforts towards their resolution, highlights the challenge (and investment required) of constructing practical transformations on the ground.[18]

The process behind the Bantry Bay Charter involved the financial and institutional support of state agencies, authorities and departments, in addition to European funding. Cork County Council led a team of three partners, including the Coastal Resource Centre (University College Cork) and the Nautical Enterprise Centre (Cork Regional Technical College), in undertaking the Bantry Bay Coastal Zone Charter Project. This was initially supported for three years as an EU LIFE Project. LIFE is an EU instrument for supporting the development of innovative actions for the environment. Many government departments, including the Department of Marine and Natural Resources and Department of Environment, were supportive in putting together the proposal for this project.

On the ground, the people who live and work around Bantry Bay and who participated in the process invested considerable time and energy in attending meetings and round tables in order to reach points of agreement across their differences. As the website states: 'The Charter was agreed through a process that involved several stages. This process required sustained hard work, patience, and commitment from all those involved. Given the diversity of interests and perspectives that were represented in the process, achieving an agreed management programme was not straightforward.'

The commitment at local and government level required to sustain the Bantry Bay Charter continues after the charter itself was drafted and agreed upon. If anything, the implementation of such strategies is where financial and institutional support becomes most crucial.

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17 http://bantrybaycharter.ucc.ie/

18 The INTERCAFE project in the Po Delta engaged stakeholders with different perspectives on fisheries-cormorant interactions (Carss & Marzano, 2007). One of their findings was that "cormorant-fishery conflicts are an issue of major social, cultural and economic concern across Europe and so these essential non-biological factors must also be taken into account when formulating and implementing practical management policies based on scientific findings. It is evident that technical (scientific) solutions alone are not sufficient for environmental conflicts with social and economic dimensions" (*ibid.*: 2).

Council Reflection: Local Participation and Decision-making in Natural Resource Use and Management

The research strongly emphasises the need to create effective forms of engagement of key actors, particularly those with deep knowledge and a strong stake in local economic, social and environmental outcomes. Such engagement is a central theme in the approaches that increasingly inform the work of actors and public agencies in aquaculture and other spheres. EU policy continues to emphasise the importance of integrated and participatory approaches. For example, the 'ecosystems-based approach', which is influential at both international and national level, is premised on effective engagement of the diverse actors, at various scales, that shape a given ecosystem. Successful implementation of ecosystem-based management depends on identifying and understanding different stakeholders, their practices, expectations and interests (Pomeroy & Douvere, 2008: 817). While this understanding is considered critical, there is less certainty over how best to achieve it, and this is the subject of much experimentation and reflection in many countries.

While EIA is an important part of the regulatory process, at times it has become the site of conflict and dispute over particular projects, and there can be a kind of deadlock on evidence between different parties. One reason for this is that such procedures cannot substitute for a social and unavoidably political process of deliberation, contestation, accommodation and decision. The paper prompts us to suggest that, instead of a linear approach (in which a *given* project is evaluated against fully *defined* environmental criteria), a more recursive one might be more effective, in which possible and promising projects are crafted and adapted in a way that reflects the knowledge, capabilities, evaluations and interests of a range of stakeholders. This would include a more experimental, collaborative and participative approach to examining 'technical' matters that arise in aquaculture and other sectors, which could enable more sustainable outcomes. It seems important to think about the correct balance between, or combination of, a developmental process of project identification, exploration and execution, on the one hand, and a quasi-judicial process of impact evaluation and planning control, on the other.

The paper raises an important question about how meaningful participation in environmental decision-making (as identified in the Aarhus Convention, for example) can take place when there are different ways of knowing and valuing the environment (Garavan, 2007). Making the most of local knowledge and capabilities, in order to both protect ecosystems and manage production, would involve local engagement and deliberation on aspects which are currently largely channelled into the EIA process. This, in turn, would seem to require changes in the realm of regulation and EIA. Instead of focusing only on the details of EIA and the use made (or not made) of it in policy decision, we think also about the 'option generation' process itself. The kinds of projects that could be imagined and proposed—the space of economic, social and ecosystem possibilities—is shaped by a range of factors. While these include natural factors and technical possibilities, probably the most significant is the national policy framework and the associated work of the relevant state development agencies. This suggests that we need to ask how national policy can consistently make the most of local knowledge in exploring the kinds of aquaculture projects and development path that can enhance local employment and value added, and manage local ecosystems. It may require the articulation of clearer and/or different policy priorities.

Critics of the current planning process for aquaculture, such as An Taisce, have called for a strategic and integrated statutory marine spatial planning system to better integrate marine planning and development management.[19] Such a system would involve greater stakeholder participation than is currently the case. Others, such as the Enablers Task Force on Marine Spatial Planning, in its report carried out on behalf of the Marine Coordination Group, also argue that there are good reasons for going beyond the minimum mandatory requirements and for actively encouraging stakeholder participation in marine spatial planning (DAFM, 2015b). SWAN, too, have argued that Ireland needs to establish a national coastal policy and strategy to progress integrated management of coastal resources.[20]

There are a number of pilot examples where such integrated management, including stakeholder engagement, has been applied. The Bantry Bay Charter (see Box 4) published in 2000, provides an example of an integrated and participative approach to planning for marine development. Award-winning, and supported by EU LIFE funding, it has been described as a 'magnificent failure[21]' by some; it involved pioneering innovation, using ground-breaking techniques in public participation and coastal zone management with 90 stakeholders.[22] It focused on building consensus and created procedures for conflict resolution. However, others argue that it failed to sufficiently consider the needs of the aquaculture sector from a farming and environmental point of view. This points to the challenges of balancing different priorities and perspectives in any multi-stakeholder forum, but also points to its potential value if this can be achieved. The Bantry Bay Charter is no longer active owing, according to one report, to 'a lack of sustained financial and policy commitment' (Scottish Natural Heritage, 2006).

Another example, which emerged in the same period as the Bantry Bay Charter, is Community-Led Aquaculture Management Systems (CLAMS) which was developed in the late 1990s under the auspices of Bord Iascaigh Mhara (BIM). CLAMS is rooted in the principles of Integrated Coastal Zone Management, which include a multidisciplinary and iterative approach, as well as seeking to balance environmental, economic and social considerations. CLAMS provide for interested parties to have a consultative role in the drawing-up of aquaculture management plans. It represents the only agency-led approach to the management of coastal areas in Ireland (O'Hagan & Ballinger, 2010). It differs from the Bantry Bay Charter in that it was restricted to aquaculture stakeholders. This provides an interesting example of a general dilemma in participative entities: wide participation versus

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19 http://www.antaisce.org/issues/fish-farms-aquaculture

20 http://www.swanireland.ie/download/resources/coastal_&_marine/ICZM%20Report.pdf

21 Comment by a former project manager of the Bantry Bay Charter in conversation with the NESC Secretariat.

22 The Bantry Bay Project, which led to the development of the charter, won the National Planning Achievement Award, 2000 (awarded by the Irish Planning Institute) and a Special Merit Award for its 'innovative participatory process', awarded by the European Council of Town Planners in 2002.

privileged engagement of actors with deep knowledge. Another difference was that its role was clearly defined in terms of inputting on plans, rather than on building consensus.

A more recursive and deliberative model at local and indeed national level might enable different, often competing perspectives and values to be articulated and negotiated. As emphasised by Hulme (2015, following Arendt, 1958), facts are not sufficient for humans to act; we need to pass judgements. There is a strong argument that scientific or natural evidence does not absolve society from decision-making. This challenges us to create 'public spaces of encounter' (Hulme, 2015).

The Bantry Bay Charter and other examples of Integrated Coastal Zone Management provide a model which could be drawn upon in creating new processes of deliberation and engagement. Lessons from the charter's implementation and ultimate winding-down need to be learned and addressed so that institutional supports and commitment are built in over the long term. While these bring stakeholders together to help plan and monitor a bay or coastal zone, there would also be a need to consider how best to support local participation. Clearly there are examples in the research which point to a highly engaged public; however, the best structures and processes for meaningful participation to shape decisions are not clearly defined or widely agreed. While designing an effective process can be challenging, once achieved, it can be more difficult still to influence any final outcome or decision.

The NESC work on wind energy pointed to local participation as critical to the effective development of wind and related infrastructure (NESC, 2014). It argued that this needed to be present at a number of levels to be effective: nationally, at the level of the local authority, and locally. In this way, creating participatory structures nationally and at county or city level is important; bringing together key local actors, informed by expert knowledge and experience, would offer the best opportunity for positive outcomes. Certainly, the critical role of expert intermediaries in supporting communities to discuss and feed into local planning decisions is one also identified in NESC's (2014) work on wind-energy. The EPA's research on public engagement in integrated catchment management also points to the key role of bottom-up initiatives and solutions (EPA, 2015).

Whatever its particular form, it seems clear there is a growing need for a focused approach to finding, testing and adapting forms of public participation suited to natural resources management and appropriate local management. Another area that requires fleshing out for Irish practice and policy is to realise an ecosystems approach to natural-resource use and management, which is by definition inclusive of all stakeholders, to balance diverse societal objectives, so that this is built into our policy and governance processes.

Some of the key questions concerning public engagement include: How can greater deliberation and engagement in decision-making be fostered in relation to planning for aquaculture and other areas of natural-resource management and use? NESC considers this to be a question that is now arising across many different areas of policy. While there is a body of knowledge on participative methods, there is still a gap in understanding the kind of structures, processes and agencies that can best progress this kind of engagement. A final question is, therefore: how can a systematic national approach to participation as part of an Integrated Coastal Management model be further progressed?

Conclusion

This interesting paper throws light on an area not previously discussed by the Council. Aquaculture is regarded as a sector ripe for sustainable growth, despite many challenges. This research outlines the possibility of different models of economic development and what each can bring.

The paper has pointed to some of the contexts, conditions and relationships that enable and support fish farmers to further protect and enhance their local environment. It concludes that fish farmers are largely responsible and responsive to their environments, but are not always enabled to do more than is minimally required, given limited resources. There may be a set of incentives, capacity-building, networking and other supports that could be effective in enhancing environmental protection, alongside sustainable growth for the sector. There is much to learn from recent experience: on the one hand, avoiding some of the difficulties outlined in the research in terms of licensing and environmental protection; on the other, building on innovative practice, such as the Bantry Bay Charter for stakeholder engagement.

With the current potential for the sustainable growth of aquaculture in Ireland, it is important to acknowledge that developing it sustainably requires much learning and understanding. This will involve capturing local knowledge and experience, engaging with local farmers and the industry, and absorbing insights from science and new technologies, along with the policy system reflecting on the implementation of the first multi-annual plan developed for the sector. This process of review will undoubtedly occur at EU level and nationally with the implementation of the Marine Strategy Framework Directive as an iterative process. Achieving sustainable growth of a sector in the context of the challenges of climate change, disease and pest control, and competing in global markets involves a learning process for all. It is important to reflect on what needs to be put in place to enable forms of aquaculture that are ecologically sensitive *and* sustain employment, enterprise and social cohesion in Ireland’s coastal areas.

This paper, along with other recent NESC research papers, such as the Overview of the Burren Life Programme (Dunford, 2016), may contribute to the development of a more integrated perspective on environmental, economic and social policy. Many of the themes and issues raised are not unique to aquaculture, but touch on recurrent concerns of sustained regional development, environmental sustainability and environmental policy integration. In this way, the Council hopes that the wider significance of the paper on aquaculture will be considered for Ireland’s future sustainable development.

Part One Bibliography

Arendt, H. (1958), The Human Condition, Chicago: University of Chicago Press.

Bijker, W. E., Bal, R. & Hendriks, R. (2009), The Paradox of Scientific Authority: The Role of Scientific Advice in Democracies, Massachusetts: Massachusetts Institute of Technology Press.

BIM (2015), Aquaculture Licence Application for a Marine Fish Farming Unit off Inishdalla, South East of Inishturk, Co Mayo. http://www.bim.ie/media/bim/content/projects/deepseafarming/Inishturk%20Scoping%20Letter%2030-04-15.pdf, 07/12/15.

Carss, D. N. & Marzano, M. (2007), 'Extensive Aquaculture Systems and Relationships Between Stakeholder Perspectives and Different Spatial Scales and Institutional Levels', Conserving Biodiversity–Interdisciplinary Initiative to Reduce pan-European Cormorant-fisheries Conflicts, September, Po Delta: INTERCAFE.

DAFM (2015a), National Strategic Plan for Sustainable Aquaculture Development, June, Dublin: Department of Agriculture, Food and the Marine.

DAFM (2015b), Enablers Task Force on Marine Spatial Planning: Report to the Inter-Departmental Marine Coordination Group. http://www.ouroceanwealth.ie/sites/default/files/sites/default/files/news/Final%20Our%20Ocean%20Wealth%20Enablers%20Task%20Force%20Report.pdf, 14/12/15.

DECLG (2013), Ireland's Marine Strategy Framework Directive: Article 19 Report Initial Assessment, GES and Targets and Indicators. http://www.environ.ie/sites/default/files/migrated-files/en/Publications/Environment/Water/FileDownLoad%2C34365%2Cen.pdf, 14/12/15.

DECLG (2014), Marine Strategy Framework Directive Response to Submissions – MSFD Initial Assessment Consultation, 14/12/15. http://www.environ.ie/sites/default/files/migrated-files/en/Publications/Environment/Water/FileDownLoad%2C38199%2Cen.pdf.

DJEI (2013), Action Plan for Jobs, Department of Jobs, Enterprise and Innovation, Dublin: Government Publications.

Dunford, B. (2016), The Burren Life Programme: An Overview, Research Series No. 9, Dublin: The National Economic and Social Council.

EPA (2015), Public Engagement in Integrated Catchment Management: StreamScapes Recommendations. http://www.epa.ie/pubs/reports/research/water/EPA%20Research%20155%20-%20Public%20Engagement%20in%20Integrated%20Catchment%20Management%20WEB.pdf, 08/01/16.

European Commission (2013), Strategic Guidelines for the Sustainable Development of EU Aquaculture, COM(2013) 229 final, April, Brussels: European Commission.

FAO (2014), The State of World Fisheries and Aquaculture: Opportunities and Challenges, Rome: Food and Agriculture Organization of the United Nations.

Garavan, M. (2007), 'Resisting the Costs of "Development": Local Environmental Activism in Ireland', Environmental Politics, 16(5): 844–863.

Hulme, M. (2015), (Still) Disagreeing about Climate Change: What Way Forward? http://www.mikehulme.org/wp-content/uploads/2014/03/15_08-Hulme-for-Zygon.pdf, 08/01/16.

Jasanoff, S. (2012), Science and Public Reason, Oxon: Routledge.

Marine Institute (2009), Irish Ocean Climate and Ecosystem Status Report 2009, Galway: Marine Institute.

NESC (2011), Quality and Standards in Human Services in Ireland: Overview of Concepts and Practice, Report No. 124, December 2011, Dublin: The National Economic and Social Council.

NESC (2014), Wind Energy in Ireland: Building Community Engagement and Social Support, Dublin: National Economic and Social Council.

NESC Secretariat (2013), Reframing the Climate Change Policy Challenge, Background Paper No. 1, Dublin: National Economic and Social Council.

O'Hagan, A. M. & Ballinger, R. C. (2010), 'Implementing Integrated Coastal Zone Management in a National Policy Vacuum: Local Case Studies from Ireland', Ocean and Coastal Management, 53(12): 750–759.

OECD (2014), Fishing for Development, Background Paper for Session 3: Green Growth in Fisheries and Aquaculture, Paris: OECD Publishing.

Owens, S. (2015), Knowledge, Policy, and Expertise, Oxford: Oxford University Press.

Pielke, R. Jnr. (2007), The Honest Broker, Cambridge: Cambridge University Press.

Pomeroy, R. & Douvere, F. (2008), 'The Engagement of Stakeholders in the Marine Spatial Planning Process', Marine Policy, 35: 816–822.

Scottish Natural Heritage (2006), A Review of Relevant Experience in Sustainable Tourism in the Coastal and Marine Environment, Inverness: Scottish Natural Heritage.

Sparrow, M. K. (2008), The Character of Harms, Cambridge: Cambridge University Press.

SWAN (2015), National Strategic Plan for Sustainable Aquaculture Development: Response to Public Consultation, July, Dublin: Sustainable Water Network.

SWAN & Coastwatch (2013), Aquaculture in Ireland in the Context of EU Water Law (MSFD & WFD): Challenges and Opportunities, Proceedings of SWAN/Coastwatch Seminar, 30 October, Dublin: Sustainable Water Network (SWAN).

UNEP (2011), Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, Nairobi: United Nations Environment Programme.

Part Two
The Dynamics of Environmental Sustainability and Local Development: Aquaculture

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Chapter 1
Introduction

1.1 Abstract

In a context where wild fish stocks continue to be overexploited and agricultural production is under stress, aquaculture has been identified as a new frontier for food production (FAO 2014; OECD, 2014) (Box 1.1). This 'blue revolution' must be understood in the wider context of the 'blue economy' (European Commission, 2012b), a concept that envisions ocean wealth as a key element of economic recovery and sustainable growth. The expansion of aquaculture activity is thus going to be a significant new area of environmental policy-making and development over the coming years.

In Ireland, shellfish and finfish aquaculture have been in operation since the 1970s. Mostly concentrated along the Atlantic coast, the development of the industry has been relatively slow compared to other European countries, particularly Scotland and Norway (Callier *et al.*, 2011); volume production of Irish-grown shellfish and finfish has in fact declined since the peak of the early 2000s. The limits to growth in the sector are not unique to Ireland, however. Across Europe, aquaculture production has been stagnating for the past decade (EC 2013). With yields from European capture fisheries set to reduce over the coming years, growth in the aquaculture sector has now been targeted at European and national policy levels.

It is in this context that the Irish Government published the first National Strategic Plan (NSP) for the Sustainable Development of Aquaculture in December 2015. The plan aims to increase volume production across the Irish aquaculture sector by 45,000 tonnes by 2023. At the same time, the NSP is committed to achieving this growth sustainably. In line with a broader vision of the green economy,[23] economic

[23] A green economy is one which is low-carbon, resource-efficient and inclusive. The United Nations Environment Programme defines it as resulting in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). The green-growth concept has been further developed recently by the OECD. They outline it as fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies (OECD, 2014:5).

growth is envisaged as being compatible with the integrity of ecosystems and the advance of local socio-economic development. This broad promise of sustainable development is a familiar one. The question is: how can these different and demanding goals be brought together and realised in practice?

Drawing on national and EU marine and aquaculture policy, scientific reports, articles, archives, and extensive interviews with representatives from fish farming, processing, environmental Non-governmental Organisations (NGO), and local and national agencies, this report focuses on how environmental sustainability and socio-economic development are currently being framed and experienced in the aquaculture sector.

Box 1.1: What is Aquaculture?

Aquaculture is the cultivation of any aquatic organism such as fish, crustaceans, molluscs and aquatic plants. The intervention of human techniques and technologies of husbandry and manipulation in the production process are assumed to be what distinguishes it from wild or capture fishing: "It [aquaculture] may be differentiated from fishing because, as in agriculture, some measure of care or cultivation is involved" (Beveridge & Little, 2002: 4). Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.

This distinction between farming and fishing is not always clear-cut, however. Around the world, small-scale inshore fisheries employ management tools that care for and cultivate wild fish and shellfish stocks - as in the case of restocking lobster fisheries or cultivating wild oyster beds. At the same time, more extensive (rather than intensive) fish farming does not focus on the production and harvesting of a single commercial 'crop'—in parts of the southern Mediterranean, for example, extensive forms of aquaculture take place in marsh lands, estuaries, deltas and reclaimed salt ponds and would historically have served to augment food production for a family or community (Bellona, 2013) (Figure 1.1). Similarly, in parts of South-East Asia, integrated aquaculture for rice-fish farming is probably one of the oldest existing forms of aquaculture, demonstrating a kind of co-evolution of agriculture and aquaculture (FAO, 2009).

The significance of this blurred distinction between farming and fishing is that both involve human interaction with, and impact on, the marine environment. Neither is more or less inherently sustainable or 'natural' than the other; both require sustainable models of management to ensure that marine environments are not over-exploited.

A second aspect of aquaculture that is seen to distinguish it from capture fishing (and make it more akin to agriculture) is the concept of ownership or the extension of access and exploitation rights. According to the UN Food and Agricultural Organization (FAO), fish farming

> **… implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of capture fisheries.**[24]

The suggestion is that aquaculture and ownership are intrinsic. However, this assumption is not entirely accurate either. On one hand, the extension of exclusive rights of ownership over wild fish stocks (in the form of individual transferable quotas) has meant that ownership of aquatic organisms is not limited to fish farming. On the other hand, there are historic and existing examples of aquaculture production that are "based on multipurpose water bodies in which the organisms themselves are 'common property', i.e. 'owned' neither by an individual nor by some corporate body or the state" (Beveridge & Little, 2002: 4). Unsettling the assumptions that underlie particular, dominant models of aquaculture is important for recalling that aquaculture can and has been organised in different ways.

Figure 1.1: Aerial View of Marshes and Fish Farms in Old Saltponds (*esteros*) in the Bay of Cádiz, Spain

This is a form of extensive aquaculture where multiple species of fish and shellfish are cultivated for harvesting (SEACASE Project, 2010: 11).

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[24] Coordinating Working Party *Handbook of Fishery Statistical Standards*: http://www.fao.org/fishery/cwp/handbook/j/en

1.2 Approach

In analysing the dynamics of sustainable development in any sector, it is necessary to take account of the complex, sometimes conflicting interests and perspectives that invariably exist. This requires careful consideration of the different actors involved, the contexts in which they operate, and the ways in which they interact. In the context of this project, this has involved examination of the environmental, social and economic factors that have shaped and will continue to shape the development of aquaculture in Ireland. Understanding how these different factors are being coordinated and managed has required an examination of the different national and European policy frameworks, agencies and regulatory systems that together make up the emerging area of marine governance.

As well as looking at policy aspirations and commitments, there is a need to pay closer attention to what is happening on the ground. The call for this report identified the importance of looking at how sustainable development is *experienced* by those involved—in this case, fish farmers, seafood processors, local communities and residents, as well as the marine scientists and managers who have long involvement with the sector. A priority of this study was to gain insights into the opinions and perspectives of the people who are most closely engaged with the challenges and opportunities of aquaculture in Ireland.

This report is based on over thirty extended interviews with fish farmers, representatives of seafood processing companies, marine scientists, representatives of Irish environmental NGOs and local campaign groups, the Marine Institute, Bord Iascaigh Mhara (BIM) regional officers and Dublin-based staff, the Sea Fisheries Protection Authority (SFPA), Inland Fisheries Ireland (IFI), and the Department of Agriculture, Food and the Marine (DAFM), including a representative from the Aquaculture and Foreshore Management Division. These interviews took place in Dublin, Cork, Mayo and Donegal between August and October 2015.

Most of these fish farmers, along with many of the individuals involved in processing, environmental NGOs and relevant state agencies, have been involved in the aquaculture sector since the 1980s and 1990s. Considering how quickly the sector has developed (in Ireland and globally), this amounts to a significant body of experience and knowledge that should be foregrounded in any debate on the future of the sector.

All the individuals interviewed were keen to give their views on the development of the sector. This was particularly the case with the fish farmers themselves—those who produce the mussels, oysters and salmon that are the basis of the aquaculture industry. Everyone was supportive of this report in so far as it might give a more ‘objective’ picture of aquaculture in Ireland. This refers to historic differences and conflicts that have at times characterised the development of the industry. The report thus aims to be as impartial as possible; in bringing different perspectives to light it seeks to be as accurate and non-judgemental as possible. The intention is to highlight (rather than obscure) the complexities and tensions that exist within the aquaculture sector.

This report does not seek to offer any concrete recommendations. Rather, it identifies the key challenges in the aquaculture sector, some of the ways these have been addressed, and some limits and possibilities that could be explored further. The report will hopefully provide some perspective on a significant and emerging area of environmental governance and coastal development.

1.3 Outline & Summary of Report

The structure and emphasis of this report have been shaped by the material gathered through the interviews. They reflect the recurring questions, frustrations and hopes relayed to me by the diverse respondents I met and spoke with. Common themes arose throughout the course of my research. These included problems relating to the licensing process, concerns over the environmental impacts of aquaculture, and the challenges of competing in a global seafood market.

For some of the respondents, particularly those involved in the industry, there was a sense of frustration that Ireland's aquaculture sector had gone backwards, while in other parts of Europe (particularly Scotland and Norway) it had moved on—thanks in part to perceived efficiencies in aquaculture licensing, private investment and state support. While this is true, aquaculture in Ireland has gone through significant changes over the past twenty years. In terms of innovations in production, salmon farming today is almost unrecognisable from what it was in the early 1980s. While techniques for cultivating oysters and mussels have not changed as much, the integration of shellfish aquaculture (particularly Pacific oysters) into transnational supply and commodity chains has led to new economic and environmental relationships being developed between sites in Ireland and hatcheries and markets abroad. Accompanying these changes in production and marketing have been new environmental and food-safety regulations and standards, covering everything from impacts on habitats to fish health.

The focus of this report is on local experiences of aquaculture development. But it is important to recognise that now, more than ever, the local is shaped by global market dynamics and regulatory frameworks. These factors are not always foregrounded in discussions of the aquaculture sector in Ireland. It is beyond the remit of this report to give an account of the global seafood industry or the evolution of transnational regulatory frameworks, but in the course of the report I seek to identify the different (and uneven) ways these forces are interacting with and shaping realities on the ground. Paying attention to these relationships might bring to the surface a number of different paths for aquaculture development and a number of possibilities for the sector and its role in local employment and environmental management.

There are four main chapters in the report. The first provides a general overview of the aquaculture sector and the relevant national and European policy frameworks. The subsequent three chapters focus in more detail on the key challenges that have shaped and will continue to shape the development of aquaculture in Ireland.

Chapter three examines the environmental risks and problems that affect aquaculture production and the ways these have been addressed by industry and the State. Chapter four examines conflicts over aquaculture developments and the way decisions are made about the allocation and use of the foreshore more generally. Chapter five examines the challenges and limitations of market-led development for a sustainable aquaculture industry, and the possibilities for more diverse economic models.

1.3.1 Environmental Risk and Resilience

Aquaculture is both a relatively new activity and one that is fraught with risk and uncertainty—from the point of production (weather, sea lice, disease) to the point of consumption (biotoxins, contamination). These environmental risks have worked against the expansion of aquaculture in Ireland, limiting volume production and reducing certainty of supply to buyers and retailers who increasingly demand consistency of product. Efforts to mitigate these risks, and address the problems associated with them, have focussed on technical improvements in fish farming practices and more rigorous monitoring and regulation. These measures have largely sought to control the environment in which aquaculture takes place and the production and supply chains that aquaculture products pass through. This approach has not always proven effective due to economic factors shaping the decision-making of producers and processors, as well as the unpredictability of the marine environment. Furthermore, measures that focus on increased monitoring, regulation or costly improvements can unfairly affect smaller operators. Other approaches to sustainable food production emphasise the importance of fostering resilience in the expectation of uncertain environmental outcomes and futures. This perspective requires that local capacities and skill be encouraged and supported.

1.3.2 Contestation and Decision-Making

The question of how publicly owned marine resources and territories are going to be used and by whom is always going to be a contested area of decision-making. As aquaculture is set to expand, the need to develop effective, participatory processes through which different, often competing perspectives and values can be articulated and negotiated appears crucial. There are efforts currently underway to develop a general strategy for marine spatial planning at a national and European level—to coordinate and manage competing uses of the marine territory and resources. The focus of this chapter is on two disputes over aquaculture developments and the dominant ways these have been represented by those involved. These disputes revolve around the allocation of marine space and resources, and the perceived social and environmental impact of fish farms in local areas. There is a tendency in policy-making to emphasise the role of scientific expertise and information for deciding such disputes. This can obscure the different *values* that groups and individuals have regarding the environment and place they live and work in. Finally, the history of conflict and opposition surrounding aquaculture development in Ireland (and elsewhere) has contributed to a polarisation of positions on aquaculture development. The representation of individuals or groups as either being ‘for’ or ‘against’ can close down the space for constructive dialogue about what *kind* of aquaculture would be desirable and how it might be brought about.

1.3.3 Diverse Economies for Development

The aquaculture industry in Ireland has historically depended on large, continental buyers who control access to European retail markets. This has meant that the value of Irish farmed seafood has tended to be captured further down the commodity chain. A growing and valuable feature of Irish aquaculture (and agriculture) has been its ability to promote a 'green' image. A clear strategy of the Government's aquaculture development policy is to translate this 'green' image into added-value within the global seafood market—through Quality and Organic labelling schemes. These schemes promise to pass value on to the primary producers, but the continued reliance on global seafood markets ensures that large intermediaries continue to dominate. While such market-led strategies are largely imposed on Ireland because of the small, internal market and the growing international demand for seafood, there are social and environmental limitations to this model of development and, more positively, other economic models that can and do exist alongside it. The long-term sustainability of aquaculture in Ireland will involve the valuing and fostering of more diverse, local economies that perform vital social and ecological functions.

Chapter 2
Overview and Policy Context

2.1 Introduction

Aquaculture production across Europe has stagnated in comparison to the rest of the world. This is due to a lack of coordination in marine spatial planning, administrative delays in licensing and a lack of competitiveness (European Commission, 2013). In many ways, Ireland's aquaculture sector crystallises these problems—reflected in the decline in volume production over the last ten years. The *National Strategic Plan for Sustainable Aquaculture Development* (NSP) outlines a broad set of recommendations to overcome the obstacles to increased production and growth in the aquaculture sector.

The NSP fits within the Government's ambitious plans for growth in both the marine and seafood sectors. In terms of the marine sector, aquaculture is identified as one aspect of Ireland's burgeoning 'blue economy', as outlined in the *Harnessing Our Ocean Wealth* strategy (DAFM, 2012). In terms of the seafood sector, the *Food Harvest 2020* and *Food Wise 2025* strategies call for aquaculture production to expand, while at the same time building on the Irish food industry's 'green' image abroad. This relates to environmentally orientated accreditation schemes such as the Organic standard. These market-led accreditation schemes are intended to incentivise improvements in the environmental performance of aquaculture producers and processors.

In terms of environmental considerations, the Government's plans to develop aquaculture (and the marine) will have to comply with European environmental directives, particularly the cross-cutting Marine Strategy Framework Directive (MSFD). This recent and significant piece of environmental legislation (2014) requires member states to achieve and maintain Good Environmental Status (GES) of marine coastal waters by 2020. The MSFD is based on an ecosystems-based approach, which recognises the inter-connectedness of marine processes and economic activity.

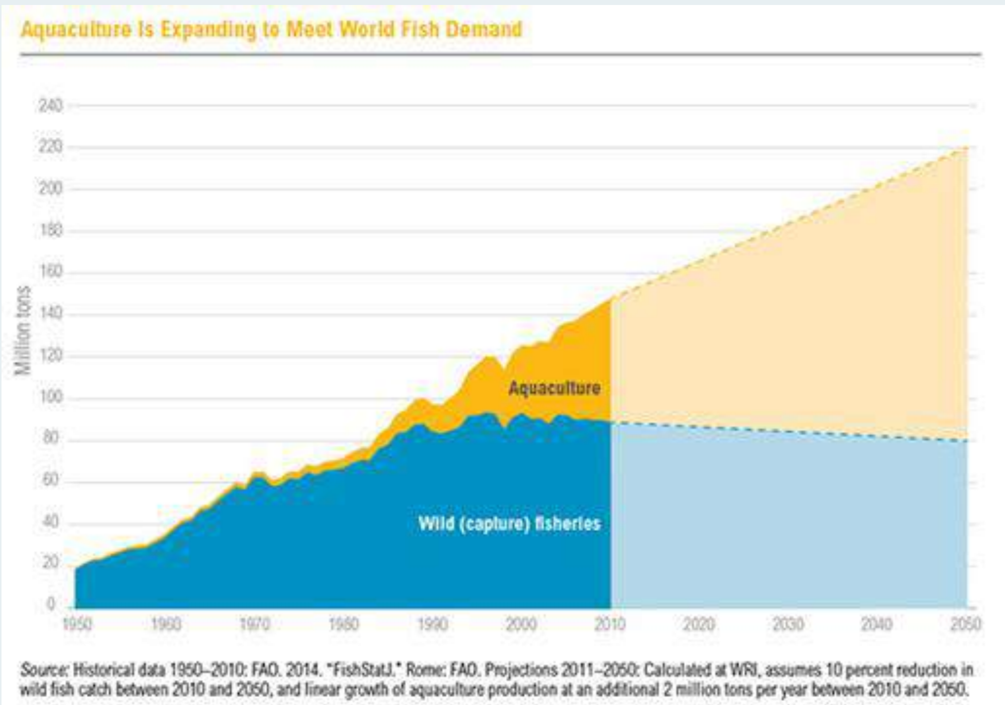
2.2 Aquaculture in Context

2.2.1 Globally

While the history of aquatic farming dates back thousands of years, its modern, commercial incarnation is relatively recent. In a little over forty years, aquaculture has moved from being a marginal sector in seafood production to claiming nearly half of all seafood produced worldwide (for human and non-human consumption). Between 1970 and 2008 aquaculture production grew at an annual average rate of 8.4 per cent, and remains among the fastest-growing food production sectors in the world. According to the FAO, aquaculture production should reach about 85 million tonnes in 2022 and will represent 47 per cent of global fishery production and 55 per cent of total fish destined for human consumption (FAO, 2014).

In a context of continued overfishing of many commercial fish stocks and obstacles to land-based food production (water shortages, soil degradation, competition for land), aquaculture has been identified as one of the best ways to meet the challenges of global food security into the 21st century. The scale of this challenge is vast. The World Bank has projected that, even if global aquaculture production doubles by 2030 (from a baseline in 2010), the resulting 211 million tonnes of global fish supply will not satisfy the 261 million tonnes of expected future fish demand. To have enough fish to satisfy future demand, world aquaculture production would need to treble during the 2010–2030 period (Figure 2.1).

Figure 2.1: World Expansion in Aquaculture



Source: (Waite *et al.*, 2014)

Framing food security in these economic terms thus places considerable pressure and promise on the aquaculture industry (OECD, 2012). The much-hoped-for expansion in aquaculture production has been described as the 'blue revolution', a reference to the green revolution of the 20th century that saw agricultural production soar to unprecedented levels. While this comparison promises much in terms of output and growth, it also highlights the need to pay greater attention to the social and environmental effects of any such developments. With global demand for aquatic food products continuing apace, there are justified concerns about whether and how further growth can be met in a way that does not degrade marine ecosystems or generate risks to human health, and that ensures equitable and inclusive forms of economic development (Hall *et al.*, 2011).

Together, China and the rest of Asia supply 91 per cent of global aquaculture production (61.5% and 29.5% respectively). Production in China and the rest of Asia is predominantly intensive, freshwater farming of carp, tilapia, pangasius and prawns (Figure 2.2). These species make the greatest contribution to the supply of affordable protein food for direct consumption, particularly in developing countries in Asia, Africa and Latin America. This sector of aquaculture production is also expected to be responsible for fulfilling the long-term food and nutrition needs of the growing global population in the coming decade. According to the World Bank's report *Fish to 2030,* the production of tilapia is projected to more than double between 2008 and 2030.

However, in addressing the challenge of sustainable aquaculture it is important to look beneath the stark figures of global output and demand to examine and compare the different models of aquaculture production and consumption. What species are being farmed (shellfish, finfish, seaweed)? Where are they being farmed (seawater, freshwater)? Why are they being farmed (export, local consumption)? How are they being farmed (what inputs and outputs)? How is this activity regulated (what standards, what regulatory bodies)? All of these questions provide very different answers; different forms of aquaculture can have harmful or beneficial effects on the environment, from pollution to carbon sequestration, from the spread of disease to improved biodiversity (Hishamunda *et al.*, 2014). In other words, it is important not to paint aquaculture with a broad brush; aquaculture is massively varied across geographies, species and systems of production (*ibid.*).

Figure 2.2: Intensive Shrimp Farming in Belize

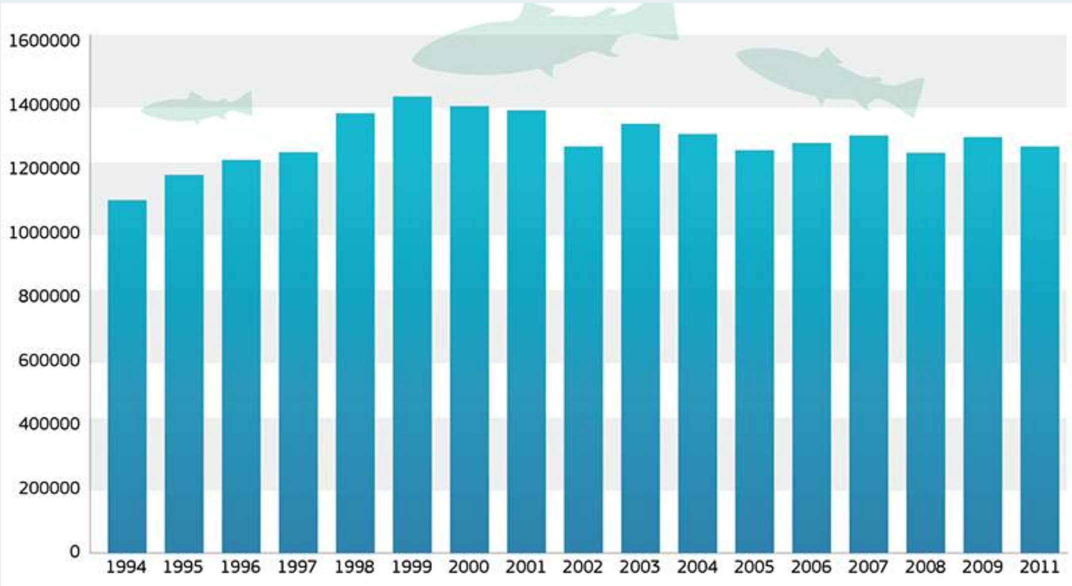
Source: http://www.fishfarming.com/shrimp.html

2.2.2 Europe

The volume of aquaculture production in Europe is relatively very low: the EU only produces 2.2 per cent of global farmed seafood (European Commission, 2013). More significantly, aquaculture has not grown consistently in Europe as it has in other parts of the world (Figure 2.3). The annual average growth rate in aquaculture between 2003 and 2005 in North America and Europe was slow (1.4–1.6%); it was rapid in China, Asia and South America (6, 11.2, 7.8% respectively) and explosive in Africa (16.2%), albeit from a very low baseline. This is explained by several factors: an historic emphasis on capture fisheries (in terms of investment, research and marketing); strong environmental and food safety regulations, and the lack of an effective licensing system, and marine planning more generally, to secure higher levels of private investment.

While aquaculture production offers significant economic potential for meeting the growing global demand for seafood, Europe needs to plug the gap in its own demand for seafood. There is an estimated gap of 8 million tonnes between the level of consumption of seafood in the EU and the volume supplied by aquaculture and capture fisheries (COM, 2013). The EU seafood market is currently supplied for 25 per cent from EU fisheries, 65 per cent from imports and 10 per cent from EU aquaculture.

Figure 2.3: Evolution of EU Aquaculture Production Volume (1994–2011)



Source: http://ec.europa.eu/fisheries/cfp/aquaculture/facts/index_en.htm

The new European Common Fisheries Policy (CFP) came into effect on 1 January 2014. The reforms place the conservation of fish stocks at the heart of European and national fisheries management, reflecting a global trend towards diminished or stable yields from the capture fisheries in the future. This is demonstrated by the goal of achieving maximum sustainable yield (MSY) in all fisheries by 2020, and the unprecedented decision to ban discarding by 2019. As part of this strategy to limit the exploitation of fish stocks, the CFP also places new emphasis on aquaculture as a source of seafood for European consumers and as a source of employment in coastal areas—particularly those areas that have historically depended on the fisheries. In this context, growing the aquaculture sector has emerged as an important strategic priority in terms of providing food security, employment and growth in line with the Europe 2020 objectives of smart, sustainable and inclusive growth.

Article 34 of the new CFP requires member states to prepare multi-annual national strategic plans for aquaculture. The national plans are intended to inform investment priorities for aquaculture under member states' seafood operational programmes under the European Maritime and Fisheries Fund (EMFF)[25] (European Commission, 2011b, European Union, 2014). Article 34 is a reflection of the limited success that EU member states have had regarding aquaculture development, and the overall stagnation of the sector since the turn of the century.

Member states' national aquaculture plans are to be drawn up with regard to the European Commission's non-binding Strategic Guidelines for the Sustainable Development of EU Aquaculture (European Commission, 2013). Four priority areas are identified in these guidelines:

a) Administrative delays

This priority aim complements the Commission's proposed action plan to support entrepreneurship in Europe. The action plan invites member states to reduce time for licensing and other authorisations necessary to start a business activity to one month by the end of 2015, provided that requirements of EU environmental legislation are met.

b) Spatial planning

The development of spatial plans (now legislated for through the Marine Spatial Planning Directive, 2014) is identified as necessary for reducing uncertainty, facilitating investment and speeding up the development of sectors such as aquaculture and offshore renewable energy.

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[25] The EMFF is the new funding instrument for the EU's maritime and fisheries policies for the period 2014–2020. In line with the ambitious reform of the CPF, the fund is intended to help fishermen in the transition to sustainable fishing, and support coastal communities in diversifying their economies. There are six main Union priorities of the EMFF: Priority 1: Sustainable Development of Fisheries; Priority 2: Sustainable Development of Aquaculture; Priority 3: Implementing the CFP (Control & Enforcement and Data Collection); Priority 4: Sustainable Development of Fisheries & Aquaculture Areas; Priority 5: Marketing & Processing, and Priority 6: Implementation of the IMP.

c) Competitiveness

The Commission identifies aquaculture producer organisations and improved market organisations as important steps towards a more competitive aquaculture industry. These are a priority for the reform of the Common Market Organisation (CMO) and for the new EMFF (European Union, 2013).

d) Level playing field

The Commission identifies that high environmental, animal health and consumer protection standards are among EU aquaculture's main competitive factors and should be more effectively exploited so as to compete on the markets. If the level of sustainability of EU aquaculture products is correctly addressed and communicated to the public, this can improve the competitiveness and societal acceptance of EU aquaculture and its products.

2.2.1 Ireland

The challenges facing the (non)development of aquaculture in Europe are amplified in the case of Ireland. From its experimental beginnings in the late 1970s and 1980s, aquaculture has not fulfilled the economic promise that many in the industry and state agencies such as Bord Iascaigh Mhara (BIM) may have hoped for.

Aquaculture takes place mainly in coastal areas (the focus of this report) but also inland in freshwater and land-based recirculation systems. The main areas where aquaculture takes place are the North-West (Donegal), the West (Galway and Mayo), the South-West (Cork and Kerry), and the South-East (Waterford and Wexford). One of the key benefits of aquaculture for these areas is that it provides a vital source of employment and economic activity on a year-round basis.

Aquaculture in Ireland is generally divided into shellfish and finfish, although a burgeoning seaweed farming sector has good potential for growth. The two main species of shellfish are mussels and oysters, with the main finfish being salmon. In trying to understand the difference between these species (their environmental impact, role in local development, economic value), it is important to understand how they are cultivated and how this activity has changed in response to developments in science and technology, environmental and food safety regulation, and global seafood markets. These questions will be addressed in more detail in subsequent chapters.

In 2014 (the most recent year for which there are figures), the total value of finfish was €64m (€57m attributable to salmon), and of shellfish €52m. The total volume of aquaculture production for 2014 was 32,000 tonnes (10,700 of finfish, 20,800 of shellfish). In 2005, the total volume from the sector was 63,000 tonnes (12,700 tonnes of finfish, 44,700 of shellfish). That is nearly a halving of volume production in the space of nine years (Table 2.1). In terms of value, however, there has been an increase: €109m in 2005, rising to €116m in 2014.

Table 2.1: Total Aquaculture Output by Volume and Value, 2005–2014[26]

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Volume (tonnes)	63,000	57,000	53,000	45,000	48,000	47,000	45,000	36,000	35,000	32,000
Value (millions)	109	123	118	94	107	123	128	131	117	116

The above figures make two things clear. First, there has been a dramatic decline in the volume of seafood produced in Ireland through aquaculture. This is further clarified when Ireland's rate of production is compared to Scotland or Norway: the entire volume of farmed salmon produced in Ireland in a year (12,000 tonnes) is covered by three days of production in Norway. This comparatively poor performance in terms of volume is particularly surprising considering Ireland's coastline of 7,500km is known to be longer than that of many European countries.

Second, the value per tonne of farmed seafood is going up, and is set to continue rising, as demand in Europe and Asia continues. Added to this potential is the positioning of Ireland as a 'green', quality seafood producer. In the broader context of *Food Harvest 2020* and *Food Wise 2025*, increasing attention is being focused on the aquaculture sector in order to deepen and extend this strategy (DAFM, 2013b, 2015a).

2.3 National Strategic Plan for Aquaculture

In 2015, the Department of Agriculture, Food and the Marine (DAFM) published the first National Strategic Plan for Sustainable Aquaculture Development (NSP) (DAFM, 2015c). The plan aims to increase production across the sector by 45,000 tonnes, starting from a baseline figure of 36,700 tonnes (2012). This represents a 120 per cent increase in volume production by 2023, resulting in an estimated volume output of 81,700 tonnes by the end of 2023. This projection is aligned with the funding proposals outlined in the Seafood Development Programme 2014–2020 (EMFF Operational Programme) (DAFM, 2015d). Significantly, the projected increase in volume production is arrived at by adding together the highest production figures achieved in each of the key aquaculture species over the past

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26 Figures provided by BIM, personal communication.

twenty years. Thus, while new licences will be issued in order to develop the industry, the intention is to increase and maintain productivity on *existing* licensed sites. This requires identifying the main obstacles that have weakened the capacity of fish farmers to maintain steady supplies of farmed seafood in recent years. The NSP outlines five areas that need to be prioritised if these obstacles are to be overcome and aquaculture is to become an important part of Ireland's 'blue economy'.

First, to boost volume production, the industry needs to build capacity and scale—the industry is largely made up of SMEs employing fewer than five employees. This is particularly the case in the shellfish sector. The NSP recommends providing greater support for new entrants (presumably those with the resources to invest in building capacity); support for organic certification, and aid to shellfish producers affected by biotoxin closures (see Chapter 1).

Second, the NSP identifies the need to foster knowledge, innovation and technology transfer between industry, scientific and development bodies. This includes providing expert advice to improve environmental and business performance, as well as supporting best husbandry and disease management practice. This latter point is key as aquaculture producers continue to be affected by biotoxins, disease, parasites and unexpected changes in the marine environment (jellyfish, weather). The NSP also supports the development of commercial-scale growing systems for novel species. This could be important from an environmental point of view as the cultivation of native species (native oysters, varieties of seaweed) can foster more resilient forms of aquaculture production.

Third, the NSP recognises that the aquaculture industry must operate sustainably. It suggests the development of an industry code and 'Guiding Principles for the Sustainable Development of Aquaculture'. It also identifies the need for scale limits in the development of offshore salmon farms. This has proven important in the context of an outstanding application for an offshore salmon farm submitted by BIM on behalf of the DAFM (see Chapter 4).[27] As well as ensuring that aquaculture monitoring is consistent with the requirements of the MSFD, the NSP also suggests a programme to assess the environmental contribution of aquaculture. This could be potentially important in terms of expanding and diversifying the value of aquaculture activity (see Chapter 5).

Fourth, the NSP situates itself alongside a broader inter-departmental effort to shape a Marine Spatial Planning strategy for the country. In this light, the NSP calls for more coordinated spatial planning, including possible synergies with offshore renewables. Extending an ecosystems approach to marine planning, it also identifies the need to map aquaculture activities in order to take specific account of environmental issues, Natura 2000 sites and inshore fisheries. The NSP also

27 Since this report was completed, the licence submitted by BIM for the salmon farm in Galway Bay has been withdrawn. The reason given by BIM was that the scale of the proposed farm was not in keeping with the limits proposed by the draft NSP.

proposes to invest in research into Integrated Multi-Trophic Aquaculture (IMTA) and possible synergies with offshore wind farms or other marine renewable energy (see Chapter 5). Once again, these recommendations open up interesting possibilities for cross-sectoral cooperation that could potentially tie together local development and environmental sustainability.

A fifth and final theme discussed in the NSP is the need to review the licensing process and remove the current backlog in the licensing system (see Chapter 4). Specific recommendations include the phased introduction of appropriate timescales for licence determination; the development of a data management and information system with online aquaculture licence application and tracking functionality, and spatial mapping of aquaculture sites and exclusion areas.

The NSP was put out to public consultation in June 2015 and the final plan was published in December 2015. To get a better sense of the impetus and direction behind the NSP, it is instructive to look at three overarching national policy strategies: the first relating to the ‘blue economy’, represented by the *Harnessing Our Ocean Wealth* strategy; the second to the ‘green’ seafood industry, represented by the *Seafood Development Programme, Food Harvest 2020* and *Food Wise 2025,* and the third to environmental sustainability, represented by the European MSFD.

2.3.1 Blue Economy: Harnessing Our Ocean Wealth

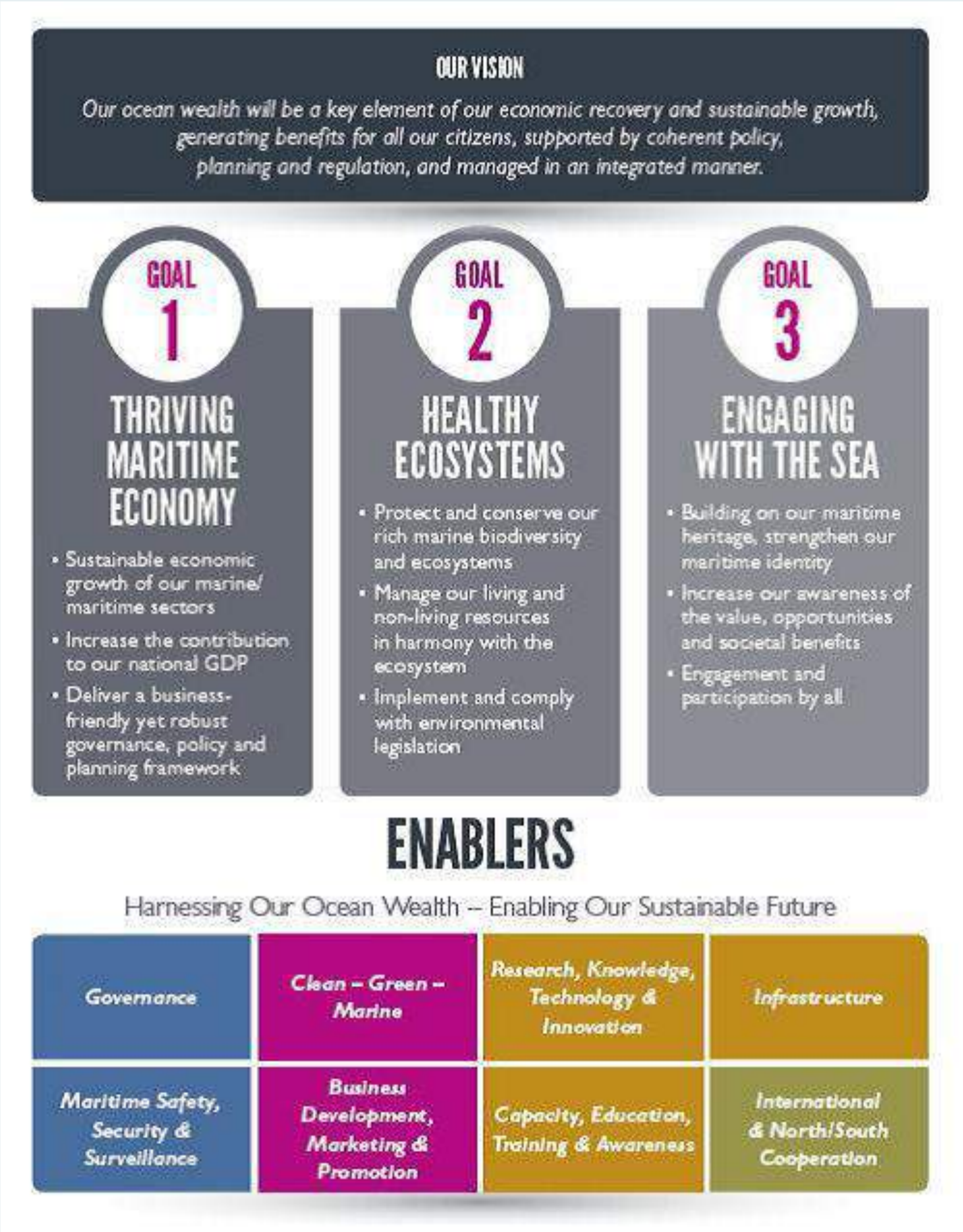
Blue Growth is a long-term European strategy to open up new commercial development and sustainable growth in the marine and maritime sectors as a whole (European Commission, 2012b). It is the maritime contribution to achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth (European Commission, 2011a, EEA, 2013). The blue economy currently represents roughly 5.4 million jobs and generates a gross added value of almost €500bn a year across the European Union. Five sectors are identified within the Blue Economy as having high potential for growth: aquaculture, coastal tourism, marine biotechnology, ocean energy and seabed mining.

In Ireland, responsibility for marine matters is spread across a number of government departments and agencies. In recognition of the need for better coordination, the broad scope of the sector and the underuse of our marine resources, the Government, through the Marine Co-ordination Group (MCG), which includes senior representatives from the departments with marine responsibilities, developed *Harnessing Our Ocean Wealth—An Integrated Marine Plan for Ireland* (IMP) (DAFM, 2012) (Figure 2.4). The IMP provides a new momentum for growth in the marine area and seeks to ensure that government departments work together more efficiently and effectively on the diverse issues related to the marine.

The strategy sets out to foster and sustain:

- A thriving maritime economy.
- Healthy ecosystems.
- Engagement with the sea.

Figure 2.4: *Harnessing Our Ocean Wealth*—Vision, Goals and Enablers



Source: (DAFM, 2012

The vision and goals outlined in Ireland's IMP respond to and reflect policy changes at a European level, particularly in regard to the *Blue Growth* strategy (Marine Institute & NUI Galway, 2015). Introducing Ireland's IMP in 2012, Minister Simon Coveney said: 'Our ocean is a national asset, supporting a diverse marine economy, with vast potential to tap into a €1.2 billion global marine market for seafood, tourism, oil and gas, marine renewable energy, and new applications for health, medicine and technology' (DAFM, 2012).

In 2007, Ireland generated 1.2 per cent of GDP (€2.4bn direct and indirect gross value added) from its ocean economy, supporting about 1 per cent of the total workforce. The *Harnessing Our Ocean Wealth* (HOOW) strategy sets the ambitious target of increasing turnover from the ocean economy to more than €6.4bn by 2020, and doubling its contribution to GDP by 2030. To achieve this, the Government has committed to put in place a range of actions across all relevant policy areas related to the seas, including transport, environment, offshore renewable energy, enterprise, employment, research, seafood and external relations (Vega *et al.*, 2012).

2.3.2 Ireland's 'Green' Seafood Industry

In 2013, Minister Simon Coveney announced plans for Ireland's €241m Seafood Development Programme (SDP) for the period up to 2020 (DAFM, 2013a). The new programme will be co-funded by the EU through the EMFF and is subject to adoption by the European Commission (see F.N. 3). The proposed EMFF/SDP investment package of €241m will represent by far the largest-ever government investment in the seafood sector. It represents a doubling of funds available compared to the previous period, 2007–2014. In announcing the new programme, the minister said: 'The investment package … will provide the capital to assist seafood enterprises to sustainably grow their production, add value to our seafood exports and create much-needed employment in our coastal communities.'

Increased financial support for the seafood industry reflects estimates from BIM that total seafood value to the Irish economy will be €1.25bn per annum and that it will employ an extra 1,250 full-time equivalent jobs by 2025. It is hoped that a final document agreed with the EU Commission will be in place by the end of 2015, to allow full implementation to begin in 2016.

Of the €241m allocated to the seafood sector under the EMFF/SDP, €31m has been allocated to Aquaculture Support and Development. This is a substantial increase on the previous programme (€2m was allocated to aquaculture in the period 2007–2014), but less than in previous programmes.[28]

[28] The Operational Programme for Fisheries 1994–1999 allocated £36.04m from the national exchequer, with a further £11.04m from the EU.

The proposed measures specific to aquaculture included in the SDP include: improving scientific and technical knowledge; business, planning and environmental advisory services; training and networking; capital investment in sites to grow production; new farmers scheme; support for organic aquaculture production, and stock insurance and aid for harvesting suspensions. There are also other areas within the SDP that have significance for the aquaculture sector: €9.4m has been allocated for the implementation of EU Directives for Fisheries and Aquaculture; €41.3m for Seafood Processing and Marketing; and €12m for Fisheries Local Action Groups (FLAGs). The funding for the FLAGs will be allocated across the FLAG regions[29] to support projects that enhance the economic and social prosperity of the local area, add value to fisheries products, and maintain and support job creation through support for diversification, particularly in areas suffering from reduced fishing opportunities.

The SDP fits within the Government's national strategy for the development of the food industry, outlined in the *Food Harvest 2020* (2010) and *Food Wise 2025* (2015) policy documents. The strategy seeks to further orientate food production and processing towards existing and emerging markets, harnessing Ireland's image as a 'green' food producer to add value and enhance competitiveness.

Food Harvest 2020 and *Food Wise 2025* both emphasise the need for aquaculture production to increase. To this end *Food Harvest 2020* calls on relevant departments and state agencies to resolve 'perceived current difficulties related to environmental protection, to facilitate a timely processing of licence applications consistent with EU conservation directives. This will underpin existing investments and underpin additional investment'. *Food Harvest 2020* also recommends that 'the Marine Institute in conjunction with BIM should work with industry to research and develop inshore and offshore aquaculture and alternative species on a commercial and profitable scale' (DAFF, 2010). In response to this recommendation, BIM had been leading a project to develop the largest salmon farm in Ireland, in Galway Bay (see F.N. 5). It was hoped that the Galway Bay farm would be capable of producing 15,000 tonnes of Irish organic salmon annually, valued at €102m (BIM).

However, *Food Harvest 2020* and *Food Wise 2025* also insist that industry growth should not jeopardise Ireland's current 'green' reputation by building on the existing sustainable and environmentally friendly primary production sector. Ireland's green reputation is presented as a key competitive advantage: 'Ireland can become synonymous with the production of environmentally sustainable and welfare friendly products' (DAFF, 2010: iii).

In the seafood sector, this will involve differentiating Irish seafood through implementing quality and traceability labelling, including voluntary labelling and certification. This requires adapting and enhancing existing independent third-party

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[29] Six FLAGs were established in 2013 by the minister. These are cross-county, regional groups with a specific focus on developing traditional fishing areas and the local marine-focused economies of those areas (FLAG, 2014).

verified standards and quality assurance measures such as BIM's Quality Assurance Programmes, Marine Stewardship Council (MSC), Aquaculture Stewardship Council (ASC), organic certification and green manufacturing to facilitate measurement of its environmental credentials (DAFM, 2015c). While quality assurance schemes currently exist in the sector, the development of Origin Green, the national quality assurance scheme, will be the likely benchmark for Irish seafood products hoping to access new markets.

2.3.3 An Ecosystems Approach: the Marine Strategy Framework Directive

As the range and intensity of human activities in Irish marine waters increase, so too will the associated pressures on this marine environment. At the same time, the value of marine ecosystem processes for ensuring the health of the planetary ecosystem, through its role in maintaining food webs, biodiversity and climate regulation, is only now beginning to be identified and assessed. The Government's strategy for aquaculture (and marine-based) growth thus operates within a context of environmental limits and the wider value of vital ecosystems services. The main policy-form these environmental considerations take is through European environmental directives, particularly the recently transposed MSFD.

The MSFD requires each member state to put in place measures to achieve GES of their marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend (2008/56/EC). The Directive defines GES as 'ecologically diverse and dynamic oceans and seas which are clean, healthy and productive' where '... the structure, functions and processes of the constituent marine ecosystems … allow those ecosystems to function fully'; 'human-induced decline of biodiversity is prevented' and '[a]nthropogenic inputs ... into the marine environment do not cause pollution effects'. Member states are required to prepare marine strategies for their marine waters (European Commission, 2014b). A national Marine Strategy requires:

- Initial assessment of current environmental status of marine waters.
- Determination of a set of characteristics that describe what GES means for those waters.
- A comprehensive set of environmental targets and associated indicators.
- A coordinated monitoring programme for ongoing assessment of marine waters.
- A programme of cost-effective measures designed to achieve or maintain GES.

The Directive enshrines in a legislative framework the ecosystem approach to the management of human activities that have an impact on the marine environment, integrating the concepts of environmental protection and sustainable use. In terms of aquaculture, this includes various influences on biodiversity and ecosystem functioning, and services such as interactions with wild fisheries resources, physical damage to or replacement of habitat, organic and nutrient enrichment, a vector for invasive species and interactions with seals and birds. In covering these multiple ecosystem interactions, the MSFD cuts across and integrates other instruments such as the Water Framework Directive, the CFP, the Birds and Habitats Directive and the Regulation concerning use of alien and locally absent species in aquaculture in the marine field (SEC 2011/540).

The introduction of the MSFD marks explicit recognition by the EU that the prevailing fragmented approach to marine management is no longer feasible given the context of increasing pressures on European marine ecosystems[30] (Brady *et al.*, 2013). As an EU member state, Ireland's maritime policies—including the possible creation of a marine spatial planning framework—have been developed in the context of European policies. This also reflects the fact that the seas around Ireland are shared with other member states, and that marine ecosystems are not confined to national marine waters.

As with other European directives, the MSFD does not prescribe how the goal of GES in marine waters is to be achieved by member states (European Union, 2010). It supports an adaptive management approach, involving public participation, which recognises the need for continuous assessment of the marine environment. There is an understanding that scientific knowledge will continue to advance and that initial measures taken to achieve GES will have to adapt accordingly (2010/477/EU).

Ireland transposed the MSFD in the European Communities (Marine Strategy Framework) Regulations 2011 (S.I. 249/2011). The Regulations specify that the Department of Environment, Community and Local Government (DECLG) is the competent authority for the implementation of the Directive. The DECLG has also carried out an initial assessment of the marine environment (with public consultation) and put in place a monitoring programme and programme of measures (DECLG, 2013).[31]

30 To better coordinate the economic and environmental pillars of European Maritime Policy, legislation for a common framework for maritime spatial planning in Europe was adopted in 2014 (European Commission, 2014a). This reflects an understanding that many activities compete for the same marine space and resources; fishing grounds, aquaculture farms, marine-protected areas exist alongside maritime infrastructures such as cables, pipelines, shipping lanes and oil, gas and wind installations. The Maritime Spatial Planning Directive is intended to help member states develop plans to better coordinate the various activities that take place at sea, ensuring they are as efficient and sustainable as possible. The Directive sets minimum requirements for the drawing-up of national maritime spatial plans. These plans will identify all existing human activities, taking into account land-sea interactions, and the most effective way of managing them.

31 http://www.environ.ie/sites/default/files/migrated-files/en/Publications/Environment/Water/FileDownLoad%2C38199%2Cen.pdf

Chapter 3
Environmental Risk and Resilience

3.1 Introduction

Aquaculture is both a relatively new activity and one that is fraught with environmental risks and challenges—from the point of production (weather, sea lice, disease) to the point of consumption (seafood contamination). These risks and challenges pose particular problems for the development of the industry in terms of boosting production volume and ensuring consistent, quality supply for the market. This chapter will describe some of the challenges facing producers of mussels, oysters and salmon, as well as the main responses from industry and government. These responses include improvements to farming practices and farm management, and improved monitoring and regulatory systems across production and supply chains.

The dominant approach to managing the environmental and health problems associated with aquaculture production has been to isolate and control each particular problem as it arises; there has been a tendency to treat each new problem as a stand-alone problem to be better understood, managed and controlled, either by technological intervention or increased regulation. But the unpredictability of the marine environment and the complexity of aquaculture production have limited the efficacy of some of these responses, while at the same time generating new risks. This does not mean we should stop fish farming, but it does mean recognising that scientific knowledge, technology and regulation are not always sufficient to mitigate against these risks or enable systems to better adapt to them when they occur.

In a context of future environmental uncertainty, a growing emphasis is now placed on the need for more resilient forms of food production. This will involve developing strategies for sharing risk, as well as valuing and supporting the role of local producers in coping with changes in their environment. With this in mind, it is important to question whether and how technical and/or regulatory innovations can promote resilient forms of aquaculture, rather than displacing the local, situated knowledge and capacities of primary producers (Dunne, 2003).

3.2 Overview

It is remarkable just how quickly commercial aquaculture has advanced in terms of the selection of species, fishing practices, technologies and equipment, and in the expansion of new production and supply chains. Salmon farming is undoubtedly the best example of this. In the 1980s, the pioneers of salmon farming in Ireland (supported by state development agencies) included young science graduates, ex-fishermen and farmers keen to try something new in coastal areas deprived of many other opportunities. These small-scale experiments no doubt involved a lot of trial and error, and the application and innovation of local technologies, resources and materials. Salmon farming today would be barely recognisable in comparison—from automatic feeders, to well-boats and underwater CCTV cameras, as well as a far more rigorous system of monitoring and regulation based on international advances in the science of fish health and welfare. While the cultivation of mussels and oysters has not gone through such easily observable transformations, there have been changes in cultivation practices, new transnational supply and marketing networks, and new monitoring and regulation systems.

Developments in farming practices, technologies and regulation have advanced considerably over the past thirty years. However, the unpredictable and dynamic nature of the marine environment continues to pose many challenges to the industry. While every primary food-producing sector faces difficulties associated with the environment, from weather conditions to disease, the relative novelty of aquaculture and the specific challenges posed by the marine environment make the conditions for securing consistent food fit for human consumption particularly hard.

Aquaculture occupies an interesting halfway position between land-based farming and the wild fisheries;[32] while marine organisms are cultivated like crops, the absence of any well-defined enclosures (walls, fences, gates) reduces the extent to which environmental interactions can be controlled—resulting in unpredictable external impacts on the fish farm and impacts from the fish farm affecting the surrounding environment. This is a feature of fish farming globally but the Atlantic coast of Ireland poses particular challenges.

First, the Atlantic coastline is more exposed than other areas where fish farming takes place. Unlike Scotland or Norway, for example, Ireland does not have many loughs or fjords—geographic features that act as natural shelters. At the same time, the relative exposure of some salmon farms in Ireland is also considered a positive quality; higher-energy sites reduce the impacts of nutrients and waste from salmon farms on the surrounding environment, can reduce the levels of sea-lice population, and improve the quality of fish itself by making the flesh firmer and less fatty.

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[32] This is not to suggest that modern farming is somehow immune from unexpected environmental changes (such as the weather), or that certain types of fishing are not highly technologically mediated and controlled.

Second, Ireland's southerly location and proximity to the Gulf Stream ensure that water temperatures are relatively high compared to elsewhere (Scotland and Norway, for example). This can contribute to a higher instance of disease and algal blooms (which affect finfish and shellfish). At the same time, the warmer temperatures also ensure that there is a rich source of phytoplankton (the algae that produces algal blooms), which provides the main source of food for shellfish.

Environmental conditions will undoubtedly change over coming years, with the possibility of more intense storms, warmer ocean temperatures, higher sea levels, ocean acidification and increased salinity (Ní Longphuirt *et al.*, 2010). Ireland, and Ireland's aquaculture industry, will be susceptible to these changes—leading one industry representative to say that Ireland is seen by other countries as the 'canary in the coalmine', both in terms of changing environmental conditions and in terms of aquaculture innovation, specifically the development of offshore salmon farming capabilities.

The challenging and unpredictable environmental conditions that characterise Ireland's coastline provide a real obstacle to the development of the Irish aquaculture industry in the context of global seafood markets and their demand for consistent, safe seafood. This is highlighted in the proposed National Strategic Plan where the goal of increasing volume production by 45,000 tonnes is derived from *past* peak production levels across each of the main species farmed in Ireland. While there are different reasons for declining and inconsistent production across the sector, one of the most significant has been the difficulty of producing farmed fish in the face of persistent environmental problems, including weather, disease, parasites and contamination. Even where investments in new technologies, improvements in farm management and increased regulation have been introduced, the changeable character of the environment and the appearance of new threats to production have persisted. The following section will give a brief overview of some of the challenges the fish farming industry has faced and continues to face.

3.2.1 Mussels

There are two ways of growing mussels in Ireland. Bottom-grown mussels are grown directly on the seabed in shallow coastal bays. Young mussels, also known as seed mussel, are fished in coastal waters and re-laid in inshore bays. The main sources of this seed mussel are wild seed beds mainly located in the western Irish Sea; local settlements are found in Castlemaine Harbour and periodically in Lough Foyle. The bottom-grown mussel industry is thus heavily dependent on the availability of these wild settlements; recent, dramatic falls in production volume are directly related to a shortage in the availability of wild seed (DAFM, 2015c). This downward trend in seed availability has been observed since 2009. From a height of 13,700 tonnes of bottom-grown mussels produced in 2007, production levels fell to 4,200 tonnes in 2014. Employment in the sector has also decreased proportionally (Bottom Grown Mussel Reveiw Group, undated).

The alternative way of producing mussels is by cultivating and growing them on ropes. These ropes are suspended at intervals from a horizontal long line on the surface of the water down to a depth of between 6m and 10m. The long line is kept afloat using purpose-built mussel floats and is usually about 100m in length. Mussel spat is collected on special collector rope in the spring, usually stripped from that rope within six months and restocked onto grow rope until the mussels are ready for harvest. The average grow-out time for rope mussels is about 24 months. Rope-mussel farming is carried out in relatively sheltered bays from Co Cork up to Donegal, with the majority of production is in the South-West.

In contrast to bottom mussels, rope mussels have less ‘grit’ and, depending on water quality, require less depuration (purifying) than bottom mussels. Among the drawbacks of rope-technology mussels is greater exposure to naturally occurring toxins and poor water quality, due to land-based pollutants. This report focuses on rope-grown mussels and the problems related to biotoxins.

Between 2004 and 2007, the rope-mussel sector experienced a significant increase in production from over 8,700 tonnes to a high point of 14,000 tonnes. The strong demand encouraged producers to invest and increase their capacity. By 2008, production had fallen back to 10,000 tonnes and has stayed between 8,000 and 10,000 tonnes since then. One of the biggest factors affecting rope-mussel production is the loss of mussels and product devaluation arising from temporary harvesting suspensions associated with naturally occurring biotoxins.

Biotoxins are substances that are naturally produced by phytoplankton in seawater. There are many different types of phytoplankton, which are single-celled plant-like organisms that move with the ocean currents (Guiry, 2012). Not all phytoplankton produce biotoxins, and these are only produced under certain conditions. The growth of marine phytoplankton is generally limited by the availability of nitrates and phosphates, which is one of the reasons why water pollution is an important variable for shellfish farmers (it can be both beneficial and harmful). Large blooms of phytoplankton tend to occur in late spring and early summer as the sea warms and nutrient-levels are high (Marine Institute, undated). These blooms can produce coloured pigments (usually green or red) in the sea, commonly called Red Tides or Harmful Algal Blooms (HABs). As shellfish feed on phytoplankton, they can accumulate these biotoxins in their flesh. These biotoxins can then cause illness in humans if consumed. Biotoxins are only toxic to humans.

There are two ways in which biotoxins affect the shellfish industry. First, in the event of biotoxins being detected in a growing area, prolonged closures can arise. This effectively means that mussel farmers cannot harvest their shellfish. While this is not a regular occurrence, it has happened several times since 2000, with significant impacts on fish farmers in those areas. The year 2000 was one of the worst years on record; about half of the State’s mussel producers were hit. Areas such as Bantry, Kenmare and Cromane in Kerry, Killary on the Galway-Mayo border and Bruckless in Donegal closed for periods of up to 15 months; losses to the industry were estimated at £4m. It was on the back of these extended closures that the shellfish industry called on the Department to introduce a speedier response from the Food Safety Authority on toxin testing (Siggins, 2000). The year 2014, one of the warmest years on record, resulted in a rare and extensive autumn bloom of the most common and harmful algal species, dynophysis. Although these plankton-rich conditions also favoured remarkable growth in the mussels, no harvesting could take place in most of the South-West of the country—in some cases for up to 25 weeks (Hickey, 2015). The Irish Farmers Association's analysis showed that up to 10,000 tonnes of top-quality mussel crop were lost to the elements or were unusable (Inshore Ireland, 2015).

The second way that biotoxins affect the industry is if contaminated mussels manage to get through the monitoring system and end up poisoning consumers. While this does not happen often, there have been some high-profile cases of toxic shellfish. These cases do not just affect the particular companies or shellfish producers responsible; they also damage the image of the industry as a whole, particularly in a national context where there are efforts to increase consumer demand for Irish seafood.

Response

There is not much a shellfish producer can do about a HAB, but efforts have been underway to provide better warning of when and where a HAB is likely to hit,[33] and, more importantly, to ensure that contaminated shellfish does not enter the market.

The Shellfish Safety Monitoring Programme is supervised by the Sea-Fisheries Protection Authority (SFPA) and the Marine Institute, under service contract to the Food Safety Authority of Ireland. Along with samples of seawater tested in local laboratories (as a pre-screening and early warning system), samples of farmed shellfish meat are collected by fish farmers and sent every Monday to the Marine Institute to be tested for the presence of four biotoxin groups:

- Azaspiracid poisoning (AZP).
- Amnesic shellfish poisoning (ASP).
- Diarrhetic shellfish poisoning (DSP).
- Paralytic shellfish poisoning (PSP).

The results of the tests are released on Thursday morning (two days after the sample has been received). The test results provide a simple biotoxin status for the particular harvesting area:

- Open—areas with two clear samples, taken 48 hours apart.

33 http://www.marine.ie/Home/site-area/news-events/press-releases/killary-survey-unlocks-key-early-warnings-harmful-algal-blooms

- Closed—areas with a biotoxin positive sample.
- Closed pending—areas with one clear sample but awaiting the result of the second sample taken 48 hours later.

Only shellfish from open areas are allowed to be harvested and placed on the market. The problem for shellfish producers is that they are often operating according to the demands of suppliers. This means that the speed with which results can be given to them is crucial in terms of their ability to respond to the market and manage their farms.

This monitoring system has come a long way from its origins in 1984. The most significant reforms happened between 1998 and 2002, largely due to a campaign by the shellfish industry calling for the introduction of a more organised and responsive testing system. Up to 2002, the toxin test involved an EU regulation-prescribed mouse bioassay: feeding a sample of the shellfish meat to a live mouse and monitoring its response. The shellfish industry argued that this test could not cope with the complexity of the biotoxins present in Irish waters. Other complaints included delays in sampling and reporting, lack of species-specific closures, and a lack of plankton monitoring or early warning tools.[34] The sensitivity of the test ensured that many shellfish-producing areas were closed for prolonged periods. A review of the system was called for by the Department and, after a series of workshops and studies, an overhaul of the system was brought about. This included improved response time, more resources for testing and the first text-alert food safety system in the world.

Despite these changes, the monitoring programme is neither fool-proof (in terms of preventing toxic shellfish getting to market), nor entirely satisfactory from the point of view of the shellfish producers (Flynn, 2008). In early 2008, one of the leading shellfish export companies was temporarily closed by the SFPA for a food safety enforcement order. This was on the back of contaminated shellfish (due to high levels of biotoxin) being sent out from the company between July 2007 and March 2008, resulting in 219 people becoming ill in France (Irish Examiner, 2009). The order was lifted in April 2008 and the factory was reopened. The SFPA then prosecuted the company for breaches of food safety regulations; in 2009 it was found guilty and ordered to pay a fine. Although the company continued to trade, it closed in late 2010 for commercial reasons—largely due to the large expense of product recall in 2009. This was a major loss to the shellfish industry in Ireland as a whole as it meant the loss of a major route to market.

In 2014, another of Ireland's pre-eminent shellfish companies was involved in a recall of contaminated mussels. Batches of mussels traced back to the company

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34 http://oar.marine.ie/bitstream/10793/580/1/Proceedings%20of%20the%20Second%20Irish%20Marine%20Biotoxin%20Science%20Workshop%202001.pdf

were linked to reports of illnesses associated with DSP. In August 2015, mussels from Roaringwater Bay were also recalled after incidences of shellfish poisoning in Dublin and Limerick. In this case, fresh mussels were recalled from leading retailers across the country after they were found to contain more than three times the legally permitted level of certain toxins. This was unexpected because that area of the South-West has historically been free of biotoxins—which meant that mussel farmers in that area may have been less vigilant than farmers in other areas where there was a high incidence of biotoxins. The implication here is not that some sections of the industry are less rigorous than others when it comes to food safety, but that the distribution and frequency of HABs is hard to predict and influenced by factors beyond the control of the industry, the regulators and the scientists.

3.2.2 Oysters

Like mussels, oysters are cultivated in a variety of ways. Historically, the native oyster (*O. edulis*) was a wild stock that was fished in places such as Clew Bay, Lough Swilly and Tralee Bay (Dubsky, undated). Techniques have also been applied to enhance these wild beds or to fully restock areas through hatcheries. Today, the principal fisheries for native oysters in Ireland are in Tralee Bay, Galway Bay, Lough Foyle, Lough Swilly, Kilkieran Bay and Clew Bay.

Due to the impact of diseases and a shift to the rearing of Pacific oysters, the production of *O. edulis* has dropped across Europe. Ireland and the UK were the only two countries in Europe to produce more than 200 tonnes in 2002. However, the value of the native oyster is higher than the value of the Pacific oyster, which ensures that it remains an important sector in the areas where it continues to be produced.

Pacific oyster (*Crassostrea gigas*) account for the bulk of oysters grown today in Ireland. This is a faster-growing species introduced in the 1980s for commercial reasons. They can be bottom-grown like mussels, but are mostly grown in the inter-tidal zone between the Mean High Water Spring Mark and the Mean Low Water Spring Mark in sheltered bays. Oyster spat or seed is placed in plastic mesh bags in the spring. These bags are secured to steel trestles. As the oysters grow they need to be thinned out and distributed across new bags. The bags must be turned and/or shaken as often as possible—making this form of oyster farming relatively labour-intensive. To ensure optimum growth rates, they must also be graded two to three times during their growth cycle and moved to different areas of the shore. Site maintenance involves the lifting and moving of trestles, which sink into the ground over time, and replacement of old, broken trestles. The oysters are harvested at a commercial size of anything from 75g to 150g, depending on market demand, and the growth cycle is between 24 and 48 months depending on the farm site. Oyster spat is purchased mostly from hatcheries in France, with a small amount available in Ireland. The sites are generally accessed by tractor and trailer or in some cases by a flat-bottom boat.

Only 361 tonnes of Pacific oysters were produced in 1990, rising steadily to 8,887 tonnes in 2014. In contrast, native oyster production has barely increased in volume, with 420 tonnes produced in 1990, and 555 tonnes in 2014. Even more than with mussel farming, the factors constraining increased oyster production lie with environmental conditions, namely the combined effects of toxic algal blooms (biotoxins) and a series of diseases that have resulted in high rates of mortality.

Oysters are filter feeders, like mussels, and thus suffer from the same problems relating to severe HABs and biotoxins. Severe HABs can cause direct losses. In 2012, a large algal bloom of *Karenia mikimotoi* severely affected areas of the North-West of Ireland. The effect of this bloom was to draw oxygen out of the water, effectively suffocating any marine organisms that came in contact with it. This led to high mortalities amongst wild marine life, farmed finfish (salmon in this case) and mussels and oysters. In Donegal, mortalities for oyster growers were around 70 per cent.

The native oyster has been hit by the parasitic protozoan *Bonamia ostreae* (Culloty & Mulcahy, 2007). This is a parasite that is thought to have been spread by the movement of oysters in the 1970s and 1980s. It was first reported in Ireland in 1987 but has not caused mass mortalities here. It causes the oyster to waste away and has inflicted high mortalities in France. Other parasites such as *Marteilia refringens* have come into Europe, but not yet to Ireland.

In 2009, a new strain of oyster herpes virus (OsHv1) arrived in Ireland and inflicted high mortalities on the Pacific oyster stocks; in some instances, mortality rates were as high as 80 per cent (DAFM, 2015c). As with the *Bonamia* parasite, the herpes virus is thought to have stemmed from the introduction of stock from an infected area, or latent infections in existing populations. Besides the herpes virus, other diseases appear to be manifesting. In summer 2015, several large oyster growers in Donegal reported mortalities ranging from 30 to 70 per cent in near-market-size oysters—a situation that was ‘unheard of’ according to one respondent. In the past, this experienced oyster producer expected to get 50 tonnes of oysters from 1 million seed, but now is happy to get 20 tonnes—due to persistent mortalities. The cause of these mortalities is not yet known but there is concern about the frequency of the diseases and the widespread losses they are causing.

There is an additional risk relating to the interaction between the Pacific oyster and the native oyster in Ireland. When Pacific oysters were first introduced to Ireland in the 1970s, conventional wisdom was that the water temperatures were good for it to grow in but too cold for it to reproduce in. This meant that Pacific oyster seed had to be bought in to oyster grow-out sites each year—either from Irish or, more frequently, French hatcheries. This assumption has since been proven wrong, as wild populations of Pacific oysters have been identified in parts of Ireland. The Marine Institute has subsequently carried out research into the proliferation of Pacific oysters in the wild and the factors governing its success. Although there has not been a comprehensive study carried out on the scale of their reproduction in the wild or their impact, potential impacts include a decrease in the carrying capacity of bays (for aquaculture), reduction in native oyster populations, and changes to the habitat in the form of oyster reefs.

Responses

As well as being regulated under the Shellfish Safety Monitoring System, oyster growers are subject to EU Directive 2006/88/EC on animal health requirements. The objective of the Directive is to raise standards of aquaculture health throughout the EU and to control the spread of disease while maintaining the freedom to trade. It provides what it calls 'a comprehensive risk-based approach to disease surveillance and puts in place controls on the movement of potential vector and susceptible species'. It also provides a structure for declaring the health status of member states and areas within them.

The new surveillance and monitoring system was not able to prevent the high levels of oyster mortality recorded in 15 Irish bays in 2009. The oyster herpes virus, OsHV1, was identified in 14 of 15 sites affected by mortalities. In all 14 sites, oysters that had been imported from France in either 2009 or 2008 were present. According to Marine Institute movement records, oyster mortalities occurred in all bays where seed was imported from France in 2009. Six bays where seed was imported from England and the Channel Islands did not experience mortalities.[35]

The 2006 Directive replaced previous legislation established by Directive 91/67/EEC and 93/53/EC. Directive 91/67/EEC was also designed to prevent the spread of aquaculture diseases following the advent of the single market in 1991. It stipulated that the movement of oysters could only take place between areas of the same disease status or from clean to infected areas. However, the French realised that their opportunities to trade would be dramatically limited by such a rule, since France had 13 growing areas identified as disease zones. French industry and government argued for a derogation on the Pacific oyster (*Crassostrea gigas*). Although it was a carrier of disease it had never been known to pass the disease on to stocks of *Ostrea edulis*, the native oyster. This amendment was granted in 1993 (Aquaculture Ireland, 1994). The problem was that *O.edulis* spat came in with the *C. gigas* by accident (causing the spread of disease to the native oyster) and a temporary ban was put in place.

3.2.3 Salmon

Atlantic Salmon, *Salmo salar,* has both a freshwater and sea-water phase to its life-cycle. The natural breeding cycle of the Atlantic salmon involves the fish spawning in freshwater, migration and growth in the sea until sexual maturity is reached, and then returning to its parent river to spawn. Largely for this reason, the farming of salmon involves greater degrees of human intervention in the production process and, by extension, greater levels of investment. In turn, salmon farming faces more problems relating to husbandry and fish health than shellfish farming.

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[35] http://www.marine.ie/Home/site-area/news-events/news/update-oyster-mortalities

The different stages of the Atlantic salmon cycle mean that farming is divided into two separate stages: freshwater and seawater. Salmon farming in Ireland is typically based on smolt production in freshwater (in a land-based hatchery) and farming at sea. The complete life-cycle of the Atlantic salmon can be reproduced in a period of 3–4 years.

Farmed salmon output reached a peak in production of 23,312 tonnes in 2001. Thereafter, total annual salmon harvest volumes suffered a series of setbacks (related to disease and a drop in prices), which resulted in a reduction in production to a twenty-year low of 9,124 tonnes recorded in 2013 (less even than total volume output in 1991). Once again, setbacks in production levels can be traced to unexpected environmental challenges at the point of production—in particular the incidence of Amoebic Gill Disease (AGD), which caused significant losses of young stock in 2012.

While the mussel and oyster sectors have experienced considerable setbacks in production due to the occurrence of toxic algal blooms and the spread of specific diseases, the salmon industry has suffered more varied, persistent and significant challenges. These include weather, disease, sea lice, jellyfish, HABs and unexpected changes in environmental conditions.

Salmon farming takes place in Donegal, Galway, Mayo and Cork. As with shellfish farming, these sites and locations bring with them different challenges. Sites that are not sheltered within bays or loughs (as in Donegal) are more exposed to harsh weather. This can have a considerable impact on fish farming and the welfare of the fish. This is because, unlike mussels or oysters, salmon must be fed and inspected regularly. The normal feeding method is by means of a workboat travelling from cage to cage delivering the feed via a feeding cannon. This method works well in reasonable weather but in adverse conditions workboats can encounter severe difficulties when attempting to tie up to a cage, and may be forced to forgo feeding altogether rather than risk damage to both cage and boat (Ryan, 2004).

After feeding, the most important task on a salmon farm is harvesting. Harvesting is the culmination of up to two years of careful husbandry, so it is vitally important that the fish are not damaged or lost at this stage. Harvesting can only be carried out in reasonably fine weather as it involves tying the workboat to the cage, bringing a quantity of the fish to the surface with a sweep net and then pumping them out with a fish-pump. Harvesting is thus largely a summer activity or is confined to weather windows at other times of the year. This in turn means that the supply of fish from exposed or offshore farms can be unreliable, making it difficult to continuously supply the market.

Beyond the everyday challenges of weather, extreme weather events can pose a risk to the salmon farm infrastructure itself, raising the possibility of escapes. While Ireland's record on escaped salmon is good compared to Scotland or Norway, there have been occurrences. Over 83,000 salmon escaped from a salmon farm in Donegal in November 2010 due to storm damage. Just over a year later, in February 2012, more winter storms resulted in the breaking-up of a salmon farm in Bantry Bay. This resulted in the largest reported escape of farmed salmon in Ireland: an estimated 230,000 salmon escaped or perished. Besides being a concern for wild salmon in terms of interbreeding, this was a massive knock for one of the few remaining locally owned and operated salmon farms in the country.

The main diseases affecting farmed salmon in Ireland have been Pancreas Disease (PD) and, more recently, AGD.[36] The first epidemiological studies of PD in Ireland, in the early 1990s, indicated that significant losses occurred in farmed Atlantic salmon in their first year at sea on some individual farms (Ruane *et al.*, 2005). Incidents of PD increased in the early 2000s resulting in a series of research initiatives coordinated by the Marine Institute.

Until the 1990s, AGD was understood to exist in Tasmania alone. AGD, a gill disorder found in marine fish, only appears to threaten farmed species, with fish in their first year at sea seeming particularly susceptible. After some small outbreaks in parts of the world (including Ireland) in the 1990s, it has become widespread and frequent since 2010. This is thought to relate to rising sea temperatures. In Ireland, production losses due to AGD became a serious health and welfare challenge for marine salmon farms in 2011 and 2012, when over 25 per cent of the sites in Ireland were affected. It appears to have now re-established and persisted during 2013 and into 2014.

Arguably, the most significant and certainly persistent problem for salmon farms is that of sea lice (Asche *et al.*, 2009, Costello, 2009). Sea lice are a marine parasite that feed on the mucus, skin and blood of the fish. They range in size from 0.5cm to 2cm and have both a free-swimming and parasitic stage to their life-cycle. This means they pose a problem both in terms of their potential interaction with wild salmon and trout populations, and in terms of their feeding on the farmed salmon. While they existed before the advent of fish farming (their presence would historically have been considered a sign of a fish returning from the sea), they have proven to be one of the biggest challenges facing the salmon industry. Despite years of research, innovation in treatments and farming practice, and improved monitoring, the problem of sea lice was identified in 2015 by Marine Harvest, the largest aquaculture company in the world, as the biggest challenge to the salmon farming industry.[37]

Some other less frequent but potentially significant risks for salmon producers are swarming jellyfish and severe HABs. In October 2013, up to 20,000 farmed salmon were lost due to a jellyfish bloom off Clare Island, Co Mayo. Large blooms of *Pelagia*

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[36] Disease has been a problem from the beginning in salmon farming. Perhaps the most serious and well-known globally is Infectious Salmon Anaemia (ISA), a viral disease that affects Atlantic salmon but poses no threat to humans. First identified in Norway in 1985, it was detected in Canada in 1997 but was believed to be 'exotic' in the EU until 1998 when it was discovered in a salmon farm at Loch Nevis. This led to widespread slaughtering of fish in Scotland, particularly in the Shetlands, as it was believed that the disease could only be contained by removing and destroying all the fish from the infected site, disinfecting equipment and fallowing the farm for at least six months. ISA has never been detected in Ireland.

[37] https://www.undercurrentnews.com/2015/10/28/marine-harvest-q3-earnings-exceed-expectations-despite-drag-from-americas/

noctiluca or mauve stinger have been occurring more recently over the past decade, due in part to warmer sea temperatures. It was this same species that inflicted losses of €1m at a fish farm in Glenarm Bay, Co Antrim, in 2007 when some 120,000 fish died (Siggins, 2013). This problem may well get worse due to the observed increase in jellyfish numbers.

Some phytoplankton (*K. mikimotoi*) produce ichthyotoxins that are harmful to the gills of fish and their organs. A large bloom may also (in sheltered sites) consume all the oxygen in the water column when the phytoplankton start to die, resulting in fish deaths. When the bloom dies off, this also can release ammonia into the water, resulting in further toxic damage to fish.

During the summer and early autumn of 2003, approximately one million salmon were killed in Inver Bay, Donegal (Cronin *et al.*, 2004). At the time, different explanations were put forward, including potential contamination associated with sediments from the dredging of Killybegs Harbour or from disturbance associated with trawling by local fishermen in the vicinity of the salmon farms. The official report carried out by the Marine Institute was less conclusive (Cronin *et al.*, 2004).

Responses

Given the commercial value of farmed salmon, the considerable costs associated with its production and the historic involvement of large private companies, it is not surprising that salmon farming has been subject to the most significant changes in terms of farming practices, technologies, management and regulation.

From a fish health perspective, the industry and relevant state agencies have tended to respond to problems as they arise. In 1994, for example, an outbreak of Cataract Syndrome in salmon smolts resulted in a research programme costing £300,000 investigating the nutritional value of vitamins and minerals to smolts. In the mid-1990s and early 2000s, outbreaks of PD led to surveys and research initiatives being carried out and supported by the Marine Institute. The Pancreas Disease Research Group was set up by the Marine Institute in early 2004 to advise on these research initiatives, and in 2008, in partnership with the Agri-Food and Biosciences Institute in Belfast and Vet-Aqua International in Galway, it published its final report on a two-year research project into PD in Ireland.

In 2007, the AquaPlan project was funded by the National Development Programme. This marked something of a departure from the past in that it represented a joint approach of industry and government working together to implement an integrated and planned approach to fish health in Ireland. The aim was to develop a comprehensive national strategy to build and enhance sustainable production of farmed finfish in Ireland. As part of the project a comprehensive manual on fish health for Ireland’s salmon and trout farming industry was developed. This was in line with the European Commission’s identification of the promotion of animal health and welfare standards as one of the main objectives for the future sustainable development of European aquaculture (European Commission, 2009). The main outcome of the AquaPlan project was *The Farmed Salmonid Health Handbook* (IFA Aquaculture, 2011). This handbook contains detailed and practical information on all aspects of fish stock care, including veterinary issues, environmental protection, feed and nutrition, treatments, best practice for biosecurity, waste management, bay management and fallowing, and current legislation. It was compiled by experts from both private and government organisations representing the Irish aquaculture industry, including IFA Aquaculture, the Marine Institute, Vet Aqua International, Global Trust Certification, and the Department of Agriculture, Food and the Marine (DAFM).

One of the main topics covered in the handbook is the challenge of managing sea lice. As early as 1991, the Department instigated a Sea Lice Monitoring Programme for finfish farms, and in 1993 monitoring was expanded nationwide. In 2000, the Sea Lice Monitoring Protocol was implemented. Under this protocol all stocks of farmed salmon must be inspected by Marine Institute inspectors 14 times per year. All the data from the inspections is published annually. The programme also includes ‘treatment-trigger-levels’. These triggers relate to the average number of sea lice per fish detected on fish farms; if the number of egg-bearing sea lice is more than 0.5 per fish in the spring, the trigger for treatments is set off. These treatments can include chemical treatments (within the specifications of European regulations and organic standards in the case of organic salmon), water bathing and early harvesting to remove the fish from the water (see Box 3.1).

Box 3.1: Single Bay Management

As well as carrying out the Sea Lice Monitoring Programme, the Marine Institute facilitates the Single Bay Management (SBM) strategy for finfish farms. Established in 1997, SBM is designed to co-ordinate husbandry practices within individual bays to promote best practice on individual farms and to ensure that stocking, fallowing and treatment regimes on individual farms are compatible with the arrangements on neighbouring farms (O'Donohoe & Jackson, 2011). The fallowing of production sites after harvest, a principle long accepted in the agricultural sector, is an internationally accepted fish-farm management strategy to improve husbandry and survival rates for farmed finfish. The use of separate sites for each generation of fish has also been identified as a strategy which should be encouraged in an effort to break the cycle of infections with sea lice and reduce risks of other diseases. The additional benefit of rotating sites is that it allows the sea bottom to recover from the accumulation of faeces and uneaten food.

SBM was an innovative response to the problem of sea lice (and other disease-related problems and environmental impacts) that was actively supported by the Irish Salmon Growers Association (ISGA) (the organisation representing salmon growers throughout Ireland) when it was introduced in the 1990s. A major component of SBM was the need for a strong communication network between the operators and between the fish farmers and their neighbours. This is because SBM plans need to be revised for each production cycle. One respondent who has been involved in facilitating and monitoring SBM since the 1990s said that arriving at an agreed plan between salmon farmers could be difficult due to conflicts over commercial interests—one farmer wanting to harvest when another one doesn’t, for example. However, he said that these differences could always be resolved and that ultimately this level of coordination and planning was in their mutual interest.

One of the problems that arose with SBM, particularly in the 1990s, was the conflict between salmon farmers and those who opposed salmon farming. These conflicts sometimes resulted in the blocking of licence applications for sites that may have been necessary for SBM—rotating between sites and fallowing are basic requirements for breaking the life-cycle of sea lice. Opponents of salmon farming did not believe that these new sites would be used for effective sea-lice control but rather would be used to increase production, thereby exacerbating the problem (see (Phyne, 1996). Partly as a result of this opposition, new licences were not issued for inshore areas.

In 2008, the Department of Agriculture, Fisheries and Food (DAFF) published *A Strategy for Improved Pest Control on Irish Salmon Farms* (DAFF, 2008b, 2008a). The strategy outlines a comprehensive range of measures to provide for enhanced sea-lice control. It was developed by a joint DAFF, Marine Institute and Bord Iascaigh Mhara (BIM) workgroup in response to difficulties experienced by farms in achieving the low levels of infestation required under the national control programme. This improved pest-control programme is regarded as international best practice. However, despite the extent of this programme and the improvements in fish management since the 1990s, sea-lice numbers have risen again over the past two years (from a low baseline), and trigger levels for sea lice continue to be breached, sometimes for 4–5 months in a row without any drastic action being taken.

What is clear from the sea-lice problem is that sea lice are remarkably resilient and adaptable (Costello, 2006). Even chemical treatments become ineffective over time as the sea lice quickly become immune. According to the Marine Institute, levels of infestation were successfully controlled through the 1990s. Since 2002/2003 this has become more difficult for salmon farmers, despite their best efforts (M.I. May 2008 Pest Control). The causes were numerous: a succession of warm winter sea temperatures, resistance by the pest to the veterinary medicines, limited access to ‘fallowing sites’ for temporal and spatial separation of stocks, and other complicating fish health problems—for example, PD and AGD reduce fish appetites, resulting in poor uptake of the active ingredient in lice treatment from the diet. The latest figures from 2014 show that the number of egg-bearing sea lice per fish increased from 0.19 in May 2013 (lowest on record) to 1.27 sea lice per fish in 2014 (O'Donohoe *et al.*, 2015). One of the responses to the persistent problem of sea lice (amongst other problems) has been a call for salmon farming to move to more exposed, offshore sites.

Offshore fish-farming sites are not neatly defined but generally refer to more exposed, high-energy sites, such as the salmon farm off Clare Island. The open nature of offshore sites improves dispersion of uneaten food, treatments and fish faeces as a particular body of water is unlikely to pass through the cages more than once. Offshore sites are also expected to experience lower levels of sea lice because the juveniles tend to be swept away by the faster-moving water (Ryan, 2004). In the Irish context, offshore sites would also be further away from the mouths of rivers and the migratory routes of salmon and trout smolts, thus reducing the risk of interaction between them and the sea lice on farmed salmon. Offshore sites can also benefit from more stable water temperatures, which is particularly important for avoiding potentially high summer temperatures which are conducive to disease and slow growth. Finally, high-energy sites also have the advantage of improving the quality of the fish. For these and other reasons, offshore farming has been supported by representatives of the industry, BIM and the DAFM. In 2012, BIM took the unprecedented step of applying for a licence for an offshore salmon farm in Galway Bay (see Box 3.2).

Box 3.2: Offshore Salmon Farming

One of the characteristics of aquaculture development in Ireland (and globally) has been the transformation of technologies and farming techniques. This is particularly the case in salmon farming where the level of inputs and intervention required by the fish farmers is greater than with shellfish, for example. The cost of these innovations, combined with the cost of complying with new regulations, has meant that many of the smaller producers or operators in the salmon farming sector have been pushed out. In the 1980s and 1990s in Ireland, there were more individual, owner-operated salmon farms than there are now (Phyne, 1996). The impact of low prices in the early 2000s certainly contributed to their demise, but a succession of disease-related and sea-lice problems and a lack of resources to deal with them compounded their vulnerability to market fluctuations. By the mid-2000s the industry in Ireland had become largely consolidated within one company, Marine Harvest Ireland (MHI), a subsidiary of the Marine Harvest Group that owns or operates aquaculture farms in 22 countries around the world. The technical and financial resources of this company have meant that salmon farming in Ireland now operates to the highest standard in the world—reflected in the organic accreditation of nearly all salmon farmed in Ireland.

An employee of MHI involved with applying for new licences said that it cost roughly €5m to set up a new salmon farm. 'It's not a small operator's game anymore,' she said. 'Regulation has overtaken everything and it has dictated cost, and it has also dictated the scale.' Coupled with the increased costs of initial investment are the ongoing costs associated with compliance. Salmon farming has had to become far more technically advanced and administratively compliant with sea-lice monitoring programmes, benthic monitoring programmes, and organic certification (European Union, 2009). MHI have their own in-house vet, three marine biologists working on the farms, an environmental technical supervisor, three laboratory technicians working on food safety and quality environmental monitoring and a geneticist, as well as access to finance for outside services and consultants. The result of all this, of course, is that it is almost impossible for new entrants to enter the sector.

The decision to move salmon farming offshore has been driven by various factors, including opposition to inshore sites for environmental reasons, better environmental conditions for growing salmon (reduced risks of sea-lice infestation and disease) and additional economic benefits derived from cultivating salmon in more exposed sites (larger-scale and better-quality fish). The combination of these factors appears to offer convergence between environmental and economic goals—particularly as regards the problem of sea lice. However, the move towards offshore salmon farming also represents an example of a technical solution to underlying environmental problems. While some problems relating to salmon farming may be addressed, other risks and problems are (and will be) created.

Offshore fish farming offers a qualitatively different kind of fish farming because of the level of exposure, the difficult of accessing the site and the farm scale necessary to justify the financial investment (Ryan, 2004). The Environmental Impact Statement published by BIM relating to the proposed site in Galway Bay includes considerable information about the different environmental variables, including wave climate, topography, water speed, temperature, salinity and oxygen. It also provides details about the cage structures and equipment that will have to conform to the Norwegian Standard for Containment Systems NS 94152009, the various working boats, and the feeding system which will have to be remote-controlled because weather may prevent workers accessing the site. The prohibitive cost of these infrastructural requirements makes it likely that the only company capable of taking on such a licence will be a large multinational.

As well as multiplying the cost of salmon farming, the level of risk associated with an offshore salmon farm is multiplied due to the increased scale of the farm. The loss that would be incurred from a severe algal bloom, a swarm of jellyfish or severe weather and potential salmon escapes would be far greater when the number of salmon, and money invested, is so many times more than on existing sites. While infrastructure, monitoring systems, contingency plans and farming practices can be implemented according to the most advanced, current knowledge and specifications, unpredictability remains a constant feature of aquaculture. For example, in November 2010 one of the MHI farms in Inver Bay lost approximately 83,800 salmon as a result of an escape. According to the Engineering Division Report from the DAFM, this was due to the failure of farm moorings during a storm. The report concludes that the moorings were not adequately designed against abrasion, nor was there a sufficiently frequent inspection prior to the failure occurring (O'Sullivan, 2011). Accepting that risks (such as fish escapes) are an inherent part of aquaculture does not mean that fish farming should not take place. It does, however, question the confidence with which science, technology and regulation are presented as sufficient responses to these risks.

3.3 Risk and Resilience

The challenge of addressing problems such as biotoxins, disease and fish welfare is clearly central to the future development of aquaculture in Ireland, both in terms of increasing production from existing sites and cultivating Ireland’s reputation for safe, quality seafood. Managing the risks associated with aquaculture production in a way that does not put an excessive burden on smaller producers is also important if younger generations are going to be attracted into aquaculture in the long term.

Historically, the environmental and health problems that have affected the aquaculture industry have been addressed through a combination of regulation and technical innovations. These measures have undoubtedly brought about improvements in the understanding and management of particular problems, such as disease or sea lice. At the same time, new and old problems continue to persist despite these improvements. Furthermore, the costs associated with controlling these problems, particularly in salmon farming, have inadvertently pushed out smaller operators.

The introduction of more uniform monitoring and regulation of the industry, and the advance of fish-farming techniques and technologies, can be understood as a progressive move towards a safer, more professional and risk-averse aquaculture sector. One of the limitations of this understanding, however, is that it tends to see environmental and health problems (such as biotoxins or sea lice) as stand-alone problems that can be isolated, scientifically understood and effectively controlled by technical applications and/or regulations. This approach does not always locate such problems, and the risks associated with them, within the wider economic contexts that shape fish farming. Contextualising environmental and health risks in this way can result in different measures being taken.

Further questioning the efficacy of narrowly defined technical responses to environmental and health risks is the growing recognition amongst the scientific community that environmental change is becoming the norm. This perspective suggests that present and future risks associated with environmental change are not necessarily knowable or controllable in ways that had previously been imagined. In the context of food production, one of the strategic responses to this condition of uncertainty has been the call for more resilient systems of production. An important and acknowledged part of resilient food systems is the role of primary food producers in coping with uncertain environmental change. A first step towards promoting more resilient forms of aquaculture would thus involve recognising and valuing the different forms of knowledge and skill that many fish farmers possess and perform on a daily basis, and the ways these capacities can be properly supported.

3.3.1 Locating Risk

The environmental and health risks associated with aquaculture are often perceived to be the result of 'naturally occurring' phenomena such as the weather, biotoxins or sea lice. I was told, for example, that sea lice existed before the advent of salmon farming and had even been a sign of a healthy salmon returning from sea to the rivers in spring. Similarly, HABs occur regardless of whether there are shellfish being farmed in an area. As one fish farmer suggested, 'HABs would probably not have been discovered if it wasn't for the harmful effects they had on farmed fish'. Rather than revealing the 'natural' origins of sea-lice infestation or biotoxin contamination, however, these observations illustrate how fish farming *generates* risks and problems that didn't exist previously.[38] This is because the interactions between fish farming and the highly dynamic marine environment are what are significant, not

[38] The understanding that environmental risks are inseparable from the technical and economic organisation of contemporary society has been argued since the 1990s. This literature on the 'risk society' thus challenges the view that environmental and health risks can be progressively controlled and managed through the advance of new techno-scientific applications (Beck, 1992, Blowers, 1997, Forsyth, 2004, Wynne, 1992, 2002).

the ‘natural’ phenomenon itself. This observation may seem obvious but it has important consequences for how these environmental problems are approached and managed. Rather than isolating a ‘problem’ in an effort to control it, efforts to situate these problems, and the risks associated with them, within wider economic developments can be instructive. Some examples will make this point clearer.

Mussels

The biotoxin monitoring and control programme is considered a world-class programme of its kind. It has the support of shellfish producers and seafood companies. It is in their individual and collective interests to ensure that no contaminated mussels get to consumers; each time a case of shellfish poisoning makes it into the media the whole industry is set back. Despite the collective interests of the industry and the backing of a scientifically rigorous, state-supported monitoring system, several high-profile cases have occurred over the past seven years. How can this be explained?

The biotoxin monitoring programme requires every shellfish producer to send a sample of the shellfish meat to the Marine Institute in Galway every Monday. The results of the test are returned to the fish farmer on Thursday. If the harvesting area is given the all-clear, the shellfish farmer is able to safely harvest until Sunday evening. This allows them to be certain that toxin levels won’t have risen above the limit since they sent in their sample the previous Monday. On Monday morning a new sample is sent to the Marine Institute. The question for the mussel farmer is whether to risk harvesting up until they receive the results on Thursday, or whether to wait. If they decide to harvest and the result on Thursday is negative, they will have to recall what they have harvested at a loss. This is important because it shows that the shellfish producer continues to have a considerable amount of responsibility in the biotoxin monitoring process. It also points to the importance of their experience. As one mussel farmer explained:

> For the most part it’s not a problem because there is a pattern. For example, the red tide usually lifts November, December. Now this year was very unusual. It didn’t lift from us until the 19th March. Which was a disaster for us, a complete disaster. But if your levels are low—for example, if they’re below quantification on January 21st—then I’m quite happy to go harvesting ‘cos I know from experience that there is a 90% chance that a bloom won’t come in. And it’s when the bloom comes in and shellfish start eating it that there’s a problem.

This mussel farmer said that his decision whether to harvest or not always depended on the level of biotoxins recorded by the Marine Institute. If the level is close to the limit, he won’t harvest. After 39 years working with mussels in the same bay, he also trusts his own knowledge. He administers his own tests, including eating the mussels and putting them out for the birds. He also observes the sea in case there might be a sudden HAB. This mussel farmer has never had a withdrawal in all his time fish farming.

In the case of the recent recall of mussels from Roaringwater Bay, it is likely that the mussel growers took a calculated risk to harvest on the basis of previous experience; there had not been a closure due to biotoxins for many years. But they also took the calculated risk in a context where they are trying to make a livelihood. As I was told by another mussel farmer, if you are under financial pressure and it looks like the closure might be for a couple of months, or summer is approaching (when the risk of closure increases), then there might be an incentive to take more of a risk.

Tied to the decision-making of mussel farmers, then, is the extent to which they are able to cope economically with the burden of a bay closure or, in the case of a processor, the cost of a recall after the mussels have been dispatched. In the latter case, the burden is much higher because a processor can buy mussels, process them, and then discover that there is a residual problem. This means recalling and destroying the entire stock after having paid for them. At the same time, these processors are working on relatively small margins and are tied into contracts with retailers who may decide to buy seafood elsewhere if there is not a regular supply. On the other hand, smaller shellfish producers who are not as economically reliant on harvesting and selling their mussels to order, or who carry fewer overheads, may be less likely to take a risk if the biotoxin levels are high. This was reinforced by a large oyster producer in Donegal. He said that smaller oyster producers were not as hard hit by closures or mortalities because they could just buy in more seed the next year. In contrast, because of the money he has invested over the past number of years he is more susceptible to such problems. He said that every July–August brings sleepless nights, waiting to see how the oysters will do, how many mortalities there will be. He said it was like gambling and he wouldn’t now encourage his children to get into the business. It is illustrative that two of the three recent cases of biotoxin contamination involved seafood-processing companies, rather than producers selling directly to buyers. Both seafood companies had a reputation for quality processing facilities and state-of-the-art Hazard Analysis & Critical Control Point (HACCP) and traceability systems.

One way in which the burden of bay closures (and thus the risks associated with biotoxins) has been allayed in the past is through government-funded compensation in the event of an extended closure or widespread mortalities. In 1995 a £400,000 aid package was made available to shellfish growers after unprecedented losses in oysters and mussels. In the previous funding programme, 2007–2013, European funds intended for fish farmers as compensation in the event of similar disasters were not made available to Irish producers (IFA, 2014). This was because of the hold-up in the aquaculture licensing system due to the failure of the Irish state to comply with the Birds and Habitats Directives. Existing licence-holders were not able to renew their licences and, under Section 19A4 of the 2006 Fisheries Amendment Act, this meant that they were ineligible for state developmental grant aid and/or compensation. In a context where financial pressures may shape the decision-making of fish farmers, state compensation in the event of a prolonged closure thus appears as an important policy instrument. In other words, the availability of compensation for fish farmers is not just a way of sustaining smaller operators in times of crisis but also a buffer against the risk of contaminated shellfish reaching the market.

Oysters

The development of the Pacific oyster sector provides an example of how changes in economic production over time have interacted with the environment, changing the biological constitution of the oyster itself and bringing about unexpected new risks.

The decision to cultivate the non-native Pacific oyster (rather than the native oyster) in the 1980s was commercial: the Pacific oyster grows faster, produces larger meats and has a bigger market (Tully & Clarke, 2012). The Pacific oyster is grown from spat that has to be brought in from hatcheries—largely based in France. Initially it was thought that the Pacific oyster could not self-seed itself in the wild due to the cold waters. Warmer sea temperatures combined with other environmental factors have now proven this to be wrong. The Pacific oyster is now established as an invasive alien species in Lough Swilly, Lough Foyle and Strangford Lough.

This self-reproduction of the Pacific oyster also poses an economic problem for the oyster industry: when the oyster spawns it loses up to 70 per cent of its weight. One of the responses has been to introduce the sterile 'triploid' oyster—an oyster with three chromosomes (instead of two) that is deliberately selected by the hatcheries to avoid erratic spawning. The triploid was first introduced into Ireland around 2005-6. According to one oyster producer, the triploid oyster is like a 'thoroughbred horse' because it grows very fast. He did not believe the meat was as good, however, and felt that the increased incidence of disease over the past few years (including 2015 this year) may have something to do with the triploid oyster being more fragile and prone to disease.

The changing relationship between the French oyster industry and the Irish oyster industry has also contributed to the increased chance of disease transmission amongst different stocks. The transfer of oyster spat from France is only part of an exchange that now involves the so-called 'bed and breakfast' arrangement. This involves oysters grown in France being shipped to Ireland to be finished off due to the nutrient-rich waters around the coast. The oysters are then returned to France where they are sold as French oysters. Economic arrangements between Irish oyster producers and large French oyster companies have increased over the past decade or so. This is due to the limited sites for expansion in France where the industry is well-developed and has a long history of operating. It is also due to the relatively clean, nutrient-rich waters on the Irish coast where the necessary size and quality of meats required for the premium French market can be attained. The development of these transnational trade routes in oysters has prompted the tightening of monitoring and controls on the movement of shellfish.

A new EU directive was introduced in 2006 and brought into force in 2008 to control the movement of shellfish and the potential spread of disease. Oyster producers (as all shellfish producers) are now required to fill out a 'gatherer's handbook' to record each batch of oysters that leaves an area, for example. There is clearly a tension between increased economic trade and the heightened risk of disease transmission. This is identified in Clause 5 of the Directive (2006): ‘All disease control measures have an economic impact on aquaculture. Inadequate controls may lead to a spread of pathogens, which may cause major losses and compromise the animal health status of fish, molluscs and crustaceans used in Community aquaculture. On the other hand, over-regulation could place unnecessary restrictions on free trade.’ The question is whether a regulatory system can adequately control the movement of oysters (with potentially latent diseases) between different areas. In 2009–10, for example, an outbreak of the herpes virus was recorded in Ireland, with the source of the virus most likely traced to France, suggesting that the new system was not working effectively.

What these brief examples from the shellfish industry illustrate is that risks of contamination and/or disease are not uniform across the sector. While there may be a greater likelihood of biotoxins occurring in certain geographic areas along the coast, the risks of contaminated mussels being harvested and sold depends on other factors, such as economic demands on the producers and processors. Similarly, while the outbreak of disease in oysters is always going to depend on biological and environmental factors, the extent of the mortalities and the risks they pose for producers is shaped by the genetic selection of oysters, regulation and degree of movement between areas and the numbers of oysters cultivated.

The factors that generate risks in aquaculture production are not restricted to the environmental sphere but relate to economic decision-making and the development of production and supply chains; what is best commercially in the short term may not be best for the long-term interests of sustainable aquaculture. While the industry has become more professionalised, regulated and technically informed about fish and shellfish cultivation, new risks have arisen due to changes in the sector, particularly the increased integration of local sites of production and global seafood markets and the development of riskier forms of technology.

As well as investing in science and technology, and tightening regulation, other areas that could be worked on in this regard include developing support structures that enable producers and processors to be less exposed to economic pressures and demands. The risks taken by producers and processors are not necessarily due to negligence on their part. It is in the interests of the industry to make all efforts to ensure the welfare of their fish and the consumer. But, under pressure to cover costs, to expand production or supply a buyer in time, decisions may have to be taken that are not the most desirable from a risk-management point of view.

3.3.2 Uncertainty and Resilience

One of the challenges with managing environmental and health risks is that the environment is uncertain and unpredictable.[39] This has become evident in Ireland where, despite technical advances, fish farms around Ireland continue to be hit by unexpected problems; 'things are never boring', as one of the technical staff from Marine Harvest put it. Many of the more recent problems that have affected the aquaculture sector have not been predicted or even explained. These include the swarms of jellyfish that have begun appearing around the coast, the changes in reproduction habits of Pacific oysters, the high levels of mortality in certain salmon and oyster farms, and the appearance of viruses that were thought not to affect this part of the world. These unpredictable events fit within a more general narrative that points towards increasing environmental change associated with climate change—warming sea temperatures and acidification being two of the key trends associated with marine environments (Marine Institute, 2009).

In a context where environmental change can be assumed but the character of those changes cannot, greater attention has been given to forms of food production (and economic development in general) that are able to respond to and absorb disturbance. This has been called resilience (Holling *et al.*, 1998, Mitchell & Harris, 2012). Resilience applies to both social and ecological systems and reflects the need to develop flexible systems that manage for change, to see change as a part of any system, social or otherwise, and to expect the unexpected (Berkes & Folke, 2000, Folke, 2006). It is significant that larger industry players in the aquaculture sector have recognised the inherent 'riskiness' of aquaculture production and, as a result, the need to employ strategies to spread their risks.

MHI does not just rely on technical expertise to manage risks associated with salmon farming. Controlling multiple grow sites around the coast enables it to spread risk between farms and manage them in a more co-ordinated fashion. Whereas an individual fish farm will never be able to mitigate against unforeseen environmental problems, the spread of risk across different sites will ensure that there is a buffer against such risks. A spokesperson from Marine Harvest said: 'For example, two or three years ago we had a lot of jellyfish damage, we lost fish due to jellyfish. It doesn't necessarily affect the whole coast at the same time, but we had some farms that were badly affected, and we had some farms weren't affected at all. But if you have all your fish in one basket, or all your eggs in one basket, and something happens to them, it can wipe the whole business out.'

A similar logic is materialising in the oyster sector where larger operators are able to manage their supply from different producers. French companies are either directly buying up sites in Ireland or else financing Irish producers to take on and farm more

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[39] The understanding that science can establish the objective 'facts' about complex, multi-scalar ecosystems as a basis for policy-making has been challenged from within different disciplines—including ecosystems science, anthropology and sociology (Folke *et al.*, 2007, Holling *et al.*, 1998, Jasanoff, 2003, Leach *et al.*, 2005). At the same time, these positions do not necessarily result in the de-valuing of scientific expertise or an inability to mitigate and adapt to unpredictable events.

sites in order to spread the risk. Because the distribution of mortalities or HABs are so geographically concentrated, the company will be able to satisfy buyers in France regardless of what happens to individual producers (provided there is not a widespread disease or similar disaster).

The recognition that risk is an inherent part of fish farming in a context where consistency of supply is required by the market results in new economic arrangements between local producers and larger companies selling on to retailers in European and global markets. Effectively, this consists of spreading the risks by owning, operating or buying from a number of different sites around the coast. This means that larger companies that buy stock from small, individual producers can be less concerned with the particular environmental conditions that exist on those sites. If a problem happens, they are not directly affected, whereas if a fish farmer is only paid for what they produce, they continue to be vulnerable to environmental risks. Uncertainty is thus managed through a form of resilience—but one that applies mostly to the company rather than to the particular environments, fish farms and farmers where seafood is being produced.

A different approach to uncertainty and resilience shifts the focus to the primary producers and their capacities to respond to unexpected events—whether environmental (weather, pests) or economic (fall in prices). The uncertainty and changeability of the marine environment is not something new to those who work on the sea, whether as fishermen or fish farmers. Negotiating these changes is a large part of the skill they bring to their work. This skill can sometimes be overlooked but it is also celebrated by those who work with fish farmers and see their passion and knowledge. As one respondent from BIM put it:

> They're there every single day, they see the changes that happen there, they see the wild life that are there, they're the ones who identify when there is something strange going on, a new species, you know, an invasive species […] they're looking at their lines and going 'hang on a second, that's not meant to be here'. They're the ones who notice those things and we want to encourage that because they're farmers … they're the ones who are, you know, custodians of the bay—they're there to make a living but they also, they need to have a good environment to do their farming in and […]you cannot farm in a bad environment, it has to be good for your animals, for your products—so they are just as invested, probably more invested in having good environmental standards in an area […] than anybody is because they've got to live in it (BIM).

This account of fish farmers needs to be nuanced by recognising that fish farmers do not operate in a bubble. There are different kinds of fish farmers who are, to varying degrees, integrated into economic relationships that shape their farming practices and decision-making. Although it is in their interests to care for and sustain their environments, it is not always possible for them to do so. Rather than reinforcing ideal types of fish farmers as 'environmental stewards' or, conversely, fish farmers as short-term economic opportunists with little care for their environments, the focus should fall on the contexts, conditions and relationships that enable (or disable) fish farmers from being attentive to, and caring of, their environment.

Furthermore, the knowledge that fish farmers possess about their activity and environments is not limited to 'local' experience. While they necessarily work (and usually live) within particular environments, they are innovative in so far as they collect and adapt knowledge and technologies from other places. One shellfish farmer spoke of how he had learnt a new technique for bagging his mussels from a New Zealand mussel farmer when they were having a drink after an industry show in France. Such encounters are not unusual and have been facilitated in the past by state agencies such as BIM and the Marine Institute.

A salmon farmer who had worked for nearly thirty years on the same site had been involved from the beginning in designing and building special-purpose boats for use on the salmon farm. This was because the science and technology (and resources) were only just emerging and fish farmers and scientists had to experiment with different techniques, materials and resources they developed themselves. This salmon farmer and his crew continue to operate in a constant state of alert for equipment failure. They must also struggle against the vagaries of weather to carry out essential repairs, feed the fish and harvest as required. They are under constant pressure to try to get everything done within available weather windows, regardless of prevailing wave conditions. 'The sea is still the master,' he said. He emphasised the importance of local knowledge in using and caring for the equipment, as well as reading the weather in order to plan feeding, harvesting and monitoring of the fish. Recalling this attentiveness and skill seems particularly important in salmon farming where the tendency is towards replacing such labour with automatic technologies.

It is not just the knowledge of individual fish farmers that may be important for more resilient forms of aquaculture. When problems arise in aquaculture, immediate action is often required that draws on a range of local resources and *repertoires.*[40] This relies on the mobilisation of social networks and local resources that might not otherwise be possible if a farmer didn't live in an area, relationships with local residents were not good, or planning regulation was too rigid.

Over the past two years, AGD has probably been responsible for the most significant losses to the farmed salmon industry. Coming out of the blue as it did, the response had to be very swift from the industry. The virus stops the salmon feeding, which weakens the fish and also renders certain sea-lice treatments ineffective. The most effective treatment for AGD is to bathe the salmon in a freshwater bath for 2–3 hours. This requires finding a source of fresh water and transporting it to the farm site—a logistical, regulatory and engineering challenge that no one would be trained for. In two cases in Ireland, the problem was 'solved' by the quick actions of the fish-farm employees. However, access to the water was not carried out in accordance with planning regulations or, in one case, with the

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[40] A repertoire is the entire stock of skills, techniques and or devices used in a particular field or occupation.

prior permission of members of the local community. This has led to difficulties for the company involved as it has been forced to seek other (more expensive) sources of water and apply for foreshore licences to extract water. This experience ‘conveys the difficulty of control, the need to proceed in the face of substantial uncertainty, and the importance of dealing with diversity and reconciling conflict among people and groups who differ in values, interests, perspectives, power and the kinds of information they bring to situations’ (Folke *et al.*, 2007: 539). The extent to which environmental risks and problems are already dealt with on the ground through *ad hoc*, situated and sometimes collective responses points to the need to value these capacities rather than ignore or displace them through new technologies or an over-reliance on scientific expertise.[41]

In discussing the situated knowledge and skill of fish farmers, it is important not to create a false distinction between the ‘local’ knowledge of fish farmers and the ‘global’ knowledge of scientists. At the Daithi O’Murchú Marine Research Station (DOMMRC) in South-West Ireland, the researchers work closely with commercial fish farmers. Daniel, one of the scientists who works there, said that their work wouldn’t be possible without the collaboration of the fish farmers. This is partly made possible by the physical proximity of the research station to the fish farms, but also by years of working together and building up trust. This is formalised by having the fish farmers involved included on the board of the institute; ‘that way they feel like they are really part of the organisation and don’t feel used’, Daniel said. One of the benefits of this close relationship is that knowledge is exchanged between partners, rather than between experts and ‘lay’ people. Daniel thought it was a mistake to treat fish farmers merely as ‘data points’ from which ‘real’ science could then be extrapolated. By this he meant that fish farmers are too often enrolled to record information but not necessarily involved in designing research questions or contributing to the analysis of the data. He said that fish farmers more often know the scientific names for different species of marine organism as well as the colloquial ones. This is because they are as likely to read books to find out what is going on around them as rely on their ‘experience’. Through their own research and discussions with other fish farmers, they can have a sophisticated knowledge of the ecological factors shaping their activity. This includes being able to identify different algal blooms or diagnose different diseases in salmon.

While this attentiveness and commitment does not apply to all fish farmers, the lack of engagement with those to whom it does apply means that there is much that is missed in terms of identifying and understanding different problems—particularly in situating the problems within both economic and environmental contexts. For example, an oyster farmer I met connected the increased mortality in oysters to a virus that may have been triggered by higher than normal rainfalls and the inability

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41 Recent work in agricultural studies has shown that, where decision-making over production processes is vested in the farmer, and resources for production are locally sourced and mixed (in terms of inputs and outputs), farms are more resilient to shocks compared to farms that are more integrated into global supply chains and markets (van der Ploeg, 2013). The same can be applied to fish farms and, more generally, the fostering of local synergies in coastal areas.

to fallow out oyster-growing sites. While fallowing in oyster cultivation is not normal practice (and not thought to be detrimental to oyster health), he thought that the presence of old shell in the bay could have a detrimental effect. He also identified the fragility of the triploid oyster and the mixing of seed over the years from France as overall contributing factors.

The extent to which different forms of knowledge are blended to anticipate and manage environmental risks has been identified as one of the key characteristics of resilient governance (Landström *et al.*, 2011). This echoes the view of a salmon farmer who emphasised the need for technology, but technology that is environmentally appropriate and co-designed by the teams that work on the farms themselves. This does not necessarily align with the way technologies have been introduced on salmon farm sites, particularly those that are intended to improve efficiencies by reducing labour costs. The main issue here relates to the role of the fish farmer workers themselves and the extent to which their knowledge and experience is brought to bear in the production process. As has become clear with the recent outbreak of AGD, the importance and value of these workers is vital to an effective response to unexpected problems. While improved technologies and automation can help to regularise salmon farming and cut costs, they can also displace the local, situated knowledge of skilled workers and amplify the threat of risks arising in the process.

Chapter 4
Contestation and Decision-Making

4.1 Introduction

There appears to be broad agreement that the licensing process for aquaculture needs to be reformed in order to ensure greater security for fish farmers and greater transparency for the public. Such changes must be seen within a broader process of marine spatial planning as Ireland's coastal waters come under increasing pressure and demand for development. However, while there is consensus that the licensing system should be changed, there is not necessarily consensus on what these changes should consist of or how they can be implemented. These questions are important as they will largely determine how marine resources and territories are used and who benefits from them.

This chapter looks at two disputes over aquaculture licensing and development. The first concerns a licence that was granted for an oyster farm on a beach that is used as an amenity by those living in the area. This conflict thus relates to how coastal areas should be used and by whom. The second example looks more generally at disputes over salmon farms, with a particular focus on the Bord Iascaigh Mhara (BIM) application in Galway Bay. In this case the dispute relates more to the perceived risk and environmental impact associated with salmon farming. Both of these cases illustrate some of the limitations of existing licensing and marine planning processes.[42]

The first of these limitations is the over-emphasis on scientific expertise to address the concerns and differences that people may have regarding a proposed development. This ignores that social perceptions of risk are as much to do with trust in governing institutions as with the availability of information. The emphasis on environmental assessment and expert evidence can also reduce the decision-making process to arguments over technical details, while excluding other ways of valuing place and environment. Finally, disagreements over aquaculture

42 These two cases are particular examples that are not intended to represent the sector as a whole. However, the two examples do hold lessons that can be applied more generally to the licensing process and decision-making on new developments.

developments tend to be represented in polarised terms. Rather than discussing fish farming (or any development in the foreshore) in terms of ‘for’ or ‘against’, a more participative and constructive process could be fostered in which developers, fish farmers, local residents and communities and concerned groups could participate in the planning process from the beginning.

4.2 Licensing: Past, Present and Future

The aquaculture licensing process is one of the most important factors shaping the development of the sector. Commitments to review and reform the licensing process have been acknowledged in three key government policy documents:

- Feedback from the *Harnessing Our Ocean Wealth* consultation in 2012 found*:* ‘An effective licensing system was viewed by many submissions as the single most important contribution the public sector can make to the development of the marine sector. It was felt that such systems must be fit-for-purpose, quick, consistent, efficient and transparent in order to attract investment’ (DAFM, 2012: 61).

- In 2015, the Government’s *Food Wise 2025* strategy document identified the need to review the licensing system as a matter of priority. The first action point relating to the seafood sector states: ‘Commission an independent review of the existing aquaculture licensing system involving all key stakeholders, to identify the current shortcomings and bottlenecks (legislative, resource and logistical), to report by early 2016 and implement necessary changes to the aquaculture licensing system as a matter of priority’ (DAFM, 2015a: 96).

- Finally, the National Strategic Plan for Aquaculture also commits to removing the current licensing backlog and to reviewing and revising the licensing process (DAFM, 2015c).

Much of the current backlog of licences, and relative lack of new licences issued over the past eight years, can be traced back to a European Court of Justice (ECJ) ruling against the Irish Government in 2007 and the subsequent undertaking to bring Ireland into compliance with the Birds and Habitats Directives. This requires some explanation.

Most of the aquaculture that takes place in Ireland occurs close to shore. This has historically been due to cost, ease of access and shelter from prevailing winds and weather. Subsequent to many of these aquaculture sites being granted licences in the 1980s and 1990s, these coastal areas were designated as Special Areas of Conservation (SACs) or Special Protected Areas (SPAs) in accordance with the Birds and Habitats Directive signed by EC member countries in 1992 (European Commission, 2012a). The purpose of this legislation was to protect the most seriously threatened habitats and species across Europe. Together, the SACs (for habitats) and the SPAs (for birds) make up the Natura 2000 network of protected areas. There is no automatic exclusion of any economic activities in and around Natura 2000. Instead, human activities need to comply with the provisions outlined in Article 6 of the Habitats Directive to ensure that these activities are in line with the conservation objectives of Natura 2000 sites.

In December 2007, the ECJ ruled against the Irish Government for failing to fulfil its obligations under the Birds Directive. The ECJ upheld five complaints against the Irish State by the European Commission in relation to the designation and classification of Special Protection Areas for wild birds. The ECJ declared in case C418/04 that, by failing to take all the measures necessary to comply with Article 6(3) of Directive 92/43 (Habitats Directive) in respect of the authorisation of aquaculture programmes, Ireland had failed to fulfil its obligations under that Directive. Article 6(3) stipulates that all applications in Natura areas must be appropriately assessed for the purpose of environmental compliance with the EU Birds and Habitats Directives.

To comply with the EU Directives, the Irish Government agreed on a Roadmap to Compliance with the European Commission (DEHLG, 2009). Under direction from the Department of Agriculture, Fisheries and Food (DAFF), the Marine Institute and the National Parks and Wildlife Service (NPWS) began carrying out a comprehensive 'bay by bay' data-collection programme. The purpose was to record the baseline data from which conservation objectives and the criteria for appropriate assessments could be established for all new and existing developments within Natura areas (including aquaculture). This represents a significant financial, administrative and scientific investment by the State and is not yet complete after six years. Only after this process is complete can all new, renewal and review aquaculture applications be appropriately assessed for the purpose of ensuring compliance with the EU Birds and Habitats Directives. Once a particular bay has undergone appropriate assessment, however, new or existing developments (such as aquaculture) that take place in that bay can apply for a licence or have a licence renewed.

The result of all this is that almost no new licences were issued, and no existing licences renewed, between 2007 and 2013 (Table 4.1). It is estimated that 600 licences were blocked within the licensing process during this period as a result of the effective moratorium on developments in Natura areas until the State had carried out the Appropriate Assessments. There was a derogation made by the Irish Government so that existing licences were entitled to carry on with their activity if they were waiting for a renewal. However, this derogation did not allow existing licence-holders access to national or European grant aid or development funds. Only those fish farmers who held a 'full' licence, meaning a fully valid licence, were able to access these funds. According to one industry group, this has resulted in a loss of €60m in public and private investment in the industry (IFA). This lack of investment has been particularly hard on smaller operators and those suffering from biotoxin closures.

While the ECJ ruling and subsequent Roadmap to Compliance set back the development of the Irish aquaculture industry, one positive outcome is the considerable body of baseline environmental data the State now has relating to

Ireland's coastline. This will be important for the sustainable development and planning of the foreshore area,[43] not just in terms of aquaculture but offshore renewables, tourism and conservation objectives.

Table 4.1: Number of Licence Applications and Licences Issued, 2007–2014

	2007	2008	2009	2010	2011	2012	2013	2014	Total
Applications Received	57	24	106	106	123	62	99	140	717
Licenses Issued	11	2	4	3	6	16	108	94	244
Licenses Refused	1	1	0	0	0	0	0	2	4

4.2.1 Security of Tenure and Private Investment

Even before difficulties arose concerning compliance with the Birds Directive, there were problems with the aquaculture licensing system introduced under the 1997 Fisheries (Amendment) Act. These include: the complexity of the licensing process, the lack of adequate time-frames for licence applicants, and the inflexibility of the licence once it has been granted.

Aquaculture licensing is administered through the Aquaculture and Foreshore Management Division of the DAFM. The Minister for Agriculture, Food and the Marine provides the final determination on applications after they have gone through an in-house technical examination and been put out to consultation with up to 14 statutory agencies.[44] Depending on the type of aquaculture (finfish or shellfish) and where the development is to be located (inside an SAC or SPA), an Environmental Impact Assessment (compulsory in the case of applications for salmon farms) may be required. Once any additional requirements or amendments have been met, the licence is put out for one month's public consultation. Any objections are submitted to the Aquaculture Licensing Appeals Board (ALAB).

Although the application does not require feedback from all 14 of the statutory agencies, there is no limit on how long the application process should last. If an applicant doesn't provide all of the necessary documentation from the beginning

43 The foreshore is the land and seabed between the high water of ordinary or medium tides and the 12 nautical mile limit off the baseline (approx. 22.24km). This equates to 9.7 million acres or 36 per cent of Ireland's land area.

44 These include: Department of Agriculture, Food and the Marine (DAFM), BIM, the Marine Institute, the Sea Fisheries Protection Authority, National Parks and Wildlife Service, Údarás na Gaeltachta, Bord Fáilte, Commissioners of Irish Lights, Department of Transport, Department of Communications and Natural Resources, Department of Arts, Heritage and the Gaeltacht, Marine Survey Office, IFI, Environmental Protection Agency, An Taisce, and the relevant local authority and harbour authority.

(sufficient maps marking the site, information regarding the species, quantity, production, etc.), the process can be slowed down. Critics also point to the lack of any single person or agency driving the licensing process; while the minister signs off on the final application, this is only after it has been passed from one agency to another.

The licensing system has no mechanism for prioritising renewals of licences for aquaculture operators who run low-impact, well-sited operations and have a good track record. Thus, an entirely new application could be processed ahead of a licence renewal case. A further frustration for applicants is the lack of transparency in the licensing process. There is no way for an applicant to track the development of their submission, and there is no way for the different agencies involved to follow how the other agencies are progressing—whether they have looked at the application, for example, or even if they are intending to comment on an outstanding application.

Responding to this criticism, the National Strategic Plan (2015) has identified the need for an online data-management and information system. This would act as a central repository where the application and all additional documents/submissions could be uploaded and accessed by those involved. There have also been suggestions for an interactive mapping function so that existing aquaculture sites and sites marked out within pending applications can be identified more easily. This would also be of benefit to the public when applications go out to open consultation. In this sense, a more transparent, accountable decision-making process could also mean a more efficient one.

Much of the emphasis on speeding up the licensing process relates to the need for the aquaculture industry to have more certainty and security as regards planning and investing in the future. In other words, it is not just a lack of licensing that hampers development but uncertainty over how long a licence application will take. This extends to criticism of the 10-year limit on most licences before a renewal is required. This can work against long-term investment on the part of an individual fish farmer or company.

Concerns over security of tenure reflect one of the key features of licensing for activities carried out in the foreshore area, including aquaculture. Unlike land-based forms of private or exclusive tenure, there are no property rights to the marine territory or resources. This has been identified as an obstacle for attracting private investment and supporting economic development. In both Scotland and Norway (countries with a far more developed aquaculture sector), aquaculture licences effectively function as land-based private property rights; individual operators buy licences off the state at a considerably higher cost than in Ireland and the licence-holder is entitled to hold that licence provided they comply with government regulations (Phyne, 1996).[45] In a context where Ireland is trying to develop its

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45 This argument has also been made more broadly in relation to both Ireland's and Europe's strategies on marine spatial planning. In a consultation paper published by the Department of Environment, Community and Local Government in 2013, entitled 'A New Planning and Consent Architecture for Development in the Marine Area',

capacity for salmon farming by attracting private investment, the pressure to provide more secure licensing is strong.

At the same time as the industry calls for greater security in licensing, there are also calls for more flexibility. Licences issued in the 1980s and 1990s, for example, are no longer considered appropriate for fish farming, particularly in the case of salmon farming. At an everyday, practical level there are also complaints that current licences are too restricted in terms of what they allow a fish farmer to do in the event of environmental, economic or technical changes during the period they hold the licence. Allowing for more flexibility in the licensing conditions could support greater resilience in the sector. At the same time, it could allow for the encroachment of fish farming into areas with existing environmental and/or social uses.

4.2.2 Public Ownership and Participative Decision-Making

While the potential commercial value of Ireland's marine resources, particularly in relation to aquaculture, is undoubtedly one of the motivating reasons for proposed rationalisation of the licensing system, it must also be remembered that these marine territories and resources are in the public domain and therefore hold different, often competing uses and values. The vast majority of the foreshore is owned by the State and is thus a matter of public concern. 'It is effectively the biggest national park we have,' as one respondent from the Department put it. In this sense, it is clear that, beyond administrative improvements and efficiencies to the licensing system, there is also a challenge in providing a fair licensing system that allows for meaningful participation of the public, particularly those communities who are most affected by marine developments (Taisce, 2014).

This issue is identified in the Enablers Task Force Report on Marine Spatial Planning carried out on behalf of the Marine Co-ordination Group (DAFM, 2015b). In reference to stakeholder participation, they quote the Aarhus Convention (1998) as enshrining a number of rights of the public with regard to the environment, 'including the right of access to information, public participation in environmental decision-making, and access to justice in environmental matters' (*ibid.* 53). They go on to say that there are good reasons for going beyond the minimum mandatory requirements and for actively encouraging stakeholder participation in marine spatial planning. In this regard they quote the 2008 EU Roadmap on MSP: 'In order to achieve broad acceptance, ownership and support for implementation, it is

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a number of criticisms of the current foreshore legislation were identified, including the lack of co-ordinated planning and the lack of strict time limits on application determinations (DECLG, 2013). In 2014, the European Commission stated: 'Marine Spatial Planning allows improved understanding of the distribution of marine resources and offers investors greater certainty about potential economic development. With Maritime Spatial Planning (MSP) , operators will know what, where and for how long an activity can take place. MSP will also reduce existing over-regulation and administrative complexity. For instance, in some countries up to nine executive agencies need to be contacted before securing a permit for an offshore aquaculture site. Better coordination will speed up procedures which will generate economic gains. For instance by accelerating investments in offshore aquaculture or renewables by 1, 2 or 3 years, economic gains from €60 million to over €600 million could be generated by 2020' (EU COM Press Release 2014c).

important to involve all stakeholders, including coastal regions, at the earliest possible stage in the planning process. Stakeholder participation is also a source of knowledge that can significantly raise the quality of MSP' (*ibid*.).

There can be a conflict between meaningful public consultation (which necessarily takes time) and a more efficient, speedier licensing process capable of attracting private investment (which wants development projects to move forward as fast as possible). As one respondent from the DAFM said, 'There aren't many people knocking down the door to come salmon farming in Ireland over the last five or six years, right? So we could build all kinds of safeguards and very complicated processes [in the licensing system] but will it make us competitive in the market? So we have to sort of balance what we can do with what will actually deliver.' Striking the right balance will be crucial for gaining support for sustainable aquaculture projects. However, agreeing on what meaningful participation consists of and how it can be enabled is bound to be contested. Already, the lack of meaningful engagement with key stakeholders in the drafting of the National Strategic Plan for Aquaculture has been identified as a failing by some groups, thereby potentially weakening the effective authority of the plan when it is finalised (SWAN, 2015). Other approaches worth noting include community based resource management (see Box 4.1).

Box 4.1: Community-Based Resource Management (CBRM)

When considering different property regimes and institutional frameworks for allocating and managing resources, it should also be borne in mind that there are options beyond the private/public distinction. Since the 1990s, CBRM has emerged as a popular and mainstream policy alternative for governments around the world (Acheson, 2003, McCay & Acheson, 1990). Building on the work of Nobel-prize-winning economist Elinor Ostrom, the CBRM approach designs and supports institutional tools that enable resource-users to share and collectively manage the resources they rely on for their livelihoods (Ostrom, 1990).

Efforts to implement such models of resource management in Ireland have been underway for some years in the lobster fisheries. Oyster stocks and their fisheries are in some cases also managed under collective aquaculture licences issued by the DAFM. These licences are renewed every 10 years and part of the renewal condition is that a production and management plan for the relevant oyster bed be developed by a cooperative or group. In other areas, the management of oysters has been devolved to Co-operatives or Societies in Fishery Orders (FOs) under the Fisheries Act, 1959. These Orders effectively grant permanent rights of access to a co-op or group to cultivate oysters within the area covered by the Order—although the minister may revoke orders in certain circumstances. These FOs are administered by the Department of Communications, Energy and Natural Resources (DCENR). Oysters are also fished in areas not subject to FOs or aquaculture licence but as public fisheries, which include the oyster beds in Lough Swilly and the 'public' bed in Galway Bay.

While CBRM has mostly been implemented in small-scale, artisanal contexts, there are lessons that can be applied to the aquaculture sector as involving one activity taking place in a shared bay or coastal area. One of these lessons is the need to strengthen the participation of resource-users in decision-making over how resources are used within a broader set of parameters governing marine planning and regulation.

4.3 Aquaculture Developments in Dispute

Aquaculture developments can be framed in black and white terms ('for' or 'against'). In reality, the views held by people cover a more diverse and nuanced range of feelings, perspectives and opinions. At the same time, individuals interviewed for this report also expressed and defended different values associated with the environment, communities, livelihoods and places where they lived and worked.

The following section briefly describes two cases where disputes have arisen about aquaculture developments. The first concerns a licence that was granted for an oyster farm on Linsfort Beach, Lough Swilly, County Donegal. In this case the dispute centres on how decisions are made regarding public resources (in this case a beach). The second case focuses on the proposed Galway Bay 'Deep Sea' salmon farm and disputes regarding the perceived environmental risks associated with it. What is at stake in this case is how concerns about environmental risk are represented and addressed through the licensing process.

4.3.1 Linsfort Beach

In May 2014, Minister Simon Coveney approved an application for a new oyster farm on the shores of Lough Swilly in County Donegal. The application was made by a Donegal oyster farmer who already owns and operates two other sites in the area. A 42-acre site was approved, which is a relatively big oyster farm by Irish standards.[46] The application was to grow Pacific oysters by bag and trestle in the intertidal zone.

The developer started laying the first trestles on Linsfort Beach in June 2015. This was the first that local residents knew about the development; those with houses overlooking the beach thought at first that a new pier was being built. People who live locally, as well as those who visit, use the beach for walking, swimming and recreation; it is a picturesque, sandy beach.

Some of the people who use the beach regularly began to inquire about the trestles being laid out. They discovered that the licence was for a 42-acre oyster farm that would stretch between 1.2 and 2.5km down adjacent beaches. These metal structures and the presence of tractors working on the site were perceived by these residents as barriers to the safe use and enjoyment of the beach and water. After some investigation, these residents also discovered that the licence had already been approved and that the one-month window for public objection had closed.

A campaign to have the licence repealed began almost immediately. Led by local residents, the campaign has involved social and mainstream media—including the collection of 4,000 signatures. A case has been initiated against the Department for

[46] The initial application was for a site covering 162 acres.

breach of the 1998 aquaculture regulations, specifically sections 8.1, 9.1 and 19 of S.I. No. 236/1998. The campaigners also contend that the licence determination has contravened the Aarhus Convention, specifically 'the right to participate in environmental decision-making' and 'the right to review procedures to challenge public decisions that have been made'.

Under the 1998 Aquaculture (Licensing) Regulation, it is not a legal requirement to erect site notices for new developments. Instead, the licence application must be circulated in a local newspaper read by people in the relevant area. The application for the oyster farm was only published in the Thursday edition of the *Donegal Democrat* newspaper, which sells only around 80 to 100 copies in Inishowen. The *Donegal Democrat* is only approved for planning notices in the area of Manorcunningham in Inishowen, which is not where the development was planned for.

Even if people living in the area had seen the application in the newspaper, the information provided was vague. It only specified a site on Lough Swilly, but Lough Swilly covers an area of 150km^2, and is over 40km long and 8km wide. No one reading the notice would have been able to identify where the proposed development was going to take place. The address of the applicant was not published in the public notification either, nor the species of oyster being cultivated. This is of particular significance (as the campaign group learnt) because the Pacific oyster is known to be invasive and can displace the native oyster. The native oyster is already in decline in Lough Swilly and introducing more Pacific oysters to the lough could have an impact and accelerate its decline.

In order to be approved, the application for the oyster farm had to undergo a pre-screening Environmental Impact Assessment (EIA). This is carried out by the Marine Institute as part of the licensing process and is intended to establish whether a full EIA is necessary for the proposed development. The pre-screening for the oyster farm refers to an adjoining Natura 2000 site and makes reference to the invasive nature of the Pacific oyster. It recommends the use of sterile triploid oysters, although there is no such stipulation in the licence (DAFM, undated). Because the proposed development is not within the nearby SAC, the pre-screening EIA advises that there is no need for a full EIA.

The campaign group contest the conclusions of the pre-screening EIA. They argue that the oyster farm is within 1km of an SAC and in an area of sensitivity for the native oyster. Article 6 (3) of the Birds and Habitats Directive stipulates that any concern for potential effects on Natura 2000 sites is put at the forefront of any decision made in relation to proposed developments. They also feel that the oyster trestles and activities on the farm will have unknown impacts on '(i) human beings; (ii) flora; (iii) fauna; (iv) soil; (v) water; (vii) air; (viii) climate; (ix) the landscape; (x) the interaction between the beings and things listed in subparagraphs (i) to (ix); (xi) material assets; (xii) the cultural heritage' that were not adequately assessed through a pre-screening. Through a Freedom of Information request they have established that the pre-screening assessment that informed the licensing decision was carried out in one day.

These particular grievances of local residents are combined with a strong sense that they were deliberately excluded from the decision-making process that led to granting of the licence for the farm. This was repeatedly emphasised during a meeting with them: the feeling that the development and licensing process had been carried out behind their backs and that they were 'deprived of having any voice'.

The developer of the site confirmed that he had done 'everything by the book'. He already owned and operated two other oyster farms in the area and was 'simply trying to make a living'. In a newspaper article, he is quoted as saying that the farm would provide salaries for 21 workers (Harkin, 2015).[47] He had invested €300,000 to €400,000 in the new Lough Swilly development and thus was not willing to back down. He also claimed that the opposition came from 'outsiders' who didn't know what they were talking about and that they had gone about things the wrong way by 'spreading lies'. He also said that the oyster trestles did no damage and people could still appreciate the beach.

As the campaign has evolved, individuals and groups with little understanding of the specifics of the situation have sometimes resorted to strong and personal accusations through social and mainstream media. This has resulted in an escalation of the conflict, with a growing sense of acrimony and mistrust between those involved. The individuals I spoke to from the group regretted this development because for them it wasn't personal (they didn't know the developer) or about broader agendas. They simply felt that proper process wasn't adhered to by the Department and that as a result the beach they used and enjoyed was being given over to a private development.

Individuals involved with state agencies, the Department and the industry tended to support the position of the developer without knowing much about the situation. Yet the potential scale of the development and the site that was chosen (a public beach) would suggest that the concerns of local residents are at least justified. Although so-called 'outsiders' may have become involved through their support for the campaign, it is also evident that the people leading the campaign are individuals who live close to the beach and use it regularly. Unfortunately, the situation has reached a point where there is considerable mistrust between the two sides, making the possibility for constructive dialogue all the more difficult.

47 This is not accurate, though it is not clear if it was the developer or the journalist who made the mistake. The figure of 21 workers applies across all three of his farms. Furthermore, it is not likely that any new jobs would be created in the first two years of the development.

4.3.2 Salmon Farming: A Contested History

The development of salmon farming, both in Ireland and around the world, has met with more opposition than other forms of fish farming. This is primarily because of its greater impact on the surrounding environment, concerns about fish welfare, and perceived human health risks. At the same time, the development of salmon farming in Ireland is one of the key goals in the National Strategic Plan (2015). This is in line with an ongoing Government-backed project that involves BIM applying for licences (from the Department) for large, offshore sites for salmon farming on the West coast. This commitment to expanding salmon farming must be set against a backdrop of historically low levels of output achieved by the sector in Ireland. The demand for high-quality farmed salmon is projected to increase and Ireland appears well-situated to claim a share of that demand if more sites are licensed.

Despite the commercial benefits that could be derived from developing the sector, only one new licence for salmon farming has been granted over the past 13 years—and that licence was granted to Marine Harvest in September 2015 for a site off Shot Head in Bantry Bay.

In the early days of salmon farming in Ireland, one of the main concerns was pollution: nitrates and phosphates derived from uneaten feed and faeces, as well as the chemical residues from antibiotics and other treatments (Lowes, 2013b). There were also concerns among inshore fishermen that salmon farming would negatively affect the lobster, crab and other species that they targeted. Concerns about the visual impact of salmon farms and the risk of escapes (with the relatively unknown impact of farmed species of salmon on wild salmon stocks) were also raised (Box 4.2).

Box 4.2: The 'Greening' of Salmon Farming

Many of the concerns raised by opponents of salmon farming in the past have been addressed by regulatory authorities and the industry itself. Advances in understanding the impacts of salmon farming have led to significant changes in how sites are chosen, fish husbandry (stocking levels, sea-lice control, feed) and regular monitoring and tighter regulation (see (Marine Institute, 2007, 2015). This is particularly the case in Ireland where nearly all of the salmon produced meets international organic standards. Organically farmed salmon are only fed with approved natural ingredients from sustainable sources; they are reared in cages with lower densities of fish, and they are grown in high-energy sites so that they can be continuously flushed with clean water, preventing the build-up of parasites or pollutants.

Fish farms are more tightly regulated than before and regularly audited in terms of environment, food safety, navigation, fish health, water quality, health and safety, feed controls, residues, seabed quality and equipment standards, by eight different statutory organisations in Ireland. As the industry has become more professionalised, there has been a clear push to re-brand the farmed salmon product as high-quality, sustainable and dependent on a clean and healthy environment. Reflecting this commitment, Marine Harvest Ireland (MHI received the Aquaculture Stewardship Council (ASC) salmon standard certification in March 2015.[48] This is one of the highest international environmental and social sustainability standards in the fish farming sector. Despite the considerable improvements in salmon farming, environmental problems persist and opposition continues to be voiced.

Perhaps the most significant and as yet unresolved question regarding the impact of salmon farming on the environment is the relationship between sea lice and wild trout and salmon populations (Lowes, 2013a).

As discussed in the previous chapter, sea lice have proven a problem for salmon farmers because of their impact on growth levels and fish welfare. However, a secondary effect of high sea-lice numbers on farmed salmon is their potentially negative impact on wild salmon and trout smolts passing outside of the salmon cages (Gargan *et al.*, 2012, Inland Fisheries Ireland, 2013) (Box 4.3).

Scientists from Inland Fisheries Ireland (IFI), the state agency with responsibility for inland fisheries and sea angling, have made clear their concerns about the levels of sea lice and the mechanisms in place to control them. Since 2010 they have identified the inability of certain salmon farms in the West of Ireland to control sea lice during the critical spring period. As well as calling for tighter enforcement of sea-lice protocols and 'treatment-trigger levels', IFI has advised that salmon farms should not be located near the mouths of rivers or estuaries, where the risk of interaction between sea lice and migrating wild salmonids is increased. The development of offshore sites or sites located at an appropriate distance from the mouths of rivers (and outside the path of migrating salmonids) has thus been supported by IFI, the Marine Institute, BIM and the industry itself. Offshore sites also promise higher-energy sites, which promote better-quality fish and less problems with the accumulation of residues from the farm.

48 The standard was obtained for the site at Deenish Island in Ballinskelligs Bay, Co Kerry which is the first ASC salmon standard held by the company. Marine Harvest intend to achieve the ASC accreditation for all eight of the sites they currently operate in Ireland.

Box 4.3: The Contested History of Sea Lice and Salmon Farms

As the problem of sea lice and their interaction with wild salmonid (trout and salmon) stocks is a problem wherever salmon farming takes place, there is a considerable body of international research on the question (Jackson *et al.*, 2013a, Jackson *et al.*, 2013b). A definitive review of over 300 scientific publications by a team of international scientists from Norway, Scotland and Ireland on the effects sea lice can have on sea trout stocks was published in 2014 (Thorstad *et al.*, 2015).[49] The studies reviewed indicate that salmon farming increases the abundance of lice in marine habitats and that sea lice in intensively farmed areas have negatively affected wild sea-trout populations. The effects of sea lice on sea trout are increased marine mortality and reduced marine growth. This new study confirms the evidence collected since the early 1990s in Ireland regarding the impact of sea lice on wild sea-trout stocks, particularly in relation to the collapse of Connemara's sea-trout stocks (Gargan *et al.*, 2012).

While these conclusions are not really in doubt, there is less consensus on the *extent* to which increased levels of sea lice cause mortalities amongst wild trout and salmon, and the *efficacy* of existing measures taken to reduce or even eliminate this interaction. Following a sea-lice infestation and a resultant collapse in sea-trout stocks in Western fisheries during the early 1990s, sea-lice control protocols were introduced in the mid-1990s to control sea lice on salmon farms nationally. While there has been an improvement in sea-lice control recently, aided by lower stocking densities, fewer sites, and Single Bay Management, some locations remain a threat to wild salmonid stocks. This is largely due to their proximity to rivers and problems with maintaining farm lice levels at a level where they do not impact on wild fisheries. Monthly lice monitoring shows that sea-lice levels regularly breach protocol levels in certain areas, particularly Connemara where sea-lice levels are known to be consistently high.[50]

In 2012, under direction of the Department, BIM submitted an application for an offshore salmon farm in Galway Bay (BIM, 2012c, 2012b). This was intended to be the first of two licence applications made by the state agency for what it called a 'Deep Sea Project' for salmon farming[51] (BIM, 2015). It was the first time that a government agency had submitted an application for a salmon farm. The intention was that BIM would be the licence-holder and would franchise the farm out to a private company or consortium of companies (see F.N. 5). The aim of the initiative was to speed up the licensing process for salmon farming, attracting private investment while at the same time ensuring that the licence remained in state ownership and the development complied with strict social, environmental and economic conditions.

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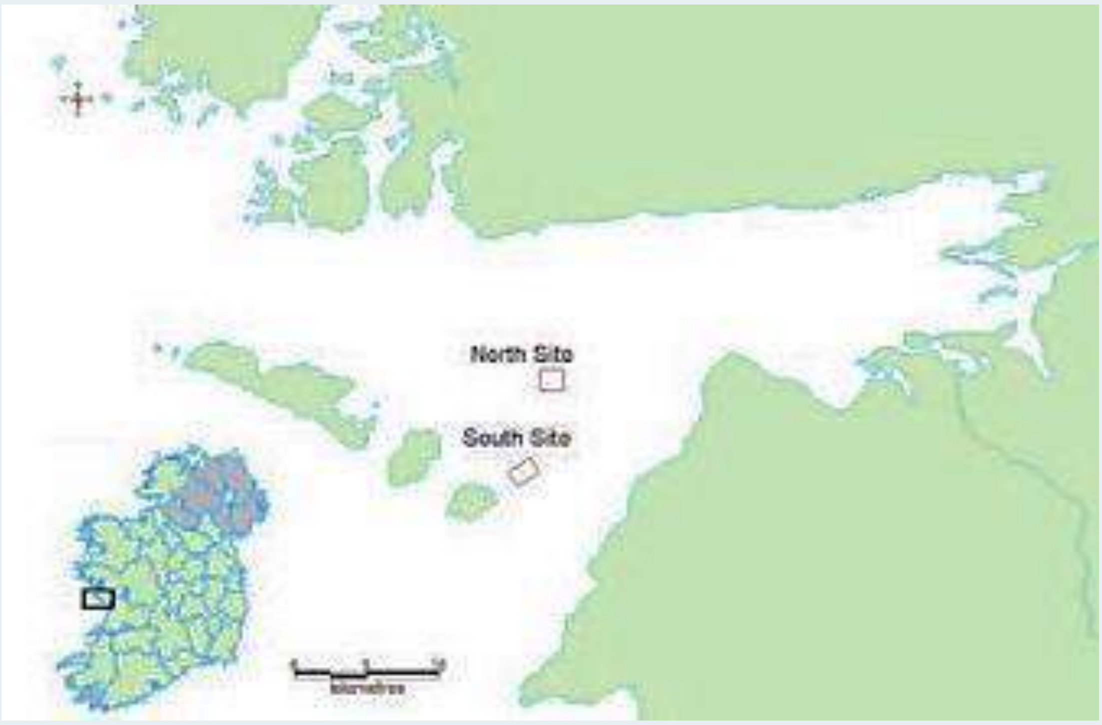
49 The project was funded by the Norwegian Seafood Research Fund, which invests in Norwegian seafood industry-based R&D with the objective of creating added value for the seafood industry.

50 This was communicated to me by a representative from IFI.

51 The second proposed site is off Inishturk, Co. Mayo.

The proposed development in Galway Bay was 1.7km from the nearest land mass—further out to sea than most other farms. It would be protected from the full force of south-westerly winds and seas by the protective barrier of the Aran Islands. The licence application was for 456 hectares spread over two sites. BIM stated that this relatively large area was necessary to minimise environmental impact and create optimal conditions for fish welfare; where a conventional farm allows for about 95 per cent water to 5 per cent fish, BIM's licence requires the operator to maintain a ratio of 99 per cent water to 1 per cent fish, to meet strict organic conditions. The scale of the farm was also necessary to attract private investment due to the high costs and risks involved. The scale was unprecedented, providing for a greater production tonnage of salmon in one location than is currently produced nationally. The proposal was for a farm harvesting 15,000 tonnes based in two sites in Galway Bay; the average production volume for farms currently in Ireland is between 2,000 and 4000 tonnes (Figure 4.1).[52]

Figure 4.1: Previously Proposed Galway Bay Salmon Farm, BIM



Source: http://www.bim.ie/our-work/projects/deep-sea-organic-salmon-farming/proposed-galway-bay-organic-salmon-farm/

52 The NSP for Aquaculture has set scale limits for offshore salmon farms at 5,000 tonnes. The decision by BIM to withdraw its application in December 2015 was due to these new guidelines.

IFI and its predecessors, the Central and Regional Fisheries Boards, have consistently sought the relocation of such farms away from river mouths. In this context, the proposal for a deep-sea salmon farm in a more offshore location was considered by the IFI to be a move in the right direction. However, in their submission on the Environmental Impact Statement (EIS), they made it clear that this new site and the scale of the project proposed had potential for negative impacts in terms of wild salmon and sea-trout stocks. They stated that the decision to apply for a development producing 15,000 tonnes of salmon was of 'very significant concern' due to the substantial jump in volume relative to other sites currently operating in Ireland (Inland Fisheries Ireland, 2012).

The EIS for the Galway Bay salmon farm admitted that there was a risk of sea lice from salmon farms adversely interacting with migrating salmonids. However, it concluded that there was little or no spatial overlap between the modelled distributions of sea-lice larvae from the proposed farm sites and the migration routes of Atlantic salmon smolts. The IFI submission disputed this, pointing to a lack of sufficient data provided and failure to reference the extensive literature on interactions of sea trout and salmon lice in Ireland. As well as pointing to the unresolved question of sea-lice control, the IFI submission also identified the threat of escapes from the proposed development. It highlighted the lack of literature cited on the negative interaction of farmed and wild salmon stocks and pointed to the increased risk due to the high volume of fish on the site. It concluded that '[e]ven an escape of 1% of the farm stock, numbering approximately 25,000 adult salmon, would outnumber all wild salmon in Galway Bay rivers and pose a serious threat' (Inland Fisheries Ireland, 2012). Finally, the IFI submission raised the possibility of invasive species due to the high number of smolts required for this development—3.6 million annually. Such a high number would likely involve importation of smolts from the UK, increasing the chance of invasive species being introduced.

The IFI was not the only body to criticise the proposed salmon farm in Galway Bay. As in the case of Linsfort Beach and the conflict over the oyster-farm development, different groups were drawn into the controversy, including environmental campaign groups that oppose the development of all salmon farms in Ireland; concerned local residents and fishermen, uncertain about the effects of the salmon farm, and those who question the scientific evidence and financial viability of such a development—including people working in the industry.

Those who defended the proposal pointed to the significance of the development for local employment; the scientific rigour of the EIS; the openness of the application process, and the exaggerated emphasis on the scale of the volume being produced. While significant in comparison to other Irish farms, it is necessary to expand production volume if Ireland is to catch up with developments in Norway and Scotland. Exacerbated by the media and concerns over a conflict of interests due to the role of a state agency in carrying out the application, the application for the farm remains undetermined and was highly contested (see F.N. 5).

4.4 Knowledge, Values and Process

Concerns about the aquaculture developments at Linsfort Beach and Galway Bay are specific to those sites and the proposed developments. But there are also themes and questions that emerge from the two cases that can be applied more generally to disputes over aquaculture developments. In drawing on these two examples, the intention is not to provide any judgement but rather to draw out some of these general themes. These not only relate to the concerns people have about aquaculture but the way these concerns are perceived to be included or not in the decision-making process. Too much faith is placed in scientific expertise and technical instruments (such as the EIA) to resolve conflicts that are ultimately about how environments and place are valued. A lack of trust and the extent of polarisation that characterises debates within the sector can place unrealistic (and counter-productive) demands on science to provide a 'neutral' judgement.

4.4.1 Social Perceptions of Risk

Scientific knowledge plays an important role in marine planning and aquaculture licensing. It is hoped, for example, that the considerable quantities of data gathered by the NPWS and Marine Institute in the course of carrying out the Appropriate Assessments for Natura 2000 will provide the basis for more rational, consensual and sustainable management of the foreshore. However, while there is no doubt that scientific evidence is necessary for decision-making, it is not always sufficient to allay the concerns that people may have about particular developments (European Commission, 2014c). This relates to the real and perceived risks associated with aquaculture and the extent to which people trust scientific, industry and state institutions to manage those risks in the best interests of the local area or wider public.

The proposed Galway Bay salmon farm raised concerns about the unprecedented scale of the development. Targeting an output of 15,000 tonnes of salmon across two adjacent sites, the farm would have been the largest open-cage salmon farm in Europe, and would have exceeded total salmon production across all existing farms in Ireland. While the EIS made clear that the site chosen in Galway Bay had sufficient carrying capacity, and that the infrastructures required for the farm would be of the highest standard, such reassurances do not necessarily satisfy the concerns of people.

Those who supported the new development and the scientific rigour of the EIS tended to dismiss these concerns as grounded in ignorance and 'perception'. They argued that the scale was necessary because of the costs involved and the difficulty (and cost) of managing a site so far from the mainland (particularly in the event of an outbreak of disease or other unexpected event); it had to be commercially viable if it was going to operate. Furthermore, it was suggested, Ireland had to increase its volume output to catch up with countries such as Norway and Scotland and the only way of doing this was through the licensing of larger, offshore sites.

For those who opposed the development, this kind of pragmatic, economic reasoning could contribute to, rather than diffuse, outstanding concerns. The express need to cater for private, commercial interests, while at the same time claiming to protect the environmental and/or public good appeared contradictory to some respondents. These respondents also pointed to the potential conflict of interests when the state agency for developing aquaculture (BIM) was being directed to carry out an application for a salmon farm by the Department that ultimately determines whether the development can go ahead. The sense that the EIS was geared towards 'assuring' the public of any concerns they might have in order to fast-track the salmon farm was also identified.[53] In their submission, the Friends of the Irish Environment (a grassroots environmental NGO) made this point by quoting the following extract from BIM's EIS: 'If a private company was to apply for the licence on the scale of the proposed unit, the public perception would potentially view the project as unwarranted; a private company would be severely limited in terms of delivering a convincing communications and fact-based reassurance programme required to support such an application' (BIM, 2012b: 18).

The unprecedented scale of the Galway Bay site did not just attract the concerns of environmental campaign groups. Individuals who have been involved in the salmon-farming industry for three decades expressed doubt about its financial viability due to the risks involved—for example, a severe algal bloom or attack of Amoebic Gill Disease (AGD) could inflict considerable losses on a farm producing that many salmon. One individual supported the decision to move offshore and increase the scale of salmon farming but was sceptical about the rigour of current regulatory systems and the extent to which BIM and the Department would regulate the company taking up the licence. Another individual who works as a technical advisor to the salmon industry expressed doubts as to the quality of the science underlying the EIS due to the lack of time and limited resources that BIM was given by the Department. That individual said that any company that took on the site in Galway Bay would undoubtedly carry out their own EIA to make sure the site was feasible. While the motivation for the BIM application was supported, the criticism came down to not trusting the science behind the project because of the way in which it was carried out.

The group opposing the Linsfort Beach development also mistrusted the pre-screening EIS. In their case, the lack of trust was exacerbated by their perceived exclusion from any public consultation. As well as being unwilling to see a public amenity that they use regularly transformed into a private development, they also have concerns about the impacts of the oyster farm on the local environment. These concerns include the danger the metal trestles might pose for seals, birds and even children; the impact of the Pacific oysters on native oyster stocks, and the possibility of old trestles and equipment being left behind on the beach after they have been used. While these concerns cannot always be articulated in scientific terms, this doesn't mean that they are not real. They are also a reflection of how

53 Submission to the EIS published by BIM in support of its application for Aquaculture and Foreshore Licences for a salmon farm in Galway Bay. Friends of the Irish Environment.

the governance process itself is perceived. Local residents involved in the campaign said that their sense of grievance and opposition to the development was amplified by their perceived exclusion from the licensing process. Because of this they did not trust the process and were thus anxious about what else might happen in the future regardless of what commitments were made by the developer and/or the Department.

In both cases, concerns about the aquaculture developments arise from a lack of trust in the licensing process, in the science behind the EIS and/or the commitments of government agencies and departments to ensure that criteria set out in the licence are complied with. These perceptions cannot just be addressed by the addition of more scientific information or stricter criteria. This is significant because often the institutional response to such concerns is to re-affirm the objectivity of science and a faith in regulatory bodies.[54] Such an approach can also give rise to a dismissal of those who may object to the development, downplaying the justified concerns that people may have. ‘I honestly don’t see a problem with it [Galway Bay development],’ an employee at BIM told me, ‘I think it’s more a perception issue and that it is so much bigger compared to what we’ve had before.’

Such distinctions between social ‘perception’ and the scientific evidence behind the development suggest that what is at issue is a lack of understanding on the part of those who object, an ‘information gap’ that needs to be filled. But the concerns that people have are not just a reflection of personal ignorance or a failure to engage with the ‘evidence’. They reflect a mistrust in the ability of technological systems and regulatory bodies to ensure the public good and/or account for all eventualities (Wynne, 1992). ‘In other words, it is increasingly accepted that the issues of public understanding of science, and of public risk perceptions, are not so much about public capabilities in understanding technical information, but about the trust and credibility they are prepared to invest in scientific spokespersons or institutions’ (Whatmore, 2009: 292).

The mistrust that people feel in the face of new (aquaculture) developments may be amplified when state institutions or industry bodies attempt to address local or popular concerns by providing *more* information or evidence supporting their plans. Sheila Jasanoff, a social scientist who has worked with policy-makers to change how scientific expertise interacts with society, has written about the need for greater *humility* in the methods and approach of science and technology (Jasanoff, 2003). These methods, she writes, must acknowledge and come to grips with the unknown and the uncontrollable, particularly in the context of large-scale (public) infrastructure projects. Acknowledging the limits of predictive modelling and control, these scientific practices of humility call for different forms of engagement between experts, decision-makers and the public than were considered necessary in the past. At the heart of this approach are the shared questions that we need to ask about every new development that intends to alter society and the environment: what is the purpose? who will lose out? who benefits? and how can we know? On

[54] This is not to suggest that scientific data and research are not central to decision-making.

all these points, there is good reason to believe that wider public engagement would improve our capacity for analysis and reflection.

There can be reluctance on the part of planners and policy-makers to actively involve the public in more participative and consultative roles when it comes to large-scale, technically sophisticated projects—such as the salmon farm in Galway Bay. In the aquaculture sector this is particularly sensitive due to the relatively small but vocal opposition that has blocked developments in the past. However, early and meaningful engagement with the public, particularly local residents and communities most affected by the development, can not only help to avoid the mistrust and antagonism generated through perceived exclusion, it can also potentially result in constructive dialogue and a more embedded, and thus resilient, development. As the Marine Co-orindation Group taskforce report on MSP states:

> Those who are likely to be most affected by marine management decisions are more likely to support MSP implementation if they are given full access to the evidence base for marine plans and have an opportunity to shape policies and management measures based on that evidence. In particular, they need to be involved in any consideration of potentially conflicting marine uses within a given area and of ways of resolving such conflicts.

In the case of Linsfort Beach, for example, it was the lack of transparency and the reluctance to engage with the local residents that intensified the conflict and further entrenched positions. A more open and participative engagement with local residents from the beginning might have averted this scenario and the long-drawn out, and potentially expensive, legal case that is now ensuing (Ertör & Ortega-Cerdà, 2015).

4.4.2 Assessing Environmental Impact

The two cases described so far reveal something else important about the relationships between science and governance. In both cases there are disagreements over what counts as environmental impact. At one level this leads to an over-emphasis on the scientific assessment process itself and a narrow focus on technical details that can be used to block or further the proposed development. At another level, the emphasis on what counts within pre-defined scientific parameters can exclude other ways of knowing and valuing the environment.

In the case of the Galway Bay salmon farm, there is no definitive consensus on the scientific data and analysis regarding the interactions between sea lice on farmed salmon and wild salmonids (BIM, 2012a). This is partly due to ongoing debates within the scientific community itself, as well as questions about the methodologies and analysis used for the EIA in Galway Bay. Even if further data collection and modelling could prove more definitively that there was no overlap between migrating salmonids and the sea lice from the farm site, other, unpredictable variables can come into play that undermine the ability of any EIS to speak with confidence about the sea-lice problem: the unprecedented number of caged fish, for example, or the possible outbreak of a disease that would adversely affect sea-lice control measures (in-feed treatments). These variables become more important when IFI claim that a 1 per cent reduction in salmon returning to their native rivers because of sea-lice mortality could be the crucial tipping point between having an open or closed fishery (Inland Fisheries Ireland, 2013). Combined with other concerns about the risk of escaped salmon, disease and impacts on marine life, campaign groups like Friends of the Irish Environment also focused on the insufficiency of the EIS for the Galway Bay application, calling for a new Strategic Environmental Assessment to be carried out.

Similarly, in the case of Linsfort Beach, the formal objection to the development identified weaknesses in the pre-screening for the EIA. The Marine Institute's pre-screening impact assessment concluded that the proposed oyster farm would likely have no significant impact, and that, because the proposed development is 1km outside of aSAC, there was no need to carry out a full assessment. The campaign group disagrees and points to two criteria used by the minister in justifying his determination in May 2014: 'the limited magnitude and extent of the direct impacts arising from the proposed aquaculture activity' and 'the low visual impact of the proposed aquaculture activity' (Coveney, 2014). In their submission to the Department, the group ask:

> What are the criteria and decision matrix which determines the magnitude and impact of licences? The level of public support for 'Save Linsfort Beach' would indicate that the magnitude and impact of this development is significant (over 4,000 people have signed a petition against this Licence). The scale of disruption is felt throughout the whole West Inishowen coast community and, also importantly, by the sizeable number of tourists who frequent the beach during summer months. With limited other amenities in the area beaches such as Linsfort Beach/Stragill Strand are key products in the regional tourism offering. This stretch of coast is also located along both the Wild Atlantic Way and the Inishowen 100 Tourism Routes.[55]

It is significant that objections to the two proposed aquaculture developments target perceived holes in the EIA (or pre-screening) in order to block the development going ahead. This has the effect of channelling more general concerns about the lack of transparency and participation in the licensing process, and potentially divergent social and environmental values, into a relatively narrow, technical domain defined by the terms of the EIA (Tovey, 2009). This emphasis on the EIA has consequences for how disputes over aquaculture developments are framed and negotiated.

The decision to grant a licence or not can hinge on who can mobilise more technical and legal expertise to support their position. Because the decision is seen to rest on scientific evidence (and compliance with national and European law), rather than being a political decision made in the best interests of local and national

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[55] Linsfort Oyster Farm Briefing provided by 'Save Linsfort Beach' campaign group.

development, there can be a de-valuing of the information and evidence presented as particular interests marshal what resources they can to obstruct or support a particular development (De Bruijn & Leijten, 2007). This has the effect of turning the decision-making process into a battle over technicalities as the Department seeks to justify decisions on the basis of science (and compliance with European legislation), rather than on the basis of collectively articulated values.

Related to this is the undermining of scientific expertise when it appears to be mobilised for particular interests. Different interpretations of the data are thus seen to reflect different interests, rather than bodies of knowledge that can inform constructive debate over what is more desirable from a social, environmental and economic point of view. The IFI, for example, is perceived to be close to the angling community, which has historically opposed fish farms, while the Marine Institute is perceived to be compromised by its role in sea-lice monitoring and control (Siggins, 2013).

Scientists interviewed for this report expressed their discomfort and frustration when decisions over particular developments were assumed to rely on their findings and advice. This level of responsibility was not only unwelcome but potentially undermined their credibility by drawing them and their work into what was unavoidably a political domain—the decision on whether or not to go ahead with an aquaculture development. Rather than calling on *more* science to resolve a contested development, these scientists suggested that responsibility had to be properly located in the political sphere, informed by scientific evidence and public consultation.

This relates to a further limitation of the EIA as a basis for decision-making: the question of what knowledge counts within the licensing process indicates that even before a decision might be made there is a conflict over what and whose knowledge counts?

For the campaign group at Linsfort Beach, the fact that the pre-screening EIA carried out by the Marine Institute was done in a day was taken as clear evidence that local residents and their opinions did not matter. The decision not to carry out a full EIA because the site was 1km from the SAC was perceived to reflect a rather rigid, top-down understanding of the local environment—how could anyone claim to know the impact of a 42-acre oyster farm on a place after only one day of assessment? Speaking to the local residents in Linsfort, it was clear that they knew a lot about their local area, both in terms of wildlife and weather conditions, as well as the architectural and cultural history. It was also a place that was overlaid with personal histories. But this knowledge and experience was not invited into the (pre-screening) environmental assessment.

The frustration that these campaigners felt over not having their voices included in the licensing process echoes some of the frustration that fish farmers themselves feel when they submit applications for licences. Several respondents from the industry pointed out the limitations of some licensing criteria that failed to account for the changeable, unpredictable contexts in which they operate.

In both cases the emphasis on technical criteria can exclude other qualities and values, such as the situated knowledge and experience that local fish farmers and residents possess because of their daily interaction with their environments. It is important to note that some scientists were also critical of the EIA in its current form—specifically, how it works off a baseline of data about the environment. Measuring environmental impact principally from a given baseline can result in a static understanding of ecosystem dynamics and inflexible criteria for new developments.

The limitations of the EIA (in its current form) as a tool for determining environmental impact raise challenging but important questions about how meaningful participation in environmental decision-making (as identified in the Aarhus Convention, for example) can take place when different ways of knowing and valuing the environment are understood to exist (Garavan, 2007). Making room for different ways of knowing within environmental governance is not easily achieved (Leach *et al.*, 2005). In practice, despite the various experiments in 'public participation' that have begun to accrue around environmental governance (particularly within the EU), regulatory institutions still operate in such a way as to 'invoke and thus reinforce' a boundary between science and other forms of knowledge. Unconventional forms of expertise cannot easily be accommodated in environmental governance without renegotiating the basic rules of decision-making (Long Martello & Jasanoff, 2004).

A starting point could be the recognition that all environmental knowledge arises from different *practices* of environmental engagement. This opens up the possibility of seeing different perspectives as tied to such practices, rather than 'correct' or 'incorrect' information about an unchanging 'nature'. For example, the methods and practices applied by a scientist during a pre-screening EIA on Linsfort Beach differ from the everyday, practical interactions that walkers or fish farmers have with that environment. The different understandings that arise are thus connected to these practices, practices that involve different relationships with the place. By adopting new practices, new understandings of the environment can be opened up and shared. Since the campaign to stop the oyster farm at Linsfort Beach began, for example, local residents have started learning about oyster farming and its potential impact on their environment. While this education has largely been peer-supported and self-guided (through online and documentary research), it has also been supported by experts in other fields, most notably a marine biologist with knowledge of the area.

The current licensing process for aquaculture includes a window of one month for public consultation after the licence has gone through the EIA and statutory consultation. A different approach would be to open up the EIA to other inputs from the beginning.[56] There is already some experience of this within the Irish

[56] This reflects the findings of the European Union's 2001 White Paper on Science and Governance. This drew on the activities of a working group on 'Democratizing Expertise', whose report promised new guidelines 'on the collection and use of expert advice in the Commission to provide for the accountability, plurality and integrity of the expertise used'.

aquaculture sector. Cairde na Mara (Friends of the Sea) was established in the Connemara Gaeltacht in 1991, for example, to provide a more consultative approach to dispute resolution. An association of 600 fishers and fish-farm workers, Cairde na Mara conducted surveys of coastal communities in conjunction with Údarás na Gaeltachta (the Gaeltacht Authority). The purpose of these surveys was to evaluate the impact of salmon aquaculture in a way that extended analysis beyond environmental impact statements and licensing processes that were found to exclude the community from coastal management. The idea was that resource-users should not be on the 'back-end' of an aquaculture planning process, with their participation limited to protests, public hearings and court cases (Phyne, 1997).

4.4.3 Beyond Polemics

Debates over the development of aquaculture in Ireland, particularly salmon farming, are frequently represented in black and white terms: there are those that are 'for' and those 'against'. As is often the case with such binaries, the reality is less clear-cut. There are different types and scales of aquaculture, just as there are different ways of reaching decisions on where, how much and for whom aquaculture should be developed. By turning the question of aquaculture development into a question of 'for' or 'against', these important differences and the potential for debate around them can be sidelined. This is not to suggest that divergent values and positions don't exist, but that these positions are not necessarily fixed or even entirely consistent; they can be worked on and negotiated. Polarising debates over aquaculture development can also lead to unhelpful simplifications of specific disputes and the people involved. This partly stems from a history of opposition within the sector but also a lack of institutional mechanisms for accommodating different positions and working out potential problems. Aquaculture projects can be developed that cut across assumed differences, but only if the necessary institutional supports and commitments are put in place.

The Galway Bay Salmon Farm project has been criticised for different reasons. Many of these criticisms are not insurmountable, nor do they point towards outright opposition to offshore salmon farming. Most of them relate to concerns about the environmental impact of the development. There are anti-salmon farming campaign groups who have sought to mobilise these specific concerns in order to generate support for their general goal of stopping all open-cage salmon farming in the country. It is this kind of generic, broad-brush campaign that people in the industry object to. They feel it unfairly typecasts all fish farming as environmentally harmful and fails to engage with advances in fish-farming practices and regulation. At the same time, the response from industry (and state agencies) also typecasts those who may have justified concerns about the particular salmon farm in Galway Bay as 'anti-aquaculture'.

A similar pattern is evident in the case of Linsfort Farm. The local residents made it clear that they were not against fish farming in general. They pointed out that 44 licences for aquaculture developments in their area had been granted in 2015. Their concern was that this particular site and development were not appropriate. They knew oysters were part of the social, economic and cultural fabric of the area. But these farms tend to be on mudflats, not on sandy beaches used by locals. Despite this important distinction, the people objecting to the farm have been typecast as ‘anti’ fish farming. This typecasting brings with it other assumptions that fail to properly engage with the specific concerns that the local residents have. For example, it was assumed that their main objection was to do with the farm ‘spoiling the view’; that they were ‘outsiders’; that they were ‘one or two troublemakers’; that they were ignorant about oyster farming, and even that they were looking for compensation. While many people support this campaign for different reasons, the problem with these generalisations is that they undermine the validity of the objection itself and the right of people to participate in environmental decision-making. The effect of this is to further entrench positions and turn the particular issue of this aquaculture development into a polarised debate over aquaculture in general.

One of the most common representations of disputes over aquaculture licences is the supposed opposition of jobs versus the environment. This can map on to other binaries, including local vs outsider—the assumption being that jobs are more important for ‘real’ locals than a scenic view enjoyed by people who don’t live and work in the area. Aquaculture is an important source of employment in coastal areas, particularly as it provides work all year round. However, the argument that any one opposing such developments is against jobs or development in the area has the implicit (or explicit) effect of closing down any opposition and making it harder to identify and work on alternative developments that might provide different kinds of jobs that are more socially acceptable and sustainable within the environment.

In the case of Linsfort Beach, the campaign sought to address the jobs and development argument by not only emphasising the scenic value of the beach on the Wild Atlantic Way, but also the importance of such sights for attracting tourism to the area. Their submission points to the 2012–2018 Donegal Development Plan, which supports both aquaculture development and the Wild Atlantic Way tourist initiative. The group argue that these two sources of development can and should take place together but that, in the case of the oyster development at Linsfort Beach, this is not happening. The group also point out that the number of jobs to be provided by the new oyster farm is not as high as people may think—while oyster farming is labour-intensive, the developer already operates two other farms and can rotate his workers between the sites. Tourism is not a solution but, as I will explore in more detail in the next chapter, alternatives do exist that can move the debate beyond either/or binaries. There are opportunities for productive relationships and synergies *between* the environment and aquaculture, private development and public benefit. But not all aquaculture developments fulfil this, and it is disingenuous to assume that commercially driven aquaculture will foster these broader social and environmental goals.

The term 'environmental impact' usually refers to potentially negative disturbances of aquaculture on a pre-existing 'natural' environment.[57] But examples also exist of unintended *positive* impacts that result from fish farming. In 2007, a salmon farm closed in Mulroy Bay due to problems with sea lice. A mussel farmer in the bay told me that growth on his mussels had declined dramatically as a result—rather than reaching full size in two years, they now took nearly three years—and his production had fallen from 900 to 500 tonnes a year. While this could have been because of other factors, it was likely that there was a positive relationship between the nitrates and phosphates escaping from the salmon farm and the increased growth rates of the mussels.

In the South-West of Ireland, a local man described a time he was fishing in Kerry with a friend. They were trying to catch mackerel for a local restaurant which had mackerel on their menu but hadn't been able to get any locally. They were not having any luck so they decided to go over to the salmon cages and fish near them. One of the men knew the workers on the salmon farm and they let him tie up the boat between the salmon cages. Not only did they catch enough mackerel for the restaurant, they also caught wrasse and pollack. The water column under the cages was full of fish because of the uneaten food and nutrients that fell through the cages, creating a small, nutrient-rich ecosystem for other fish. Significantly, the man said that, if the level of nutrients or uneaten food had been too high, everything below the cages would have been dead.

These anecdotes are intended merely to show how localised interactions between salmon farms, the ecosystem and other activities taking place in the area can invert the idea that outputs from a salmon farm are necessarily 'pollutants'. They suggest that the significance or value of something (like nitrates) depends on its *relationship* to other organisms and processes sharing the same territory. This is not to suggest that aquaculture is always benign or positive, but it can help move the debate beyond 'for' or 'against' on the basis that aquaculture is inherently 'good' or 'bad' vis-à-vis the environment, or the local community. The fact that these two examples of positive interactions between salmon farms and the local environment were unintentional raises the question of how resources could be shared, and activities co-ordinated, in an *intentional* manner for mutual benefit.

One of the key issues that arose from talking to respondents about conflict resolution was the lack of trust within the sector. When I suggested to a mussel farmer that it might be in his interests to situate his ropes near a salmon farm, he replied:

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[57] In 1995, John Joyce, a marine biologist and former chief executive of the Irish Salmon Growers Association (ISGA), wrote a children's book, *Captain Cockle and the Loch Ness Monster,* an allegory for the aquaculture industry and the disputes over its impact on the environment. A salmon farm on Loch Ness is targeted by protestors for polluting the loch and poisoning the fish. Closer inspection reveals that the salmon farm is partly responsible, but so too is run-off from a farm and sewage from a nearby hotel. This is only accepted after those involved come together to carry out experiments on the loch—facilitated by an outside scientist. By working together in this way they set about regulating the pollution into the loch for the benefit of all. The story continues to offer a useful reflection on the conflicted development of aquaculture.

> It is good and they'll grow very fat and all that but what we'd be afraid of is if somebody found something in the mussels. We don't know the safety and that. Technology is always moving on and don't ask me what that might be. The whole thing could blow up in the mussel farmer's face. So we're afraid of it for that reason. And I would certainly be afraid of that, the fear of the unknown. If I got the option of getting a load of sites next to salmon farming I know my fish would grow much, much faster, which they will, but I wouldn't take it at this present time.

This mussel farmer also recounted how a shellfish co-op he had been involved in setting up in his bay in the early 1990s had only lasted a year before relationships between individual farmers had broken down. The one lesson he gained from that experience, he said, was the value of an external mediator or facilitator. Because the shellfish farmers harboured historic differences, as well as concerns about who was carrying out what work and who was benefiting from it, there was need for an outside actor who could speak to all the farmers, allay concerns, communicate information and mediate differences.

Having an individual or organisation to facilitate cooperation, or debate in the case of a dispute, is important if the process is going to result in meaningful outcomes. On the other hand, exercises in publicity or promotion by those who have a clear interest in a particular outcome have little value in terms of generating constructive dialogue across differences. A salmon-farming company, for example, currently carries out scoping exercises in areas it has marked for potential new sites. This includes compiling and circulating attractive brochures to people living in the area, explaining what a salmon farm would potentially bring to the area. This is followed up by community meetings with particular groups that are willing to meet. In carrying out this exercise the company goes beyond any statutory requirement on public consultation. But this gesture towards consultation doesn't extend to holding public meetings that might explore how the company might adapt its plans to local needs and activities; a respondent from the company told me that they would avoid any town-hall-style meetings because of the potential for confrontation. In this sense, the motivation of the company is to inform people living in an area about their proposed operations. It is not to engage in open dialogue with those who have objections or those who may want greater local benefits to be generated by the development.

The management of the Irish coastline is characterised by the predominance of sectoral interests that in many cases pre-date aquaculture and disputes over its licensing (Phyne, 2009). If representatives of the aquaculture industry are to participate in effective environmental stewardship, they cannot focus only on their own commercial interests. Conversely, environmental groups and opposition campaign groups must recognise that jobs and livelihoods are necessary for an area to remain sustainable. On both sides, more effort needs to be made to move beyond historically defensive positions and the rehearsal of familiar arguments that can obstruct and obscure the potential for constructive dialogue. Facilitation and early, open consultation with all stakeholders can play an important role in this process (see Box 4.4 and Box 4.5).

Box 4.4: Historical Precedents in Coastal Zone Management

There have been efforts in the past to develop more integrated forms of inshore marine management with diverse benefits. These efforts have not always focused on fish farming. In the early 1990s, lobster co-operatives formed around the South-West and South-East of the country lobbied the Government to devolve management of the lobster fisheries to the co-ops (as happened in Maine in the United States in 1995). This could have formed the basis for wider co-operation within an area as the use of inshore waters by lobster fishermen would inevitably overlap with other uses, including those of fish farmers. In an article written in 1994, Dr Terence O'Carroll and Fergal Nolan make the point that well-managed lobster fisheries might even have more in common with aquaculture than 'wild' fishing. They reference Japan where no distinction is made between aquaculturalists and trawlermen: both are considered fishermen. They also outline how a devolved, co-operative model might work: 'The government assigns the co-op vast areas of water and the co-op then classifies the usage of the water so as to optimise production and also take into account the needs of *all* its members' (O'Carroll & Nolan, 1994: 23).

Around the same time (1995), Tony Fox, then chairman of the ISGA, gave a speech at the annual ISGA conference entitled: 'Wild fisheries and aquaculture—from conflict to co-operation' (Fox, 1995). In the speech he called for a 'revolutionary approach' to salmon and trout fisheries that would involve salmon farmers, game anglers, driftnet fishermen, scientists and government authorities coming together to develop a 'holistic' plan for the salmon and trout industries. This collective action would also involve working together to target common problems, such as pollution, under-funding and market prices. While this goal was never realised in full, the development of Single Bay Management (SBM) at this time did represent an important state-supported initiative for managing fish welfare co-operatively at a bay scale (O'Donohoe & Jackson, 2011). This management tool was designed because of the understanding that the problem of sea lice was best managed at a collective bay level, rather than at an individual level through costly chemical treatments with potentially negative environmental impacts.

SBM subsequently became the nucleus for CLAMS which developed in the late 1990s under the auspices of BIM (BIM, undated). Seeking to extend the co-operative model beyond salmon farming, CLAMS require all fish farmers in an area to co-ordinate environmental monitoring (BIM, 2003). Some CLAMS (as in Kilkieran CLAMS) are mainly in the hands of finfish producers; others have greater representation from shellfish farmers (such as Clew Bay CLAMS). The recommendations of a CLAMS group are advisory in nature; legislative authority remains with the DCMNR. The licensing of aquaculture sites is a DCMNR responsibility and the Marine Institute (a DCMNR body) conducts the monitoring of sea-lice levels on salmon farms. CLAMS provide for interested parties to have a consultative role in the drawing-up of aquaculture management plans. BIM insists that this participation is merely consultative, and cannot become a basis for launching criticism of aquaculture. Such criticism had been a feature of public hearings in the 1980s, as well as the disputes that developed in the 1990s (see (Phyne, 2009).

Box 4.5: The Bantry Bay Charter

The Bantry Bay Charter[58] is an example of how different interests and stakeholders in an area (Bantry Bay) came together to agree a common set of principles and strategies for guiding their own social, economic and environmental development. As with the rationale for SBM, the Bantry Bay Charter begins from the recognition that people and the environment in which they live are inter-related. For example, the charter's proposal on Water Quality Information & Monitoring cuts across a range of interests within the area, both on land and at sea: the tourism sector requires water quality that meets bathing water standards; the aquaculture and wild fisheries sectors require high water quality for fish reproduction, and local residents and visitors require clean water for consumption, which is looked at under the Waste Management proposal.

A notable feature of how the question of water management is discussed in this context is the involvement of local knowledge and experience, and engineering and scientific expertise, including representatives from both natural and social science. Fostering links between the biological and social science communities, local stakeholders, economists and policy advisors to better understand the role of socio-cultural issues in conflicts, their management within legal frameworks, and efforts towards their resolution, highlights the challenge (and investment) required for constructing practical transformations on the ground.[59]

The process behind the Bantry Bay Charter involved the financial and institutional support of state agencies, authorities and departments, in addition to European funding. Cork County Council led a team of three partners, including the Coastal Resource Centre (University College Cork) and the Nautical Enterprise Centre (Cork Regional Technical College), in undertaking the Bantry Bay Coastal Zone Charter Project. This was initially supported for three years as an EU LIFE Project. LIFE is an EU instrument for supporting the development of innovative actions for the environment. Many government departments, including the Department of Marine and Natural Resources and Department of Environment, were supportive in putting together the proposal for this project.

On the ground, the people who live and work around Bantry Bay and who participated in the process, invested considerable time and energy in meetings and roundtables in order to reach points of agreement across their differences. As the website states: 'The Charter was agreed through a process that involved several stages. This process required sustained hard work, patience, and commitment from all those involved. Given the diversity of interests and perspectives that were represented in the process, achieving an agreed management programme was not straightforward.'

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58 http://bantrybaycharter.ucc.ie/

59 The INTERCAFE project in the Po Delta in Italy engaged stakeholders with different perspectives on fisheries-cormorant interactions (Carss & Marzano, 2007). One of the findings of the Carss and Marzano study was that 'cormorant-fishery conflicts are an issue of major social, cultural and economic concern across Europe and so these essential non-biological factors must also be taken into account when formulating and implementing practical management policies based on scientific findings. It is evident that technical (scientific) solutions alone are not sufficient for environmental conflicts with social and economic dimensions' (*ibid.*: 2).

The commitment at local and government level required to sustain the Bantry Bay Charter continues after the charter itself has been drafted and agreed upon. If anything, the implementation of such strategies is where financial and institutional support becomes most crucial. Although beyond the remit of this project, two respondents with knowledge of the Bantry Bay Charter suggested that this commitment had not always been forthcoming and as a result the work and enthusiasm that had gone in to the charter had never been fully realised.

Chapter 5
Diverse Economies for Development

5.1 Introduction

A growing and valuable feature of Irish aquaculture (and agriculture) has been its ability to promote a 'green' image in global food markets. The relative absence of large-scale, intensive aquaculture operations and the unique environmental conditions on the Atlantic coastline contribute towards ensuring that Irish farmed seafood is amongst the highest-quality in the world. Thus, while Ireland falls behind in the quantity of seafood produced by aquaculture, it has been able to capture more market value through product differentiation. While this has only emerged recently (and unevenly) in the case of shellfish, Ireland's salmon industry pioneered the organic label and dominates the European organic farmed salmon market.

A clear strategy of the Government's *Food Wise 2025* strategy is to intensify and expand market differentiation for Irish quality-produced food through labelling schemes, such as the Organic standard, and quality assurance schemes, such as Origin Green (Bord Bia, 2015). On one hand, this appears to reward more sustainable, environmentally compliant producers through greater market access. On the other, the challenge of translating sustainable environmental aquaculture practices into globally recognised and accredited seafood products requires considerable resources, knowledge and access to new markets. This market-led strategy can thus reinforce the power of buyers and retailers at the expense of primary seafood producers in Ireland. While this policy is largely imposed on Ireland because of the small, internal market and the growing international demand for seafood, it is important to recognise that other models of economic development can and do exist alongside this.

This chapter provides a brief overview of the economic development of the three aquaculture sectors, outlines some of the limitations of market-led development and identifies why a more diverse economic model can be socially, economically and environmentally beneficial.

5.2 Overview

One of the attractions of aquaculture is that it is an indigenous industry based in coastal areas. It relies on the nutrient-rich, energy-intense Atlantic and provides livelihoods for fish farmers who produce high-quality seafood. Unlike other industries, it cannot easily be moved elsewhere. Ireland's relatively pristine environment is thus a key selling point in a context where consumers are increasingly seeking out environmentally sustainable food. At the same time, this also illustrates the extent to which local sites of production are tied to non-local sites of consumption—markets in Europe, Asia and the North America. As one respondent from the DAFM put it succinctly:

> The sector in itself, while operating at a very local level, has lots of global connections and global drivers, market and otherwise, so you've got to take that whole perspective. If you try and see where aquaculture will go, what will be the issues, what will be the issues for Ireland, it may be very local but it's very global in the way it's traded and the way the knowledge transfers.

Historically, Ireland's aquaculture and seafood industry has depended on export markets. This has meant that primary producers (the fish farmers) are price-takers, selling in bulk to large, continental buyers who in turn sell on to large retailers. Not only does this mean that much of the value is captured further downstream, by the buyers and retailers, but also that Irish farmed seafood has been indistinguishable from other farmed seafood.

With the help of Bord Iascaigh Mhara (BIM) and other state agencies, this situation has been changing as the Irish food industry seeks to position itself as a producer of premium-quality, environmentally sustainable food, able to command higher prices for Irish producers and processors. However, the translation of environmentally sustainable fish farming practices and provenance into commodity markets involves new intermediaries and knowledge that shape the relationships between fish farmers around the coast of Ireland and consumers around the world.

Nor are these new global connections experienced equally by the different actors involved. There are considerable differences across the aquaculture sector in terms of scale of production, level of market integration, model of ownership, distribution of value, and even the nature of work that is involved; for example, while the salmon-farming sector produces most value, the shellfish aquaculture provides a greater number of jobs. There are also important differences between seafood companies, processors/factories, and the actual fish farms where fish and shellfish are cultivated, even as these different sites are increasingly integrated within European and global seafood markets.

There are currently 850 licensed operations in Ireland, covering 2,000 sites. These are predominantly shellfish producers. The sector continues to be dominated by small enterprises—in 2012, 68 per cent of Irish aquaculture enterprises had fewer than five employees—but the structure of the industry is changing. The salmon-farming sector has undergone a series of changes in ownership over the past 15 years and is now dominated by Marine Harvest Ireland (MHI). The mussel and oyster sectors have not seen the same level of consolidation but private investment and acquisition from France and Holland represents a similar tendency in terms of the growing integration of farms into global production and supply chains.

One of the consequences of greater market integration is that the Irish aquaculture industry has been able to capture more market value for the seafood that it produces. Despite a negligible increase in total volume output over the past 20 years, the market value generated has nearly doubled (Table 5.1). At the same time, the numbers employed on production sites have more than halved. These figures reveal a shift in emphasis within the sector, away from supply-side, production-led development towards a more market-led model of development. As a respondent from the Department of Agriculture, Food and the Marine (DAFM) succinctly put it, 'It isn't all about the primary production. In fact, to many extents it's not about the primary production at all, it's what we do with it' (DAFM). While this shift echoes transformations within the seafood and agrifood sectors more generally, it has arguably been more marked within aquaculture. This has largely been forced on the industry as it has had to respond to the historic lack of capital investment and new licences issued, difficulties with stabilising rates of production, and competition from overseas, particularly Norway and Scotland. Innovative fish farmers and companies, with the support of state agencies such as BIM, have been able to survive under these conditions by, on the one hand, differentiating their product in the market, and on the other, relying on local support networks and resources.

Table 5.1: The Irish Aquaculture Industry: 1994–2014

	1994	2014
FTE employed	1,911	941
Volume tonnes	28, 612	31, 600
Value (millions)	62	116

Source: BIM

5.2.1 Mussels

Ireland is a marginal player in the European market where mussel farming is concerned. Spain, the Netherlands, France and Denmark are the four largest producers of mussels by volume. In the 2000s, Ireland's bottom mussel sector did very well, partly due to investment from the Dutch mussel farming industry, the largest in Europe (Phyne, 2009). In the mid-2000s, production volumes even surpassed the farmed salmon sector, reaching a peak of nearly 30,000 tonnes in 2003, only to drop to 3,200 in 2014. Bottom mussels grown here and around Europe supply five or six large, well-established buyers in Yerseke, Netherlands. These buyers have substantial relaying plots where they can hold stock, and then react to the market. Growing demand for the food service mussel sector in Europe thus saw Ireland become something of a 'growing outpost', as one respondent called it, for the supply chain into the European market. As mentioned, the decline in bottom mussel production over the past several years has largely been due to limited supplies of mussel spat in the Irish Sea.

The rope mussel industry emerged after state-supported trials of raft culture in Killary Harbour in the 1970s. Raft culture was replaced by long-line technology in the 1990s. With this method, mussels were put in 'socks' that were then attached to long lines suspended in a bay. The technique was further refined with wild mussel spat simply collecting on specially chosen ropes in the springtime.

Rope-mussel operators are mostly small-scale owner-operators with few employees, though there have been some larger concerns such as Bantry Bay Seafoods (BBS). This company owned grow-out sites in the South-West and a processing plant in Bantry before it closed in 2009. The closure of BBS meant that mussel growers in the region (and in other parts of Ireland) relied once again on selling in bulk to large French buyers (Box 5.1).

The fresh-mussel market in France absorbs the vast majority of Ireland's production of rope-grown mussels but secures the lowest price for producers. Irish growers tend to deal with a handful of large importing companies that in turn sell the product to a retail market dominated by five firms (Phyne, 2009). Irish producers are at an obvious disadvantage; they are unable to match the volumes and same-day deliveries of their competitors in Europe. One respondent claimed that mussel farmers got roughly the same price today as they did 15 years ago. BIM has sought to address this situation by adding value to Irish-produced mussels, such as organic certification. However, these initiatives have proven hard to implement and continue to rely on the intermediaries that control distribution channels in the French market. Because of their reliance on French and Dutch buyers and their routes to market, mussel growers have found it hard to become more involved in marketing their own product.

For example, Premier in the Netherlands buys a large amount of mussels from Ireland. They buy organically certified mussels and regular mussels but in the past have not differentiated between them. In response, BIM approached Premier to encourage them to create a new product line for organic mussels with their retail outlets. The idea is that Premier can push the French multinational retailer Carrefour, for example, to open up a new consumer line for organic mussels and sell them at a slightly higher price. If this product line takes off with French consumers, Irish organic mussel producers will potentially be able to secure that market through Premier. There is now a 'Bio' mussel range in the large French retailers and Premier have paid €100,000 to get a new machine to take in rope-grown organic mussels (rather than bottom-grown mussels that do not have the organic accreditation). It remains to be seen whether Irish mussel growers with the organic standard will benefit from this arrangement.

Although rope-mussel growing does not involve the same level of inputs in terms of feed, infrastructure or equipment, the little investment that is required and the difficulty of making it economically viable have meant that consolidation has been happening within the sector. Larger mussel growers/companies may make formal or informal agreements with smaller mussel growers in a bay or area (the licence-holders). These might entail a small payment or cut of the profits going to the smaller growers, while the larger operator manages the farms, harvests the mussels and sells them. One of the main reasons for this type of arrangement is the economies of scale involved in the machinery used for harvesting. Because this machinery is only used for a small number of weeks in the year, the cost of owning it can be prohibitive for a smaller farmer. A person or company that has invested in this equipment can thus take on managing and harvesting mussels in an area and simply employ people for that period of time. Other ways of getting around this problem include renting out the harvesting boat and equipment to other operators during the year; one mussel farmer in Donegal, for example, rents his machinery to a Scottish fish farm for most of the year to cover his costs.

Box 5.1: A Mussel Farmer

Like many fish farmers, Joe has been cultivating mussels for over twenty years. At first he was involved in capture-fishing and mussel-farming. In the early 2000s he was able to focus on mussel-farming entirely because he leased a nearby farm from a neighbour. This brought production from 80 or 90 tonnes up to 260, which is enough to make a living. But this only lasted for six years as the son of the licence-holder eventually took back the running of his father's site. Without any options in the area, Joe was forced to work abroad on aquaculture sites.

In an effort to find a more sustainable, long-term solution, and to continue the work he loved (mussel-farming) in an area he wants to live in with his family, Joe took the decision to market his mussels. At first he participated in a BIM-supported programme to have his mussels labelled organic. This built on existing schemes, such as the Irish Quality Assured mussel; criteria focus on environmentally friendly farming practices, such as waste disposal. However, the French buyer he sold to was not interested in organic as he sells Irish mussels in bulk to French retailers who are only interested in price. Joe said: 'We went to our buyers and they were rolling around the floor laughing at us.' More important for the buyers was the Class A waters that Joe grows his mussels in; this means his mussels do not have to go through any processing (depuration). The quality of the water is not even included in the organic accreditation scheme because the class of water is beyond the control of any one mussel farmer or even group of mussel farmers. Illustrating the extent to which such buyers have control over the producers, the French mussel buyer told Joe: 'If you lose your class A certification, for whatever reason, it doesn't matter, I'm going to move on to the next fella with class A. You know it is as simple as that.'

Rather than trying to differentiate his mussels, Joe decided to turn his mussels into a new seafood product. With the help of the Seafood Development Centre (SDC) in Clonakilty, Co Cork, he created a convenience food product based on a family recipe. The product is on sale in certain Irish retailers but will require additional investment to expand and enter the European market. While he was full of praise for the SDC and Enterprise Ireland in developing the

product and getting it to a market-ready stage, the difficulty of turning this into a viable enterprise is starkly apparent.

To begin with, the equipment required to process the mussels is not available in Ireland. This means he has to send the raw mussels to the Netherlands where they are processed and packaged to specification before being sent back to Ireland for sale. Realistically, due to the low demand for shellfish in Ireland, the product will have to access UK and continental markets to make it commercially viable. Access to such markets requires accreditation and quality assurance, provided through schemes such as Origin Green (which Joe has recently secured). However, it also requires significant financial investment to increase production and develop routes to market, something Joe was all too aware of: 'It's totally scale-dependent, because the retailing industry is not very profitable. Margins are very tight and the retailers are probably always at war with each other pricewise … so you're talking about a serious scale before you make a profit.' This requires entering into an agreement with a seafood company which will package the product under their own label and harness their supply chains and retail partners. Joe said:

> **We will have to sacrifice our brand if we want to move forward. Because the two guys we're talking to at the moment, they're saying, oh that's brilliant, lovely, brilliant and all that but we will be using our own brand … we were prepared for that eventuality but we're still quite happy at this stage. I wouldn't say quite happy but we know that's just life, we just have to sacrifice that. And if we can make a living out of it then so what, you know that's really the bottom line.**

What this will mean for Joe is unclear. What is clear, however, is that after all of his hard work and commitment, not only in producing high-quality mussels but also his innovation in developing a market-ready product, the commercial reward he will receive continues to depend on much larger companies.

5.2.2 Oysters

Irish oyster growers have been doing well in recent years due to the high quality of their product and new market opportunities that have arisen as a result of production difficulties in France; French production fell 37 per cent from 126,000 tonnes in 2006 to 79,000 tonnes in 2013 as a result of disease-related oyster mortalities. However, as with mussels, the oyster sector suffers from a dependency on large French buyers: 86 per cent of all oysters grown in Ireland go directly to France, and, out of that 86 per cent, about 99 per cent go in bulk format, packaged in France and rebranded as French oysters (BIM, 2015).

Compared to France, Ireland produces a very small volume of oysters; about 8,000 tonnes as opposed to 140,000 tonnes in France (BIM, 2015). Largely due to the nutrient-rich waters of the Atlantic and the relatively low-intensity shellfish cultivation that takes place, Irish oysters are acknowledged within the industry as producing good-sized meats and high-quality oysters. Until recently, however, there has been little or no recognition of this in the retail market (Box 5.2).

Over the past five years, several of the larger Irish oyster-producing companies have sought to explore new markets for their product in order to escape the dependence on French markets and buyers. Developing new routes to international markets, largely in Asia, has required a strategic shift from offering bulk, non-purified oysters to packed, purified and Irish-branded oysters.

While one or two Irish oyster companies have managed to develop these new markets independently, they have also benefitted from a BIM initiative to build greater scale amongst oyster producers from a sales and marketing perspective. The Asia Oyster Group has brought together five of the largest oyster-producing companies in the country to share the administrative and logistical burden of selling to Asian markets and to develop better brand awareness in these emerging markets. Hong Kong was the first market that opened to European food products as affluent consumers sought high-end imported products. Shanghai and Beijing have now followed suit. This is an example of what the Government's *Food Harvest 2020* report calls 'Co-opetition': 'Co-opetition refers to the strategic decision of companies to work cooperatively in markets where pooling resources would be most effective, while remaining competitors in markets where this remains a pragmatic option' (DAFF, 2010: 6).

The need for scale reflects the cost of air-freighting oysters to Asia, as well as the cost and effort of negotiating food safety standards and other regulatory requirements. The five companies together are able to air-freight between 500 and 1,000 tonnes of oysters under one contract. They are also working on sending the product to one distributor in China, which will then redistribute it, reducing costs by 20–30 per cent. With the help of Bord Bía and Enterprise Ireland (which have offices in Shanghai), BIM was able to support the five oyster companies in dealing with these challenges, as well as helping them to design their own individual brands (including websites) for their oysters under the generic Irish mark of Origin Green—the idea being modelled on a wine region such as Champagne that has various vineyards with their own distinct qualities producing and selling within it. As a respondent in BIM said:

> So what we did was try to bring four or five of the producers together and say well guys, if you come together we can sort of assist you much better and you don't need to be competing with each other here. The competition is against France and other food products. You need to try and get some sort of an identity for each of your brands. So the first part of the project was creating a brand for each of the producers, because they didn't have websites, they never use Facebook, never would use Twitter, would never think of business cards, brochures, all that—because they're coming from a grower's background, they're basically, they're farmers, so this is all new.

The Asia Oyster Group only started up in 2015 but have already doubled their sales to China. The group have also agreed to hold their price at €8.50 per kg. Such price-fixing is allowed when dealing with a non-European market. According to a respondent in BIM, the challenge going forward will be to get the group to work closer together by establishing greater trust and getting over the idea that they are competing against one another.

There are roughly eight big oyster companies in Ireland, controlling 70–80 per cent of the total production. The five companies involved in this initiative all fall within this bracket. These companies are already at a scale that allows them to employ 30–40 staff, including in the areas of administrative and marketing, as well as workers across multiple oyster sites. They also have premises for processing and packing their oysters. Most oyster farmers in Ireland are not at this scale and will not be able to set up similar marketing groups. BIM are now trying to funnel the other growers into supplying raw material to one of these five companies, which are now establishing routes to market and brand recognition.

As a result of the good growing conditions and availability of sites in Ireland, there has been growing interest from large French oyster companies in further integrating and buying up Irish grow sites. This is also a reflection of the limited, costly and vulnerable (to disease) areas for oyster production in France; a two-hectare site in France to carry out oyster production might cost about €100,000. As a respondent from BIM put it:

> So from their perspective, coming over to Ireland, they see a lot of what was relatively dormant capacity, because the returns had been poor and the rate of growth in the industry had been actually very slow. So there was a lot of space that was licensed, but nobody was doing very much in it. And from the perspective of a French guy who can't get space in France, it's either impossibly expensive or just isn't available, they see this as a new frontier for them to grow in the other direction. They can't grow their production in France, but they can find real estate in Ireland that they see as quite reasonable.

New arrangements are thus arising between French companies and Irish oyster growers. These new relationships do not necessarily follow a consistent pattern. It might involve a 'bed and breakfast' situation where oysters are grown to a certain size in France and then finished off in Ireland (where growing conditions are better) before being shipped back to France where they are sold as French oysters. It may involve a French buyer arranging to buy an Irish producer's entire yield at an agreed price; a French company leasing a site from an oyster farmer and operating it themselves; or it may involve investment by a French company in an Irish grower to expand their production into new sites.

Box 5.2: An Oyster Farmer

Tom is a second-generation oyster farmer in the North-West. His father began with 13 trestles in 1980. From 1987–2000 there wasn't that much money to be made. After 2000, the company began developing its own branding, packaging and marketing, and from this point on began making money. Today the company is one of the eight big producers selling directly to Asia as part of the Asia Oyster Group. Tom has about 20 people on the books, two factories, and, when the production sites are full, about €2m worth of oysters growing on about 6,500 trestles (5 bags a trestle).

Tom said there was good money to be made in oysters. The problem was that the supply was so uncertain. This uncertainty has been growing over the past five or six years and is due to the unexpected outbreak of diseases. The mortalities that hit the North-West in 2015 come after significant losses three years ago. These hits can be absorbed by companies like Tom's, but not if they start happening more regularly; another bad year and he would be in trouble. In July and August, before the harvest happens, he has sleepless nights, he said, as he waits to see if he has lost many oysters to disease.

The flip side of the high mortalities (in Ireland and France) is that the price for oysters has doubled over the past 5–6 years. If you can secure supply, there is a lot of money to be made. Tom said that a €2m turnover might give you €0.5m in profits. This has led to a 'goldrush' in some areas, he said, but also big losses. French oyster companies have been buying up sites in the North-West, as well as investing in Irish oyster growers to expand their production. A friend and local oyster producer he knows was offered €1m for his 30ha site by one of the largest French oyster companies. The site produces about 25 tonnes of oysters a year.

When I asked him whether he thought it was a bad thing that French producers were buying up and investing in Irish oyster sites, he felt it was, but couldn't put his finger on why. He felt the local connection was still important. If the licences were all French-owned, or Irish producers were entirely dependent on the French companies, then the only thing coming into the local economy would be relatively low wages for the people who were doing the physical labour of cultivating the oysters—all the profits would go back to France. This arrangement also shifted the risk onto Irish producers: if there was an outbreak of disease in one bay, the French company could still ensure supply from elsewhere. Finally, he felt that the presence of locally owned oyster companies like his meant something for the area beyond just the additional economic value that remained there. He regretted that he didn't get down to his farm sites as much as he wanted but he still knew what was going on. He also had connections with the town and local area and supported local businesses and events by supplying oysters.

5.2.3 Salmon

Salmon farming in Ireland began in the 1980s, roughly the same time as in Scotland and Norway. From the beginning, Ireland produced smaller volumes than its two main competitors and the gap has widened. By the end of the 20th century, Norway and Chile (a new arrival) controlled nearly 70 per cent of the world's farmed Atlantic salmon production (Phyne & Mansilla, 2003). In 2013, according to Food and Agricultural Organization (FAO) estimates, the total volume of farmed salmon in the world was around 2 million tonnes. Ireland produced around 15,000 tonnes compared to 1.1 million tonnes in Norway, 515,000 tonnes in Chile and 155,000 tonnes in the UK. Ireland's global market share in salmon production is less than 1 per cent (FAO, 2014) (Figure 5.1).

In parts of the North-West and South-West, salmon farming was initiated by individual entrepreneurs who were more often science graduates than farmers or fishermen. A different pattern emerged in Connemara, where Údarás na Gaeltachta encouraged local involvement in the industry by financing the acquisition of cages and smolts. Small producers were paired with larger producers to help them access export markets and ensure a balance between local, family-owned salmon farms and the larger investors who brought the necessary economies of scale and financial investment. Údarás na Gaeltachta also helped to develop the Irish Salmon Producers Group (ISPG) (Phyne, 2009). Originally established to market farmed salmon and other fish products for Gaeltacht producers, ISPG became the largest exporter of farmed salmon in Ireland in the 1990s.

Figure 5.1: A Barge Monitors and Pumps Feed to Salmon in Net Pens at Marine Harvest Farm in Norway

Source: Marine Harvest ASA

The Irish industry has always competed with larger Norwegian and Scottish salmon-producing industries. To prevent the Norwegians from dumping ‘excess production’ in EU markets, a Minimum Import Price (MIP) was applied to Norwegian exports to the EU in 1997. When this MIP expired in 2003, the Irish and Scottish salmon-farming associations pressed the EU to impose tariffs on Norwegian production (Phyne, 2009). Concerns were also raised about the small but rapidly growing presence of Chilean salmon (Chile has a free trade deal with the EU) in the EU market.

One of the factors that is understood to have saved the industry at this point was the higher premium that Irish-farmed salmon could command, in large part due to organic accreditation which was already being applied to some farms in the early 1990s. Nearly all of the salmon farmed in Ireland is now organic, with Ireland supplying 50 per cent of the organic farmed salmon market in Europe (BIM, 2015). For some producers, however, the low prices in 2003 combined with a series of disease-related problems resulted in their departure from the industry or their acquisition by larger operators. The Irish farmed salmon industry has now moved from numerous smaller firms—24 in the early 1990s (Phyne, 2009)—to a situation today where there are only six to seven salmon-farming companies operating in Ireland. These companies operate between them 15 production units over roughly 32 sites, not all of which are in use at any one time. One company, MHI, controls about 80 per cent of the total production of farmed salmon.

While the Irish salmon-farming sector has seen a series of changes in ownership and consolidation since the 1980s, the current dominance of the sector by MHI is unprecedented. MHI is a subsidiary of the Marine Harvest Group, the largest aquaculture company in the world, listed on both the Oslo and New York stock exchanges and operating across 22 countries.

MHI operates nine grow-out sites in the North-West, West and South-West of Ireland, as well as a breeding facility, two smolt production units, and a processing unit in Rinmore, Co Donegal, which employs 150 people. Amongst other products, this unit processes and packages organic salmon fillets for direct sale to two of the largest French retailers. MHI sells 86 per cent of the fish produced in Ireland to retailers in the EU, Asia, USA and Canada.

Due to its size, MHI is able to integrate the entire production cycle from genetic selection of eggs for breeding to the processing and packaging of salmon fillets ready for sale in multiple retail outlets around the world. The benefit of this integrated cycle is that more of the market value generated by Irish farmed salmon remains in the country. This is in contrast to the recent past (2001), for example, when over 75 per cent of the value of fresh Atlantic salmon fillets accrued to French supermarkets and hypermarkets (Phyne, 2009). The presence of processing, marketing, technical and administrative activity in the country also generates more employment; the company employed 285 people in 2015.

MHI is the only producer of organic farmed salmon in the Marine Harvest Group and looks set to continue and expand this focus here, aiming to boost production from 7,000 tonnes annually to 20,000 tonnes by 2020.[60] This growth in volume production will require increased processing capacity and new markets, resulting in a projected revenue jump from €55m to €300m and direct employment from 300 to 1,142 by 2020. The biggest obstacle for MHI is the lack of availability of appropriate sites to boost volume production; it already has excess capacity in its processing facility. The presence and ambitions of such a large industry player in Ireland will undoubtedly have an impact on how the aquaculture sector in Ireland develops over the coming years, particularly in light of the growing demand for high-quality farmed salmon.

Although there is support for MHI and its operations in Ireland, particularly from the Government, concerns have been raised about the dominance that this one company has over such an important sector. A BIM respondent admitted:

> From a national policy point of view it would be good if there was a second big player. They wouldn't have to be as big as Marine Harvest, but if there was a second substantial player, just so that all our eggs weren't in one basket. So that a decision made in a boardroom in Oslo wouldn't necessarily have a catastrophic effect on the national industry. So just from a national financial security point of view it would be good to have a second big player. (BIM).

Apart from the issue of financial security, there are also questions about how the operations of MHI affect those who work on the farms, the character and value of their activity, and the role and benefits of salmon farming for the local areas where it takes place. Most debates about the merits of salmon farming tend to focus on its environmental impacts or the health impacts of the fish produced; there is much less attention paid to the work that takes place on the salmon farm and the ways this has changed since the 1980s. It is not within the remit of this report to document these changes, but technical, regulatory and economic changes over the past three decades have altered work practices on the farms and the way this work is valued. The need for MHI (or any other company) to satisfy its buyers by ensuring continuity of supply in a competitive market may not always be compatible with the needs of workers who cultivate the salmon, the welfare of the salmon, or the communities and places where salmon farming takes place.

At the same time, one of the surprising things about salmon farming (and Irish aquaculture in general) is the extent to which the people involved in the sector today maintain a continuity with the early days of the industry—either because they were working then, or are related to the early pioneers. MHI, for example, has taken over from a series of other companies that existed in the 1980s and 1990s, based in Donegal, but the administrative and technical staff, and many of those who work on the farms themselves, have remained the same. This is significant because,

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[60] The data on MHI was contained in a presentation given by MHI in 2015 and sent on to me.

despite being the subsidiary of a global aquaculture company, MHI still relies on a considerable degree of local knowledge, social networks and a collective experience built up over the last thirty years (Box 5.3).

Box 5.3: A Salmon Farmer

During a visit to a salmon farming site on the West coast, I met several local men who worked on the farm. One of them, Peter, had worked on the farm since it began in the late 1980s. It had been initiated by the local community as a way to create much-needed employment in the area and, although private investment was needed to set it up, retained a close relationship with the local community, largely through the work it provided.

Peter described how he and another local man had been tasked with managing the farm in the beginning. This involved learning how to operate the equipment and care for the fish as they went along. They even designed and built specialist boats that could work on the exposed site (in the 1990s no such boats existed). The experience that these men derived from fishing and working at sea was invaluable, he said. Because the weather is crucial in determining when activities are carried out (feeding, harvesting or treating the fish), their ability to read the weather and the time it would take to carry out different tasks was not just important for the health of the fish but also for the safety of those working on the site. Peter spoke about the importance of the other workers and the fact that they had learnt and worked together over the years. A second generation of fish-farm workers is now working on the farm, carrying on the tradition. It was clear from the way he spoke about his work that he was not only committed to the farm but also proud of the salmon they produced. He spoke of how you could tell good-quality salmon from the way they looked and felt.

The salmon farm has passed through a number of different hands since the 1980s. This was necessary to bring in the required investment to upgrade the site and equipment. Investment and marketing decisions were always made by the company owners, but the day-to-day running of the farm was in the hands of the local team of workers. In recent years this relationship has changed, according to the men. They spoke of a change in the way their work was being valued. On one hand, they felt that they were not being paid enough—the work was hard and unpredictable, and demanded a lot of experience, which they felt should be properly remunerated. Peter spoke of the care that was required when using the machinery, including the boats—a care which he and the other workers who had grown up with and relied on the farm understood. He also spoke of the attention involved in caring for the fish. By devaluing that work, 'the rearing of fish is forgotten about', he said. On the other hand, they felt that the independence they had once had was being eroded and they were being put under more pressure to respond to decisions made off-site.

Peter said that after working on the farm for 28 years (not just him but others too) they were being treated with no respect. This was compounded by the replacement of some of the local workers by men from outside who were not as reliant on the salmon farming for income. The new company was also proposing to bring in remote, automatic feeders, further undermining the value of their work. There was a feeling that these decisions were about ensuring greater profits, rather than taking care of the workers, the fish and the local area.

A related criticism that came from people living locally (rather than just the workers) was that the salmon produced on the farm was not available to them. This is not a new situation but it crystallises a tension articulated by some of the people living there about their involvement in the salmon farm and the benefits that arise from it. While they relied on the farm as the main source of employment, they also felt removed from it; while the salmon produced on the farm is recognised as being amongst the best in the country, even the world, the people who live beside it, and work on it, do not have access to it. When tourists come to the island, for example, they are unable to eat the salmon in local restaurants. There is good potential for a small smokehouse in the area that could sell cured or smoked salmon to tourists or in local restaurants and shops. These secondary economic activities would greatly expand the benefit of the salmon farm to the local area without necessarily losing money for the company. But such options are not open to the local community, nor are they encouraged by the company. According to the respondents, the company does not communicate with the people who live near the salmon farm, except when a problem arises.

Not all salmon farms operate in the same way. Further down the coast I was told of a locally owned farm where the manager was involved in the day-to-day running of the business. A mussel farmer who works in the same bay said:

> **He [the salmon farmer] is more focused like ourselves in growing good product, as opposed to bottom line. Now he's watching the bottom line of course. But he would also make sure that his staff would be deployed more efficiently. And that his equipment and everything would be deployed more efficiently. And you know, so he's not going to get some fella who's going to go bash the boat into the pier and things like that. So he's going to get a guy that will work good with him but he'll also pay. That's how it works.**

This farmed-salmon producer sells most of his fish to a local processor for export. Because he has more control over decision-making he can also be more flexible in terms of selling salmon to smaller, local businesses for processing or to restaurants. This flexibility means that the salmon produced in the area can have a wider benefit to the local area; this embeds the farm more in the community. The manager is also more concerned with hiring people who are committed to the farm and able and willing to take on responsibility and 'do a job well'. In turn, this means he pays his workers better. As the mussel farmer quoted above (see Box 5.1) told me: 'We could get fellas here for nine euros an hour. Or nine sixty five or whatever, eight sixty five, whatever the minimum wage is like. We don't want them like, we prefer the fella for fifteen euros an hour. And he would do twice the work in half the time. I know it is only part time but I'm saying that's the difference between us and those who are always about the bottom line.'

Peter's grievance about the worsening pay and working conditions on the salmon farm were not just personal. He felt that decisions were being made that were not in the best interests of the fish (delaying harvesting, for example), not in the best interests of worker safety, and, perhaps most tellingly, not in the long-term interests of the community. This latter point referred to the lack of real incentive for young men growing up in the area to stay on and work on the salmon farm. This was repeated by other people involved in the industry: a shift from fish-farm workers being owner-operators with a long-term commitment to their farm to seasonal workers paid the minimum wage for hard work and long hours.

Peter admitted that the lack of incentive for local people to get into fish farming was not entirely due to the salmon company. Unlike in the 1980s, most of the children growing up in the area were now going all the way through school and college. There was one young man who had worked on the salmon farm for a few summers. Peter said he was a great worker with lots of ideas for the farm. But he had also just secured a degree in marine engineering and was not going to stay to work on the farm when the pay was so bad and the work not secure.

Another young man who may have considered working on the farm had recently received a degree in marine biology. Even with better working conditions it is hard to see how such highly qualified people would take up work in the aquaculture industry without adequate opportunities for them to apply their knowledge and be paid appropriately for it.

5.3 Diverse Economies

The National Strategic Plan for Aquaculture and *Food Wise 2025* emphasise the importance of increasing the volume of aquaculture production and building scale in the industry so as to capture greater value in the global seafood market. This policy aims to harness Ireland's aquaculture potential in response to escalating global demand for high-quality seafood. The promise of this strategy is an increase in earnings for the seafood industry, the creation of jobs, and the positive knock-on effects this growth in economic activity will bring, particularly to coastal areas.

There is no doubt that the development of aquaculture in Ireland will continue to depend on global seafood markets, and the established routes to those markets dominated by larger buyers and retailers. It is thus important that initiatives like the Asia Oyster Group are supported and extended, and that efforts to differentiate Irish seafood through labelling and quality assurance schemes like Origin Green are promoted. However, it is important to question whether these market-led development strategies are always compatible with the goals of social and environmental sustainability (Guthman, 2004, Libery *et al.*, 2005). In raising these questions, it is possible to identify other forms of economic value and activity that exist within coastal areas that are not orientated towards export markets and thus do not depend on the same intermediaries, uneven value networks and access to financial, informational and technical resources; there is room for a diversity of economies involving aquaculture. While such diversity already exists, the forms of social, environmental and economic value generated within local contexts do not always gain the recognition they deserve—in large part because standard forms of economic measurement do not account for these kinds of value. This is starting to change as new possibilities for local development and environmental protection begin to emerge (Polman *et al.*, 2010, Roelvink *et al.*, 2015, van der Ploeg *et al.*, 2012). This section looks at an initiative facilitated by BIM and Fáilte Ireland in 2015. The success and potential of this initiative was orientated around the value of the local economy, social networks and relationships and the commitment of those involved to sustaining long-term livelihoods.

5.3.1 Keeping it Local: 'Taste the Atlantic—a Seafood Journey'

The 'Taste the Atlantic' seafood trail is an initiative developed between fish farmers and small producers based in counties Mayo and Galway, BIM and Fáilte Ireland in 2015. It started when some of the small mussel and oyster producers in the area began setting up stalls on the side of the road to sell directly to passing tourist traffic. BIM approached Fáilte Ireland to see if these individual initiatives could be tied into the Wild Atlantic Way—a Fáilte Ireland initiative that had established itself within a relatively short time as a successful tourist attraction. Because BIM did not have the financial or human resources to develop a project of their own, they effectively piggy-backed on the tourist 'infrastructure' created by another state agency. As a BIM respondent said:

> BIM approached Fáilte Ireland and said, look, you have the Wild Atlantic Way, you've all the money for promotion and you need to keep reinventing the story, like yes, travel on the Wild Atlantic Way but what are you going to see? You can do your dolphin swimming, you can do your horse riding, whatever, but we said we have aquaculture producers all the way from the very start of the Wild Atlantic Way to the very end. So the original idea was to say set up a seafood trail where you didn't just go to a restaurant, but you could actually go down on the farm as a tourist and say 'oh well, this is where oysters are from' and find out about oyster-growing, maybe taste the product there, meet the farmer, and get in touch with … exactly like a farmer's market or, you know, that you go down to see this is where the cattle are, this is where the sheep are bred.

The first pilot project of the Wild Atlantic Way seafood trail took place in summer 2015. A number of small producers, retailers and restaurants were chosen in an area that stretched from Achill Island down to south Galway. The producers were mostly oyster and mussel farmers, several artisan smokehouses and a couple of lobster fishermen. As well as producing a map (Figure 5.2) and a guide for the trail, BIM made a short film showcasing the producers and the area in which they work. Restaurant owners and chefs also went down to the farms to see where the seafood they were buying was grown or caught, how, and how best to serve it.

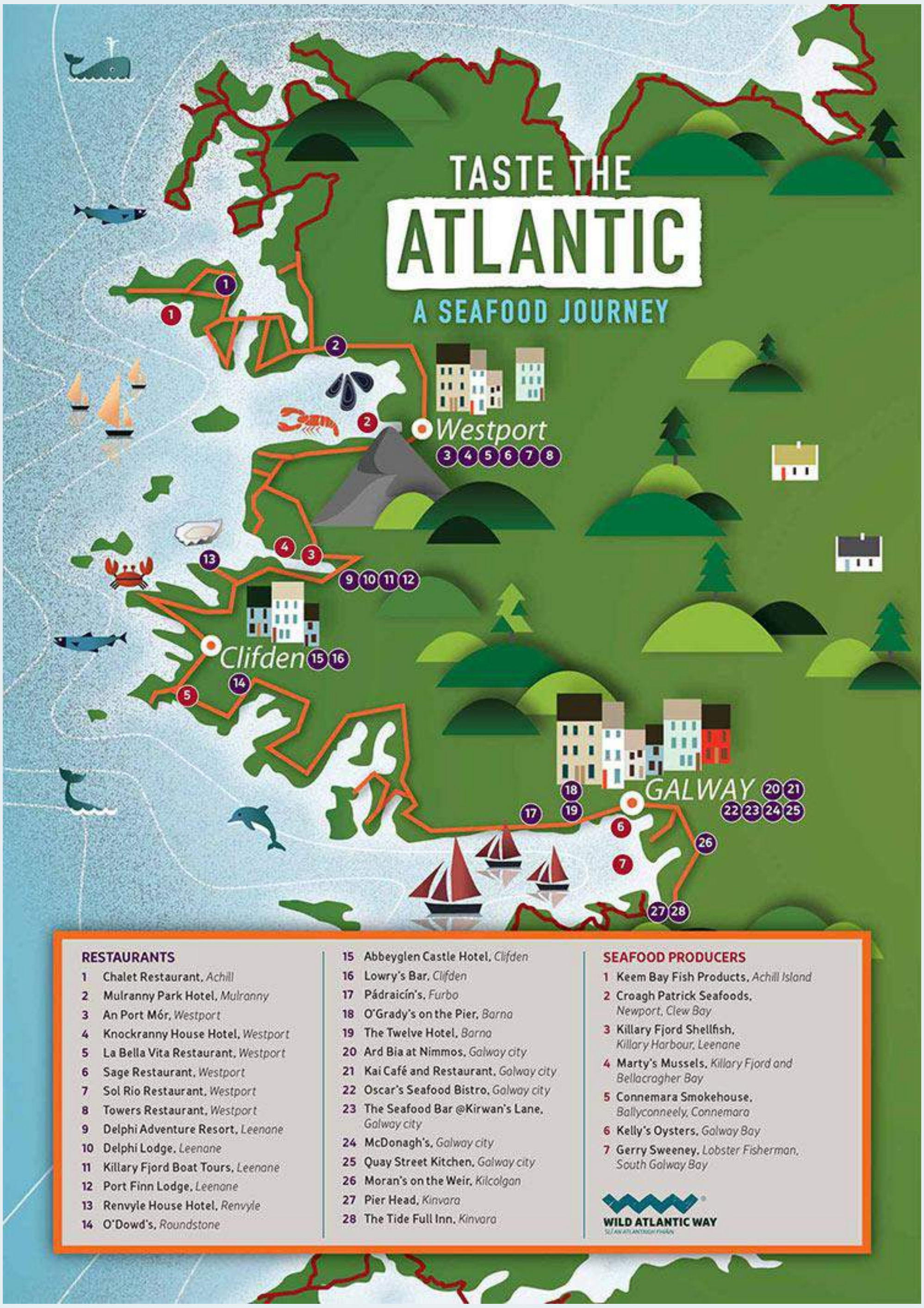
A respondent from BIM made it clear that the key to the whole initiative working was that tourists and visitors get a sense that these are 'real' people producing 'real' food and artisan products. He said that in the past BIM had often received calls from people visiting these areas wanting to know where to get seafood. Now there was a way this could be formalised.

The pilot Seafood Trail was a success: after only one summer, there was an estimated sales increase for each producer of 30 per cent (BIM). Besides keeping more of the value in the area, the project brought together independent producers and businesses. As a BIM respondent commented:

> Our feedback to date is brilliant—everybody's happy, which never happens—you know, the restaurants are delighted, they have a local product to offer, which is absolutely right up their street. They're really,

really delighted with it … The farmers are delighted because they're selling in their local area, you know, they're not shipping it off miles away. They get a higher unit price for their product because they're selling it, you know, in smaller volumes. They're also, you know, a few of them are taking people out on to their sites and things like that and showing them the process and hopefully the people who are coming to visit the areas are happy because, you know, they get a day out and they see a bit of information and then they can go and eat the product in the evening.

Figure 5.2: Taste the Atlantic—A Seafood Journey



While local development, place and artisanal food production are widely recognised as valuable qualities within the food industry, there is an important distinction to be made between how these are capitalised on through labels and other accreditation schemes in non-local (global) markets, and the way they are worked on and valued within local economies.

To begin with, the extent to which the Seafood Trail has been welcomed as a success by people in the area reflects the much higher return that producers make when they sell directly to consumers. A mussel farmer from Killary Harbour put this into context: they usually expect to get 70c per kg when the mussels are sold in bulk and exported, compared to €15 a kg when the mussels are sold in a local restaurant. By connecting local producers with local restaurants, a substantial amount of value remains in the area, rather than being captured further downstream.

Second, the Seafood Trail could not have happened were it not for the control that local producers maintain over their product and the production process, and the innovation that this allows. While it is commonly understood that large, financially well-resourced companies are more innovative than primary producers within seafood chains, this fails to recognise the inflexibility that can characterise larger, centrally controlled and integrated operations, as well as the flexibility that more independent, small-scale producers can bring (van der Ploeg, 2013). The Seafood Trail began with mussel and oyster producers in Killary setting up stalls and cafes on the side of the road; this could not happen with certain salmon farms, for example (see Box 5.3). Similarly, local knowledge and local networks allow for innovation *between* producers; the wife of one of the mussel farmers in Killary buys mussels and oysters from other local producers and supplies them directly to local restaurants.

In addition to local control, what distinguishes small-scale aquaculture is the heavy dependence on the producer's own labour and that of family members (Cush & Varley, 2013). This labour is often unpaid and goes beyond what a waged worker would be willing to do. Relying on unpaid labour and limited capital to invest was one of the motivations for shellfish producer cooperatives being established in the 1980s and 1990s. While these formal co-operatives (such as the mussel growers co-op in Killary Harbour) have fallen apart in some cases, this doesn't mean that more informal co-operation between individual producers, processors and businesses has not persisted (*ibid.*).

Interestingly, the Seafood Trail could mark a new phase of co-operation that does not operate within a particular sector (mussel farming), but rather cuts across sectors within a region or locality—including primary producers (fishermen, fish farmers), processors (smoke houses), restaurants and the wider tourism industry. There is also potential for such synergies to cut across the supposed binary of jobs versus the environment, or aquaculture versus tourism, which have tended to dominate the debate over aquaculture development in the past. As a respondent from BIM said:

> The plan is to make it work together for everybody's benefit because I think some of the anti-lobbies are saying, you know, tourism is so important to us, aquaculture will destroy tourism and we want to say

> no, we can be part of it and we can add to the value of, you know, people coming to the area, you know, give them a better experience by having aquaculture there rather than not having it there.

The level of innovation, the extent of unpaid work (carried out by family members) and the value of social networks in sustaining local economies, does not mean that government support is not necessary; the relative independence and self-reliance of the people living in these areas should not be taken for granted. The Seafood Trail pilot project is a good example of how much can be done for local initiatives with relatively little institutional and financial resources, but resources that are nonetheless necessary. One of the most important roles that state agencies such as BIM play in this context is not even directly financial.

Several respondents involved in the Seafood Trail pointed out the importance of networking events such as the one that took place in Westport (see Box 5.4). They felt that such events did not happen often enough, but were important for getting together to find out what other people in the area were doing. A shellfish producer said that such events were very useful for getting to know other producers and businesses in the area (particularly when they tend to live so far away from one another), and for meeting people in other sectors (restaurants, smokehouses, retail) who may be able to offer advice or collaborate. It was also important to do this in a more social context—there was lunch provided as well as a field trip to a nearby oyster farm.

While many of these individuals may be aware of one another, or even have working relationships, there is often a need for outside facilitation, for a space to be opened up that is not perceived to be dominated by any particular interest. Related to this networking function is the role that media and ICT play in facilitating local economic activity. As a BIM respondent put it:

> As well as providing a website with information about the Seafood Trail, the idea is that if you’re a tourist on the trail you’ll find out, first of all, if I want to go and eat oysters then Killary Fjord Shellfish, they sell oysters, they sell mussels, so you can go on to their website, see how they’re produced, meet the producer, we have a video profile of them and then you could say you can either eat it at their stall on the road or else go to restaurants that they actually supply. And we’ve also brought the restaurant owners on to the farms, so the restaurant owners, and that’s right from the waiting staff to the chef to everybody, to say when you’re selling the product, okay, here’s the Killary Fjord Shellfish, so tell me about the mussels—and so they can actually tell the public or the tourist about the mussel product, how it’s farmed, where it is and that if you want to go and see it it’s only up the road.

Box 5.4: Experiences of Local Businesses

At an event in Westport in October 2015, organised by BIM and the Local Enterprise Office, some of the producers and businesses involved in the Seafood Trail pilot project came together with other seafood businesses to talk about their work. There were about twenty five people in total, including several younger people, perhaps interested in getting involved in the sector.

One woman from Achill had only started her business in 2013 after watching a documentary about the harvesting of salt in Wales. Convinced she could do the same, she began experimenting with different techniques of harvesting salt from the sea beside her. She began selling the salt in local markets and now supplies restaurants in Dublin and Belfast, as well as local restaurants and artisan producers in Mayo and Galway. What was most significant for her, however, was that her two grown children were now getting involved in the business. Her son was developing the craft of salt-harvesting, while her daughter, a science graduate, was learning about the health benefits of sea salt. The emphasis was on developing a business that was sustainable, that had longevity.

This was a common theme across the presentations: the creativity and commitment involved in sustaining and creating local livelihoods. A pop-up shellfish bar on the pier in Killary Harbour, for example, which provides employment for three young people in the summer … or the mussel farmer in Killala who invested in a depuration plant that now provides three days' work a week throughout the year for a local man, enough to keep him and his young family in the area. Having the mussels cleaned in the depuration plant also means that they can be sold directly to restaurants; the mussel farmer's wife carries out this side of the business, marketing and selling the mussels in the area.

Nor was it just fish farmers who were represented. One woman had worked for twenty years in a seafood factory in Killala. The factory employs fifty people and is thus vital for the sustainability of the area. Besides just talking about the number of jobs, she spoke of 'the life' that the factory brought in terms of the activities that were orientated around it, the children it put in the schools, and the small shops and pubs it kept in business. She also spoke with pride about the work they did in the factory, producing high-quality smoked salmon. Despite it being a factory, the fish still require skilful handling and the production process requires timing and coordination. 'Each day is an achievement,' as she put it, 'to get the seafood out onto the trucks.' She also said that the smoked fish was sold to a big retailer in Ireland as their own brand but she could tell which fish was from her factory from the reference code on the packaging.

From the way these people spoke, it was clear how much they valued living and working where they did. There was an emphasis on the local environment and the value they derived from making a living from it (rather than 'working in offices'); the local people and the value of social relationships and networks that provided vital support when you needed it (childcare, unpaid work on the farm, lending equipment), and local history and the value of maintaining a link to the place, people and work that had come before. Besides simply making a wage, the theme of these (often heartfelt) presentations was a desire to sustain a 'living' that extended to keeping the *place* they lived in vibrant and alive.

Information about the seafood available in an area is thus made accessible to tourists, as well as people who live in the area. Beyond marketing, however, the development of ICT capacities (both better broadband access and training for people) could benefit producers, restaurants and businesses in terms of sharing resources and information. These exchange networks already exist informally (lending equipment, selling produce locally) but ICT could extend such networks to a wider number of people.

Some of the producers who had been involved in the industry since the 1980s said that more gatherings used to be organised by the industry and BIM. One explanation for this decline in relatively informal, social networking events could be the re-organisation of the industry, particularly the salmon-farming sector, along more professional, formal and market-led rationalities. In this set-up there is less need for informal exchanges and learning to take place between individual operators. It is hard to quantify the economic value of these informal, social encounters and exchanges but, in the case of the Seafood Trail, it seems clear that the relationships that have been created (or fostered) have led to new economic opportunities—for example, supplying local seafood to restaurants that previously may have bought imported seafood.

More money is to be made available under the Community-Led Local Development Fund from the European Union for the period 2014–2020. This fund is available to support community-led initiatives like the Seafood Trail. Beyond financial support, however, it is important to think more about how local innovation and diverse economic activities are supported (or not) in a context where primary policies and regulatory and institutional support tend to be directed towards consolidation and export-led economic development. The successful example of the Seafood Trail (and the values and relationships that enabled it) suggest that different types and qualities of work are, to different degrees, embedded in local communities and environments; these different economies and work practices use and value local resources and social relationships in different ways. Rather than pitting jobs and economic development against the environment, these alternatives open up possibilities for thinking about the inseparability of sustainable livelihoods, quality of life and environmental integrity (Phyne, 1996).

5.3.2 Aquaculture for the Future

Market-led development may not always be compatible with the longer-term aims of social, economic and environmental sustainability. Exporting oysters to China, for example, may enable a small number of Irish companies to benefit from short-term access to new markets but the environmental impact and long-term economic sustainability of this arrangement is questionable. One of the oyster producers involved in the group admitted that this was the case. He felt that the demand for oysters in Asia at the current price ($10 per oyster) would not continue. Beyond the cachet of buying an imported Irish oyster, he also felt that the quality of the product (after travelling half way around the world) was never going to be very good. Perhaps more importantly, he did not believe, despite the ‘green’ branding, that these oysters could be considered environmentally sustainable in a context where carbon emissions from air-freighted food was contributing to climate change.

A common response to these kinds of argument is that there are commercial realities that cannot be ignored. On one hand, oyster producers in Ireland are competing with much larger companies, particularly in France, that have command over much of the European market. On the other hand, suggestions of moving away from Pacific oysters in order to develop a native oyster industry are dismissed as being commercially unviable. Currently, native oyster production totals only about 500 tonnes (compared to 9,000 tonnes for Pacific oysters), and the market for native oysters is small—although native oysters can fetch a price three to four times greater than Pacific oysters. In an interview with scientists from the Marine Institute, there was agreement that in an 'ideal world' native oysters would be the species to cultivate in Ireland as the mainstay of the farmed shellfish industry. This was because it was a native species, unlike the Pacific oyster, and a potentially keystone habitat (reef)-forming species. The obstacle, as these scientists put it, was that native oysters were hard to cultivate at a commercial scale. This is due to difficulties faced when growing it from seed and thus a reliance on (limited) wild stocks. Added to this is the longer growing time of the native oyster—three years, as opposed to two. In other words, Pacific oysters have been selected and cultivated because they are more commercially viable within a global seafood market.

Perhaps one way of combatting this economic reasoning is to shift attention to the longer-term outlook for aquaculture development and the uncertain environmental and economic futures it undoubtedly faces. Working on the basis of this longer time-scale will require more strategic investment in, and support for, forms of aquaculture that may not be as commercially viable in the short term but will provide more resilient, sustainable food systems in the long term (van der Ploeg, 2013). One species with clear economic and environmental potential in this regard is seaweed (Organic Monitor, 2014).

Native species of seaweed have been harvested by hand for decades around the coast, particularly in Connemara where commercial seaweed harvesting and processing continues to this day. Currently, Ireland's seaweed and biotechnology sector is worth €18m per annum; it processes 36,000 tonnes of seaweed (wild product) and employs 185 people (Morrissey *et al.*, 2011). The product source is currently limited to wild seaweed, while Ireland's product range is limited in the main to high-volume, relatively low-value products such as animal feeds, plant supplements, specialist fertilisers and agricultural products (Walsh *et al.*, 2011).

Cultivating seaweed adds a different stage to the process. It allows more commercial, edible species of seaweed to be cultivated from wild spores and grown out at sea. The infrastructure required for this is not much different to that used for rope-growing mussels—long lines suspended in sheltered bays. One of the potential advantages of seaweed cultivation is that it can be grown alongside other organisms that are being cultured, providing a form of Integrated Multi-Trophic Aquaculture (IMTA) (see Box 5.5). This applies to salmon cages, for example, where seaweed could provide additional benefit by absorbing the nutrients from the fish farm (Chopin *et al.*, 2001).

The benefits of seaweed aquaculture are that it grows quickly and does not require many inputs. The limitations (at the moment) are that it does not yet have significant commercial value due to the limited capacity for processing and the limited market. This is sure to change in the medium to long-term, particularly as research develops around the applications of seaweed in bio-tech and demand for new, healthy food grows. The cost of the most common red species of seaweed has doubled in the past two to three years.[61]

The cultivation and processing of seaweed in Ireland has had 'potential' for over two decades—nearly every edition of *Aquaculture Ireland* from the early 1990s has an article about seaweed farming. While there are only a few seaweed licences currently in operation, the National Strategic Plan for Sustainable Aquaculture Development (DAFM, 2015c) stated that more than 20 new seaweed aquaculture applications were awaiting determination. It added: 'Should these licence applications be approved and production start on these sites, farmed seaweed production would increase significantly over the coming years' (DAFM, 2015c: 46). Yet at the moment there is not enough seed being produced in Ireland to supply the 20 new farms, should they be licensed. Currently, only one researcher, with a small lab (funded through BIM) in the South-West, is carrying out this work in collaboration with a fish farmer; he is successfully growing seaweed out at sea and then processing it into a specialised feed for animals.

All around the coast I met people who were keen to pursue seaweed cultivation and processing. In remote areas where capture fishing has declined, seaweed is one of the few natural resources that grow in abundance. But cultivation and processing will only be possible if they are assisted through a more supportive licensing system, R&D and technical assistance, start-up grants and links with processing units and commercial applications.[62] A point made frequently about the seaweed sector was that it lacked commercial application and required more investment in R&D. In other words, if the seaweed industry is to develop, it is not going to be through private investment and enterprise alone.[63] At the same time, Ireland is currently

61 Perhaps the clearest sign of the growing commercial value of seaweed was the recent acquisition of the state-owned Arramara Seaweed Company in Galway by the Canadian company Acadian Seaplants Ltd. This caused some controversy as it brought into question the rights of local people to harvest seaweed from the shore, an historic practice that they have exercised for many years (Barrett, 2014). Although this deal relates to wild seaweed harvesting (rather than cultivated) and was overseen by the Department of the Environment, Community and Local Government, it suggests a lack of strategic thinking by the State in terms of developing an indigenous seaweed industry.

62 The two more commercially valuable red species of seaweed are *Palmaria palmata* (Dulse) and *Porphyra umbilicalis* (Nori) (BIM, 2011b, 2011a). These species have complex life stages and more work needs to be done to make cultivation more consistent and ensure there is enough seed to supply farmers (Watson & Dring, 2011, Werner & Dring, 2011). At present, BIM, Marine Institute, Údarás na Gaeltachta, Queen's University Belfast and NUI Galway provide financial, technical and scientific support for the expansion of seaweed cultivation and commercial applications (including a trip to Japan to learn about their seaweed industry (Millard, undated).

63 When I asked a representative of MHI about seaweed farming, he was supportive of the idea but said the company wouldn't invest in it because their ambition was to increase salmon production in Ireland. He said

one of the leaders in research on seaweed cultivation in Europe and is well placed in terms of having the environmental conditions to produce large quantities of it. In many ways the situation is similar to the early days of fish farming in Ireland.

In considering the active role that the State would play in such development, it is worth recalling that in the 1980s, oyster, mussel and salmon farming began with financial and technical support from state agencies such as BIM and Údarás na Gaeltachta, in Connemara. The first 'pioneers' of aquaculture were individual entrepreneurs but they were supported through workshops, grants for equipment and even co-operative structures, such as the mussel co-operative in Killary Harbour. While there was clear commercial value to be generated from aquaculture activity, the industry was under-developed and reliant on state support to get started. Today, BIM, the Marine Institute and other research institutes continue to invest in the industry through R&D and technical support, but the focus is more on monitoring and managing fish health and consumer health issues (disease, sea lice and HABs), or, in the case of BIM, marketing seafood products abroad or applying for expensive, offshore salmon farming licences. Less money and time is invested in developing new methods and species of aquaculture production, or local initiatives such as the Seafood Trail.

In one important sense, the context has changed significantly since the 1980s. Over the last twenty years the idea that the natural environment is not just a store of resources to be processed into consumable goods—food, fuel and water—has gained in momentum (European Commission, 2011c, Working & Educating for Biodiversity (WEB), 2012). The environment provides other services that are necessary for functioning ecosystems, which in turn are necessary for vital social and economic activities (Murphy *et al.*, 2014). The EU Biodiversity Program[64] outlines four categories of environmental services:

- Provisioning services are the products obtained from ecosystems such as food, fresh water, and medicines.

- Regulating services are defined as the benefits obtained from regulating ecosystem processes such as climate and water purification (forests, wetlands and protected areas with dedicated management actions often provide clean water at a much lower cost than man-made substitutes like water treatment plants).

- Habitat services highlight the importance of ecosystems to provide habitat for migratory species and to maintain the viability of gene-pools.

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that if he went to a director's meeting in Norway and told them that he had put in an application for a seaweed farm, they would look at him as though he had 'three heads'.

64 http://biodiversity.europa.eu/topics/ecosystem-services

- Cultural services—these include non-material benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values.

One of the motivations for marine spatial planning at a European scale is not only to better co-ordinate existing and new economic activities, but also to co-ordinate these commercial activities with non-commercial goods and services that are necessary for functioning ecosystems and economies.

Ireland's *Harnessing Our Ocean Wealth (HOOW)* strategy acknowledges this without necessarily elaborating on the variety and value of these ecosystems services. It states: 'Our marine resources also provide essential non-commercial benefits such as amenity, biodiversity and our mild climate. Ireland's marine ecosystems (i.e. offshore, inshore and coastline) are home to a rich and diverse range of species and habitats' (DAFM, 2012: 1). This statement appears limited by a 'conservationist' outlook informed by the need to comply with European environmental legislation (Birds and Habitats). The Appropriate Assessment is the main tool of this legislation, setting parameters on economic activity in an SAC or SPA on the basis of a baseline of existing species and habitats. By focusing on the *conservation* of habitats and species, a rather limited and static vision of the environment is generated. This fails to acknowledge the diversity of ecosystems services and the important ways these overlap with, and involve, human activities. The only other mention of environmental value in the *HOOW* document relates to Ireland's 'reputation' and 'image' for having a clean, green marine environment. It states that '[t]he future sustainability and growth of our marine industries depends on protecting the credibility of this clean, green image' (*ibid*.: 36).

Both the conservationist and 'green' economy frameworks outlined above are limited in their capacity to account for and value a range of existing and potential ecosystems services that could be fostered *through* aquaculture activity (Brummett, 2013).[65] In the words of the FAO, an Ecosystems-based Approach to Aquaculture (EAA) 'is a strategy for the integration of the activity within the wider ecosystem in such a way that it *promotes* sustainable development, equity, and resilience of interlinked social and ecological systems' (FAO, 2007: 3); my emphasis).

The EAA is not a new approach to aquaculture; it has always been a feature of traditional models of aquaculture. In these models, multiple species of fish and plants are grown together and/or organic wastes are used as feed resources for the culture of freshwater fish (FAO, 2007). These systems of aquaculture are not, however, designed as commercial-scale operations. The EAA becomes a real challenge in the case of intensive, industrial production where the focus tends to be on the individual farm or farmer and on maximising profitability. A big obstacle in moving towards an EAA will thus be developing forms of aquaculture production that contribute to (rather than detract from) ecological diversity and work in

65 See Bullock and Sylviron (2014) for an overview of natural capital values as they apply to Ireland's woodlands.

tandem with other activities occurring in the area, while at the same time generating economic value (see (SEACASE Project, 2010).

The significance of an ecosystems-based approach is that it recognises the important role that human activity can have within and for an environment (rather than limiting human activity to conserve habitats or species), as well as attaching value to a range of activities that are otherwise discounted in market-based forms of valuation (Murphy *et al.*, 2014, NESC, 2013). Recent work on IMTA shows how outputs from aquaculture production can be transformed into valuable inputs elsewhere—such as where shellfish and seaweed are harvested to compensate for nutrient enrichment through the metabolism of fish feed. On an even larger scale, it is possible to imagine the cultivation of marine parks that incorporate marine organisms for harvesting (seaweed, shellfish), wild species for fishing (lobster, pollack) and marine habitats linking these together—an aspiration that would go some way to undoing the distinction between capture fishing and fish farming by properly instituting forms of marine stewardship (see Box 5.5).

Box 5.5: Integrated Aquaculture

Integrated Multi-Trophic Aquaculture (IMTA) is the term given to the co-culture of species for environmental and economic benefit. In these systems species that are fed or farmed are grown alongside species whose culture results in nutrient (or energy) extraction (FAO, 2009). IMTA thus builds on more traditional, extensive forms of aquaculture that were designed to reduce the need for costly inputs by combining different organic and inorganic elements that existed in the locality (Bellona, 2013, Ridler *et al.*, 2007). These forms of aquaculture thus generate a diversity of outputs that work more in tune with local ecosystems, rather than being managed for the production of one single crop.

The development of IMTA today has two principal objectives: reducing pollution, and increasing productivity and profit. The result is a production unit that uses manufactured fish feed and embedded energy input more efficiently and releases less potentially damaging effluent (organic and inorganic) into the surrounding environment (Whitmarsh *et al.*, 2006). While the concept and practice of integrated aquaculture is well known in inland environments, particularly in Asia and parts of the Mediterranean, in the marine environment it has been much less tested. However, in recent years the idea of integrated aquaculture has been considered a mitigation approach against the excess nutrients or organic matter generated by intensive aquaculture in marine waters—otherwise known as bioremediation. The potential value of aquaculture goes beyond bioremediation, however. Shellfish cultivation can sequester carbon dioxide from the atmosphere (Wolff & Beaumont, 2011), as well as providing important reefs for marine organisms with commercial (shrimp) and non-commercial value.

In 2015, Bren Smith, a former commercial fisherman, won the Fuller Challenge, one of the most important prizes in sustainability. Smith is the executive director of a non-profit called GreenWave (headquartered in New York).[66] GreenWave designs and builds 3D ocean farms that address overfishing, mitigate climate change, restore marine ecosystems and provide jobs for fishermen. Each of Smith's model farms includes hurricane-proof anchors on the edges. Within its boundaries, seaweed, mussels and scallops hang from floating ropes. Oysters grow in cages below the ropes, and cages of clams hang beneath them. GreenWave farms also harvest salt. The kelp that is grown soaks up five times as much carbon as land-based plants. These farms are capable of producing 30 times more biofuel than soybeans and five times more biofuel than corn—without polluting the food chain. The GreenWave website states 'We envision a day when there are millions of restorative ocean farms on coasts around the world contributing food, fertilizers, energy and much more to local economies, while saving our oceans—and ourselves.'

A more diversified system of aquaculture also increases resilience when it comes to both fluctuating market prices for particular species and unexpected environmental changes. Despite these benefits, the FAO states that '[it] is not valued in its real social and economic potential'. The FAO report identifies Ireland as one of the countries where IMTA could be developed commercially. Several steps are suggested:

- **Establishing the economic and environmental value of IMTA systems and their co-products.**
- **Selecting the right species, appropriate to the habitat, available technologies, and the environmental and oceanographic conditions.**
- **Promoting effective government legislation/regulations and incentives to facilitate the development of IMTA practices and the commercialisation of IMTA products.**
- **Recognising the benefits of IMTA and educating stakeholders about this practice.**
- **Establishing the R&D&C continuum for IMTA.**

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[66] http://greenwave.org/

Chapter 6: Conclusion

This report has sought to provide some perspective on the sustainable development of aquaculture in Ireland, a relatively small but significant area of policy-making, coastal development and environmental governance. Aquaculture undoubtedly has potential to provide safe, nutritious food (and other materials), sustain livelihoods in coastal areas, and ensure (even enhance) the quality of the marine environment. The harder questions are what *kind* of aquaculture will deliver on this potential, and how will it be achieved? In response to these questions, this final section draws together three key themes of the report that are important to consider as Ireland's maritime frontier is opened up to new challenges and opportunities.

6.1 The Role of Science and Technology

Science and technology have played a formative role in the development of aquaculture over a relatively short period. Advances in understanding about shellfish and finfish culture, and their impact on the environment, have resulted in improvements to fish welfare, fish quality and the environmental sustainability of fish farming. There is no question that science and technology will continue to play a decisive role in the future development of aquaculture in Ireland and around the world. In this context, it is important to recognise that science and technology do not play a neutral role in such developments, nor are they able to provide the objective grounds from which political decisions can be made. This doesn't mean abandoning evidence-based decision-making, or obstructing technological innovation. It means accepting that science and technology are not sufficient on their own to mitigate environmental risks, resolve value conflicts or determine the best direction for aquaculture to develop towards. Rather than limiting the productive potential and importance of scientific research, a more experimental, collaborative and participative approach to 'technical' matters could enable more sustainable outcomes. There are two areas where this is most immediately evident.

First, as work in the area of Integrated Multi-Trophic Aquaculture (IMTA) shows, there are many unexplored possibilities within aquaculture and what it could mean in the future. While the emphasis in Ireland and elsewhere has been on producing seafood commercially, a range of other goods and services can be generated from aquaculture, including vital ecosystems services. The National Strategic Plan for

Sustainable Aquaculture Development identifies these possibilities and promotes further exploratory research in this area. For this commitment to be meaningful, however, sufficient financial and institutional investment by the State will be required—to develop novel species, techniques and applications that do not necessarily have short-term commercial value. Beyond these investments, the fostering of working collaborations between scientists and fish farmers on the ground will also be an important part of any experimental, ecosystems-based approaches to aquaculture production.

Second, as aquaculture (and other marine-based) developments look set to increase over the coming years, the role of scientific expertise in the decision-making process will be more important than ever. As discussed in Chapter 4, however, there are limitations to an approach that places too much emphasis on scientific knowledge as the basis for decision-making. Scientific research and data must inform decision-making, but they cannot be a basis for decision-making. One of the paradoxical consequences of framing debates over aquaculture developments in narrowly technical terms is that the decision-making process and the scientific findings that inform it can actually be de-valued; opposing sides in a dispute can draw on different bodies of data and struggle over technical details in order to promote or oppose the development. In this context, it appears important to re-situate the role of science in environmental decision-making as one voice around the table. This shouldn't just be seen as a move towards greater participation, but as a way to enhance the validity of scientific findings and the decisions that are eventually made.

6.2 Market-led Development and Long-term Sustainability

One of the most significant changes to the aquaculture sector in Ireland over the past thirty years has been the shift from production-led to market-led development. While European markets for seafood have always shaped the development of the sector, there has been a marked policy and industry move towards trying to capture greater market value for farmed seafood. This has involved the addition of some form of processing (whether depuration for shellfish or filleting and packaging in salmon); the opening-up of new markets (in Asia, for example), and product differentiation through Irish quality and organic certification and labelling.

The assumed advantages of market-led strategies are that the Irish seafood industry will be able to capture more value for its producers, and that the environmental performance of Irish growers will be rewarded. As discussed in Chapter 5, however, these assumed advantages also need to be questioned. First, the dependence of small producers on large intermediaries in the European and global seafood markets does not disappear through the differentiation of Irish produce. Nor does the globalisation of markets (particularly to Asia) promise to be economically or environmentally sustainable. Second, despite aiming to incentivise and reward the environmental performance of producers, the connection between this performance and market value (mediated by big intermediaries) means that accreditation can become more of a marketing tool than an effective way of actually supporting sustainable aquaculture production. Third, the translation of environmental performance into market-based accreditation schemes is not neutral; in other words, only some qualities are measured and assessed, while other qualities and values associated with local economies and environments are not. The emphasis on the *representation* of Irish aquaculture in retail markets also shifts value from the sites of production (fish farms, processing factories) to the sites of marketing and the knowledge and skills required for that. While this has not received much attention by policy-makers or analysts, it will have ramifications (for example, in terms of de-valuing the material practices and knowledge involved in 'caring for fish', as one respondent put it).

6.3 Diversity & Resilience

The vision of development outlined in the National Strategic Plan is on building scale and capacity within the aquaculture industry in order to increase volume production and market value in global seafood markets. This is understandable given the relatively small domestic market, the growing global demand for seafood and the need for Irish industry to be more competitive within European and global seafood markets. Other possibilities for development also exist, however. These alternatives are capable of generating local economic value and activity, as well as fostering more resilient, environmentally sensitive systems of aquaculture and marine stewardship.

The Taste the Atlantic seafood trail project (Chapter 5) provides a good example of how different economic models of development exist alongside more dominant, export-led models. The difference lies in the orientation of the economic activity (local rather than global markets), the places where value is generated and captured (local producers and businesses) and the place-based social networks that are necessary for it to work. What the Seafood Trail, and subsequent meetings in Westport, also revealed was the considerable levels of innovation and commitment that smaller producers (particularly) perform in order to sustain their livelihoods. The value of these locally orientated forms of innovation, production and consumption are not always counted within economic metrics that focus on waged jobs and/or market sales of seafood. Diverse economies that orientate around local production and consumption not only contribute to local development, they also promise to be more environmentally sustainable and sustaining of long-term livelihoods. As the success of the Seafood Trail suggests, there are ways that such models of development can be facilitated and supported by state agencies like BIM.

One of the values of Irish aquaculture is the unique, diverse and relatively pristine environmental conditions around the coast. The commercial and non-commercial value of these environmental conditions and ecosystems services is now starting to be recognised and appreciated by policy-makers. Fish farmers, to varying degrees, rely on these ecosystems and their ability to negotiate, respond and work through them. As unpredictable environmental change becomes the norm, particularly as it relates to aquaculture, the capacity of food-production systems to respond to disruption will become more important. As discussed in Chapter 3, technological innovations will not be sufficient to provide resilient aquaculture systems. Fish farmers have an important role to play in fostering resilience at a local level. At the same time, fish farmers do not always have the autonomy to make decisions that could foster more ecologically resilient forms of aquaculture. From this perspective, it is important to recognise the necessary and valuable work that fish farmers (and fishermen, more generally) can play in caring for and actively managing marine environments: what needs to be put in place to enable forms of aquaculture that are ecologically sensitive *and* sustaining of livelihoods? This is a challenging question but it can help us move beyond the supposed binary between economic activity and environmental sustainability. In the broadest sense, aquaculture should be seen as a necessary component of healthy, diverse marine environments.

Bibliography

Bibliography

Acheson, J.M. (2003), *Capturing the Commons: Devising Institutions to Manage the Maine Lobster Industry,* Lebanon: Upne.

Aquaculture Ireland (1994), 'Dangers of Free Movement of Gigas', *Aquaculture Ireland Newletter,* (March).

Asche, F., Hansen, H., Tveterås, R. & S., Tveterås. (2009), 'The Salmon Disease Crisis in Chile', *Marine Resource Economics,* 24(4): 405–411.

Barrett, T. (2014), 'Opening Statement to Joint Committee on Environment, Culture and the Gaeltacht on The Licensing and Harvesting of Seaweed in Ireland'. Dublin: Houses of the Oireachtas.

Beck, U. (1992), *Risk Society: Towards a New Modernity,* London: Sage Publications.

Bellona (2013), *Traditional and Integrated Aquaculture: Today's Environmental Challenges and Solutions of Tomorrow*, Oslo: The Bellona Foundation.

Berkes, F. & Folke, C. (Eds.) (2000), *Linking Social and Ecological Systems Management Practices and Social Mechanisms for Building Resilience*, New York: Cambridge University Press.

Beveridge, M.C.M. & Little, D.C (2002), 'The History of Aquaculture in Traditional Societies' in Costa-Pierce, B.A. (Ed.) *Ecological Aquaculture: The Evolution of the Blue Revolution* Oxford: Blackwell Science Ltd. 3–29.

BIM (2003), *Ecopact: Environmental Code of Practice for Irish Aquaculture Companies and Traders*, Dublin: Bord Iascaigh Mhara.

BIM (2011a), *Aquaculture Explained No. 27*, Cultivating Palmaria Palmata, Dublin: Bord Iascaigh Mhara.

BIM (2011b), *Aquaculture Explained No. 26*, Cultivating Laminaria Digitata, Dublin: Bord Iascaigh Mhara.

BIM (2012a), *Response to An Taisce Observations in relation to A&B Aquaculture and Foreshore Licence Applications at Inis Oirr Co Galway*. http://www.bim.ie/media/bim/content/newsandevents/BIM%20response%20to%20An%20Taisce.pdf, 07/12/15.

BIM (2012b), *Environmental Impact Statement (EIS) for Deep Sea Fish Farm Development in Galway Bay, Co Galway, Ireland*, Dublin: Bord Iascaigh Mhara.

BIM (2012c), *Non Technical Environmental Impact Statement (EIS) for Deep Sea Fish Farm Development in Galway Bay, Co Galway, Ireland*, Dublin: Bord Iascaigh Mhara.

BIM (2015), *Aquaculture Licence Application for a Marine Fish Farming Unit off Inishdalla, South East of Inishturk, Co Mayo*. http://www.bim.ie/media/bim/content/projects/deepseafarming/Inishturk%20Scoping%20Letter%2030-04-15.pdf, 07/12/15.

BIM (undated), *Co-ordinated Local Aquaculture Management Systems (C.L.A.M.S)*, Dublin: Bord Iascaigh Mhara (BIM) the Irish Sea Fisheries Board.

Blowers, A. (1997), 'Environmental Policy: Ecological Modernisation or the Risk Society?', *Urban Studies,* 34(5–6): 845–871.

Bord Bia (2015), *Origin Green: Sustainability Report 2015*, Dubiln: Bord Bia.

Bottom Grown Mussel Reveiw Group (undated), *The Rising Tide: A Review of the Bottom Grown (BG) Mussel Sector on the Island of Ireland*, Inshore Ireland Publishing Ltd. https://www.agriculture.gov.ie/media/migration/publications/2008/Mussel_Report08.pdf.

Brady, E., Dubsky, K., Freeman, N., Lewis, S. & O'Brien, S. (2013), *The Marine Strategy Framework Directive in Ireland: Requirements, Implications & Opportunities for Environmentally Sustainable Management of Our Marine Waters*, MSFD Working Paper Version 4/4/2013, Dublin: Sustainable Water Network.

Brummett, R. (2013), 'Growing Aquaculture in Sustainable Ecosystems', *Agriculture and Enviornmental Services Department Notes,* June 78823(5).

Bullock, C. & Sylviron, J.H. (2014), *The Natural Capital Values of Ireland's Native Woodland*, Dublin: Woodlands of Ireland.

Callier, M., Crowe, T., Green, D., Kochmann, J., O'Beirn, F. & O'Brien, G. (2011), *Strategic Overview of Influences of Aquaculture on Biodiversity and Ecosystems Services in Ireland*, Dublin: SIMBIOSYS.

Carss, D.N. & Marzano, M. (2007), *Extensive Aquaculture Systems and Relationships BEtween Stakeholder Perspectives and Different Spatial Scales and Institutional Levels*, Conserving Biodiversity–Interdisciplinary Initiative to Reduce pan-European Cormorant-fisheries Conflicts, September, Po Delta: INTERCAFE.

Chopin, T., Buschmann, A.H., Halling, C., Troell, M., Kautsky, N., Neori, A., Kraemer, G.P., Zertuche-González, J.A., Yarish, C. & Neefus, C. (2001), 'Integrating Seaweeds into Marine Aquaculture Systems: A Key Toward Sustainability', *J. Phycol.,* 37: 975–986.

Costello, M.J. (2006), 'Ecology of Sea Lice', *Trends in Parasitology,* 22(10): 447–492.

Costello, M.J. (2009), 'The Global Economic Cost of Sea Lice to the Salmonid Farming Industry', *Journal of Fish Diseases,* 32: 115–118.

Coveney, S. (2014), 'Ministerial Determination in Relation to EIS Requirements for Shellfish Aquaculture Licensing in Lough Swilly'. Department of Agriculture, Food and the Marine.

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

Culloty, S.C. & Mulcahy, M.F. (2007), *Bonamia Ostreae in the Native Oyster Ostrea Edulis: A Review*, Marine Environment and Health Series No. 29, Galway: Marine Institute.

Cush, P. & Varley, T. (2013), 'Cooperation as a Survival Strategy Among West of Ireland Small-Scale Mussel Farmers', *Maritime Studies,* 12(11): 1–17.

DAFF (2008a), *Monitoring Protocol No. 1 for Offshore Finfish Farms—Benthic Monitoring*, Dublin: Department of Agriculture Fisheries and Food.

DAFF (2008b), *A Strategy for Improved Pest Control on Irish Salmon Farms*, May, Dublin: Department of Agriculture, Fisheries and Food.

DAFF (2010), *Food Harvest 2020: A Vision for Irish Agri-food and Fisheries*, Department of Agriculture, Fisheries and Food, Dublin: Government Publications.

DAFM (2012), *Harnessing Our Ocean Wealth: An Integrated Marine Plan for Ireland*, Department of Agriculture, Food and the Marine, February. Dublin: Government Publications.

DAFM (2013a), *Consultation on the Preparation of a New Seafood Development Programme 2014–2020*, Dublin: Department of Agriculture, Food and the Marine.

DAFM (2013b), *Food Harvest 2020: Milestones for Success 2013*, Dublin: Department of Agriculture, Food and the Marine.

DAFM (2015a), *Food Wise 2025: A 10-year vision for the Irish Agri-food Industry*, Dublin: Department of Agriculture, Food and the Marine.

DAFM (2015b), *Enablers Task Force on Marine Spatial Planning: Report to the Inter-Departmental Marine Coordination Group*, OurOceanWealth.ie. http://www.ouroceanwealth.ie/sites/default/files/sites/default/files/news/Final%20Our%20Ocean%20Wealth%20Enablers%20Task%20Force%20Report.pdf.

DAFM (2015c), *National Strategic Plan for Sustainable Aquaculture Development*, June, Dublin: Department of Agriculture, Food and the Marine.

DAFM (2015d), *Coveney Launches Draft National Strategic Plan for Sustainable Aquaculture Development*. http://www.agriculture.gov.ie/media/migration/press/pressreleases/2015/june/PR10715120615.pdf, 07/12/15.

DAFM (undated), 'Screening Matrix for T12/462 Oyster Culture in Lough Swilly, Co. Donegal'. Department of Agriculture, Food and Marine.

De Bruijn, H. & Leijten, M. (2007), 'Transportation Planning and Technology', *Megaprojects and contested Information, Transportation Planning and Technology,* 30(1): 49–69.

DECLG (2013), *A New Planning and Consent Architecture for Development in the Marine Area*, Consultation Paper, Dublin: Department of Environment, Community and Local Government.

DEHLG (2009), *Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities*, National Parks & Wildlife Service. http://www.npws.ie/sites/default/files/publications/pdf/NPWS_2009_AA_Guidance.pdf, 07/12/15.

Dubsky, K. (undated), *Help Save Our World: Native, European & Flat Oyster (Ostrea Edulis)*, Coastwatch. http://coastwatch.org/europe/wp-content/uploads/2014/02/The-Native-Oyster.pdf, 03/12/15.

Dunne, C.E. (2003), 'Trojan Pig: Paradoxes of Food Safety Regulation', *Environment and Planning A,* 35: 1493–1511.

EEA (2013), *Towards a Green Economy in Europe: EU Environmental Policy Targets and Objectives 2010–2050*, Luxembourg: European Environment Agency.

Ertör, I. & Ortega-Cerdà, M. (2015), 'Political Lessons from Early Warnings: Marine FInfish Aquaculture Conflicts in Europe', *Marine Policy,* 51: 202–210.

European Commission (2009), *Building a Sustainable Future for Aquaculture: A New Impetus for the Strategy for the Sustainable Development of European Aquaculture*, COM (2009) 162 final, Brussels: European Commission.

European Commission (2011a), *Seas For Life: Protected, Sustainable, Shared European Seas by 2020*, Luxembourg: European Commission.

European Commission (2011b), *Proposal for a Regulation of the European Parliament and of the Council on the European Maritime and Fisheries Fund*, COM(2011) 804 final, December, Brussels: European Commission.

European Commission (2011c), *Our Life Insurance, Our Natural Capital: An EU Biodiversity Strategy to 2020*, Staff Working Paper SEC(2011) 540 final, May, Brussels: European Commission.

European Commission (2012a), *Guidance on Aquaculture and Natura 2000*, Brussels: European Commission.

European Commission (2012b), *Blue Growth: Opportunities for Marine and Maritime Sustainable Growth*, COM(2012) 494 final, September, Brussels: European Commission.

European Commission (2013), *Strategic Guidelines for the Sustainable Development of EU Aquaculture*, COM(2013) 229 final, April, Brussels: European Commission.

European Commission (2014a), 'Commission Welcomes Parliament's Adoption of Maritime Spatial Planning Legislation'. *Press Release.* 17 April.

European Commission (2014b), *The First Phase of Implementation of the Marine Strategy Framework Directive*, COM(2014) 97 final, February, Brussels: European Commission.

European Commission (2014c), 'Public Risk Perception and Environmental Policy', *Science for Environment Policy: Future Brief,* October. Issue 8.

European Union (2009), *Laying Down Detailed Rules on Organic Aquaculture Animal and Seaweed Production*, Commission Regulation (EC) No 710/2009 5 August 2009, Brussels: European Parliament.

European Union (2010), *Criteria and Methodological Standards on Good Environmental Status of Marine Waters*, Commission Decision of 1 September 2010, Brussels: European Parliament.

European Union (2013), *Common Organisation of the Markets in Fishery and Aquaculture Products*, Regulation (EU) No 1379/2013 of the European Parliament and of the Council of 11 December 2013, Brussels: European Parliament.

European Union (2014), *European Maritime and Fisheries Fund*, Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014, Brussels: European Parliament.

FAO (2007), *Building an Ecosystem Approach to Aquaculture*, FAO/Universitat de les Illes Balears Expert Workshop Proceedings, 7–11 May, Rome: Food and Agriculture Organization of the United Nations.

FAO (2009), *Integrated Mariculture: A Global Review*, Technical Paper No. 529, Fisheries and Aquaculture Department, Rome: Food and Agriculture Organisation of the United Nations.

FAO (2014), *The State of World Fisheries and Aquaculture: Opportunities and Challenges*, Rome: Food and Agriculture Organization of the United Nations.

FLAG (2014), *Fisheries Local Area Development Scheme: Sustainable Development of Fishery Dependent Areas*, Fisheries Local Action Groups. http://www.bim.ie/media/bim/content/fundingforms/BIM%20FLAGS%20Axis%204%20General%20Brochure-April%202014.pdf, 08/12/15.

Flynn, R. (2008), 'IFA Aquaculture: Designated Areas for Shellfish The Challenges for Local Authorities', Presentation to the Sherkin Island Marine Station, "24th International Conference 2008; Water: The Challenges for Users", Co Cork, 17-18 April.

Folke, C. (2006), 'Resilience: The Emergence of a Perspective for Social-ecological Systems Analyses', *Global Environmental Change,* 16(3): 253–267.

Folke, C., Colding, J., Olsson, P. & Hahn, T. (2007), 'Interdependent social-ecological systems and adaptive governance for ecosystem services' in Petty, J., Ball, A.S, Benton, T., Guivant, J.S., Lee, D.R., Orr, D., Pfeffer, M.J. & Ward, H. (Eds.), *Sage Handbook of Environment and Society* London: Sage Publications. 536–552.

Forsyth, T. (2004), *Critical Political Ecology: The Politics of Environmental Science,* London: Routledge.

Fox, T. (1995), 'Wild Fisheries and Aquaculture: From Conflict to Co-operation', *Aquaculutre Ireland Newsletter,* (March/April).

Garavan, M. (2007), 'Resisting the Costs of 'Development': Local Environmental Activism in Ireland', *Environmental Politics,* 16(5): 844–863.

Gargan, P.G., Forde, G., Hazon, N., Russell, D.J.F. & Todd, C.D. (2012), 'Evidence for Sea Lice Induced Marine Mortality of Atlantic Salmon (Salmo Salar) in Western Ireland from Experimental releases of Ranched Smolts Treated with Emamectin Benzoate', *Canadian Journal of Fisheries and Aquatic Sciences,* 69(2): 343–353.

Guiry, M.D. (2012), 'How Many Species of Algae are There?', *J. Phycol.,* 48: 1057–1063.

Guthman, J. (2004), 'Back to the Land: The Paradox of Organic Food Standards', *Environment and Planning A,* 36: 511–528.

Hall, S.J., Delaporte, A., Phillips, M.J., Beveridge, M. & O'Keefe, M. (2011), *Blue Frontiers Managing the Environmental Costs of Aquaculture*, Penang: The WorldFish Center.

Harkin, G. (2015), 'Community Campaigners go to War Over Oyster Farm on Wild Atlantic Way', *Sunday Independent*, 09/08/15.

Hickey, D. (2015), 'Mussel Farmers Suffer After-effects of Glorious Summer', *Irish Examiner*, 03 February.

Hishamunda, N., Ridler, N. & Martone, E. (2014), *Policy and Governance in Aquaculture: Lessons Learned and Way Forward*, Rome: Food and Agriculture Organization of the United Nations.

Holling, C.S., Berkes, F. & Folke, C. (1998), 'Science, sustainability and resource management." ' in Berkes, F. & Folke, C. (Eds.), *Linking social and ecological systems: management practices and social mechanisms for building resilience,* New York: Cambridge. 342–362.

IFA (2014), *IFA Aquaculture: Shellfish Special*. http://www.ifa.ie/wp-content/uploads/2014/07/Newsletter-Jul-2014.pdf, 03/12/15.

IFA Aquaculture (2011), *The Farmed Salmonid Health Handbook*, Marine Institute. http://www.fishhealth.ie/NR/rdonlyres/1B548A35-523D-4EE7-AA96-C6B5DFFFF7D1/0/FarmedSalmonidHealthHandbookOctober2011.pdf, 08/12/15.

Inland Fisheries Ireland (2012), *Submission on the Environmental Impact Statement for a Deep Sea Fish Farm Development in Galway Bay*. http://www.fisheriesireland.ie/fisheries-management-1/268-submission-by-ifi-on-the-eis-for-a-deep-sea-fish-farm-development-in-galway-bay-1/file, 07/12/15.

Inland Fisheries Ireland (2013), *Factsheet on the Impact of Salmon Farms on Wild Salmon & Sea Trout Stocks*. http://www.fisheriesireland.ie/fisheries-management-1/330-factsheet-on-salmon-farm-impacts-1/file, 07/12/15.

Inshore Ireland (2015), *Winter Algal Blooms Threaten South-west Shellfish Sector* http://www.inshore-ireland.com/News/winter-algal-blooms-threaten-south-west-shellfish-sector.html, 17/12/15.

Irish Examiner (2009), '200 French People Became Ill Over Contaminated Mussels', *Irish Examiner*, 19 November.

Jackson, D., McDermott, T., Kane, F., O'Donohoe, P. & Kelly, S. (2013a), 'Evaluation of the Impacts of Aquaculture and Freshwater Habitat on the Status of Atlantic Salmon Stocks in Ireland', *Agriculture Sciences,* 4(6A): 62–67.

Jackson, D., Cotter, D., Newell, J., McEvoy, S., O'Donohoe, P., Kane, F., McDermott, T., Kelly, S. & Drumm, A. (2013b), 'Impact of Lepeophtheirus Salmonis Infestations on Migrating Atlantic Salmon , Salmo salar L., Smolts at Eight Locations in Ireland with an Analysis of Lice-induced Marine Mortality', *Journal of Fish Diseases,* 36(3): 273–281.

Jasanoff, S. (2003), 'Technologies of Humility: Citizen Participation in Governing Science', *Minerva,* 41: 223–244.

Landström, C., Whatmore, S.J., Lane, S.N., Odoni, N.A., Ward, N. & Bradley, S. (2011), 'Coproducing Flood Risk Knowledge: Redistributing Expertise in Critical 'participatory Modellling'', *Environment and Planning A,* 43: 1617–1633.

Leach, M., Scoones, I. & Wynne, B. (2005), *Science and Citizens: Globalization and the Challenge of Engagement*, Vol. 2, London: Zed Books.

Libery, B., Morris, C., Buller, H., Maye, D. & Kneafsey, M. (2005), 'Product, Process and Place An Examination of Food Marketing and Labelling Schemes in Europe and North America', *European Urban and Regional Studies,* 12(2): 116–132.

Long Martello, M. & Jasanoff, S. (2004), 'Introduction: Globalization and Environmental Governance' in Long Martello, M. & Jasanoff, S. (Eds.), *Earthly politics: Local and Global in Environmental Governance,* Cambridge MA: The MIT Press. 1–29.

Lowes, T. (2013a), *Sea Lice, Salmon Farms and the Irish Government: A Lethal Mix*, Irish Environment. http://www.irishenvironment.com/commentary/tony-lowes-sea-lice-salmon-farms-and-the-irish-government-a-lethal-mix/, 11/11/15.

Lowes, T. (2013b), 'Pesticides and Salmon Farms', *Village Magazine*, July.

Marine Institute (2007), *Veterinary Treatments and Other Substances Used in Finfish Aquaculture in Ireland*, March, (SWRBD), South Western River Basin District, Galway: Marine Institute.

Marine Institute (2009), *Irish Ocean Climate and Ecosystem Status Report 2009*, Galway: Marine Institute.

Marine Institute (2015), *The National Surveillance Monitoring Programme for Residues in Farmed Fish*, March, Galway: Marine Institute.

Marine Institute (undated), *Identification Guide to Toxic and Problematic Phytoplankton in Irish Coastal Waters*. https://www.marine.ie/Home/sites/default/files/MIFiles/Docs/MarineEnvironment/PhytoplanktonIDCard.pdf, 03/12/15.

Marine Institute & NUI Galway (2015), *'Blue Economy' Significant Contributor to Ireland's Economy*. http://www.nuigalway.ie/about-us/news-and-events/news-archive/2015/july2015/blue-economy-significant-contributor-to-irelands-economy.html, 12/11/15.

McCay, B.J. & Acheson, J.M. (Eds.) (1990), *The Question of the Commons: The Culture and Ecology of Communal Resources*, Tucson: University of Arizona Press.

Millard, D. (undated), *Technical visit to Japan's Seaweed Industry*, Specifically Focussed on Kelp Production and Large Scale Processing Techniques Dublin Bord Iascaigh Mhara.

Mitchell, T. & Harris, K. (2012), *Resilience: A Risk Management Approach*, Background Note, January, London: Overseas Devleopment Institue.

Morrissey, K., O' Donoghue, C. & Hynes, S. (2011), 'Quantifying the Value of Multi-sectoral Marine Commercial Activity in Ireland', *Marine Policy,* 35: 121–127.

Murphy, G. , Hynes, S., Doherty, E., Buckley, C. & Corless, R. (2014), *What's Our Water Worth? Estimating the Value to Irish Society of Benefits Derived from Water-Related Ecosystem Services: A Discrete Choice Approach*, EPA Research Report No.127, July, Wexford: Environmental Protection Agency.

NESC (2013), *Greening the Economy: Challenges and Possibilities for Integrating Sustainability into Core Government Policy*, Secretariat Paper No. 7, Dublin: National Economic and Social Council.

Ní Longphuirt, S., Stengel, D., O'Dowd, C. & McGovern, E. (2010), *Ocean Acidification: An Emerging Threat to our Marine Environment*, Marine Foresight Series No.6, Galway: Marine Institute.

O'Carroll, T. & Nolan, F. (1994), 'The Current State of the Shellfish Industry in Ireland', *Aquaculture Ireland Newletter*.

O'Donohoe, P. & Jackson, D. (2011), *Single Bay Management Report & Summary of Plans*, Section, Aquaculture, Galway: Marine Institute.

O'Donohoe, P., Kane, F., Kelly, S., McDermott, T., Drumm, A. & Jackson, D. (2015), *National Survey of Sea Lice (Lepeophtheirus Salmonis Krøyer and Caligus Elongatus Nordmann) on Fish Farms in Ireland 2014*, Galway: Marine Institute.

O'Sullivan, P. (2011), 'Engineering Division Report on Fish Escape from Marine Harvest Fish Farm Inver Bay on 11/12 November 2010'.

OECD (2012), *A Green Growth Perspective on Aquaculture*, TAD/FI(2012)11, Paris: OECD Publishing.

OECD (2014), *Green Growth and Aquaculture*, TAD/FI(2012)11/FINAL, Paris: OECD Publishing.

Organic Monitor (2014), *The European Market for Sea Vegetables*, Dublin: Bord Iascaigh Mhara.

Ostrom, E. (1990), *Governing the Commons: The Evolution of Institutions for Collective Action,* Cambridge: Cambridge University Press.

Phyne, J.G. (1996), 'Balancing Social Equity and Environmental Integrity in Ireland's Salmon Farming Industry', *Society & Natural Resources,* 9: 281–293.

Phyne, J.G. (1997), 'Capitalist Aquaculture and the Quest for Marine Tenure in Scotland and Ireland', *Studies in Political Economy,* 52(Spring): 73–109.

Phyne, J.G. (2009), 'Production, Markets and the Coastal Environment: Exploring the Social Sustainability of Irish Aquaculture' in McDonagh, J., Varley, T. & Shortall, S. (Eds.), *A Living Countryside?: The Politics of Sustainable Development in Rural Ireland,* Surrey: Ashgate Publishing Limited. 179–206.

Phyne, J.G. & Mansilla, J. (2003), 'Forging Linkages in the Commodity Chain: The Case of the Chilean Salmon Farming Industry, 1987–2001', *Sociologia Ruralis,* 43(2): 108–127.

Polman, N., Poppe, K.J., van der Schans, J.W. & van der Ploeg, J.D. (2010), 'Nested Markets with Common Poll Resources in Multifunctional Agriculture', Presentation to the The International Society for New Institutional Economics, "14th Annual Conference", University of Stirling, Scotland, UK, June 17-19.

Ridler, N., Wowchuk, M., Robinson, B., Barrington, K., Chopin, T., Robinson, S., Page, F., Reid, G., Szemerda, M., Sewuster, J. & Boyne-Travis, S. (2007), 'Integrated Multi-trophic Aquaculture (IMTA): A Potential Strategic Choice for Farmers', *Aquaculture Economics & Management,* 11: 99–110.

Roelvink, G., St. Martin, K. & Gibson-Graham, J.K. (Eds.) (2015), *Making Other Worlds Possible: Performing Diverse Economies*, Minnesota: University of Minnesota Press.

Ruane, N., Rodger, H., Graham, D., Foyle, L., Norris, A., Ratcliff, J., Murphy, K., Mitchell, S., Staples, C., Jewhurst, H., Todd, D., Geoghegan, F. & Ó Cinneide, M. (2005), *Research on Pancreas Disease in Irish Farmed Salmon 2004/2005—Current and Future Initiatives*, Marine Environment and Health Series No. 22, Galway: Marine Institute.

Ryan, J. (2004), *Farming the Deep Blue*, Dublin: Bord Iascaigh Mhara.

SEACASE Project (2010), *Sustainable Extensive and Semi-Intensive Coastal Aquaculture in Southern Europe*. http://cordis.europa.eu/documents/documentlibrary/124722771EN6.pdf, 03/12/15.

Siggins, L. (2000), 'Toxin Test System Causing Big Losses, Say Shellfish Farmers', *The Irish Times*, 15 November.

Siggins, L. (2013), 'Marine Agency Rejects Critique of Sea Lice Data', *The Irish Times*, 19 August.

SWAN (2015), *National Strategic Plan for Sustainable Aquaculture Development Response to Public Consultation*, July, Dublin: Sustainable Water Network.

Taisce, An (2014), *Public Consultation on the Marine Strategy Framework Directive: Monitoring Programmes (Article 11)*. http://www.antaisce.org/sites/antaisce.org/files/20140911-doe-msfd.pdf, 08/12/15.

Thorstad, E.B., Todd, C.D., Uglem, I., Bjørn, P.A., Gargan, P.G., Vollset, K.W., Halttunen, E., Kålås, S., Berg, M. & Finstad, B. (2015), 'Effects of Salmon Lice Lepeophtheirus Salmonis on Wild Sea Trout Salmo Trutta: A Literature Review', *Aquaculture Environment Interactions,* 7: 91–113.

Tovey, H. (2009), 'Managing Rural Nature: Regulation, Translations and Governance in the Republic of Ireland and Northern Ireland' in Mc Donagh, J., Varley, T. & Shortall, S. (Eds.), *A Living Countryside? The Politics of Sustainable Development in Rural Ireland,* Surrey: Ashgate. 107–120.

Tully, O. & Clarke, S. (2012), *The Status and Management of Oyster (Ostrea Edulis) in Ireland*, Irish Fisheries Investigations No. 24, Galway: Marine Institute.

UNEP (2011), *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*, Nairobi: United Nations Environment Programme.

van der Ploeg, J.D. (2013), 'Peasant-driven Agricultural Growth and Food Sovereignty', Presentation to the Program in Agrarian Studies, Yale University, "International Conference Food Sovereignty: A Critical Dialogue Conference Paper #8", New Haven, September 14–15. https://www.tni.org/files/download/8_van_der_ploeg_2013.pdf.

van der Ploeg, J.D., Jingzhong, Y. & Schneider, S. (2012), 'Rural Development Through the Construction of New, Nested, Markets: Comparative Perspectives from China, Brazil and the European Union', *The Journal of Peasant Studies,* 39(1): 133–173.

Vega, A., Hynes, S. & O'Toole, E. (2012), *Ireland's Ocean Economy: 2012,* Socio-Economic Marine Research Unit, Galway: National University of Ireland, Galway.

Waite, R., Beveridge, M., Brummett, R., Castine, S., Chaiyawannakarn, N., Kaushik, S., Mungkung, R., Nawapakpilai, S. & Phillip, M. (2014), *Improving Productivity and Environmental Performance of Aquaculture*, World Resources Institute. www.wri.org/publication/improving-aquaculture, 04/04/16.

Walsh, M., Watson, L., Robinson, G., Maggs, C. & Edwards, M. (2011), *A Market Analysis towards the Further Development of Seaweed Aquaculture in Ireland*, Part 1, Dublin: Bord Iascaigh Mhara.

Watson, L. & Dring, M. (2011), *Business Plan for the Establishment of a Seaweed Hatchery & Grow-out Farm*, Part 2, Dublin: Bord Iascaigh Mhara.

Werner, A. & Dring, M. (2011), *Recommendations for optimal ongrowing and harvesting techniques for Palmaria palmata in different Irish sites with indications of yield*, Dublin: Bord Iascaigh Mhara.

Whatmore, S.J. (2009), 'Mapping Knowledge Controversies: Science, Democracy and the Redistribution of Expertise', *Progress in Human Geography,* 33(5): 587–598.

Whitmarsh, L., Cook, E.J. & Black, K.D. (2006), 'Searching for Sustainability in Aquaculture: An Investigation into the Economic Prospects for an Integrated Salmon—Mussel Production System', *Marine Policy,* 30: 293–298.

Wolff, J.G. & Beaumont, A. (2011), *Shellfish Sequestration: The Augmented Cultivation of Molluscs, and the Preservation of their Shells, as a Means of Sequestering Carbon Dioxide*. http://www.mng.org.uk/gh/private/ssr7a.pdf, 03/12/15.

Working & Educating for Biodiversity (WEB) (2012), *Ireland's Natural Capital: Considering Biodiversity in the Reform of the Common Agricultural Policy*, April, Dublin: Irish Environmental Network (IEN).

Wynne, B. (1992), 'Misunderstood Misunderstanding: Social identities and Public Uptake of Science', *Public Understanding of Science,* 1: 281–304.

Wynne, B. (2002), 'Risk and Environment as Legitimatory Discourses of Technology: Reflexivity Inside Out', *Current Socology,* 50(3): 459–477.

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HELP SAVE OUR WILD

Native, European & Flat Oyster (*Ostrea edulis)*

By Karin Dubsky

Our native oyster is a familiar sight as one of the larger heavier shells swept onto many beaches. The outer shell is irregular rough white, grey, beige or brownish with lines, but the inside is smooth and shiny. Old shells can show many growth rings – see pics by Elena Higuera below.

When alive it forms a rough rounded, hinged box, up to hand size. One shell valve is curved, the other forms an almost flat lid, which is shut tightly when out of water. This keeps the soft body secure in shell water for days. Most oyster beds are now DEAD! **We can halt and reverse this.**

Life cycle: When spring comes and the oyster is about 4 years old, the flesh starts turning milky as it gets ready to spawn. Eggs and sperm are released into the sea water as temperature rises, and float in plankton. Larvae develop in the plankton and eventually come down to the sea bottom, cementing themselves onto hard material like dead shell 'cultch' as they turn into baby shelled oysters. In naturally self seeding beds the young oysters settle in the same area as the adults, thus naturally replenishing the beds. Beds may be intertidal or in shallow coastal waters, estuaries and bays. Here the baby oyster slowly grows filter-feeding food out of the sea water and adding extra layers to the shell like tree rings.

In Lough Swilly you can find them in the low intertidal zone on the sandy mud. When disturbed, many stand like fans then dig themselves into the sediment slow motion. But behaviour and favoured settlement vary – even in Lough Foyle next door, the shape and habits are different.

Aquaculture can take various forms from transfer of stock, to enhancing wild beds, to full hatchery stock farming. The oysters grown in bags on trestles in many of our bays today usually contain the **Gigas (= Pacific) oyster** (*Crassostrea gigas)* introduced from warm Pacific waters. In the 1970s this was hailed as ideal for aquaculture due to fast growth even if placed in the mid intertidal zone. It was thought to be of no threat to European wildlife as it would not spawn in our cold waters. However that proved wrong – see section on Threats and Gigas box.

This native oyster information is produced on the eve of **Biodiversity Day 2009**, after field surveys and much discussion among Coastwatchers, Save the Swilly and native oyster fishermen on the Foyle and Swilly as well as meetings with Loughs Agency, Ulster Wildlife Trust and WWF. It is to highlight urgent issues concerning the decline of this iconic native species and put forward positive action to halt the decline and reverse the trend. Comments, ideas, help and information all welcome. Please forgive any errors Next update planned for July 2009. The research and printing was co funded by a Biodiversity week Dept of the Environment Grant.

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Or contact relevant native oyster or environmental groups in your area

‘The World Is Your Oyster’ coined in 1600

As we can see from remains in **shell middens** dotted around our coast the European oyster was in the diet of **Bronze Age** man. A century ago, it was still widely distributed from the Arctic waters through the North Sea and East Atlantic down into the Mediterranean and the Black Sea, prized as a delicacy, high protein seafood and ascribed aphrodisiac qualities. .
During the late 19^{th} and 20th century oyster stocks dwindled. Rising demand and more oyster harvesters with better gear made overfishing a widespread pressure in open shore areas like the large Irish Sea beds, harvested and exported through ports like Arklow. For inshore and privately owned localities conservation measures (e.g. minimum size, or weight and closed season) were more successful.

Today European waters are estimated to contain only about 20 productive native wild oyster sites. It is now a red list species, protection under the OSPAR Convention, but like many other marine species in EU Nature law. Ireland has 6 of these sites **Tralee Bay, Galway Bay**, **Kilkieran Bay**, **Blacksod Bay, Lough Swilly** and the shared **Lough Foyle** which is considered the largest remaining wild bed area in Europe (hectares covered not density). These sites and small dispersed beds in **Clew Bay** going North to Achill Island and Belmullet, and **Mannin Bay,** are a credit to local communities – but they are not safe.

Action is urgent to protect the European oyster from becoming extinct in the wild. Halting the loss of biodiversity by 2010 is our European promise. It’s late for the oyster, but not too late. We need to combine the knowhow of local traditional native oyster men, scientists and other stakeholders and focus on a comprehensive suite of actions to reach set goals.

This is a species man has collected and eaten for thousands of years, a species traded, embedded in our language, our maps, valued at dinners, acknowledged as ‘typical species’ where it occurs in Natura 2000 sites. This species is the livelihood for men who know more about it and the inshore waters than most others. We simply have to try and halt the loss of the native oyster. We promised to *Halt the Loss of Biodiversity by 2010*. Surely that meant we would at least try.

Coastwatch launched the Irish awareness and action campaign on 22nd May’09 – World Biodiversity Day. Within a year, both protection measures and wild native oyster status on our coasts can improve significantly. Join us, help us.

GOALS

(1) Maintain the existing native oyster beds within Irish and cross-border areas

(2) Restore the geographical range of the native oyster within Irish waters - towards 1900 levels

(3) Maintain the existing abundance and health of the native oyster on all Irish sites

(4) Increase the abundance and improve the health of the native oyster within Irish and cross-border inshore waters

Ten Threats to our Native Oyster

The rank order of the 10 threats and pressures below differs with location and some may not apply in a given site. Pressures often combine and also affect other organisms.

1. **Invasive Alien Species:** the habitat structure, competition for space and food can all change rapidly when an alien species takes over in an area. The **Gigas oyster** *Crassostrea gigas* used in aquaculture is a serious IAS threat for our coastal biota – see Gigas info box. Others like the slipper limpet *Crepidula fornicate* are not yet reported from Ireland, but our surveillance is poor and ship and seed stock movements are set to increase.

2. **Over-exploitation** - a key factor in the mid 1800s and can still be a problem locally.

3. **Disease and Parasites***:* the parasitic protozoan *Bonamia ostreae* causes the oyster to waste away and inflicted high mortalities in France. *Bonamia* has since been introduced into other countries including Ireland but has not caused mass death here. Other parasites eg - *Marteilia refringens*, have come into Europe, but not yet Ireland.

4. **Competition:** our native mussel *Mytilus edulis* is a powerful filter feeder which grows well in a similar habitat, forming high density beds, with byssus threads holding mussels together. The low density oyster beds and the thick mussel bed carpets can form a patchwork in different parts of an inlet. The odds are set against the oyster when mussels are moved into the vicinity of or on top of an oyster bed for aquaculture.

5. **Morphological area changes** may cause total loss due to land reclamation, for example, or more subtle impacts like changing hydrology on the building of a new pier, so larvae may not be swept back to parent beds. The threat is increasing as we look at plans for coastal development for transport, tourism and green energy.

6. **Habitat damage/changes** can be caused by other organisms – the accumulation of pseudo-faeces or `mussel mud` around mussel beds which degrades the grounds and hinders oyster spat from settling. More dramatic and fast is large scale dredging, which physically changes the whole sea bed, removes the oyster stock and other organisms as well as suitable culch for spat to settle on.

7. **Weather and climate change:** severe winters are reported as having caused high mortalities in the UK. It is not known how significant the last two year's high rainfall summers and consequent high freshwater levels have been for recruitment or survival. With climate change predictions this could affect the higher estuarine beds.

8. **Pollution:** High pollution – eg oil slick can kill, while lower levels may affect recruitment TBT (tri-butyl tin) anti-fouling boat paints caused stunted growth in oysters in the 1980s, well researched by Dr Dan Minchen in Ireland High silt loads, interrupt filter feeding capacity and may smother the oyster around dredging and spoil dump sites and downstream of some aquaculture sites. Sewage and farm effluent pollution reduce oyster crop value as health controls forbid direct sale.
9. **Predators:** Natural enemies include crabs, dogwhelk, some worms and starfish in full salinity areas. Its natural but when stocks get very low every predator counts. We must avoid adding extras as IAS.

10. **Last stand** - if spawning stock density drops too low, synchronous spawning or sufficient larval production for successful settlement may become too rare.

Gigas oyster as IAS in Ireland The fast growing tough Gigas or Pacific oyster is the preferred oyster used in aquaculture in Ireland for the past 25 years. Meanwhile water temperature has increased and the Gigas oyster acclimatised. It is now established as an invasive alien species in Lough Swilly, Lough Foyle and Strangford Lough All Natura 2000 sites. We do not know if others are infested.

Coastwatch scoping surveys undertaken with local native oyster fishermen in Lough Swilly and Lough Foyle show that not only the native oyster but many other native organisms are at risk as the Gigas oyster takes over bands on the foreshore occupied by limpets, winkles, seaweeds...

Urgent Action Required. We are calling for:

1. An all-Ireland approach to the protection, management and marketing of native oysters.

2. **All Gigas Oyster farmers** to undertake a site audit and remove any old Gigas oysters which may have spilled onto the ground so largest spat risks are removed as fast as possible as they are now getting ready to spawn. Any Gigas oyster found settling in their area reported as IAS. Starting now from Biodiversity Day. By mid June all sites should be clean and by late June an update on Gigas spread and a cleaner foreshore should be achievable.

3. Both governments to prohibit the movement of shellfish into or out of areas with native oysters now until there are sufficient safeguards in place and enforce transport law.

4. Both governments to declare the Gigas oyster an IAS (invasive alien species) under EU Council Regulations (EC) No 708/2007, (EC) No 535/2008 and (EC) No 506/2008 **now**.

5. The Irish government to declare the European Oyster a priority species for protection and joining with NI on one all Ireland species action plan. The plan to be prepared with cooperation of native oyster fishermen from different areas. Completing and adopting the plan in 10 months.

6. Both governments to use the window of opportunity and review inclusion of remaining native oyster beds and areas in which live oysters are still found, in the final SAC marine site list (Natura 2000 sites) with stakeholder consultation - especially wild oyster fishermen on site boundaries. The EU adoption of the final marine list is planned for early 2010.

7. Both governments and Loughs Agency to set out grant aid priorities which help oyster protection/restoration goals and help job creation and quality image of the areas. That may include stock enhancement, site restoration and research into native oyster stocks and potential for reintroducing the native oyster into areas where it was growing well in the past. Grants for hatcheries which substitute import and tourism products which highlight the wild native oyster as symbol of high quality and wise use of coastal waters.

8. Both governments to establish the extent of this IAS problem in Ireland by August 09 and facilitate elimination/removal in areas known to have the problem immediately. A draft protocol developed by Coastwatch and native oyster fishermen is available for cost effective and local benefit use. Action rolled out over the summer months should rid the three main known sites of the invasive Gigas oyster within 5 years.

9. Regional and national Government to revise the draft WFD plans so that all shellfish waters are brought to good or high quality status by 2015 with no derogations.

10. Governments and all agencies dealing with the coastal zone to support information, awareness raising and eco labelling initiatives for the native oyster and their habitats as icon for coastal environmental quality. If credible and handled transparently it will yield solid employment and economic return, as other regions in the EU has shown.

Irish Fisheries Investigations No. 24 2012

The Status and Management of Oyster *(Ostrea edulis)* in Ireland

Oliver Tully

Sarah Clarke

Marine Institute
Foras na Mara

The Status and Management of Oyster (*Ostrea edulis*) in Ireland

2012

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Marine Institute
Foras na Mara

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Abstract

Fourteen oyster surveys were completed during 2010-2012 in 6 bays on the west coast of Ireland prior to and following annual late autumn fisheries. Vessel based surveys using locally designed dredges were undertaken using in Tralee Bay, Galway Bay, Kilkieran Bay, Clew Bay, Blacksod Bay and L. Swilly. Survey extent was defined by local knowledge of the distribution of beds in each bay and from previous survey reports. The extent of oyster beds, oyster densities, biomass, size composition and growth and mortality rates are reported. The governance and management of oyster fisheries in Ireland is described and conservation requirements for oyster habitat are discussed with reference to the EU Habitats Directive.

Survey extents varied from 0.9-13km^2. Population densities of oyster were generally <0.5 oysters m^{-2} but higher densities of up to 50 oysters m^{-2} occurred in areas of inner Tralee Bay. In other sites, densities did not exceed 5 oysters m^{-2}.

The majority of national oyster biomass occurred in inner Tralee Bay where biomass varied from 980-1330 tonnes in the 2010-12 surveys. Biomass in outer Tralee Bay and L. Swilly was approximately 100 and 124 tonnes, respectively. Biomass estimates in inner Galway Bay, Kilkieran Bay, Clew Bay and Blacksod Bay were all less than 50 tonnes.

vonBertalanffy growth parameters, k and t_o, were 0.21year^{-1} and 0.23years respectively. These parameters were estimated from shell height frequency data and by fixing L_{inf} at 120mm, based on the maximum size of oysters recovered during surveys. Total mortality rates (Z) were estimated from the linear portion of length converted catch curves using these derived growth parameters. Z estimates, in pre and post fishery surveys, averaged 1.07 and 1.30 respectively in 2010 and 0.94 and 1.55 respectively in 2011. Fishing mortality rate (F), derived from the difference in Z estimates in pre and post fishery surveys in inner Tralee Bay, was 0.9 representing an annual removal of 60% of oysters recruited to the fishery. Increase in biomass of a single cohort, simulated using derived growth rate parameters, the size weight relationship and different rates of natural mortality (M) suggests that maximum biomass develops prior to the minimum landing size of 76mm if M>0.4. Improved, site specific, estimates of growth and mortality rates and size at maturity data are needed to provide fisheries management advice for native oysters.

Pacific oyster (*Crassostrea gigas*) was abundant and widespread, in what was previously *Ostrea* habitat, in L. Swilly. In some of these areas, Pacific oyster was the only oyster species present. In other areas both species co-existed although they were spatially segregated to a degree in relation to shore level.

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1 Introduction

Although commercial fisheries for oyster continue in many oyster beds in Ireland, data on the distributional extent and status of native oyster have not been reported in recent years (Barry 1981, Whilde 1973). Oyster stocks are, however, known to have declined significantly in Ireland compared to the historic highs of the 19th century. The species is listed by OSPAR as threatened or declining and a number of pressures from coastal development, disease and alien species continue in many areas (OSPAR 2009). All commercially fished oyster beds in Ireland occur in Special Areas of Conservation (SAC) designated under the Habitats Directive (Council Directive 92/43/EC). Oysters are potentially keystone habitat (reef) forming species or important characterising species in these areas and the maintenance of favourable conservation status (FCS) of oyster habitat is a requirement under conservation objectives now being defined for these habitats (NPWS 2011a,b). Sustainable exploitation consistent with the maintenance of FCS should, therefore, be a primary management objective for these fisheries. Strategies to achieve this objective need to be founded on basic information on extent, biomass, size and age composition and recruitment to native oyster beds. These attributes are reported here for 6 oyster producing areas and 14 surveys completed during the period 2010-2012. In addition, historic and current production of oyster in Ireland is briefly reviewed, strategies for the management of oyster fisheries in SACs are discussed and the governance and management of oyster fisheries in Ireland today is described.

1.1 Historic production

The history of oyster fishing in Ireland is documented back to the 1500s (Went 1962). Although the records on national production are incomplete, the peak in output appears to have been in the mid and late 19th century. This was due significantly to the offshore, but short-lived, fishery in the Irish Sea and also the Galway fishery which was important up to the early 20th century. Overall, the long term trends in national production, from descriptions given in Went (1962), is of fluctuation with local extinctions or severe declines and various attempts at restoration. By 1870, half of the Irish production originated from Arklow and Wexford and, in addition, substantial quantities of oyster were taken directly from this area by English boats. In 1871, the Arklow and Galway beds were described as being the main production areas. Production from these beds peaked at 34-38million oysters into Ireland in 1863 and 1864. The reported statistics then demonstrate a precipitous decline in production from these areas over the following years up to 1888 (Figure 1).

Important oyster fisheries have existed at approximately 50 locations around the coast at one time or another (Went 1962). In 1903, 24 public oyster beds were listed in Ireland with Tralee, Carlingford, Galway Bay, Cork Hbr, St. Georges Channel and Lough Foyle being the most important. The “once prolific public beds” in Cork, Shannon, Clew Bay and Blacksod Bays were yielding very little by the early 20th century. In addition, there were 8 chartered beds (areas where rights were claimed by virtue of a lease from the Crown and usually associated with grants of land) at Sutton, Clontarf, Cork Hbr, Sneem, Kilmacallogue, Kilkieran, Cashel, Beirtreach Bui and Malahide. The only self-recruiting stock in this list was in Kilkieran Bay. The other areas were used for relaying, storing and fattening of native and American oysters (*Crassostrea virginica*). In addition, there were 62 oyster beds covered by licences under the Irish Fisheries Acts. Important licenced areas in this category were at Clifden Bay, Ardfry, Barrow, Burren, Pollagh (Kinvara) and Sligo Bay. There were also a number of unlicenced layings. Oyster production involved a range of activities from purely fishing of wild stocks to establishing grounds and ‘put and take’ operations with native, American and Portugese oysters (*Crassostrea angulata*). Some areas, where growth rates may have been low, were used as sources of seed which were taken and re-laid into 'fattening areas' prior to sale.

Historically, attempts to manage stocks were effected through a range of licencing regimes from open public access to private licences of various forms. Causes of the dramatic decline in the important stocks are clear in some cases. In Arklow, heavy fishing pressure over a number of years decimated the offshore beds. Although these beds were extensive they were probably not highly productive and larval retention and settlement in these areas may have been sporadic. In coastal bays and estuaries, overfishing or unregulated fishing played a strong role in decline of stocks (Smyth *et al*. 2009). Poor compliance with bye-laws was also implicated as the Fishery Authorities were debarred from direct enforcement of them (Holt and Hillas 1905). However, it is difficult to separate the effects of fishing from environmental effects on recruitment and productivity over longer periods of time. Cold winters of the 1940s and early 1960s probably contributed to mortality of spawning stock in shallow water areas (Orton, 1940; Kennedy and Roberts 1999). Habitat loss (Laing 2006) and more recently, *Bonamiosis* infection, first detected in Ireland in 1987 (McArdle 1991), has had a significant deleterious effect on stocks. Other species of parasite such as *Marteilia refringens* have also been responsible for decline of *O. edulis* in France and Spain (Anon 2005). This accumulation of pressures may have been incompatible with maintenance of populations in which reproduction and recruitment may have been irregular and insufficient to counter high mortality rates.

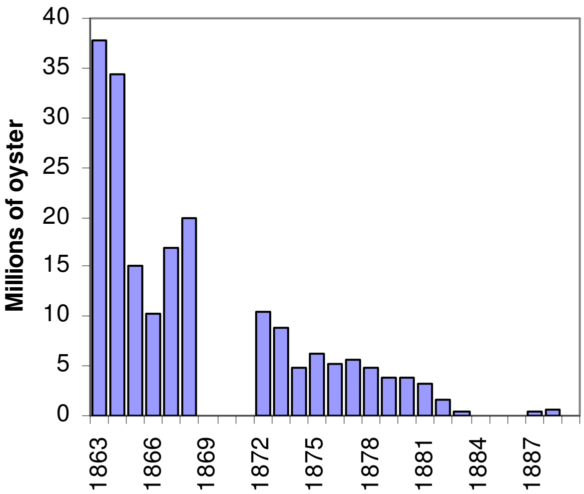

Figure 1. Landings of oyster into Ireland from the Irish Sea and Galway Bay between 1863 and 1889 derived from data reported in Went (1962).

1.2 Current production

Today, the principal fisheries for native oysters in Ireland are in Tralee Bay and to much lesser extents in inner Galway Bay, Lough Foyle, Lough Swilly, Kilkieran Bay and, infrequently, in Blacksod Bay and Clew Bay. Annual national production fluctuates between 100-300tonnes depending on the decisions of oyster managers to open beds, annual total allowable catches (TACs) for beds that are opened and trends in biomass (Table 1).

Table 1. Landings (tonnes) of oyster into Irish ports annually between 2004-2011. Source: Sea Fisheries Protection Authority and Oyster co-operatives. Records may be incomplete.

County	Port	2004	2005	2006	2007	2008	2009	2010	2011
Cork	Kinsale			5					
Donegal	Buncrana	170	55	53	51	43	20	12	4
Donegal	Greencastle							45	
Donegal	Moville	86		45	96	20	42	79	
Galway	Carna	20	28						
Galway	Kilkieran							18	
Galway	Clarinbridge	20		25		25	25	15	15
Kerry	Cromane				4				
Kerry	Inner Tralee	240			140		240	180	100
Mayo	Achill	7	5	6					
Mayo	Belmullet			90					?
Mayo	Westport		6	9					
Total		**543**	**94**	**233**	**291**	**88**	**327**	**349**	**115**

1.3 Conservation of *O. edulis*

O. edulis has declined significantly throughout Europe since the 1970s. In the UK Biodiversity Action Plan (BAP), it is categorised as having declined by over 50% in 25 years (UKBAP 1999). The species was included on the OSPAR list of threatened and/or declining species and habitats in 2003 (OSPAR 2009). Although not listed as an Annex species in the Habitats Directive, native oyster beds potentially falls within the definition of Habitat 1170 (reef) as defined in the Directive and oyster is potentially a characterising and/or key structural species in sedimentary habitats in estuaries (Habitat 1130) or large shallow inlets and bays (Habitat 1140). *O. edulis* is recorded as a structural reef forming species in shallow (7-20m) waters in exposed and semi-exposed coasts of the Black Sea although the presence of serpulid polychaetes seem to be important in providing cementing material for reef formation (Todorova *et al*. 2009). In Ireland, at least in the 20th century and in shallow water areas, topographic biogenic reefs formed by native oyster have not been documented. In all these cases, however, the beds have been disturbed by fishing activity for decades or centuries. The structure and function of offshore oyster beds in the Irish Sea and similar beds in the southern North Sea and English Channel, all of which are now extinct, is not well documented. However, given the production of oysters from these offshore beds, in the 19th century, it is likely that oysters formed continuous cover over extensive area of seabed. The extent to which these oyster beds constituted topographic biogenic reef is unknown. Presumably, however, they supported a high biodiversity as to mussel reefs today for instance (Coleman and Williams 2002).

In Irish inshore waters practically all significant oyster populations occur or have occurred in estuarine areas where there is significant freshwater inflow. The capacity of oyster to form reefs in these environments depends on the 'shell budget'. That is to say, the rate at which shell accretes onto a reef should be greater than the rate at which it is lost if the reef is to grow. Estuarine environments are unpredictable and potentially stressful to native oyster with respect to salinity change, sediment deposition rates, physical disturbance and temperature extremes. These areas are variously exposed to wind induced wave action which can turn-over shell and sediment resulting in mortality of juvenile oysters in particular. Spawning, larval settlement and recruitment fail regularly and the populations are maintained by periodic re-cruitment events. Adult oyster shell is also not well preserved in these estuarine environments (Powell *et al*. 2006). Today, oyster beds are exposed to a number of additional pressures that were absent prior to major human exploitation, which extends back to the 1500-1700s in Ire-land. These include fishing, competition from introduced species such as *Crassostrea gigas* (Pacific oyster) and infection with *Bonamia* in particular. Nevertheless, oyster beds in estua-rine waters provide, in some cases at least, a shell rich habitat in mixed sediments. In these areas, if spawning potential is sufficiently high, if environmental conditions favour frequent reproduction and if natural and fishery induced physical disturbance and mortality is low, the 'shelliness' of such habitats may increase and dead shell may accumulate forming topog-raphic relief. As in the Black Sea example, the presence of other accreting organisms such as serpulid worms could potentially lead to development of bio-genic oyster reefs. These condi-tions do not, however, coalesce in any oyster producing area in Ireland at this time, nor have they probably done so for at least 200 years, in the main producing areas.

1.4 Governance and licencing of oyster fisheries in Ireland

The governance and licencing of native oyster fisheries in Ireland varies depending on loca-tion. Oyster stocks and their fisheries are in some cases managed under Aquaculture li-cences issued by the Department of Agriculture, Food and Marine (DAFM) (Table 2). These licences are renewed every 10 years and part of the renewal condition is that a production and management plan for the relevant oyster bed be developed. In other areas, the manage-ment of oysters has been devolved to Co-operatives or Societies in Fishery Orders (FOs) un-der the Fisheries Act, 1959. These orders give, essentially, permanent rights of access to a co-op or group to produce oysters within the order area although the Minister may revoke or-ders in certain circumstances. These FOs are administered by the Department of Communi-cations, Energy and Natural Resources (DCENR). Oysters are also fished in areas not sub-ject to FOs or Aquaculture licence but as public fisheries and include the oyster beds in L. Swilly and the 'public' bed in Galway Bay. The FO for the St. Georges bed in Galway Bay is currently owned by the state agency, Bord Iascaigh Mhara (BIM), and some beds also remain in private hands the title being linked to land title.

In all cases, operators using a dredge to fish for oysters require a dredge licence from Inland Fisheries Ireland (IFI). A licence fee applies. Vessels operating in these fisheries must be listed on the Register of Sea Fishing Vessels administered by DAFM. Where they operate in public beds, the vessels should have either bivalve or polyvalent 'tonnage' attached. Vessels operating in Aquaculture or FO areas do not require tonnage and can be registered in the Aquaculture Segment of the Irish fishing fleet. Vessel operating in Aquaculture and FO areas must also have a permit from the local Co-op. A permit fee usually applies.

Whether in Aquaculture licenced areas, FO areas or in public beds the various oyster co-operatives or societies manage exploitation of the beds to varying extent. A minimum landing size of 76-78mm applies universally. Some co-ops impose a TAC, the opening and closing dates of the season and, in some cases, the total number of permits they issue. The TAC or other measures are usually not based on scientific advice although this has varied over the past 40 years depending on where and how often such data and advice is available.

Table 2. Licencing framework for the principal native oyster fisheries in Ireland

Site	**SAC**	**Licencing**					**Other bivalve species fished or produced**
		Aqua-culture	**Fish-ery Order**	**Public fishery**	**State owned**	**Private**	
Galway Bay (Clarinbridge)	Yes	No	Yes	No	No	No	Pacific oyster
Galway Bay (Public bed)	Yes	No	No	Yes	No	No	
Galway Bay (St. Georges Bed)	Yes	No	Yes	No	Yes (BIM)	No	
Galway Bay (Ballynacourty)	Yes	No	No	No	No	Yes	
Kilkieran Bay	Yes	Yes	No	No	No	No	Scallops
Tralee Bay	Yes	No	Yes	No	No	No	
Blacksod Bay	Yes	Yes	No	No	No	No	
Lough Swilly	Yes	No	No	Yes	No	No	Mussels, Pa-cific oyster
Clew Bay	Yes	No	Yes	No	No	No	Pacific oyster, Scallop

2 Methods

2.1 Surveys of stocks 2010-2012

All the main oyster beds in Ireland that have been producing oysters in recent years were surveyed between 2010 and 2012 (Figure 2, Table 3). Fishing for native oysters, in Ireland, usually commences during late autumn or in December and the fisheries are usually closed again in early Spring. Surveys were generally undertaken either before or after the seasonal fishery and in some sites surveys were completed both before and after the fishery. A total of 14 surveys in 6 Bays were completed between Sept 2010 and Feb 2012. In Tralee Bay there are discrete and separate beds in the inner and outer areas of the Bay. These are reported separately.

Local oyster fishing vessels, using local dredge designs, were used in all surveys. Dredges were generally 1.2m wide with either teeth or blade and with soft or rigid frame bags. Local rather than standardised dredges were used so that the operating skills of the skipper were not compromised and catch rates were reflective of local fishery conditions. Dredge efficiencies was estimated for the dredges used in Kilkieran Bay and Clew Bay. Here the start and end of a number of dredge tows were marked by surface marker buoys and divers surveyed the tracks after the dredge had been towed between the buoys. All oysters found in the dredge track were retained and counted by the divers and compared to the catch of the dredge. The divers were presumed to be 100% efficient in finding oysters in one pass over the dredge track. A total of 24 dredge tracks were re-counted by divers in Kilkieran and Clew Bays.

Surveys were planned by outlining the extent of the oyster bed on admiralty charts either from local knowledge or reported extents of the beds from previous surveys. Grids were established over these areas, at various resolutions depending on the size of the bed and survey time available, and a dredge tow station was allocated to the centre point of each grid cell. The knowledge of the local skipper was, however, taken into account during the surveys and stations were re-allocated randomly to areas indicated as 'oyster bed' by the skipper. In order to define the extent of the beds, tows were taken towards the edges of the beds as indicated by patterns of zero catches. The dredge was towed for approximately 50m at each station. Distance towed was measured using a Trimble® Nomad GPS unit which recorded GPS position every 5m and at start and end of the tow. Dredge track GPS position and oyster catches were, subsequently, downloaded and incorporated into ArcGIS 9.3®. Survey extent was re-defined by creating a new 'mask' polygon incorporating all positive survey stations and excluding areas which had consistent zero catches. This 'mask' constrained the extent over which oyster densities were subsequently interpolated. Oyster numbers per tow were converted to oyster densities and raised to account for dredge inefficiency. Oyster densities were then interpolated (ArcGIS Spatial Analyst) using the Inverse Distance Weighting (IDW) algorithm. This interpolation method averages the values of sample data points in the vicinity of each cell in the raster surface being estimated. A power value in the interpolation can be used to control the weighting of points based on geographic distance from the point being calculated. Specifying low power, such as 2 in the present case, gives more influence to distant points and a smoother surface. The search radius was varied so that at least 6 sampled points were used in calculating the interpolated cell. Neighbourhood areas used to calculate interpolated points were, therefore, variable depending on the sampling effort close to the cell being interpolated.

Density contours were drawn at intervals to reflect the range in oyster density over the survey grid and the geographic area within each contour was calculated. Mean biomass of oysters (B_{mo}) and its confidence limits per square meter within the contour was calculated as

$$B_{mo} = (D \pm d) * (W \pm w) = D * W \pm ((D * W) * \sqrt{d^2 / D^2 + w^2 / W^2})$$

where, D is average density of oysters at stations within the contour, d is the confidence limits for the average density, W and *w* is the mean weight and confidence limits, respectively, of oysters at stations within the contour, calculated from the size weight relationship.

Total biomass within each contour (B_c) was calculated from the product of the mean biomass within the contours and the geographic area encompassed by the contour given by the equation,

$$B_c = B_{mo} * A_c \pm CL_{Bmo} * A_c$$

where, B_{mo} is the biomass per square meter within a contour area, A_c is the area encompassed by the contour, CL_{Bmo} is the confidence limit for the biomass per square meter within the contour area as calculated above.

Finally, the total biomass (B_t) and its CL was obtained by summing the biomass estimates for all contours

$$B_t = \sum_{c=1}^{n} (B_c \pm CL_{Bc})$$

Table 3. List and timing of oyster surveys at 7 locations in relation to fisheries in 2010-2012.

Site	2010/2011		2011/2012	
	Pre-fishery	Post-fishery	Pre-fishery	Post-fishery
Inner Tralee Bay	Sep 2010	Jan 2011	Sep 2011	Feb 2012
Outer Tralee Bay	Sep 2010		Feb 2012	
Kilkieran Bay	Oct 2010	Jan 2011		
Blacksod Bay		Jan 2011		
Clew Bay	Oct 2010			
Galway Bay		Apr 2011		Feb 2012
Lough Swilly		Mar 2011	Nov 2011	

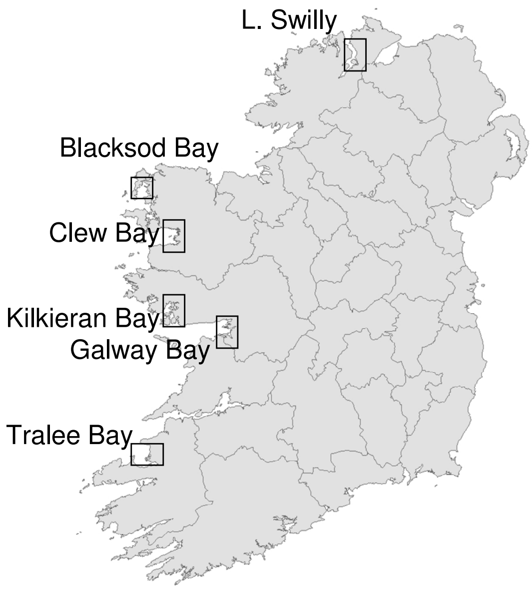

Figure 2. Areas where oyster surveys were completed in 2010-2012

2.2 Estimation of growth and mortality

Size at age data for oysters aged 0-3yrs were extracted from length frequency distributions from the survey, from Galway Bay data obtained in July 2011 (not shown) and from data presented in Barry (1981) for Kilkieran Bay. Normal distributions, assumed to represent age classes, were fitted to the length frequency distribution mixtures using maximum likelihood estimation and the solver routine in Excel. A birth date of end of June was assigned to scale the age data and mean size at presumed age was estimated. The vonBertalanffy growth function (King 1995) was fitted to the data using maximum likelihood methods and the solver routine in Excel and a fixed asymptotic size ($L_\propto$) of 120mm, which corresponded, approximately, to the largest oysters observed during surveys. A fixed $L_\propto$ was used because of the limited age range for which size was estimated and to enable convergence during the fitting process. The von-Bertalanffy growth model is defined as

$$L_t = L_\propto \left(1 - e^{-k(t-t_0)}\right)$$

where L_t is size at time t, $L_\propto$ is asymptotic length at which growth is zero, k is the rate at which size approaches $L_\propto$ and t_0 is the age at zero size.

The rate of total mortality (Z) was estimated from the right hand portion of the length distributions after converting numbers at length to numbers at age using the estimated growth parameters which included seasonality in growth. Accounting for seasonal growth is important in eliminating bias in Z estimates caused by seasonal growth patterns (Pauly 1990). A linear regression of Ln(Number) on relative age was fitted to the descending and linear portion of the resulting length converted catch curves. The slope of the regression, representing the decline in numbers with age, provides an estimate of Z. The method assumes steady state conditions or, essentially, that recruitment is constant. Although this is clearly not valid for oysters, it is useful to compare Z estimates across surveys. Generally, Z estimates were higher from surveys completed after a recent fishery had occurred compared to surveys where a fishery had not occurred for 9-12months. A fishing mortality signal, for oysters over 76mm, was, therefore, evident in the size distributions and in the Z estimates.

The relationship between shell size and weight was described by a power function as

$$W = a * S^b$$

where W is weight, S is shell size, a is a scaling factor and b, the exponent, describes the rate of increase in weight with increase in shell size.

2.3 Evolution of biomass

Following settlement, the biomass of spat increases over time as a function of growth rate and total mortality. Ideally, harvesting would occur at a time and at a shell size at which total biomass of the cohort had reached a maximum or at the point in time where effects of mortality and growth were balanced. Harvest strategy would also need to consider size at maturity, preservation of spawning biomass and the market preference. This evolution of biomass can be simulated by exposing a given recruitment to mortality and growth. Mortality effects on oysters <76mm are due to natural causes only (M) (ignoring mortality that may be caused by contact with the dredge) while mortality on oysters >76mm is a function of both natural mortality and landings or fishing mortality (F). The total mortality (Z) results from the additive effect of M and F. The size or age at which biomass of the cohort is at a maximum depends on the relative rates of mortality and growth. In this study, the evolution of biomass of a single theoretical cohort, as a function of age and shell size, was simulated for values of M ranging from 0.2-1.0, given that M is unknown, and at zero F. These rates were used to drive an exponential decay of the cohort and, thereby, to provide numbers of oysters in each size and age class over time under each M scenario in steps of 0.2. Secondly, an F of 0.9 was applied to survivors that had reached 76mm. This value of F was obtained from the average difference in Z between pre-fishery and post-fishery surveys and was thought to represent the real rate of F operating on legal sized oysters in commercially fished stocks in Ireland. Weight at size of the survivors was estimated from the size weight relationship and biomass of the survivors from the sum of the individual weights. This analysis is not a standard yield per recruit or biomass per recruit assessment but simply describes the evolution of biomass of a single cohort (settlement) under different conditions of mortality and growth rate.

3 Results

3.1 Dredge efficiency

Dredge efficiency estimates were highly variable ranging from 0-100%. On average, taking all dredge tracks in which at least 1 oyster was recovered, dredge efficiency was 32±32%. Previous estimates by Brown *et al.* (2006) indicated an efficiency of 36%. An efficiency of 35% was used here to raise the survey counts to densities of oysters except in inner Tralee where an efficiency of 17% was used. This figure was based on an exploitation rate estimate of 77% due to the fishery in December 2010 which resulted in landings of 170 tonnes of oysters from inner Tralee Bay and suggested a total biomass (at 100% exploitation) of 220 tonnes. The survey estimate, uncorrected for dredge efficiency was 38 tonnes. The survey estimate divided by the total biomass estimate (38/220) is an indirect measure of dredge efficiency of 17%.

3.2 Distribution, extent and population density

Taking all surveys together, oyster density ranged from 0 to 50m^{-2}. However, density was usually less than 1m^{-2}. On average, 27% of stations surveyed had no oysters and 48% had oyster density between 0-0.5m^{-2} (Figure 3). The proportion of stations with no oysters may be overestimated because zero counts could not be corrected for dredge inefficiency.

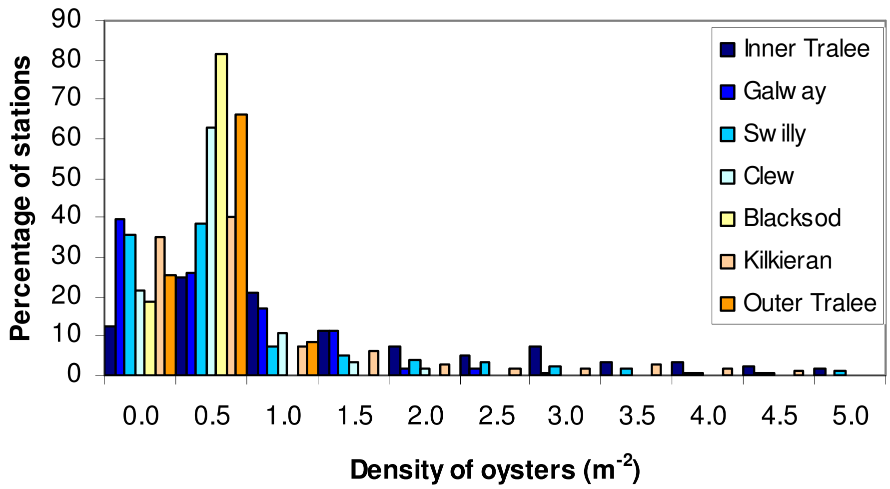

Figure 3. Distribution of oyster density (0-5m^{-2} range only) in 7 oyster beds between 2010 and 2012. Raw Counts have been raised by a factor of 2.85 as a correction for 35% dredge efficiency except in Inner Tralee Bay where dredge efficiency was estimated to be 17% and a factor of 5.9 was used

The surveyed areas (Table 4, Figure 4 & Figure 5) may underestimate the actual extent of oyster distribution as systematic zero counts towards the edges of the surveyed areas were not detected in all surveys. Nevertheless, the surveys, which specifically used local knowledge of experienced oyster fishermen, probably incorporated all significant oyster beds currently present in these sites.

In inner Tralee Bay, the full extent was identified at approximately 4km^2. Highest densities and the majority of the biomass occurred in estuarine areas east of Fenit. This pattern was consistent across all 4 surveys completed in 2010-2012 (Figure 4). Densities ranged from 0-50m^{-2}.

In outer Tralee Bay, the full extent of all beds was not completely determined. The 2012 survey was more comprehensive (Figure 4) and identified 2 separate areas, one in the west of Tralee Bay and a second to the south east of this area. The 2010 survey (not shown) identified a third area between and overlapping the beds surveyed in 2012. The full extent of oyster beds in the outer bay may be 4-5km^2. The beds are not continuous, however, and are interspersed with patches of rock and seagrass. Densities ranged from 0-5m^{-2}.

In Galway Bay, the 2011 survey (2.46km^2) overestimated the current extent of oyster beds as zero counts were recorded in many areas. This survey extended to the south of Eddy Is. and into Kinvara Bay. The second survey in 2012, covering 1.17km^2, reflects the distribution of the majority of the current biomass (and fishery) which occurs in the public oyster bed north east of Eddy Is. and west of the FO area in the Clarin River estuary (Figure 4). Densities ranged from 0-2.5m^{-2}. Pacific oyster are cultured in the FO area but were not present in the main *O. edulis* beds.

In Blacksod Bay, the survey in autumn 2011 covered an area of 2.39km^2 north of Claggan point immediately south of Belmullet. A separate smaller bed within this area, commercially fished in 2011, was not surveyed. Densities ranged from 0-1m^{-2} in the surveyed area.

In Lough Swilly, the limited survey (1.55km^2) in March 2011 underestimated the extent of oyster beds in the area. The area covered by the second survey (13.07 km^2) in November 2011 was an overestimate of extent as a lot of zero counts occurred in sub-tidal areas of Delap Bay and in the Ballymoney Flats south west of Inch Is. Oysters were common in intertidal areas of Delap Bay, on Inch flats north of Inch Is. and in intertidal and shallow sub-tidal areas south west of Ballygreen Pt. and southwest of Ballybegley Pt. Densities ranged from 0-3.8m^{-2} in the surveyed area. Pacific oyster also occurred in all of these areas as described below.

The distribution and extent of oyster beds in Kilkieran Bay was identified from two spatially non-overlapping surveys completed in the autumn of 2010 and spring of 2011. The surveys covered a total area of 1.73km^2. Oysters were not recovered from all areas and densities were generally low ranging from 0-2.5m^{-2}.

Identifying the extent of oyster beds in Clew Bay was difficult because of the complex landscape, very low densities and patchiness in the distribution of oyster in the area. The survey extent of 0.93 km^2 probably underestimates the distribution of oyster in inner Clew Bay. Nevertheless, the areas were targeted using the extensive local knowledge of the skipper of the survey vessel and as such the survey probably identifies the locations if not the full extent of the main oyster producing areas. Densities were low ranging from 0-1m^{-2}.

Table 4. Area (km^2) surveyed for oyster in 7 sites in 2010-2012.

Site	2010/2011		2011/2012	
	Pre-fishery	Post-fishery	Pre-fishery	Post-fishery
Inner Tralee Bay	4.26	Not estimated	3.57	3.80
Outer Tralee Bay	3.63		3.72	
Kilkieran Bay	1.06	0.67		
Blacksod Bay		2.39		
Clew Bay	0.93			
Galway Bay		2.46		1.17
Lough Swilly		1.55	13.07	

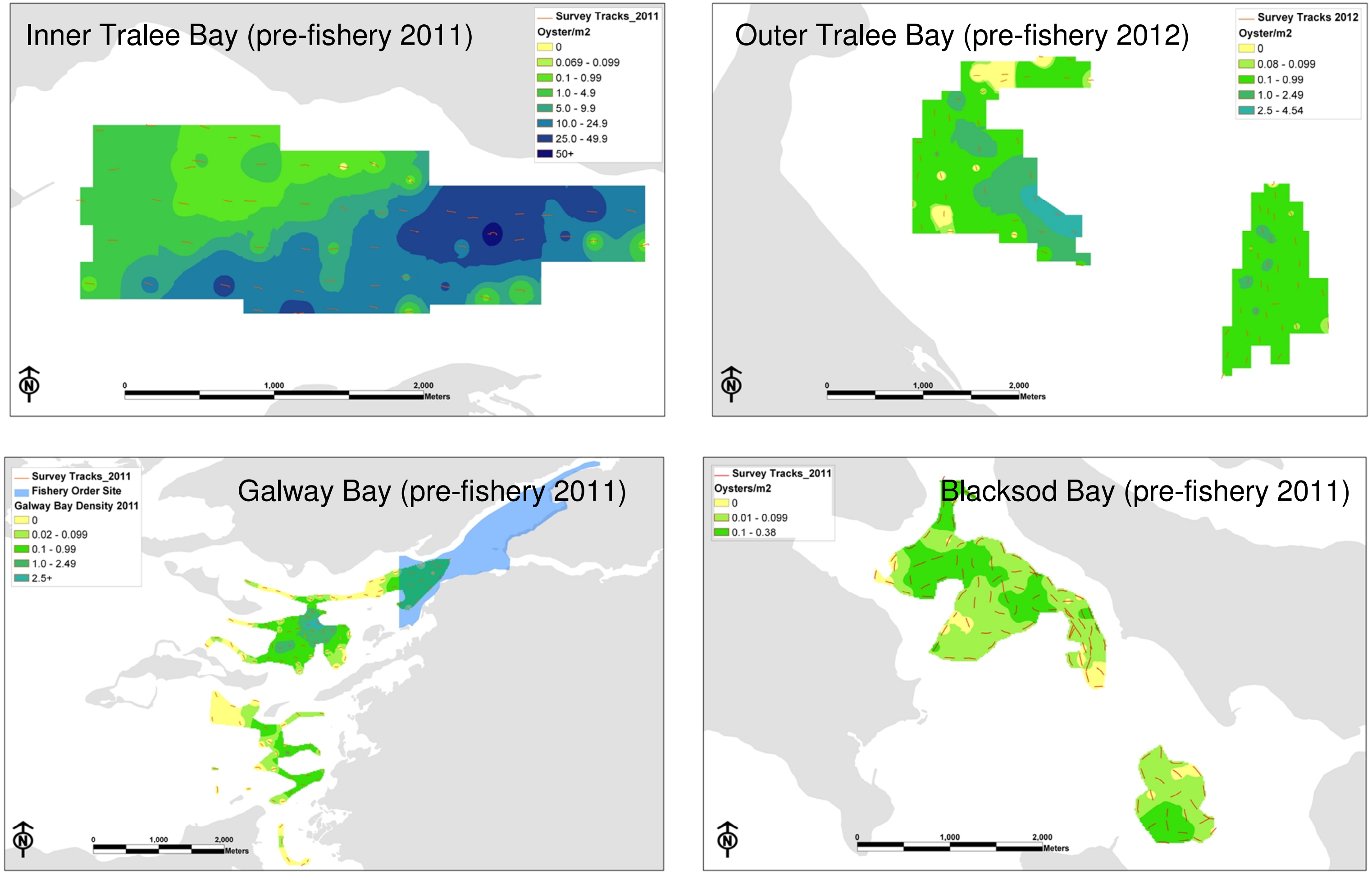

Figure 4. Distribution and density of native oysters in 4 sites surveyed between 2010 and 2012. Interpolation of densities is restricted to areas where there is sufficient survey information. The full extent of all oyster beds in outer Tralee Bay was not determined by the 2012 survey.

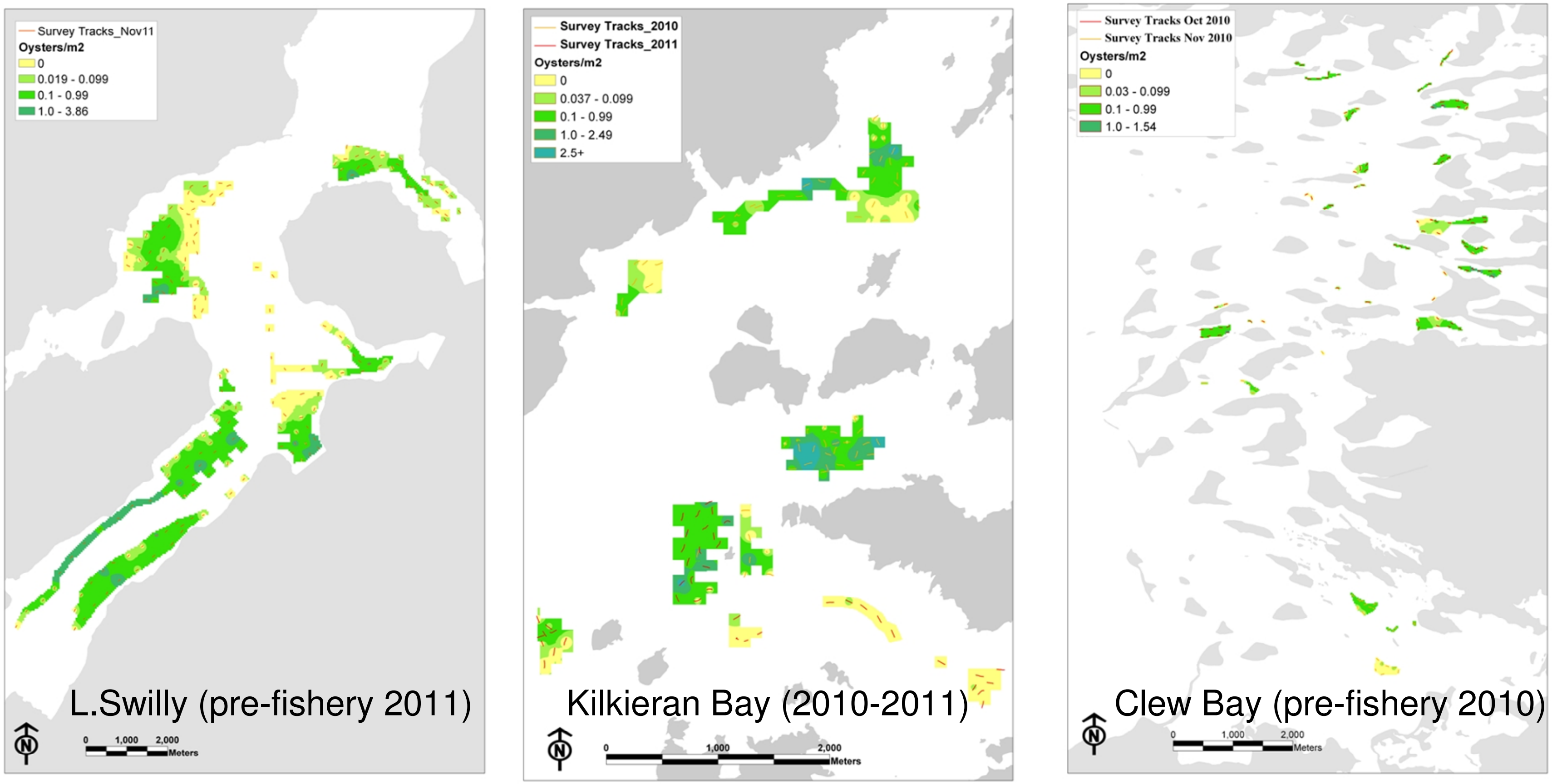

Figure 5. Distribution and density of native oysters in 3 sites surveyed between 2010 and 2012. Interpolation of densities is restricted to areas where there is sufficient survey information. The full extent of all oyster patches was not identified in Clew Bay.

3.3 Biomass

From the targeted surveys undertaken in the seven sites during 2010 to 2012 (Table 4 and Figures 4 & 5), it is apparent that the highest densities and majority of the biomass of native oyster were found in Inner Tralee Bay. Biomass in this bed varied from 982-1278 tonnes between 2010 and 2012. Relative to inner Tralee Bay biomass in other areas was much lower. In decreasing order, biomass was 124±56 tonnes in L. Swilly, 99±61 tonnes in outer Tralee Bay, 53±7 tonnes in Kilkieran Bay, 34±21 tonnes in Galway Bay, 25±6 tonnes in Blacksod Bay and 14±2 tonnes in Clew Bay (Table 5).

Table 5. Biomass (tonnes) ± 95% C.I. of oysters from 14 surveys at 7 sites surveyed in 2010-2012

Site	2010/2011		2011/2012	
	Pre-fishery	Post-fishery	Pre-fishery	Post-fishery
Inner Tralee Bay	982±224	Not estimated	1278±1059	1329±680
Outer Tralee Bay	99±61		69±33	
Kilkieran Bay	49±10	13±4		
Blacksod Bay		25±6		
Clew Bay	14±2			
Galway Bay		34±21		28±12
Lough Swilly		40±16	124±56	

3.4 Biological characteristics

3.4.1 Shell height-weight

Exponents (b) of the shell-height weight relationship were 3.70, 3.17 and 2.91 in inner Tralee Bay, Galway Bay and outer Tralee Bay, respectively (Figure 6). The common exponent for these 3 sites was 3.225. The exponents (b) of the regression of log (size) on log (weight) were significantly different (Analysis of covariance, $F=6.5$, $df = 2$, $p<0.01$). At smaller shell heights, oysters in Inner Tralee Bay were lighter than in Galway Bay but, at larger shell heights, inner Tralee Bay oysters were heavier. Changes in shape during growth account for these changes and may be related to oyster density on the seabed or differences in environmental conditions during growth.

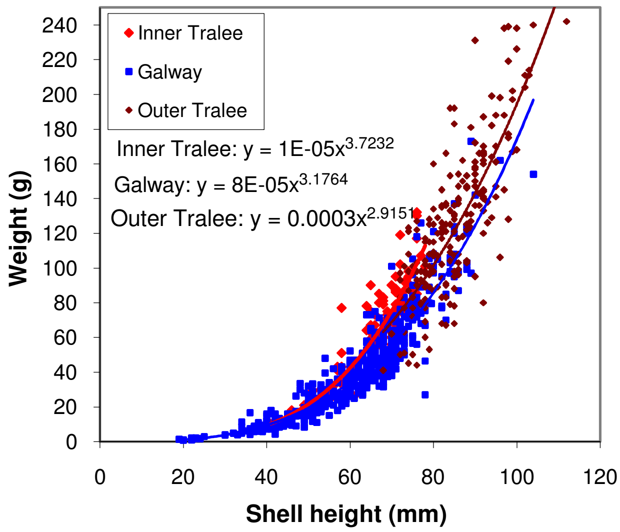

Figure 6. The relationship between size and weight of oysters in 3 oyster beds in 2011

3.4.2 Size distribution and recruitment

Oyster size distributions were generally uni-modal or, more rarely, bi-modal (Figure 7). Modal size in outer Tralee Bay and Blacksod Bay was larger than at other sites. Here, the percentage of oysters over 75mm was 91% in 2010 in outer Tralee Bay and 54% in Blacksod Bay, compared to 23% in Clew Bay, 18 and 22% in Kilkieran Bay, 21% in Inner Tralee Bay prior to the fishery in 2010, 4-12% in Inner Tralee Bay in 2011-2012, 8-11% in Galway Bay and 3-6% in L. Swilly. These differences are likely due to a combination of recruitment events, which adds small oysters to the stocks, and fishing which removes oysters over 76mm. The size distributions show an absence of any significant spat settlement, probably since 2008, in Kilkieran, Clew Bay and Blacksod and, possibly 2009, in Galway Bay and L. Swilly. In Inner Tralee Bay, settlement was strong in 2010 as shown by a mode at 25-30mm in survey data for autumn of 2011. There was also evidence of a 2010 settlement in outer Tralee Bay in the Feb 2012 survey data.

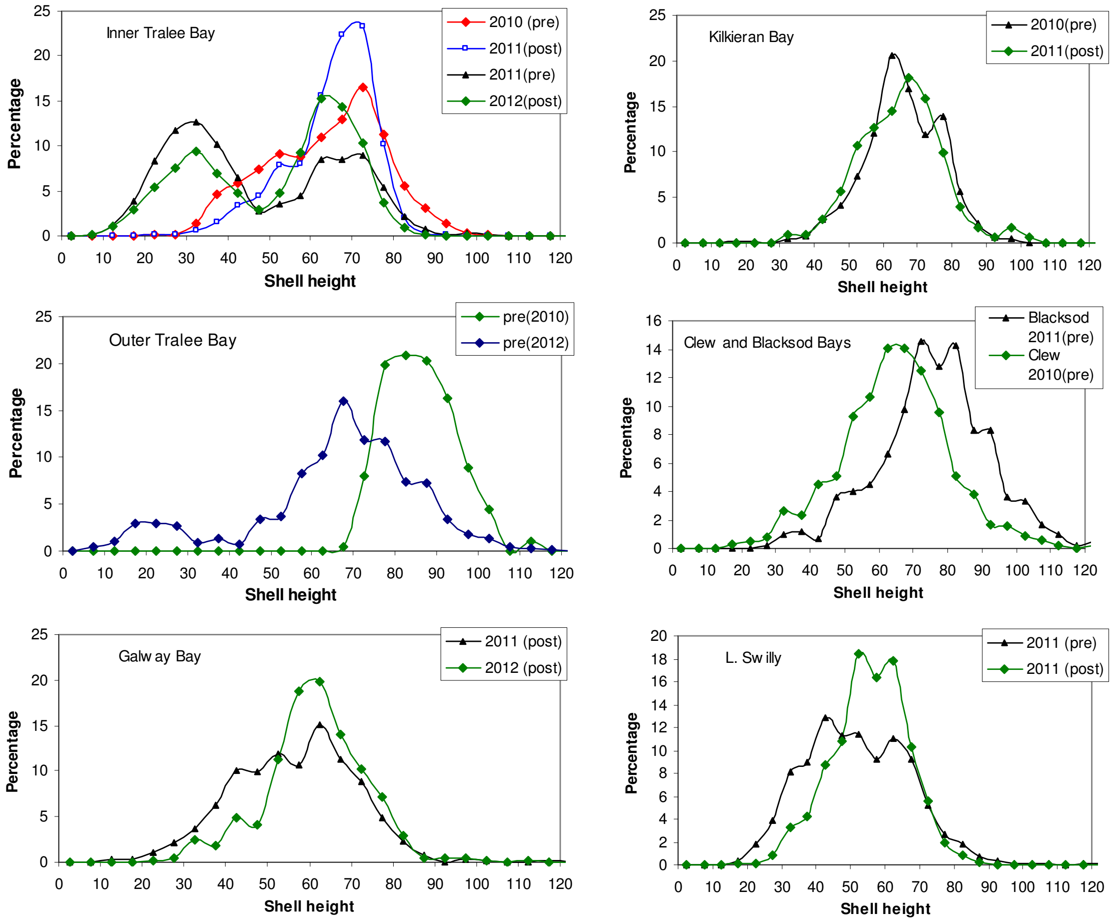

Figure 7. Size distribution (shell height) of oysters in 7 oyster beds sampled in 2010-2012 before and after seasonal fisheries that occurred at each site. Note different scales on y axis.

3.4.3 Growth

There was evidence of an age signal in the size distributions, for ages 1-2, from the 2010-12 survey data. Barry (1981) also provided data for oysters in Kilkieran and Tralee Bays which clearly shows that the modal size of 0+ oysters in Autumn surveys is approximately 7.5mm (Table 6). Based on these data, the first mode in the Galway Bay data in July 2011 and in Tralee Bay in Sept 2011 and Feb 2012 can be interpreted as aged 1+. From the data in Table 6, compiled from Barry (1981) and the present survey data, and by fixing L_∞ at 120mm, the growth coefficient (k) and size at age zero (t_0) were estimated to be 0.21year^{-1} and 0.23years, respectively (Figure 8). The size at age data for ages 0+ and 1+ also show seasonality in growth which could be incorporated into a seasonalised growth model; data for 0+ and 1+ oysters in Kilkieran (from Barry 1981) and Tralee indicate zero winter growth. The derived growth parameters are very different to those published for oysters beds in England and Wales (Table 7).

Table 6. Size at age data for juveniles *O. edulis*.

Age	Mean	Source	Site	Month
0.33	7.5	Barry 1981	Tralee	Oct
0.67	7.5	Barry 1981	Kilkieran	Feb
1.08	22	This study	Galway	July
1.33	30	This study	Tralee	Sep
1.67	30	This study	Tralee	Feb
2.16	39	This study	Galway	July
3.24	50.6	This study	Galway	July
4.30	68	This study	Galway	July

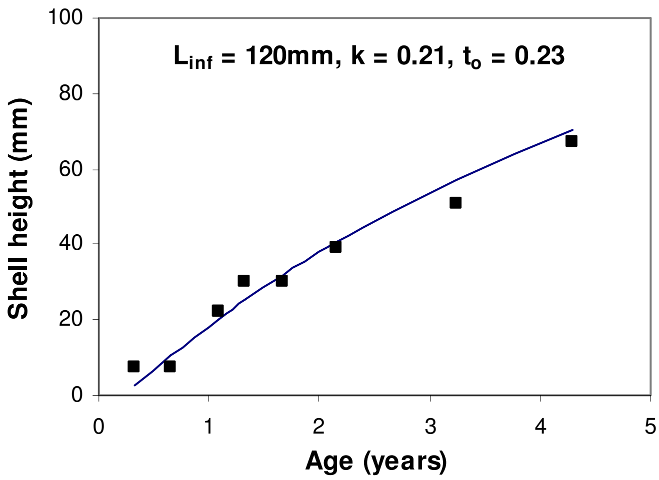

Figure 8. Size at age and fitted vonBertalanffy growth curve for *O. edulis* based on data from Table 14. Zero winter growth of 0+ and 1+ oysters is evident.

Table 7. Growth rate parameters for oysters from sites in England and Wales compared to those derived in the present study. The estimate for Wales is derived from size at weight data presented in Walne (1958) and converted to shell height using the size weight relationship in Figure 6 and using size at age 0.3 of 7mm which is clear in size distribution data.

Site	k	L_∞	Source
Blackwater (England)	0.41	93	Richardson et al 1993
Solent (England)	0.46	72	Richardson et al 1993
Fal (England)	0.35	80	Richardson et al 1993
Conway (Wales)	0.45	95	derived from Walne 1958
Ireland	0.21	120	This study

3.4.4 Mortality

Estimates of total mortality (Z), derived from the length converted catch curves, were generally higher in post-fishery surveys (Z=1.37, n=7) than in pre-fishery surveys (Z=1.03, n = 6) (Table 8). This reflects the depletion of oysters over 76mm by the fishery. In Inner Tralee Bay the differences in Z between pre and post fishery surveys was 0.93 and 0.88 in 2010/2011 and 2011/2012 respectively. This represents mortality (removal) of 58-60% of oysters, recruited to the fishery, during the fishing season.

3.4.5 Biomass per recruit (single cohort)

Both the biomass per recruit and the size at peak biomass of a recruiting cohort are lower at higher levels of M (Figure 9). This is intuitive; the overall biomass that develops will be less when M is higher and maximum biomass will occur at a lower shell size because fewer oysters are surviving and contributing to biomass at large shell size. At values of M <0.4 and at F = 0, the maximum biomass of a cohort peaks above the MLS of 76mm (Figure 9). At M>0.4 biomass peaks below the MLS and will already have declined before the cohort is fished. In this scenario reducing the MLS would provide for improved yields in reducing the time period during which oysters are exposed to M only. F of 0.9, which is the value suggested by comparing Z estimates in pre and post fishery surveys in Inner Tralee Bay, reverses the increase in biomass that would occur if F was zero especially at lower values of M (Figure 9). At all values of M, F of 0.9 produces an exponential decline in biomass in relation to shell height (and age). This is reflected in the survey size distribution data of oysters over 76mm (Figure 7). At high values of M the biomass available to the fishery, and yields, above the MLS will be very low.

Table 8. Total mortality rates (Z) derived from length converted (to age) catch curves for each survey and using growth parameters in Figure 8. Seasonalised growth parameters c = 1.0 and winter-point = 0.5 were included to minimise bias in Z estimates caused by seasonal growth.

Site	2010/2011		2011/2012	
	Pre-fishery	Post-fishery	Pre-fishery	Post-fishery
Inner Tralee Bay	1.33	2.26	1.18	2.06
Outer Tralee Bay	1.09		Not estimated	
Kilkieran Bay	1.23	0.85		
Blacksod Bay		0.54		
Clew Bay	0.64			
Galway Bay		1.32		1.04
Lough Swilly		1.57	0.70	
Average	**1.07**	**1.30**	**0.94**	**1.55**

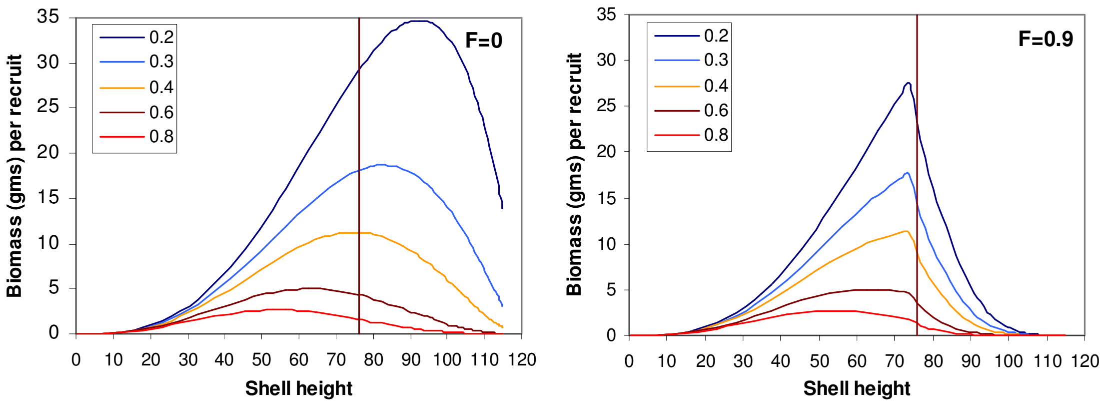

Figure 9. Evolution of biomass per recruit of a single cohort of oysters at different levels of M (0.2-0.8) with no fishing and with annual F of 0.9 above the MLS of 76mm. The size weight relationship for Galway oysters Figure 6 and growth parameters in Figure 8 were used in the model.

Co-occurrence of native and Pacific oyster

Pacific oysters (*Crassostrea gigas*) were common only in L. Swilly. In Galway Bay, although Pacific oysters are grown on the seabed in the FO area, very few were captured outside this area in the public oyster beds. In L. Swilly, on the other hand, Pacific oysters were widespread and abundant.

In March 2011, Pacific oyster densities in L. Swilly ranged from 0-5m^{-2} and the total number estimated in the survey area was 1.07 million oysters. In November, densities ranged from 0-8m^{-2}, density at the majority of stations was below 3m^{-2} and the total number in the survey area was estimated to be 5.64 million oysters. The average size was 81±28mm, in March 2011, and 84.9±25.9mm, in November 2011. It is likely that a number of age classes were present in the population.

The distribution of Native and Pacific oysters overlapped but Pacific oysters tended to be dominant in intertidal areas and shoreward of native oysters with the latter becoming more common at the edge of channels and in shallow sub-tidal areas (Figure 10).

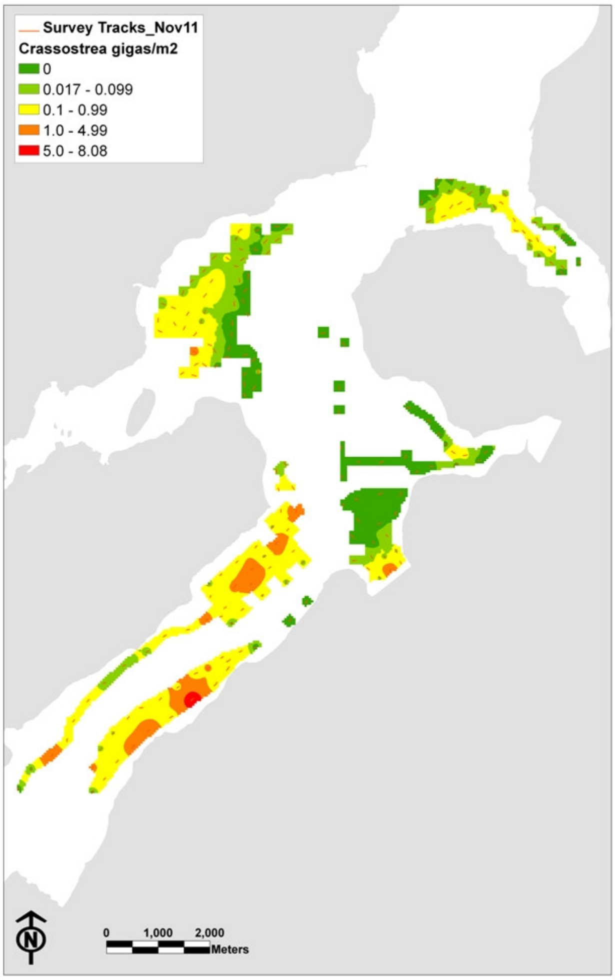

Figure 10. Distribution and density of Pacific oyster in Lough Swilly in November 2011.

4 Discussion

A series of 14 surveys in 7 of the main oyster producing areas in Ireland in 2010-2012 showed that population densities of oysters and total biomass were low. Over 80% of the national oyster biomass occurred in inner Tralee Bay although this bed represented approximately 14% of the geographic area encompassed by all surveys. This bed also produces the majority of the annual national landings. In sites that are producing oysters commercially such as Tralee Bay, Galway Bay, Kilkieran Bay and Lough Swilly the fishery is reliant on relatively small areas (patches) of oysters rather than on the entire extent over which oysters are distributed i.e. the distribution of commercial densities is quite ‘patchy’ and represents a relatively small proportion of the total area over which oysters are distributed.

Spat settlement and recruitment appears to occur regularly, although perhaps not annually, in inner Tralee Bay, Lough Swilly and Galway Bay but less frequently at other sites. Young of the year oysters, which would be 4-7 months old when the surveys were undertaken, would not have been detected effectively, given the survey methods, which involved sorting, counting and measuring oysters on the deck of the boat. However, if the shape of the size distributions is indicative of past recruitment events then there appears to be missing year classes in all sites.

The proportion of oysters above the MLS (76mm) was generally less than 20%, except in Blacksod Bay and outer Tralee Bay. The proportion over this size was lower in post-fishery than in pre-fishery surveys, as would be expected. The annual mortality of oysters over the MLS, in commercially fished stocks, appears to be approximately 60% (equivalent to the difference in Z estimates of 0.9 for pre and post fishery survey data in Tralee). The MLS is at or above the point at which biomass, from a given settlement, may be at a maximum i.e. it is unlikely that growth overfishing is occurring. However, these estimates are sensitive to rates of growth and mortality used in the analysis. Athough no maturity estimates are available, it is generally known that oysters are mature at sizes significantly below the MLS and possibly at shell heights of 30mm in Galway Bay for instance (O’Neill pers. com). The apparently high exploitation rates of oysters over 76mm may, therefore, not necessarily be problematic. However, where spawning stocks are already low and where recruitment is infrequent, which is the case in most sites, high annual exploitation rates puts stocks at risk from further depletion.

Although the data on density (and biomass) is very sensitive to dredge efficiency, densities were estimated to be less than 0.5 oysters m^{-2} at the majority of survey stations including some stations in inner Tralee Bay. Low densities may limit reproductive success in oysters. Although fertilisation occurs internally, in the pallial cavity, the eggs are fertilised by externally released sperm from neighbouring oysters. If the density of neighbouring oysters is very low then sperm dilution may reduce fertilisation success. This *allee* effect at low densities could lead to negative per capita growth rate and, theoretically, could lead to extinction (Courchamp *et al.*1999). The critical density threshold for avoidance of *allee* effects in oysters in not known. *Allee* effects may be compounded by parasite induced mortality although the low density of oysters may also limit the prevalence of *Bonamia* in these populations. The net effect depends on the virulence of the parasite, the transmission rates at low density and how these interact with density dependent *allee* effects on fertilisation (Deredec and Courchamp 2006).

Oyster growth rates are known to vary across sites in relation to temperature (Hall 1985) and tidal exposure among other factors (Walne 1958). The growth rate parameters, estimated in this report, are very different to those provided by Richardson *et al*. (1993) or estimates derived from Walne (1958) for oysters in England and Wales, where L_∞ varied from 72-93mm and the growth coefficient (k) ranged from 0.35-0.46. The size at age estimates provided here are within the range predicted by Hall (1985) who used a multiple regression model, incorporating temperature from two contrasting sites, to predict growth rates. Richardson *et al*. (1993) verified age and growth by sectioning shells and producing acetate peels to visualise annual growth rings while Walne (1958) followed the growth of oysters of known age over time. Nevertheless, oysters up to 120mm shell height were present in the survey data reported here indicating that L_∞ must be substantially higher than that reported for oysters in England and Wales. The shell height at which maximum yield is expected (L_{opt}, Holt 1958) is, as shown in the evolution of biomass simulation, sensitive to growth and mortality rates. Froese and Binohlan (2000), reporting on life history invariants in marine fish, indicated that the ratio of L_{opt} / L_∞ is predictable and averages 0.63. The ratio of MLS/L_∞ in Irish oysters is, coincidentally, also 0.63 suggesting that the current MLS is appropriate (close to L_{opt}) and, as such, that M may be close to 0.4. However, the Froese and Binohlan (2000) L_{opt} / L_∞ ratio is for finfish and cannot substitute for improved data on growth and mortality estimates for Irish oysters, including incidental mortality caused by dredge contact with undersized oysters. Given that temperature, in particular, has a strong effect on growth rate the growth parameters provided in this report should be taken as indicative only of the possible size at age of Irish oysters. Site specific growth models, which incorporate temperature, would improve stocks assessments and allow optimal, and if necessary, site specific MLS to be estimated.

A further implication of low oyster density is the level of dredging required to catch the annually agreed TACs. This is further exacerbated by the low dredge efficiency and the high minimum landing sizes relative to the size composition of oysters in the stocks. Generally, less than 20% of oysters were over the MLS, densities were usually less than $0.5m^{-2}$ and dredge efficiency was estimated to be 35%. Catch returns per unit of dredging under these conditions are very low and the fishing process is inefficient. A more productive fishery management strategy would be to restore biomass (and density), reduce minimum landing size (particularly where M>0.4) and use efficient dredges under a TAC regime.

A number of management initiatives can be established relatively easily that would promote the recovery of biomass and population density in Irish oyster stocks. The basis for recovery must be founded in protecting or, if necessary, establishing a spawning stock at densities that ensure high fertilisation success and that results in significant larval production when environmental conditions allow for this. Spawning events do not, however, necessarily lead to larval settlement either because the larval condition is poor and there is high mortality of larvae or because larvae cannot find suitable substrate on which to settle. Settlement can be enhanced by management interventions. Settling oysters need relatively clean (unsilted) substrates on which to settle (UMBS, 2007). The method chosen for the maintenance and provision of that substrate is, however, critically important. Typically, either the ground is harrowed to uncover new clean shell, and to kill epifauna, or new clean shell is spread over the bed (cultching) (Waugh 1972). Waugh

(1972) undertook systematic field experiments to assess the relative efficacy of harrowing, cultching or fallowing (no activity) on larval settlement in the Rivers Couch and Fal in England. Harrowing can only be effective if there is significant shell buried in the sediment that can be brought to the surface and if the shell remains free of silt for the period prior to larval settlement. Waugh (1972) found that harrowing was ineffective; there was no increase in shell availability after harrowing and harrowed areas quickly became silted. These areas did not receive as much settlement as areas that were fallowed or especially those areas that were culched with mussel shell. Barry (1981) demonstrated the same beneficial effect of cultching with mussel shell in Kilkieran Bay.

Management interventions to restore and maintain oyster stocks need to taken into account the conservation objectives now being described for oyster habitat in SACs (NPWS 2011). Spatial extent, structure and function of these habitats need to be maintained. As oyster, logically, is described as a characterising species of these habitats, maintenance or recovery of oyster populations in these habitats is a requirement if such habitats are to achieve and maintain favourable conservation status under reporting for Article 17 of the Habitats Directive. Guidance (NPWS 2011a,b) indicates that significant persistent disturbance should occur on either less than 15% of the habitat or, if it is above this threshold, then the disturbance should not be persistent (on-going or frequent) or significant (leading to change in the characterising fauna). The persistence and significance of disturbance should be assessed in relation to habitat resilience. Management also needs to consider the conservation objectives for other characterising species that occur in oyster habitat.

Habitat ‘maintenance’ operations such as harrowing can have negative effects on oyster ground and on oysters and may be incompatible with habitat conservation objectives. Harrowing and commercial dredging activity both lead to shell breakage and gradual homogenisation of habitat, loss of small scale structural relief, increased dominance by smaller species and decline in epifauna and burrowing megafauna (Sewell *et al.*. 2007, Thrush *et al.*. 1998, 2001, Collie *et al.*. 1996, Kaiser *et al.*. 2000). These changes may be contrary to the physical and topographic conditions required for larval settlement. Although un-silted substrate is important the angle of presentation of the substrate and small scale relief on the seabed may be important in providing suitable hydrodynamic conditions, at very local scale, that stimulate larvae to settle (Cranfield 1968). Increasing and maintaining habitat complexity, shelliness and relief is, therefore, important. Regular contact with dredges and harrows also causes mortality of oysters that are actively growing and can stunt growth in surviving oysters (Waugh 1972). Recovery from dredging impact is habitat dependent (Foden *et al.* 2010). Long term modification of oyster reef habitat was described by Cranfield et al (1999) in New Zealand who indicated that restoration of oyster also depended on restoration of habitat. Rothschild *et al.* (1994) described long term habitat degradation and a parallel decline in oysters in Chesapeake Bay which was associated with intensive fishing and over-stocking.

Translating conservation objectives for oyster habitat into management objectives for oyster fisheries is an important task for conservation authorities and oyster fishery managers alike in SACs where oysters are described as characterising species. Given that current biomass and density are low and recruitment is irregular, neither the conservation objectives or fishery objectives are being met i.e. there is a lost production to the fishery and in large areas of oyster habitat oyster is not a dominant and characterising species. Recovery of biomass is, therefore, a common objective but the means of doing so should consider other aspects of habitat structure and function that are also protected by the conservation objectives. Cultching and maintenance of habitat complexity and 'shelliness' would seem to be more acceptable and effective in this regard than harrowing or other forms of ground 'cleaning'. Closed areas may be of benefit in allowing higher densities of oyster to develop, to avoid *allee* effects and to allow habitat complexity to recover. Measures that increase larval production and that promote settlement, leading to increase in oyster density and habitat shell content, would seem to be compatible with both conservation objectives and fishery management objectives.

Management of threats to native oyster beds will also be important in optimising recovery potential. These include freshwater drainage which may increase freshwater volume flow through estuaries, urban development and associated changes in microbiological and viral status of water and introduction or management of non-native species, which pose a threat to oyster, such as the Slipper limpet (*Crepidula fornicata*) and Pacific oyster. Competition with introduced species, such as Pacific oyster, is a realised threat to the maintenance of native oyster beds as shown here in L. Swilly. The surveys showed that large areas of previous native oyster bed had high densities of Pacific oyster in some areas to the exclusion of native oyster. An intensive commercial fishery for Pacific oysters was sustained in 2010 and 2011 in areas of the Lough showing that, locally, biomass of this species was high. This is a recent development stimulated by higher market prices for Pacific oysters but also because high catches are possible. O'Sullivan (2001) did not report Pacific oysters in L. Swilly suggesting that Pacific oyster has, recently, expanded in the Lough. Successful control of that expansion will be important for the recovery and maintenance of native oyster.

From a national perspective the commercial viability of oyster fisheries and prospects for maintenance of populations could be considered to be at significant risk; biomass is concentrated in inner Tralee Bay, biomass is very low and dispersed in other sites, catch rates are low, recruitment is irregular, there are pressures from disease and non-native species, fisheries operate in areas where stocks are depleted, scientific advice is rarely incorporated into regulation of seasonal oyster fisheries and there are generally no fishery management plans with explicit objectives, harvest control rules and reference points in operation. There are exceptions, such as inner Tralee Bay, where annual survey data is being used to define total allowable catch. A management plan has been drafted for the L. Swilly oyster fishery that includes closed areas for protection of spawners, a proposal to cultch areas to promote larval settlement and closure of fisheries in areas where oyster density is low. Managing the recovery of native oyster populations is a more feasible project than restoration of stocks that have gone extinct as has occurred in many areas of the UK (Shelmerdine and Leslie 2009, Laing *et al.* 2006). Fishery management plans have a vital role to play in this recovery.

5 References

Anon 2005. Epizootic investigation into the detection of Bonamiosis in native oysters in a new area in Ireland during Spring 2005: statutory sampling (91/67/EEC). Marine Institute, Rinville, Oranmore, Co. Galway, 45pp.

Barry, M.D. 1981. Distribution and ecology of oysters, *Ostrea edulis* (L.) in Kilkieran and Bertraghboy Bays, Connemara, Co. Galway. Irish Fisheries Investigations, Series B, 24, 3-18

Browne, R., Norman, M., Casburn, P. and Breathnach, S. 2006. An oyster (*Ostrea edulis*) survey undertaken in Setpember and October 2006. Draft report to Comharcumann Sliogeisc Conamara, Kilkieran, Connemara, Co. Galway, 27pp (unpublished).

Coleman, C. F. and Williams, S.L. 2002. Overexploiting marine ecosystem engineers: potential consequences for biodiversity. Trends in Ecology and Evolution 17(1), 40-44.

Collie, J.S., Escanero, G.A. and Hunke, L. 1996. Scallop dredging on Georges Bank: photographic evaluation of effects on benthic fauna. ICES CM 1996/Mini:9

Courchamp, F., Clutton-Brock, T. and Grenfell, B. 1999. Inverse density dependence and the allee affect. Trends in Ecology and Evolution, 14(10), 405-410.

Cranfield, H. 1968. An unexploited population of oysters, *Ostrea lutaria* Hutton, from Foveaux Strait. New Zealand Journal of Marine and Freshwater Research, 2, 183-203.

Cranfield, H., Michael, K. and Doonan, I. 1999. Changes in the distribution of epifaunal reefs and oysters during 130 years of dredging for oysters in Foveaux Strait, southern New Zealand. Aquatic Conservation: Marine and Freshwater Ecosystems, 9(5), 461-483.

Deredec, A. and Courchamp, F. 2006. Combined impacts of *allee* effects and parasitism. Oikos, 112, 667-670.

Foden, J., Rogers, S.I. and Jones, A.P. 2010. Recovery of UK seabed habitats from benthic fishing and aggregate extraction – towards a cumulative impact assessment. Marine Ecology Progress Series, 411, 259-270.

Froese, R. and Binohlan, C. 2000. Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. Journal of Fish Biology, 56, 758-773.

Hall, S. 1984. A multiple regression model of oyster growth. Fisheries Research 2, 167-175.

Holt, E.W.L. and Hillas, A.B.E. 1905. Preliminary report on experiments in oyster culture on the west coast of Ireland. Annual report of Fisheries, Ireland, 1902-3, Part II, Appendix VIII, 215-228.

Holt, S.J. 1958. The evaluation of fisheries resources by the dynamic analysis of stocks and notes on the time factors involved. ICNAF Special Publication, 1, 77-95.

Kaiser, M.J., Ramsay, K., Richardson, C.A., Spence, F.E. and Brand, A.E. 2000.Chronic fishing disturbance has changed shelf sea benthic community structure. Journal of Animal Ecology, 69, 494-503.

Kennedy, R.J. and Roberts, D. 1999. A survey of the current status of flat oyster in Strangford Lough, Northern Ireland, with a view to the restoration of its oyster beds. Biology and Environment, 99B, 79-88.

King, M. 1995. Fisheries Biology, Assessment and Management. Fishing News Books, Oxford, 341pp.

Laing, I., Walker, P. and Areal, F. 2006. Return of the native – is European oyster (*Ostrea edulis*) stock restoration in the UK feasible? Aquatic Living Resources, 19, 283-287.

McArdle, J.F., McKiernan, F., Foley, H. and Hugh-Jones, D. 1991. The current status of *Bonamia* disease in Ireland. Aquaculture. 93, 273-278.

NPWS 2011a. Conservation objectives Lough Swilly SAC 002287, Lough Swilly SPA 004075, Version 1.0, 41pp.
http://www.npws.ie/protectedsites/specialareasofconservationsac/loughswillysac/

NPWS 2011b. Lough Swilly SAC (site code:2287). Conservation objectives supporting document – marine habitats. Version 1, 12pp. National Parks and Wildlife Service, Ely Place, Dublin 2.

Orton, J.H. 1940. Effect of the severe frost of the winter of 1939-40 on the fauna of the Essex oyster beds. Nature, 145, 708-709.

OSPAR 2009. Background document for *Ostrea edulis* and *Ostrea edulis* beds. OSPAR Biodiversity Series 428/2009, 22pp.

Pauly, D. 1990. Length-converted catch curves and the seasonal growth of fishes. ICLARM Fishbyte, 8(3), 33-38.

Powell, E.N., Kraeuter, J.N., Ashton-Alcox, K.A. 2006. How long does oyster shell last on an oyster reef. Estuarine and Coastal Shelf Science, 69, 531-542.

Richardson, C.A., Collis, S.A., Ekaratne, K., Dare, P. and Key, D. 1993. The age determination and growth rate of the European flat oyster *Ostrea edulis* in British waters determined from acetate peels of umbo growth lines. ICES Journal of Marine Science, 50. 493-500.

Rothschild, B.J., Ault, J.S., Goulletquer, P., Heral, M., 1994. Decline of the Chesapeake Bay oyster population: a century of habitat destruction and overfishing. Marine Ecology Progress Series 111, 29– 39.

Sewell, J., Harris, R., Hinz, H., Votier, S., Hiscock, K. 2007. An assessment of the impact of selected fishing activities on European marine sites and a review of mitigation measures. The MBA and University of Plymouth, report SR591, ISBN 0903941694

Shelmerdine, R. L. and Leslie, B. 2009. Restocking of the native oyster, *Ostrea edulis*, in Shetland: habitat identification study. Scottish Natural Heritage Commissioned Report No. 396.

Smyth, D., Roberts, D., Browne, L. 2009. Impacts of unregulated harvesting on a recovering stock of native oyster. (*Ostrea edulis*). Marine Pollution Bulletin, 58, 916-922.

Todorova, V., Micu, D. and Klisurov, L. 2009. Unique oyster reefs discovered in the Black Sea. Comptes rendus de l'Academie bulgare des Sciences, 62(7), 871-874.

Thrush, S.F. et al. 1998. Disturbance of the marine benthic habitat by commercial fishing: impacts at the scale of the fishery. Ecological Applications 8, 866-879.

Thrush, S.F. et al. 2001. Fishing disturbance and marine biodiversity: role of sediment structure in simple soft bottom sediments. Marine Ecology Progress Series, 221, 255-264.

UKBAP (1999). Tranche 2 Action plans. Maritime species and Habitats.
http://jncc.defra.gov.uk/PDF/UKBAP_Tranche2-ActionPlans-Vol5-1999.pdf

University Marine Biological Station 2007. Conservation of the native oyster *Ostrea edulis* in Scotland. Scottish Natural Heritage Commissioned Report, No. 251 (ROAME No. F02AA408)

Walne, P.R. 1958. Growth of oysters (*Ostrea edulis* L.). Journal of Marine Biological Association of the United Kingdom, 37, 591-602.

Waugh, G.D. 1972. Settlement of *Ostrea edulis* (L.) in relation to the cultivation of oyster grounds. Fishery Investigations London, Series II, 27, 2, 33pp.

Went, A.J. 1962. Historical notes on the oyster fisheries of Ireland. Proceedings of the Royal Irish Academy, C, 62, 195-223.

Whilde, A. 1973. Evaluating survey of oyster beds in Galway Bay and along the County Galway coast. Resource Record Paper, 24, Irish Sea Fisheries Board, Fisheries Development Division, 18pp.

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