

# **Scoping Study of appropriate EIA trigger thresholds for shellfish farms and other non-fish farm aquaculture**

SARF031

Scottish Aquaculture Research Forum

July 2008  
Final Report  
9S2511

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Document title	Scoping Study of appropriate EIA trigger thresholds for shellfish farms and other non-fish farm aquaculture
Document short title	SARF031
Status	Final Report
Version	06
Date	July 2008
Project name	SARF031
Project number	9S2511
Client	Scottish Aquaculture Research Forum
Reference	9S2511/R002/303319/Newc

Drafted by	Angela Nicholson
Checked by	Martin Bailey/ Angela Flowers
Date/initials check	.....
Approved by	Martin Bailey
Date/initials approval	.....

## PROJECT IDENTIFICATION SHEET

**SARF 031. Scoping study of appropriate EIA trigger thresholds for shellfish farms and other non-fish aquaculture.**

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**Date of Commencement:** 22 January 2007

**Date of Completion:** 31 March 2008

**Total project costs:** £12,330

Staff Input (Royal Haskoning)	Regional Director	Principal Consultant	Environmental Scientist	Total (days)
				63.5
<b>S1.1</b> Literature review	0.3	3	8	<b>11.3</b>
<b>S1.2</b> Completion of regulator and industry consultation	0	3	5	<b>8</b>
<b>S1.3</b> Outline of likely effects at each threshold level	0	1	2	<b>3</b>
<b>S1.4</b> Production of Matrix	0	1	2	<b>3</b>
<b>S1.5</b> Draft recommendations	0.2	1	2	<b>3.2</b>
<b>S1.6</b> Finalise recommendations	0.2	1	2	<b>3.2</b>
<b>S1.7</b> Delivery of final Report	0	1	0	<b>1</b>
Project management and QMS	0.3	2	0	<b>2.3</b>

**No intellectual Property rights have arisen from the project.**

**The primary objective of this research was to produce a scoping report based on consultation with the relevant literature, regulators and stakeholders.**

In order to do this a series of secondary objectives were realised:

- to identify the key environmental and associated issues through literature review
- to evaluate the key issues and describe a range of threshold levels through consultation;
- to outline the likely effects at each threshold level;
- to produce a matrix of potential effects based on the range of thresholds identified; and
- to produce recommendations for the most appropriate thresholds that would be likely to have a significant effect and trigger the requirement for EIA.

### **Primary Milestones**

Milestone	Target date	Title
S1.1	15:02:2007	Completion of literature review;
S1.2	15:03:2007	Completion of regulator and industry consultation to describe range of threshold levels relevant to the key receptors identified;
S1.3	14:04:2007	Outline the likely effects at each threshold level;
S1.4	28:04:2007	Produce a matrix of potential effects based on the range of thresholds identified;
S1.5	30:05:2007	Draft recommendations for the most appropriate thresholds identified and circulate to consultees;
S1.6	30:06:2007	On the basis of responses received finalise recommendations for the most appropriate thresholds that would be likely to have a significant effect and trigger the requirement for EIA;
S1.7	13:08:2007	Delivery of final scoping report

## EXECUTIVE SUMMARY

Royal Haskoning was appointed to undertake a scoping study of appropriate EIA trigger thresholds for shellfish farms and other non-fish aquaculture. The study was facilitated through support from the Scottish Aquaculture Research Forum (SARF) and Highlands and Islands Enterprise (HIE). The primary objective of the research was to produce a scoping report based on consultation of the relevant literature, regulators and stakeholders. There was a general reluctance by industry stakeholders to engage in consultation. This led to a significant delay in the study programme.

The need for the study was founded on the basis that the Environmental Impact Assessment Directive (85/337/EEC) (as amended) defines 'intensive fish farming' as an Annex II project, thereby permitting individual Member States to determine the need for EIA on a case-by-case basis through the establishment of thresholds or other criteria. To date, most Member States have determined that only finfish aquaculture projects should be subject to EIA, and few shellfish studies, regardless of scale, have been assessed through the EIA process (ICES, 2002). There also appears to be no clear definition of what constitutes 'intensive' aquaculture.

The study identified biomass production >100 tonnes per year and proximity <1 km to other installations as being suitable for consideration as trigger thresholds for EIA in Scotland. The environmental issues identified during the study were ranked according to the Regulator consultation group as:

- 1) Water and sediment quality, benthic communities, protected areas, carrying capacity, layout and design, landscape and visual, socio-economics, hydrography, and site location;
- 2) Escapees (remote colonisation) and non-native species, proximity to other farms; and
- 3) Protected species and wildlife (nature conservation), in-combination effects, air and noise, archaeology, life cycle analysis (LCA), climactic factors.

From the consultation exercise the following views were received:

- In Europe, production levels (e.g. in Holland, France and Spain) are known to be significantly higher than in Scotland: it was felt by stakeholders that any future responsibility to EIA in Scotland should recognise this.
- The cost of the addition of EIA; the requirement to growers to produce (and for regulators to assess) an environmental statement, was considered likely to have a negative effect on the potential growth of the industry in Scotland.
- SEPA water quality standards are acceptable to many growers; however, water quality standards were seen to be having an adverse effect on shellfish production in rural areas where water quality standards were affected by agriculture; e.g. sheep grazing.
- Periodic deterioration of water quality in some areas may delay harvests and increase depuration costs, thus having a negative financial impact on small growers in particular.
- Visual impacts and noise impacts of coastal development were seen by stakeholders as being particularly sensitive issues to the planning process.
- There was some confusion regarding the relationship between EIA under the Planning Regulations and Appropriate Assessment (AA) under the Habitats Regulations.

- The likelihood of any significant environmental impact from the cultivation of shellfish was considered by the industry to be negligible. It was considered by the industry that shellfish culture is an indicator of the wellbeing of the environment and is compatible with other users.

It is suggested that any such key issues or potential conflicts for individual projects should be discussed and assigned by the Regulating Authorities during 'Scoping'. All issues as shown within this study (see **Table 4.1**) should be listed within subsequent guidance as appropriate receptors for use within environmental scoping. The consultation identified that the preferred method of regulating layout and design should be through the use of best practice working. As such, it is proposed that a guidance document is developed specifically for this matter.

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## 1 INTRODUCTION

The Environmental Impact Assessment (EIA) Directive (85/337/EEC) (as amended) is concerned with the assessment of certain public and private projects on the environment. In terms of the farming of fin fish the Directive defines 'intensive fish farming' as an Annex II project, thereby permitting Member States to determine the need for EIA on a case-by-case basis through the establishment of thresholds or other criteria. Currently there is no legal requirement to undertake EIA for shellfish and other non-fish form aquaculture. When establishing thresholds or criteria for use in determining the requirement for EIA of Annex II projects, relevant selection criteria covering the characteristics of the project, the location of the project and the characteristics of the potential impacts should be taken into account.

To date, most Member States have determined that only finfish aquaculture projects should be subject to EIA, and few shellfish projects, regardless of scale, have been through this process. The main piece of legislation relating to aquaculture in Scotland (as well as England and Wales) is the Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999. These regulations apply to fish farms and state that an EIA will be required when;

- a) Any part of the proposed development is to be carried out in a sensitive area, or
- b) The proposed development is designed to hold a biomass of 100 tonnes or greater, or
- c) The proposed development will extend to 0.1 hectare or more of the surface area of the marine waters, including any proposed structures or excavations.

These regulations, however, do not cover the issue of shellfish and other non-fish aquaculture. The growth of the shellfish and non-fish aquaculture industry continues to increase both in density and scale, and as a result it has been suggested that such farms should be considered in the same manner as that of finfish farms (SARF, 2005). Short-falls in the environmental regulation would therefore need to be addressed; however, at least one of the regulators is of the view that the opportunity for Scotland to take a lead in EIA of shellfish and non-fish aquaculture exists so that benefits to the environment can be achieved without compromising the viability of the industry.

Although not currently included, it is possible that shellfish farms and other non-fish farm aquaculture could fall within future EIA regulations. At present there are no guidelines as to which proposed farms may require EIA (e.g. thresholds such as weight of production or area). This scoping study considers the available data and suggests appropriate criteria, including thresholds, which could be used in making such recommendations. The project takes into account the combined impacts of neighbouring aquaculture operations (i.e. in-combination effects), and the cost of implementation to the industry of the suggested thresholds is also considered. The results of the study may be used to provide guidance to regulators and operators on the potential requirement of EIA when considering new plans or projects for shellfish farms and other non-fish farm aquaculture.

The European EIA Directive applies to all European States, though it is down to the individual State Governments to interpret the meaning and apply the Directive within their own legislative system. As part of this study, the legislation in relation to shellfish and non-fish EIA in other EU Member States has been investigated; however, no legal

documents have been identified on this topic. While no clear definitions of the term 'Intensive fish farming' have been identified at this time for any of the European Countries, it seems finfish have been classified as falling within this category at least in one other European Country (aside from Scotland). In France, to be granted permission for a finfish farm, it is a requirement to perform a complete EIA as part of the operating permit procedure (named A as Authorisation) for production in excess of 20 tonnes per year for operations in both fresh water and sea water. For production between 5 tonnes and 20 tonnes per year from in sea water it is necessary to perform a 'light EIA' as part of a 'light' operating permit procedure (named D as Déclaration). Information from other Member States regarding any aquaculture procedure remains incomplete at this time.

Shellfish farming and non-fish aquaculture are thought to cause considerably less environmental impact when compared to finfish farming since the products are grown in the natural environment without the need for therapeutic chemical or supplementary food. The main environmental impacts associated with shellfish and non-fish aquaculture include effects on:

- Water quality.
- Sedimentation.
- Hydrography.
- Benthic communities.
- Protected species and wildlife.
- Protected areas.
- Visual and noise impacts.
- Socio-economics.

This report outlines the key environmental issues raised by consultees together with appropriate factors that could be used when setting threshold levels for determining the requirement for EIA of shellfish and non-fish aquaculture projects.

## 1.1 The purpose of this report

In response to the SARF 2006 call for proposals Item 6 project Code SARF031, this research project undertook a study in support of the provision of a scoping report of the potential environmental thresholds that are considered likely to trigger the requirement for EIA for shellfish and non-fish farm aquaculture.

This report presents the findings of the scoping study which was funded by the Scottish Aquaculture Research Forum (SARF) and the Highlands and Islands Enterprise (HIE).

Although not currently included, it is possible that shellfish farms and other non-fish farm aquaculture such as production of algae etc. could fall within any future EIA regulations. At present there are no guidelines as to the size of farm (e.g. weight of production or area) that may require EIA. The scoping study considers the available data and suggests appropriate criteria, including thresholds, which could be used in making such recommendations. The project takes into account the combined impacts of neighbouring aquaculture operations (i.e. in-combination effects), and the cost of implementation to the industry of the suggested thresholds is also estimated. The

results of the study may be used to provide guidance to regulators and operators on the potential requirement of EIA when considering new plans or projects.

## 1.2 The structure of the report

Following this introductory section, **Section 2** details the methodologies used for this assessment, including detailed descriptions of consultations undertaken.

**Section 3** presents the results of the literature review. Summaries of the findings from the literature review are detailed along with the recommendations for the key issues that were addressed in the subsequent stages of this study.

The results from the consultation process are presented in **Section 4**, while **Section 5** discusses the threshold levels for the shellfish and non-fish aquaculture facilities in terms of EIA. This discussion includes the likely effects of such developments, and presents a threshold matrix for use in the determination of such activities.

**Section 6** presents the recommendations, including a final summary and conclusions. References can be found at the end of the report.

## 2 METHODOLOGIES

### 2.1 Literature Review

A search of the available information with regards to shellfish and non-fish aquaculture was undertaken at the outset of this project. This included:

- Current legislation (Directives, Acts, Bills, Statutory Instruments, etc.).
- Proposed Legislation.
- Current Policies and Guidance.
- Proposed Policies.
- Published literature.
- Unpublished literature.
- Grey literature.
- Internet resources.

The areas investigated included:

- Legislation and regulation of shellfish and non-fish aquaculture in Scotland and the UK.
- Shellfish and non-fish aquaculture (including the culture of molluscs, crustaceans and algae and seaweed amongst others).
- Site selection criteria.
- Carrying capacity.
- Visual and noise impacts.
- Socio-economics.

This review also summarises the findings of this process and presents the recommendations for the key issues to be addressed in the subsequent stages of this study. The full literature review can be found in **Appendix A**, while a summary of the findings is presented within **Section 3**.

### 2.2 Consultation

The consultees for this study were divided into two groups; regulators and stakeholders. The 'regulator' group included:

- Statutory Regulators.
- Academic, public and non-government organisations.
- The Crown Estate.

The 'stakeholders' group included:

- Industry and trade associations.

The names of the regulator consultees were collated through discussion with SARF and internet searches/ telephone calls to the regulating authorities to identify the most appropriate individual(s). **Appendix B** contains the list of Regulators contacted during this exercise. For purposes of analysis the Crown Estate was grouped with the Regulators as, although they are not a Government Regulator, they have a number of legal obligations in this sector and contribute in the consenting and licensing process for such aquaculture facilities. Identification of the stakeholder consultees proved more difficult as existing distribution lists held by various organisations are restricted under the Data Protection Act. At the suggestion of SARF, the best available method for the study to distribute the questionnaires without learning the identity consultees was through the distribution list of the industry publication 'The Grower'. Using this industry publication as an intermediary, the identity of stakeholders was safeguarded.

It was decided the most effective way to undertake this consultation was to produce separate electronic questionnaires for the regulator and stakeholder groups. These questionnaires were then be emailed to the consultee, and followed up 1-2 weeks later with a phone call where contact details were available. These email questionnaires contained both quantitative and qualitative questions aimed at getting a full range of answers that could both be analysed statistically, but also provide more detail about general opinions and feelings in the area of potential EIA thresholds and shellfish and non-fish aquaculture. Example questionnaires are presented in **Appendix C**.

A total of 6 Regulators were contacted, 4 organisations, and 3 associations within the regulator group. It was estimated that 48 of recipients on the distribution list were shellfish growers in Scotland. In addition, a meeting was held with the Chairman of the Association of Scottish Shellfish Growers (ASSG) on to discuss the concerns of ASSG members in relation to EIA.

## 2.3 Assessments of Thresholds

During the literature review, a number of potential aspects were identified which were considered suitable for providing assessment threshold levels when determining if a shellfish or non-fish aquaculture development would require EIA<sup>1</sup>. These aspects included:

- Biomass of production.
- Size of the proposed site/farm.
- Proximity of site/farm to other aquaculture facilities.

These aspects were then included within the consultation questionnaires to provide and overview of both the regulator and stakeholder opinions of any such appropriate levels (see **Appendix C**). During the analysis of the questionnaires, this information was separated and presented within a 'matrix' to show where the majority of both the regulator and stakeholder opinions lie. This matrix is presented within **Section 5.2**.

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<sup>1</sup> In August 2008, SEPA suggested that a sensitivity threshold could be included. This would allow proposed developments within or near to statutory sites of conservation and areas of UKBAP interest to be accommodated. See Section 4.3.4.

### 3 LITERATURE REVIEW

A literature review was performed in the initial stages of this project. The full literature review can be found in **Appendix A**. Below is a summary of the key issues identified.

#### 3.1 Key Issues

A number of key issues are apparent when considering EIA for shellfish and non-shellfish aquaculture. Under the current absence of legislation addressing EIA on shellfish and non-fish aquaculture it has been stated by members of the industry that the environmental effects of operations are considered to be much less than those of a caged fish farm of similar size or production capacity; however, it has been shown that there are still environmental impacts from shellfish and non-fish production, the effects of which are likely to require consideration within an existing or future statutory framework. As with EIA processes for other plans and projects, thresholds will need to be established to determine the need for EIA for individual developments. These may include:

**1) Simplification of the process.**

The process of consenting and licensing an aquaculture farm is considered by many to be complicated, with many different organisations involved at different stages of the process. If new regulations were to be put in place for shellfish and non-fish aquaculture, there may be an opportunity to tie in the consents and licences process with this procedure to simplify the process and therefore produce easy-to-use guidelines for growers.

**2) Acknowledgment of the need for public consultation (as shown in the new EIA Regulations (Scotland) 2006 and by the EU) in the EIA process.**

The EIA Amendment Regulations (Scotland) 2006 integrate the encouragement of public participation into current EIA Regulations (namely the EIA (Fish Farming in Marine Waters) Regulations 1999 with regard to aquaculture). The purpose of this amendment is to transpose Article 3 of the European Commission Directive 2003/35/EC on Public Participation (the PPD) into the EIA Regulations in Scotland. As such, the need for public consultation when considering such developments should also be integrated into the consideration of the thresholds that would be required to assess the need for EIA.

**3) Lack of EIA Regulations applicable to shellfish and non-fish production can mean that factors such as the assessment of landscape and visual impacts, and noise can be overlooked.**

As shellfish and non-fish farms are not currently included within EIA Regulations, their activities are basically regulated through the issue of licences and consents. As such, issues such as the visual impact of the farm are not always considered in this process, and can be overlooked. Such shortfalls may need to be addressed.

**4) Balanced approach for the overview of the proposal.**

There have been many comments in the literature to suggest that certain areas/receptors are the focus for the environmental investigations when considering aquaculture facilities. For example, the hydrology of an area is a very important aspect when considering a proposal, and as such receives much attention and detailed

consideration. However, other aspects such as visual and noise disturbance etc. do not receive as much attention. All environmental effects likely to be significant should be discussed within an ES; however, proportionality should be applied to ensure that all details are considered in the appropriate detail. While every ES should provide a full factual description of the development, the emphasis of Schedule 4 of the EIA Regulations is on the 'main' or 'significant' environmental effects. In many cases, only a few of the effects will be significant and will require discussion in the ES in any great depth. Other impacts may be of little or no significance for the particular development in question, and will need only very brief treatment, to indicate that their possible relevance has been considered.

**5) The weighting of each receptor should be given in the consideration of the suitability of a site for shellfish or non-fish aquaculture.**

In previous applications, weighting has considered the use of proportionality when approaching the assessment of a proposal. This is an important issue in the determination of consent as each receptor needs to be considered both individually and in conjunction with the other possible impacts. Such decisions are made by the Statutory Bodies; however, the thresholds which determine the need for EIA can also influence this weighting by including sites that are significant under all receptors; i.e. not focussing just on the traditionally important aspects.

**6) Any EIA Regulations implemented will have to be robust enough to also consider the more potentially environmentally damaging practices of seed production etc.**

The terms of 'shellfish' and 'non-fish' aquaculture cover a vast amount of species and culture techniques. The culture of molluscs, crustaceans, and algae are all fundamentally different and use completely different farming techniques. Even when considering just one species; e.g. the mussel, there are the farms using either/ both longline and/ or raft techniques, or even facilities specialising in the production of spat for other mussel farms. As such, any regulations produced for assessing environmental impacts of shellfish and non-fish aquaculture need to be robust enough to include all forms of such aquaculture, and provide a framework which will be applicable to all such facilities.

**7) Need to consider the whole process from seed stock to on-growing and harvesting in the evaluation on the potential impacts of the farm on the environment.**

EIA Regulations normally consider construction, operation, cumulative and in combination effects, and decommissioning. In addition, when considering shellfish and non-shellfish aquaculture, the whole aquaculture process should also be considered including the seed collection, on-growing and harvesting stages.

**8) Methods; the innate differences between trestles, suspension and bottom culture.**

As raised in point 6, there are many different methods for the culture of shellfish and non-fish. As such, and development of Regulations will need to take into account the differences in these methods within the threshold levels that will be established.

**9) Species differences; e.g. some bivalve molluscs may produce more pseudo-faecal matter than others etc.**

There are many species that fall within the categories of shellfish and non-shellfish. With such a wide ranging sector, there is the danger of generalisation and grouping of aquaculture types. For example, all bivalve species may be considered as the same for assessment purposes; however, although they belong to the same class, it is not necessarily the case that all bivalve molluscs will have comparable effects on the environment.

**10) The means of determining the carrying capacity of a particular area should be defined through monitoring or numerical modelling to ensure a cohesive and coherent approach to evaluating each proposal.**

One of the benefits of having an EIA framework in place is the ability to provide a standard method of assessment with the purpose of facilitating a cohesive and coherent approach at national level. Any European Directive will affect wider spatial and political scales that will require further assessment, the details of which are beyond the scope of this study (see: Section 4 Consultation). The assessment of carrying capacity for an area is an example of approach that can be integrated into the Regulations to ensure consistency.

**11) Regulation of the farm layout to stop sedimentation and scour.**

The layout of the farm itself has been shown to be a major factor in the cause of adverse environmental impact to the surrounding area. Poor organisation of farm structures can lead to sedimentation and the smothering of cultures themselves, as well as scour. The Statutory Framework that would be provided by EIA Regulations would offer the opportunity to also regulate the placement of the farm structures. There is also the opportunity for the publication of best practice guidelines on the spatial development of a farm, which could also reflect any possible thresholds as determined for the EIA process.

**12) Possible use of GIS when determining available space for shellfish/non-fish farms.**

Guidelines currently exist for the siting of fish farms, and sensitivity maps are produced to identify the most their appropriate location. Though such maps can also be applied to shellfish and non-fish aquaculture, they are primarily for the determination of fish farm sites. The difference in the environmental impacts of the different aquaculture types has been discussed in detail throughout this report, and it is clear that different priorities exist. As such, the potential for location guidelines specifically for shellfish and non-fish farms exists. There is also the potential for new methods to be used in this assessment. For example, the successful use of GIS was recorded by Arnold *et al.*, (2000) when looking at aquaculture in Florida. It was stated that such a methodology would be applicable to any process requiring grow-out life stages, such as that seen for bivalve molluscs. However, when applying such techniques to the UK, considerations such as cloud cover (aerial photos, CASI etc) should also be considered.

**13) Although there are lobster reseeded programmes in operation in the UK; i.e. the supplementation of wild stocks with juveniles reared in hatcheries, no full term commercial crustacean (shrimp/crab/lobster etc)**

**aquaculture was identified in the UK through the literature review. Despite this, such cultures would fall under any non-fish farm policy.**

The most popular form of shellfish aquaculture in the UK is that of bivalve molluscs (including: mussels, scallops and oysters). The majority of crustacean (namely penaeid shrimp) aquaculture occurs in warmer (sub-tropical and tropical) climates. However, with the financial intractability for the production of these species, and the ever progressive development of new techniques, it is probable that in the future farming of crustaceans will develop further in the UK. As such, any Regulations developed for shellfish and non-fish farming need to be robust within a flexible system of administration that will allow such future developments to be addressed.

**14) Lack of information for non-shellfish farms. Policy should be developed with broad enough applications to cover any of these techniques.**

There was a general lack of information with regard to non-fish farming. Some minor groups; e.g. macroalgae and gastropod species and sea urchins were poorly represented. Such applications are likely to range in scale and, therefore impacts. The development of thresholds to determine the need for EIA should consider such operations. Further investigation into the likely development of this sector in Scotland (and the rest of the UK) would be beneficial, as well as further investigation into the culture techniques that are likely to be utilised.

## 4 CONSULTATION

### 4.1 Regulator Group Responses

A total of 12 questionnaires were sent to each entity within the 'Regulator' group (in instances where more than one individual was contacted within the same entity, only one unified response was received). This included six regulators, four organisations, and two associations. **Appendix B** contains the Regulator group details. Of these, a total of six replies were received; four from the regulators, one from the organisations asked, and one from the associations.

Due to the small numbers of responses received, results were analysed as fractions of those who responded; for example, 1 in 4 (1/4) is used where only one of the four responses received agrees with a statement. It should be noted that the single response received from the organisations contacted contained no input or comments; therefore no analysis can be made of their opinions on this subject.

### 4.2 Stakeholder Group Responses

A total of three responses were received from the stakeholder consultation. These results have also been considered as fractions, i.e. 1 in 3 (1/3) is used when only one stakeholder of the three agreed with a statement. In addition, a further meeting was held with the Chairman of ASSG, in November 2007. A response from Seafood Shetland was received in March 2008. These are discussed further in **Section 4.4**.

Despite considerable effort on the part of the contractor to elicit responses from industry stakeholders, informal inquiries suggested that there is considerable resistance within the industry to the principle of applying EIA to shellfish farms and many within the industry were unwilling to participate the consultation.

### 4.3 Summary of Responses

The questionnaires were divided into a number of sections. Both questionnaires contained the following:

- Legislative Requirement.
- Relevant Issues.
- Key Issues.
- Threshold Levels.

In addition, the stakeholder questionnaire also contained sections titled 'Your Operation' and 'Your General Opinion'. Summaries of all responses received are presented in **Appendix D**.

Opinions received from the Threshold Levels sections have been considered separately within this report. Analysis of this information is provided in **Section 5**.

#### 4.3.1 Stakeholder Sections; 'Your Operation' and 'Your General Opinion'

The replies received were from owners/operators of mussel farms (2/3) and Pacific oyster farms (1/3). These stakeholders operate using ropes/suspended systems (2/3)

and open lays/trays (1/3). Of these operations, the average production ranged from 30 to 110 tonnes per year with the size of the facilities falling between 4 to 8 hectares. The farms were all located in different areas of Scotland, including the west coast and Shetland. As such, all opinions presented are those of bivalve shellfish farmers with relatively low production and small farms.

When asked if existing marine shellfish and non-fish aquaculture operations and locations should be monitored, all replies (3/3) answered with 'no'. In addition, when asked if they felt that shellfish and non-fish aquaculture proposals should be assessed for environmental impacts, all replies (3/3) were also 'no'.

Comments received showed no support for any additional legislative/monitoring requirements within this industry. Summaries of these additional comments are provided in **Appendix E**.

#### 4.3.2 Legislative Requirement

When asked whether current legislation with regard to shellfish and non-fish aquaculture proposals should be addressed, the majority of the Regulators (3/4) agreed with the statement while only one (1/3) of the Stakeholders answered yes. The one Association that replied during the consultation period also answered yes (1/1).

It was also asked whether proposed shellfish and non-fish aquaculture should fall within an EIA legislative framework. The majority of the Regulators (3/4) answered that it should, while none of the Stakeholders (0/3) agreed with this prospect. The Association (1/1) also believed that such proposals should be considered within an EIA framework.

When asked whether they believed that the publication of new legislation also offered the potential to simplify the consents process, only one positive answer was received (Regulators (1/4), Stakeholders (0/3), and Associations (0/1)).

One question asked if the consultees believed that any future EIA regulations for the industry should cover both shellfish and non-fish aquaculture thresholds. The Regulators generally answered 'yes' to this question (3/4); however, the Association did not agree (0/1). In addition, it was asked whether the consultees believed that it was appropriate to group shellfish and non-fish aquaculture. Again, only the Regulators replied with any positive answers (3/4) while neither the Stakeholders (0/3) nor the Association (0/1) thought this was appropriate.

The possibility of including public consultation within any future legislation for this industry was also put to the consultees. The majority of the Regulators (3/4) agreed that this should be addressed, as did the Association (1/1). However, none of the Stakeholders agreed (0/3) and all answered 'no'.

Cost was also an issue also included within this section. The Regulators and Associations were asked whether they thought cost would be a prohibitive barrier for stakeholders when developing new shellfish or non-fish aquaculture projects under new EIA legislative conditions. There was a split of opinions for this question, with half of the Regulators (2/4) replying that cost would be prohibitive, though the Association believed that it would not be an issue (1/1). The Stakeholders, when asked whether they were concerned about new environmental requirements costing too much and/or being a poor

investment all answered 'yes' (3/3), showing that there would be concern in the commercial industry that any EIA requirements would have prohibiting costs associated with them. Following this question there was also the opportunity for Stakeholders to indicate how much they would be prepared to invest on environmental investigation. This question, was not answered by the Stakeholders, and comments received indicated that they would not be prepared to expend any resources on such issues.

#### 4.3.3 Relevant Issues

All Stakeholders (3/3) replied that they did not think EIA is necessary for the consideration of shellfish and non-fish aquaculture proposals. Table 4.1 below shows the responses received from the Regulators and the Association when asked what the key issues for consideration of such proposals should be.

**Table 4.1 Key Issue Responses Table**

Key Issue	Statutory Regulator Response	Association Response
Water and Sediment Quality	3/4	0/1
Benthic Communities	3/4	0/1
Protected Areas	3/4	0/1
Escapees (remote colonisation) and Non-Native Species	2/4	1/1
Protected species and wildlife (nature conservation)	1/4	1/1
Proximity to Other Farms	2/4	0/1
Carrying Capacity	3/4	1/1
Layout and Design	3/4	0/1
Site Location	3/4	0/1
In-Combination Effects	1/4	0/1
Landscape and Visual	3/4	0/1
Air and Noise	1/4	0/1
Socio-Economic	3/4	1/1
Archaeology	1/4	0/1
Life Cycle Analysis (LCA)	1/4	1/1
Climactic Factors	1/4	0/1
Hydrography	3/4	1/1

From the table, it can be seen that most agreement from Regulators falls on water and sediment quality, benthic communities, protected areas, carrying capacity, layout and design, site location, landscape and visual, socio-economic and hydrography as key issues for consideration of shellfish and non-fish aquaculture. In general, the important issues for the Association do not match those of the Regulators; however, there is agreement on the receptors of carrying capacity, socio-economics, and hydrography.

Within this section, it was also asked if it was felt that it was important to regulate the layout of shellfish and non-fish aquaculture farms to prevent impacts such as excess sedimentation and scour. All Regulators replied yes to this question (4/4) as did the Association (1/1). When asked the best way to regulate such an aspect, the Regulators mainly favoured the use of Best Practice Guidance (3/4), while the Association believed the regulation should come through active regulation by an appropriate authority (1/1). The Stakeholders, did not think the layout of the farm structures was important as none

answered yes (0/3), though one answered that such regulation should come through Best Practice Guidance (1/3).

When asked if they thought an LCA (life cycle analysis) approach is the best way to make sure all activities are taken into account in any environmental assessment, the majority (3/4) Regulators replied 'yes', as did the Association (1/1). None of the Stakeholders agreed (0/3).

It was also asked whether it was thought that certain environmental receptors needed to be given more weight within an environmental assessment process; the majority (3/4) of Regulators answered 'yes', as did the Association (1/1), however, none of the Stakeholders (0/3) answered 'yes'.

When asked if all shellfish and non-fish proposals should be included in such a process, only one of the Regulators (1/4) answered 'yes', while the Association (1/1) also answered 'yes'. No Stakeholders (0/3) answered 'yes' to this question.

The question of the need for standardisation of a systems carrying capacity was also raised. Only half of the Regulators agreed such standardisation is necessary (2/4), while the Association did not agree (0/1). The majority of the Stakeholders, also thought that such standardisation is necessary (2/3).

When asked if they thought there was the potential for the development of 'site location maps' with regard to shellfish and non-fish aquaculture developments and whether such a resource is needed, the majority of the Regulators (3/4) answered 'yes', as did the Association (1/1). In addition, there was also a single positive response (1/3) from the Stakeholders in this regard.

The regulator questionnaire had the additional question asking if they thought that any future EIA legislation developed for this commercial sector would need to be robust enough to take into account any future issues, especially as production techniques are developing continuously. All Regulators (4/4) replied 'yes' to this question, as did the Association (1/1).

The Stakeholders were also asked if they felt that the regulators required more information about the methods and impacts of shellfish and non-fish production under the current legislative regime. Only one Stakeholder (1/3) replied 'yes'.

#### 4.3.4 Additional Comments from Consultees

##### Regulator Questionnaire

There was generally no agreement as to whether an EIA process would be able to simplify the current consents and licences procedure for a shellfish or non-fish aquaculture facility. Only one comment was received (from a Regulator) relating to the possibility EIA covering all shellfish and non-fish aquaculture saying that the actual environmental effects of such developments are relatively narrow and therefore could be addressed by specific information related to their mitigation and avoidance, without subjecting developers to the not inconsiderable cost of a full EIA.

The opinions with regard to the issue of cost were also varied. It was stated by the Regulators that EIA does not need to be expensive (for example, achieved through the targeting of particular issues), and that the setting of the thresholds at high levels would ensure only the larger farms are subject to the entire process. This said, it was also made clear in this consultation that it is believed thresholds will primarily need to be representative of the environmental needs, and not the cost of the process. It was also stated that current fees are already too high for the average shellfish/non-fish farmer, and that any additional cost would only add to the current pressures.

The weighting of various receptors within a potential EIA framework also received a number of comments from both stakeholders and regulators. These included comments saying that a case-by-case basis would need to be adopted, as would be present within an EIA process, and that shellfish farming would have very different impacts upon the environment when compared to finfish farming (for example, significantly less impact upon water quality in terms of nutrients etc, but greater impacts upon carrying capacity, smothering of benthos etc.). One Regulator added that they did not think that EIA was necessarily the best way of addressing such operations as they are, on the whole, relatively environmentally benign.

It was also suggested during consultation that careful screening and scoping stages would be required to ensure that all the operations that fall under 'shellfish and non-fish aquaculture' are dealt with appropriately. In this way, only the proposals which do have potential to significantly impact upon the environment are considered further and required to produce a full Environmental Statement. Thresholds will need to be set to ensure smaller farms with little/no environment or visual impacts will not need to undertake a superfluous EIA procedure.

The issue of the standardisation of carrying capacity estimates also yielded a number of comments in this exercise. It was clear from the replies that the current methods of modelling an area's carrying capacity are thought to be variable with a number of uncertainties inherent. The comments suggested that standardisation of such techniques would perhaps reduce the costs of assessments and provide a fairer system, though the actual viability of creating such standardisation is unknown due to the many variable factors, the large amount of data needed, and the constantly changing parameters. It is thought by the consultees that a precautionary approach would be needed in instances where there are environmental consequences of great concern, but in the development of standardised techniques such precautions would be required less.

When asked whether an EIA framework would need to be robust enough to be able to function when considering future issues, a number of replies were received. It was stated by the Regulators that there is currently no experience of dealing with crustacean shellfish production, and that such techniques would require large feed inputs and therefore have a far greater environmental impact. As such, there is currently not the experience in place to be able to set thresholds for such an aspect of shellfish culture. In addition, it was suggested that there should also be a mechanism which will ensure that any proposal which falls outwith any preset threshold levels would be considered on an individual case basis if significant environmental impact is a possibility. A comment was also received which stated that if the potential EIA framework was robust, meaning fit for purpose, then that purpose must incorporate a mechanism that is not seen to be prohibitively onerous and/or costly.

There were also differing opinions over the use of coastal site maps to inform the consenting process. It was mentioned that such maps have been used successfully already in locations such as Shetland, and that as the industry grows, such maps of loch areas would be beneficial. In addition, SEPA stated that it is 'in favour of a Marine Spatial Planning approach to define areas favoured for shellfish production to minimise the likelihood of conflicts between farmers and other water users'. However, a comment was also received stating that such maps could be exclusive and not inclusive, and that there should be opportunity for flexibility of approach when taking into account mitigation measures etc. The use of 'marine user groups' with the appropriate regulatory presence set up at a regional (or even a more localised) basis to examine such proposed development was also identified by the Regulators.

Later comments received from SEPA in August 2008 identified that an additional threshold type of sensitivity should be included. SEPA felt that this would allow proposed developments within, or near to international designated sites (e.g. SAC, SPA) and areas with UKBAP habitats and species can be accommodated. SEPA was of the view that sensitivity would need to be elevated to a threshold for initiating EIA. Such an extension to the current field of study could be accommodated in future work upon provision of the necessary support; however, the process of appropriate assessment under the Conservation (natural habitats & c.) Regulations 1994 is of direct relevance with respect to international sites and their interest features.

#### Stakeholder Questionnaire

There was a strong 'anti-legislation' feeling among the stakeholders. None of the stakeholders wished to either participate in or pay for any environmental studies in relation to their aquaculture business, though one did say if felt that such requirements would be inevitable but would resist for as long as possible.

Cost was an issue for Stakeholders; it was stated that development of such farms is difficult enough, and that most farms are in rural locations and typically economically fragile. In addition, comments received suggested many farms are small, often with limited financial resources, and would not be able to bear such an additional burden. It was also stated that there would be no benefit to the industry.

It was suggested by the Stakeholders that EIA in finfish farming has been unsuccessful ("costly and bureaucratic"), and would not benefit shellfish and non-fish farming as it has already been proved there is no long-term environmental impact for their farms. It was also added that the current assessments (of carrying capacity) are examples of "pseudo-scientific meddling", and that they believe such calculations affect the whole business viability and limit the economic use of productive areas. One comment submitted said that by its nature, shellfish farming is environmentally self-regulating as there are no artificial inputs and the stock is totally reliant on the natural water exchange, and as such, they believe the stock will only grow to the levels that can be supported by the natural resources of the site.

Blanket legislation covering all shellfish and non-fish aquaculture facilities was not supported by the Stakeholders. It was not deemed appropriate by the stakeholders due to the variation in sites and the differences in the farms themselves. It was also suggested by one stakeholder that the standardisation of an area's carrying capacity may be a better route to take than EIA legislation, though another added that such pre-

assessment should be considered as indicative “guess-work” and that consents should allow for experimental operation to allow for assessments of performance in situ.

#### 4.4 The Views of Industry Associations

In order to allow for the low response rate from stakeholders to consultation, representatives of the Association of Scottish Shellfish Growers (ASSG) and the Scottish Shellfish Marketing Group (SSMG) were invited to attend a meeting with the project team in order to identify and discuss issues of concern and interest. This would provide a greater opportunity for the industry to provide input to the study. Although no response was received from SSMG, ASSG agreed to attend a meeting that was arranged for in November 2007 in Edinburgh. In addition to this, in comments received from SARF in February 2008 following a presentation to the SARF Board in January 2008 it was suggested that Seafood Shetland, a trade organisation which represents shellfish growers based in Shetland, be included in the consultation. A response from Seafood Shetland was received in March 2008. Unfortunately, it was not possible to include the results of the questionnaire response in the main analysis due to time and budget constraints; however, the comments received from ASSG and Seafood Shetland are discussed in their respective subsections below.

##### *The Association of Scottish Shellfish Growers*

The views of ASSG were recorded during open discussion as an expression of fact and ASSG opinion. They identified several issues in response to questions under the following subject areas:

- Expected industry growth in the next 5, 10, and 15 years.
- Competition for space with fish farming and the issue of ‘in combination effects’.
- Could pseudo faeces under installations be considered to have a similar environmental effect to excess foodstuffs used in finfish farming?
- Was there science based evidence of impacts from shellfish and non-fish aquaculture?
- Was site selection influenced by;
  - the quality of sediments and water?
  - protected species and sites e.g. European Marine Sites?
  - the presence or risk of introduction of alien species and/or pathogens?
- Was carrying capacity influenced by;
  - the ecology of a site/ area?
  - pathogens?
  - Environmental Quality Systems?
- Were visual and noise impacts a primary concern for developers and surrounding communities/ receptors?
- Were Socio-economic benefits a primary reason to justify development of installations?

From a legislative perspective:

- Was the setting of standards for water quality in EU member states through the Quality of Shellfish Growing Waters Directive and the Water Framework Directive a concern?
- Should the Shellfish Directive be applied to shellfish other than bivalves i.e. crustacean?
- Was the Aquaculture and Fisheries (Scotland) Act 2007 relevant and/ or effective?
- Did the Environmental Impact Assessment (Scotland) Amendment Regulations 2006 have any relevance to shellfish and non-fish aquaculture?

The views of ASSG identified that Scotland offered a shellfish carrying capacity of approximately 100,000 tonnes per year of which only 5,000 tonnes (5%) was being utilised in 2007. Growth targets of 10,000 tonnes (by 2010) and 20,000 tonnes (by 2020) were ideal targets, but levels of production had reached a plateau in recent years. The scope for expansion of the industry was therefore considered large but the Planning Authorities were considered to be slow in the processing and efficiency of planning applications. The additional cost of EIA and the requirement to growers to produce (and for regulators to assess) an environmental statement was thought likely to have a negative effect on the potential growth of the industry in Scotland.

The view that Scotland depends largely on niche markets and it takes longer to grow shellfish to marketable size in Scottish cold waters compared to other operations in the warmer waters of southern Europe was expressed. Levels of nutrients, and available sunlight as controlling and regulating factors of primary and secondary production should also be considered but it was made clear that growth rates generally decrease with increasing latitude. In Europe, production levels (e.g. in Holland, France and Spain) are known to be significantly higher than in Scotland. This was attributed primarily to the large scale of shellfish aquaculture in these countries on open estuarine and ria sites compared to the scale and type of sites available to shellfish aquaculture development in Scotland. ASSG was keen to see that European guidelines should recognise this difference; e.g. threshold levels could be used to trigger environmental assessment, but it was likely that European thresholds would exceed many Scottish sites. A counter argument to this is that such thresholds should be relative (proportional) to the production of an area, region or country and the ecosystems they may affect.

ASSG reported that the monitoring of sites was undertaken by the statutory authorities, not by the growers themselves. It was thought useful that a suggestion to SEPA, SNH and other statutory bodies in favour of the decentralisation of monitoring responsibilities to those within the ASSG membership who were considered by the authorities to have the relevant knowledge and experience to undertake routine environmental monitoring and report to a central resource would be a positive step in improving the management of the industry. Cost savings of decentralisation could equip approved growers with the essential instruments to enable reliable monitoring. This would have mutual benefits for growers and regulators and could also benefit local job creation and education.

The effect of agriculture, in particular sheep grazing and the impacts this was having on water quality through contamination by faecal *E. coli* is recognised by SEPA as a

significant issue. Regardless, ASSG was of the opinion that higher background levels of *E. coli* in coastal waters of rural areas were affecting the quality of farmed shellfish when this was compared against European standards. Periodic deterioration of water quality in some areas appears to be becoming more common. This may delay harvests and increase depuration costs, thus having a negative financial impact on small growers in particular.

In addition to the potential for changes to ecological factors to trigger EIA, the visual impacts and noise impacts of coastal development were seen by ASSG as being particularly sensitive issues by some receptors in rural areas. It was thought that these could have a significant effect on the outcome of a planning application; however, it was clear from discussion that the inclusion of assessment of landscape and visual impacts, and those of noise and vibration were not seen as 'environmental' issues; they were seen more as a planning consideration. There also appeared to be some confusion regarding the relationship between EIA under the Planning Regulations and EIA under the Habitats Regulations when in fact it is Appropriate Assessment (AA) not EIA that relates to the latter. Growers may therefore be required to gain a better understanding and appreciation of EIA and its application through the Planning Regulations, and AA in accordance with the Habitats Regulations.

During later discussion (January 2008) in the absence of ASSG, SEPA made it clear that such 'self-monitoring' is not a viable option as other such schemes (most notably the operator returns for marine fin fish farming with 200-300 returns per year) have resulted in a negative experience for its monitoring of the industry. The requirement of marine fin fish operators to undertake self monitoring of their sites is built into necessary licences. Most require that surveys are carried out at peak biomass (i.e. once every two years), though some sites are monitored every year depending on previous history of impact. Late submissions and failure to submit the surveys are issues of non-compliance with the licence in such cases. SEPA can then take legal action against the farm operator.

SEPA water quality standards are acceptable to many ASSG members; however, water quality standards from the Shellfish Waters Directive (that are not SEPA derived) were considered to be relevant to shellfish production in rural areas. Scottish Water has invested heavily in upgrading many rural sewage treatment facilities; e.g. recent improvements in the Oban area and around Lock Etive, and under future Area Management Plans (AMP) for water quality, considerable investment towards improvements in water quality is planned. The European Water Framework Directive (WFD) is a key driver. Under it, the Scotland River Basin Management Plan (RBMP) will consist of the three components listed below. Each component must complement the other because in total they form the RBMP for the Scotland District.

- River Basin District Plan, including annexes covering classification, objectives and measures.
- AMP for each of the Advisory Group areas.
- Geographical Information System (GIS) application with information on the classification, risk assessment, pressures and measures for each individual water body.

### *Seafood Shetland*

Referring to comments received from Seafood Shetland, it was reported that benthic analysis has been carried out at virtually all fin fish sites in Shetland for over ten years. Seafood Shetland were keen to point out that the results of such monitoring indicate that even the largest fin fish sites show little or no evidence of environmental impact. It was felt that this was particularly important and relevant when compared to levels of non-fish (mussels and Pacific oysters) production; the majority of fin fish sites in Shetland produce in excess of 1,000 tonnes of fish each cycle.

The cultivation of shellfish is considered by Seafood Shetland to be “non-invasive”. This term should not be confused with invasive non-native species, or translocation practices of; e.g. mussel seed. By using the term “non-invasive” Seafood Shetland refer to the absence of artificial feeding and chemical treatments e.g. for pathogenic control that are often associated with the cultivation of finfish. Consequently, the likelihood of any significant environmental impact from the cultivation of shellfish is considered by the industry to be negligible.

Seafood Shetland went on to add that the significant costs associated with environmental monitoring are currently met by the site operator. To carry out environmental monitoring would be an extremely onerous and costly burden on shellfish cultivators particularly when the industry is considered one of low profit margins and one that is carried out in remote, economically fragile, communities. In general, when compared to current levels of regulation, environmental investigations were not viewed as an investment by the Shetland industry.

Seafood Shetland considered that shellfish cultivators currently comply with all aspects of environmental legislation, with operations tailored to meet with the aims of all regulatory requirements. It did not support the suggestion of formal EIA for non-fish production and felt that current levels of legislation and regulation were appropriate. The organisation reported that all growers in Shetland are under an obligation to operate to strict codes of practice and to liaise regularly with the organisations tasked with ensuring communities' sustainability, cultural heritage, ethical, quality and environmental standards. The Shetland Islands Council works licence policy separation distance between farms was set at 500m; however, it should be noted that some long established sites are located at distances considerably less than the policy advised.

It was felt by Seafood Shetland that the most important environmental challenges facing aquaculture were from external influences including; the reported warming of global temperatures, harmful algal blooms, bird predation and invasion of alien species. A number of avenues currently exist to try to address these concerns but they require to be strengthened and further support made available.

Within the industry, it is considered that shellfish culture is an indicator of the wellbeing of the environment and is compatible with other users. Existing environmental assessments were considered by many in the industry to be rudimentary and inconsistent; current variability in assessments could seriously affect business viability and can even preclude the use of available productive areas.

In summary, the over-riding message from the industry responses received was that the introduction of EIA is seen as further meddling in an industry which is already subjected

to over-regulation. EIA could hamper and disrupt economic development proposals in economically fragile, rural areas.

## 5 THRESHOLD LEVELS

### 5.1 Likely factors

The first question asked with regard to potential thresholds in the questionnaires was the determination of the appropriate factors that could be used when setting threshold levels. The replies are presented within Table 5.1 below.

**Table 5.1 Key factors for consideration as threshold determinants**

<b>Factor</b>	<b>Statutory Regulator</b>	<b>Association</b>	<b>Stakeholder</b>
Size of Farm	3/4	1/1	1/3
Biomass Held/Sensitive Areas	2/4	1/1	2/3
Non-Native Crop	2/4	1/1	1/3
Proximity to Other Farms	1/3	1/1	0/3

This table shows that a number of responses were received that were in favour for each potential factor. The factors which received the most responses, and therefore the most agreement, were biomass held/sensitive areas and the size of the farm.

A question was also posed asking whether it was thought that all shellfish and non-fish aquaculture should be dealt with in the same way (i.e. graded in a common system). None of the Regulators agreed with this (0/4), nor did the Stakeholders (0/3); however, the Association (1/1) did reply 'yes'.

In addition, consultees were also asked if overarching threshold levels (in both tonnage and area) could be applied universally to all shellfish and non-fish aquaculture proposals. None of the Regulators (0/4) and none of the Stakeholders (0/3) answered 'yes' to this question, and neither did the Association (0/1).

## 5.2 Threshold matrix

Biomass Produced	>5 t	>20 t	>50 t	>100 t
		0/4 0/3	0/4 0/3	0/4 0/3

Size of Site/Farm area	>0.01 ha	>0.1 ha	>0.2 ha	>0.5 ha
		0/4 0/3	1/4 0/3	1/4 0/3

Proximity to other aquaculture facilities	<1 km	<5 km	<50km	<100 km
		3/4 0/3	0/4 0/3	0/4 0/3

- \* **Red Text** represents Regulators response
- \* **Blue Text** represents Stakeholder response

It is clear from this matrix that the stakeholders do not want such a form of environmental regulation. However, one comment was received from a stakeholder during the consultation process stating that 100 tonnes was too low as a production threshold level. It was suggested that a value of 500 tonnes would be more appropriate (though would not be of advantage to the industry). As such, a semi-positive response in relation to the use of threshold levels was received. Overall, the stakeholders were not in support of an EIA regime and did not like the prescriptive nature of the 'threshold' method of determination.

The regulators all agreed with the use of a threshold of over 100 tonnes annually in biomass, and a comment was received stating that future thresholds for EIA should be set at high levels based upon the maximum standing biomass that could be supported by the recommended equipment. The level suggested for this threshold was set at around 400 tonnes of standing stock for mussel farms. It is clear that the parameter of 'production size' has potential for use as an EIA threshold, and that there is agreement that a value of over 100 tonnes of biomass is the preferred level. We recommend that there should be further discussion to identify the exact point at which the threshold would be exceeded, and a responsible level at which it could be set.

In addition to the comments received relating to the suggested threshold levels, it was also stated by a Regulator that where an activity may influence a sensitive area or feature (e.g. a European Marine Site), and an appropriate assessment<sup>2</sup> has not been carried out, an EIA should be required regardless of size of development. This statement may not be classed as a 'threshold' as such, but perhaps as a 'mandatory' requirement for a project that matches this description. It should also be noted that appropriate assessment comes under the Conservation (natural habitats & c.) Regulations 1994 and is independent of EIA legislation.

When looking at the spread of responses received from the Regulators as shown in the matrix above, it can be seen that generally there is agreement on the EIA threshold levels of >100 tonnes of biomass and <1 km proximity to other aquaculture farms. The responses for the size of the farm, differ greatly with each Regulator opting for a different threshold value. This is clearly an area which would require further investigation to obtain a consensus.

The comments received through this process also gave an opportunity for consultees to express their opinions. All comments can be found within **Appendix E**. Within these comments, one Regulator stated that thresholds in terms of tonnage and area were very difficult to define; they were dependant upon the species cultured and the methods used. The response specified the current thresholds as presented in the Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999. In addition, another comment from a Regulator said that different thresholds should be applied and that these should be species or method dependant. Another response stated that species dependant biomass thresholds would be best, and that area and proximity based thresholds had little scientific basis.

It can be seen from the matrix that one Regulator did not answer all of the threshold questions. They supported the argument that such thresholds should be determined through scientific reasoning and not through consultation. Another Regulator stated that thresholds need to be suitable to ensure that no disproportionate costs are incurred when consenting smaller operations, and therefore not be a disincentive to the industry.

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<sup>2</sup> Appropriate assessment as may be required under Regulation 48 of the Conservation (Natural Habitats & c.) Regulations 1994 (The Habitats Regulations).

## 6 RECOMMENDATIONS

### 6.1 Summary

Overall, this study has shown that there is a difference in opinion between regulators and stakeholders regarding the need for the application for EIA through environmental legislation with respect to non-fish aquaculture. The regulators are supportive of a move to include shellfish and non-fish aquaculture within EIA regulations, while it is clear that the stakeholders represented in the consultation exercise do not want such a move to occur and would generally resist any such action.

Potential threshold levels to determine which facilities would fall into the categories which would require EIA were also addressed. The Stakeholders did not respond to these questions, maintaining that EIA is not necessary. The Regulators showed general consensus that values of >100 tonnes of biomass production per year and <1 km proximity to other aquaculture farms would be suitable for consideration as threshold levels. Area (the size of the farm in hectares) received a greater diversity of views, with no agreement between the Regulators, and as such, this aspect could also be investigated further. All factors for threshold determination received positive feedback of some kind, though the actual exceedence values would require further investigation (both through consultation and scientific investigation).

During this process it was also clear that the majority of the consultees (both stakeholder and regulator) considered the grouping of shellfish and non-shellfish farms together for consideration under the same threshold was inappropriate. Suggestions included the use of species specific threshold levels, and also potential for the distinction between different farming methods.

The layout and design of individual farms was also a topic within this consultation exercise. When presented with different options for the management of this aspect, it was generally agreed by both consultation groups that such considerations should be subject to best practice, and guidance in this way would be the preferable means to achieve any regulation of the farm structures themselves.

The use of a life cycle analysis (LCA) approach was a popular potential means for environmental assessment within the Regulator group. Stakeholders showed no support for this method. However, any future EIA regulations should consider the use of LCA as a method for use in the consideration of the potential impact a particular proposal may have on the environment.

The suggestion of standardisation of carrying capacity models also received a number of comments. This area for future development was supported by both Regulators and Stakeholders, and may offer 'common ground' to encourage positive working relationships in this area. In a similar vein, the potential for the use of 'coastal maps' (similar to those currently used in the assessment of fish farms) was also supported by both consultation groups, and could also provide an opportunity for collaborative efforts.

Bivalve shellfish were the most prominent species considered within this consultation exercise (all Stakeholder who responded were representing bivalve mollusc farms). This is most likely attributable to the fact that it is the most prominent form of shellfish and non-fish aquaculture in Scotland. This balance may change in the future, and there

are other considerations that need to be included in any legislation that is developed to regulate the industry through environmental impact assessment. This study focused on the production of species for human consumption. Elsewhere in the world, large scale production of other species such as macroalgae for non-food use is beginning and this should also be included in any proposed legislation.

## 6.2 Conclusions and future work

No examples of shellfish/non-fish aquaculture EIA legislation have been identified as being implemented in other EU Member States during the course of this investigation. As such, no clear decision has been identified as being made by any of the European countries to date as to whether shellfish and non-fish aquaculture falls within Annex II of the EIA Directive. In addition, a decision has not yet been made in the UK as to whether shellfish and non-fish aquaculture operations should fall within their own EIA Regulations.

The previous study SARF05 (2005) concluded that;

*'Given the rate of development within the shellfish sector and the likely increases in density and scale, it would seem appropriate to treat large shellfish farms in the same way as fin-fish farms'.*

As such, this project has taken the next step in this process and scoped out the potential thresholds which could be used in future legislation should it be deemed that certain shellfish and non-fish aquaculture operations can be environmentally significant and require EIA. This has included consulting both Regulator and Stakeholder groups as to their opinions on whether EIA is required in the regulation of this industry.

The Regulators in general believe there is a need for EIA regulation of shellfish and non-fish operations, stakeholders are fairly hostile to the suggestion of implementing any such regulations. As such, stakeholder opinion should be taken into account in any future work to try to prevent any further bad feeling in this area, with potential costs and barriers to planning permission being the issues of main concern to this group. If there is continued development of such legislation, a public relations exercise may be required to improve the level of information available to growers; hence allowing a greater appreciation of regulatory issues. This may facilitate the alleviation of any reluctance by growers to engage in the formulation of policy and any subsequent legislation. A proactive approach may ensure that small farms with little environmental consequence will minimise or avoid any liability to undertake EIA under future legislation should it emerge. Reassurance that any EIA regulation will be proportion to the scale of the farming venture and the environmental sensitivity will be needed if stakeholder support is to be gained, and a further study should investigate the potential mechanism for delivering this goal.

The suggestions for the standardisation of carrying capacity models and the production of 'coastal maps' received positive feedback from the Regulators and Stakeholders alike. Whilst the development of both assimilative and carrying capacity models is complex, SARF is currently sponsoring the development and validation of loch scale models (projects SARF012 and 012a - [http://www.sarf.org.uk/Project\\_index.htm](http://www.sarf.org.uk/Project_index.htm)) which should provide objective information on the potential impacts of shellfish and finfish farms. A variety of modelling tools already exist to help to optimise shellfish farm production (see for example the EU ECASA project - <http://www.ecasa.org.uk/>). Certain

comments received raised potential problems for the standardisation of carrying capacity, and it is thought that such matters should be investigated further in a separate study to assess feasibility for such development. It was suggested that these areas of future work could provide opportunity for increased cooperation between the industry and Regulators.

The consultation identified that biomass production, farm area, and proximity to other farms should be considered as appropriate thresholds for use in any future development of EIA regulation for this sector. The exact exceedance points for such thresholds remain a topic for future consideration, though the nominal values of greater than 100 tonnes for biomass production and a proximity of less than 1 km have been identified as appropriate ranges within this study and can form a basis for future discussions. It has also been shown that thresholds should also be defined for different species and farming methods. In addition, the potential for developments proposed within sensitive areas to fall within a 'mandatory EIA' category should also be considered further.

Many 'key issues' were selected during this exercise as issues that should be covered within any future EIA process. From the consultation, these issues can be ranked from most important to least important according to the Regulator consultation group. These are as follows:

- 1) Water and sediment quality, benthic communities, protected areas, carrying capacity, layout and design, landscape and visual, socio-economics, hydrography, and site location.
- 2) Escapees (remote colonisation) and non-native species, proximity to other farms.
- 3) Protected species and wildlife (nature conservation), in-combination effects, air and noise, archaeology, LCA, climatic factors.

In addition to this list, there are also other considerations which may be applicable to individual projects. These include traffic and access, health and safety, and navigation, as well as surrounding implications such as conflict with locals, operating procedures (operating hours etc), and aspects such as potential marine litter. It is suggested that any such key issues or potential conflicts for individual projects should be discussed and assigned by the Regulating Authorities during the 'Scoping' phase of the process, and that all issues as shown within this study (see **Table 4.1**) should be listed within subsequent guidance as appropriate receptors for use within environmental scoping. Many such issues are already dealt with to some degree during the consents, licences and consents process (such as opportunity for public comment); including these within an EIA tailored to each individual farm proposal will provide an opportunity to present all information required within a single document (the Environmental Statement) which can satisfy all statutory requirements. The final report for project SARF024 (EIA Guidelines for Marine Fish Farming) provides an authoritative reference for the structure and conduct of EIAs. Many of these guidelines would be equally applicable in the context of shellfish EIAs.

The consultation identified that the preferred method of regulating the layout and design of the farms themselves should be through the use of best practice working. Scottish Natural Heritage (2008) provides specific guidance on landscape and seascape capacity for aquaculture in Scotland.



## **APPENDIX A**

### **Literature Review**

**Scoping Study of appropriate EIA trigger  
thresholds for shellfish farms and other non-fish  
farm aquaculture**

Scoping Study of Appropriate EIA Trigger Thresholds for  
Shellfish Farms and other Non-Fish Farm Aquaculture

Appendix A - Literature Review

Scottish Aquaculture Research Forum

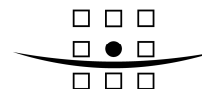
June 2008

Final Report

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Document title Scoping Study of Appropriate EIA Trigger  
Thresholds for Shellfish Farms and other  
Non-Fish Farm Aquaculture  
Document short title Appendix A - Literature Review  
Status Final  
Version 03  
Date June 2008  
Project name Scoping Aquaculture EIA Thresholds  
Project number 9S2511  
Author(s) Angela Nicholson  
Client SARF  
Reference 9S2511/R001/303319/Newc

## GLOSSARY

AA	Appropriate Assessment
ASP	Amnesic Shellfish Poison
CEC	Crown Estates Commission
CEFAS	The Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
DSP	Diarrhetic Shellfish Poison
EA	Environment Agency
EIA	Environmental Impact Assessment
ELV	Emission Limit Values
EQO	Environmental Quality Objectives
EQS	Environmental Quality Standards
ES	Environmental Statement
EU	European Union
FRS	Fisheries Research Services
HAB	Harmful Algal Bloom
HIE	Highlands and Islands Enterprise
ICZM	Integrated Coastal Zone management
Natura 2000	The networks of all SAC and SPA sites.
PSP	Paralytic Shellfish Poison
Regulatory Bodies	Bodies, often Governmental, that regulate certain activities under their legislative duty.
SARF	Scottish Aquaculture Research Forum
SAC	Special Areas of Conservation
SCI	Special areas of Community Importance
SE	Scottish Executive
SEERAD	Scottish Executive Environment and Rural Affairs Department
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
Statutory Body	Bodies that are given specific powers and responsibilities by an Act of Parliament to carry out given functions.
WFD	Water Framework Directive

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## 1 INTRODUCTION

### 1.1 Purpose of this Document

This literature review represents Stage 1 in the approach to the scoping study of appropriate EIA trigger thresholds for shellfish farms and other non-fish aquaculture, project Code SARF031. This research was funded by the Scottish Aquaculture Research Forum (SARF), and this initial first stage was undertaken in January-February 2007. This literature review is a desk based assessment comprising of primary, grey, and unpublished literature, as well as use of internet resources.

### 1.2 Scoping Study of Appropriate EIA Trigger Thresholds for Shellfish Farms and other Non-Fish Farm Aquaculture

In response to the SARF 2006 call for proposals Item 6, this research project will undertake a study in support of the provision of a scoping report of the potential environmental thresholds that are considered likely to trigger the requirement for Environmental Impact Assessment (EIA) for shellfish and non-fish farm aquaculture.

Although not currently included, it is possible that shellfish farms and other non-fish farm aquaculture such as production of algae etc. could fall within EIA regulations. At present there are no guidelines as to the size of farm (weight of production or area) that may require EIA. The scoping study considers the available data and suggests appropriate criteria, including thresholds, which could be used in making such judgements. The project takes into account the combined impacts of neighbouring aquaculture operations (i.e. in-combination effects), and the cost of implementation to the industry of the suggested thresholds will also be estimated. The results are used to provide guidance to regulators and operators on the potential requirement of EIA when considering new plans or projects. This literature review is the first investigative step in this process.

### 1.3 Need for Study

The Environmental Impact Assessment Directive (85/337/EEC) (as amended) is concerned with the assessment of certain public and private projects on the environment. The Directive defines 'intensive fish farming' as an Annex II project, thereby permitting individual Member States to determine the need for EIA on a case-by-case basis through the establishment of thresholds or other criteria. To date, most Member States have determined that only finfish aquaculture projects should be subject to EIA, and few shellfish studies, regardless of scale, have been through the EIA process (ICES, 2002).

### 1.4 Structure of Report

Following this introductory section, **Section 2** details the current regulatory and legislative environment with regard to aquaculture both in the UK and nationally. This sets the scene for the subsequent sections by providing a background to the environmental issues that have so far been addressed by the Governments and Regulatory/Statutory bodies.

**Section 3** deals with the considerations for site selection for a shellfish or non-fish aquaculture farm, taking into account all known factors that may have a direct or indirect influence on the environment.

**Section 4** presents the current information with regard to noise and visual impacts as a result of shellfish/non-fish aquaculture activities, while **Section 6** considered the socio-economic effects of such activities.

The final section, **Section 7**, summarises the findings of this review and presents the recommendations for the key issues to be addressed in the subsequent stages of this study. A bibliography of references can be found at the end of the report.

## 2 CURRENT LEGISLATION AND REGULATION OF SHELLFISH AND NON-FISH AQUACULTURE IN SCOTLAND AND THE REST OF THE UK

The legal framework for the development and monitoring of aquaculture facilities and products is complex, with many facets to consider. This section presents the relevant Conventions, Directives, Acts, Bills and Regulations for Scotland and the remainder of the UK. Sections 2.1 and 2.2 are taken from James and Slaski (2006) that provides an appraisal of the opportunity for offshore aquaculture in UK waters.

### 2.1 International Conventions

The Convention on Biological Diversity (CBD, 1992), UNCLOS (1982) and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1972 and Protocol 1996) deal mainly with the protection of the marine environment and the prevention of pollution. None refer specifically to marine aquaculture. Identification and monitoring of human activities that have an impact on the marine environment are included. Adequate environmental impact assessments are required to be carried out for any new development, followed by specific monitoring programmes.

Through UNCLOS measures to prevent, reduce and control pollution which might be originated by aquaculture are advocated. This convention also requires measures necessary to protect and preserve rare or fragile ecosystems including the habitat of depleted, threatened or endangered species. The CBD deals with impact assessments and avoiding or minimising adverse effects in general. Within the London Convention all practicable steps are to be taken to prevent pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea (see Buck *et al.*, 2003; Buck *et al.*, 2004).

Under Agenda 21, the impacts of aquaculture are discussed in the "Sustainable use and conservation of marine living resources under national jurisdiction" (Section II, Chapter 17, program area D). Coastal states are requested to conduct analysis of the potential of aquaculture and to implement mechanisms to develop mariculture and aquaculture within areas under national jurisdiction where assessments show that marine living resources are potentially available. Explicit in the language of Agenda 21 is the need for developed countries to ensure that states should provide for the transfer of environmentally sound aquaculture and mariculture technologies (see Buck *et al.*, 2003; Buck *et al.*, 2004).

The United Kingdom is a signatory to the "UN/ECE Convention on access to information, public participation in decision-making and access to justice in environmental matters" known as the Aarhus convention. Article 1 of the Aarhus Convention states that: "In order to contribute to the protection of the right of every person of present and future generations to live in an environment adequate to his or her health and well-being, each Party shall guarantee the rights of access to information, public participation in decision-making, and access to justice". In May 2003 in response to the Aarhus convention the EC adopted Directive 2003/35/EC -The Public Participation Directive. The Directive intends to implement the provisions of the Aarhus Convention on public participation in decision making and access to justice in environmental matters

by amending Environmental Impact Assessment (EIA) and Pollution Prevention and Control (PPC) Regulations.

## 2.2 Regional Conventions

The Oslo-Paris Convention of the Protection of the Marine Environment of the North-East Atlantic (OSPAR) identifies aquaculture as the technology to raise fish, molluscs and crustaceans (Czybulka and Kersandt, 2000). In addition to these convention articles, the Quality Status Report of OSPAR records the actual condition of the impacts of human activities through aquaculture on the environment in terms of the release of metabolic wastes, anti-foulants (copper), antibiotics, vaccines and parasites into the water column.

The International Conference on the Protection of the North Sea does not take any position on regulation of aquaculture, but fosters the political impetus for the intensification of the environmental protection work within relevant international conventions, and ensures more efficient implementation schemes for the existing international rules related to the marine environment in all North Sea jurisdictions.

The Convention for the Conservation of Salmon in the North Atlantic Ocean was established in 1982. The North Atlantic Salmon Conservation Organization (NASCO) established the International Atlantic Salmon Accord in 1998. The Accord is a comprehensive plan to combat the threats to salmon at all life stages, in both its freshwater and marine habitats. Created and launched at NASCO at Edinburgh, Scotland in 1998 by the Atlantic Salmon Federation of North America and the Atlantic Salmon Trust of the United Kingdom, the accord makes specific reference to salmon aquaculture. The Williamsburg Resolution, to Minimise Impacts from Aquaculture, Introductions and Transfers, and Transgenics on Wild Salmon Stocks was adopted in 2003 and amended in 2004.

## 2.3 European Law

There are eight European Directives that are relevant to aquaculture, although some are of more relevance than others. These were listed by Read and Fernandes (2003) as;

- Quality of Shellfish Growing Waters Directive (79/923/EEC)

This Directive concerns the quality of the waters in areas designated by the Member States for growth of shellfish for human consumption. It defines guideline and imperative values for both the waters and the shellfish flesh. Member States establish their own programmes for reducing pollution to shellfish waters to comply with such standards.

- Shellfish Directive (91/492/EEC)

This Directive concerns the quality of the shellfish waters and lays down the health conditions for the commercial production and the placing on the market of live bivalve molluscs. It determines that locations and boundaries of production areas are established and fixed on the basis of bacteriological criteria, and requires the classification of these areas according to the degree of contamination by faecal indicator bacteria present in samples of the mollusc flesh.

- Environmental Impact Assessment Directive (85/337/EEC) as amended

This Directive is concerned with the assessment of certain public and private projects on the environment. Aquaculture is included in Annex II of this Directive. To date, most Member States have determined that only finfish aquaculture projects should be subject to EIA, and few shellfish studies, regardless of scale, have been through this process.

- Strategic Environmental Assessment Directive (2001/42/EC)

The purpose of the SEA Directive is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. The Directive requires that environmental assessment be carried out for projects listed in the Directive, including fisheries, which are likely to have significant environmental effects.

- Birds Directive (79/409/EEC)

This Directive provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. In accordance with Article 4 of this Directive, Special Protection Areas (SPAs) have been classified for the protection of rare and vulnerable birds, listed in Annex of the Directive, and for regularly occurring migratory species.

- Habitats Directive (92.43/EEC)

The provisions of this Directive require Member States to introduce a range of measures including the protection of species listed in the Annexes, to undertake surveillance of habitats and species, and to produce a report every six years on the implementation of the Directive. The 189 habitats listed in Annex I of the Directive and the 788 species listed in Annex II are to be protected by means of a network of sites. Each Member State is required to prepare and propose a national list of sites for evaluation in order to form a European network of Sites of Community Importance (SCIs). Once adopted, these are designated by Member States as Special Areas of Conservation (SACs), and along with Special Protection Areas (SPAs) classified under the EC Birds Directive, form a network of protected areas known as Natura 2000.

- Water Framework Directive (WFD) (2000/60/EC)

This Directive sets the requirement to restore water bodies to good ecological status by 2015. The Shellfish Growing Waters Directive and the Dangerous Substances Directive will be integrated into the WFD and, in regulating marine aquaculture; Member States will be required to ensure compliance with these Directives in coastal and territorial waters.

- Dangerous Substances Directive (76/464/EEC)

A number of chemicals used in aquaculture fall within the List II definition (deleterious effects upon the aquatic environment) of this EC Directive, though such chemicals are normally for use in the fish farming sector. Member States are required to introduce programmes to reduce pollution from List II substances and only authorise their release on the basis of Emission Limit Values (ELV) to ensure compliance with Environmental Quality Objectives (EQOs).

In addition to these Directives, there are also other legislative mechanisms. The Common Fisheries Policy (CFP) is the fisheries policy of the European Union. This policy also covers the subject of aquaculture. The Reformed (2002) Common Fisheries Policy (CFP) aims to improve the management of aquaculture. In September 2002, the Commission to the Council and the European Parliament released a communication titled 'A Strategy for the Sustainable Development of European Aquaculture'. This Strategy recognises the importance of aquaculture in the frame of the reform of the Common Fisheries Policy, and develops this in a way that is coherent with the other strategies, such as the European Strategy of Sustainable Development. The main aim of the strategy is the maintenance of competitiveness, productivity and sustainability of the European aquaculture sector, and has 3 main objectives:

- Creating secure employment.
- Providing safe and good quality fisheries products and promoting animal health and welfare standards.
- Ensuring an environmentally sound industry.

A number of other European Regulations and Protocols (both proposed and passed) are also directly relevant to shellfish and non-fish farming in the UK. These Regulations include:

- Regulation 1907/2006 (OJ:L396/1/2006) on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

Annex 17 to Regulation 1907/2006, on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and establishing a European Chemicals Agency, sets out the restrictions on the manufacture, marketing and use of certain dangerous substances, preparations and articles. It prohibits the use of certain chemicals (mercury, arsenic, organostannic compounds) in cages, floats, nets and any other appliances or equipment used for fish or shellfish farming.

- Proposal COM(2001)483 (OJ:C332/E3/2001) for a Decision on the conclusion of the Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes

This Proposal is for a Decision on the conclusion of the Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which aims to promote the protection of human health and well-being. This is to be done within a sustainable development framework and involves the improvement of water management and preventing, controlling and reducing water-related diseases, part of which deals with the quality of waters used for the production or harvesting of shellfish.

As well as the Directives, Policies, Regulations, Protocols, and Communications as presented above, there are also at least another 50 plus EC directives, decisions and regulations that have an indirect effect on aquaculture (Read and Fernandes, 2003).

## 2.4 United Kingdom and National Law in Scotland

The overarching international and European legislation is written into UK and national law through Parliamentary Acts and Bills, and also within Statutory Instruments and Regulations. The following all are directly related to aquaculture in Scotland, England and Wales.

### 2.4.1 United Kingdom

- The Coast Protection Act 1949

This requires that consent be obtained for marine structures that could cause obstruction or danger to navigation. This includes mussel lines.

- The Food and Environment Protection Act 1985

This requires that consent be obtained for deposits on the seabed below the Mean high Water Spring (MHWS) tide mark that could cause an environmental impact. Examples include moorings, jetties, and shellfish lays.

- Sea Fisheries (Shellfish) Act 1967

From the mid 1990s Regulating Orders, under the Sea Fisheries (Shellfish) Act 1967, were also considered as a means of enabling more local, area management of inshore shellfish fisheries in Scotland. Several Orders, also under the Sea Fisheries (Shellfish) Act 1967, have been used specifically for the localised cultivation of shellfish, and Several Orders have been granted in Scotland to farm scallops; e.g. the Loch Caolisport Scallops Several Fishery (Scotland) Order 2002.

- The Wildlife and Countryside Act (1981) (as amended) and the Nature Conservation (Scotland) Order 2004.

These place a duty on owners and occupiers of SSSIs to protect fauna, flora and habitats for which the SSSI site has been designated. A large proportion of the Scottish coastline has been designated as SSSI and there is an onus on the aquaculture industry to protect it as it is in the best interest of owners and occupiers using such sites for aquaculture to do so.

- Environment Act 1995

This Act sets out the pollution control functions of the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA) in Sections 2 and 21 respectively under and by the virtue of the Control of Pollution Act 1974 where it is an offence for a person to cause or knowingly permit any trade effluent or sewage effluent into controlled waters.

- Environment Impact Assessment (Fish Farming in Marine Waters) Regulations 1999.

The main piece of legislation relating to aquaculture in Scotland, England and Wales is the Environment Impact Assessment (Fish Farming in Marine Waters) Regulations

1999. These regulations take into account Annex III of the EIA Directive, and apply to fish farms in sensitive areas, those that hold a biomass of 1000 tonnes or more, or that cover an area in excess of 0.1 hectares surface area. These Regulations also apply if an existing site proposes to expand and in doing so exceed any of these thresholds. These Regulations do not cover the issue of shellfish and other non-fish aquaculture. These regulations are amended by:

- Environmental Impact Assessment (Scotland) Amendment Regulations SSI 2006 No. 614

These make minor amendments to the above in Part 4 which deals with marine fish farms, but makes no mention of shellfish.

- Conservation (Natural Habitats & c.) Regulations 1994 (as amended).

Known as the Habitats Regulations, these Regulations transpose the European Habitats and Birds Directives into UK law. They apply to the protection of Natura 2000 sites and the species listed in their respective Annexes and Schedules.

- Town and Country Planning Act 1990/ Town and Country Planning (Scotland) Act 1997

These Acts are relevant to the land-based aspects of aquaculture as planning permission is required for all development of onshore facilities. Therefore, the following EIA Regulations that implement these Acts are also relevant to the land-based development considerations:

- Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.
- Environmental Impact Assessment (Scotland) Regulations 1999.

#### 2.4.2 Scotland

- The Town and Country Planning (Marine Fish Farming) (Scotland) Order 2007

The purpose of the order is to set out the requirements for applications for planning permission under section 31A of the Town and Country Planning (Scotland) Act 1997. The statutory planning controls for marine fish farming cover marine waters out to the 12-nautical mile limit. Both finfish and shellfish farming are subject to the new planning controls that also extend to farms currently in existence.

In order to come to a view on whether to grant planning permission for an existing fish farm, Ministers are to set up a review/ audit process. The circumstances where such an application is required are where an authorisation was granted pursuant to an application made before 14 March 1999. The intention of this is to ensure that an application is required where the original authorisation was considered subject to the Environmental Impact Assessment (Salmon Farming in Marine Waters) Regulations 1988.

However, where the finfish farm was subject to consideration under the Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999, The Scottish Executive not be looking for an application to Ministers as their authorisations are to be audited. Shellfish farms will be treated in the same way as these finfish farms.

- Aquaculture and Fisheries Act (Scotland) 2007

This Bill encompasses both fish farms and shellfish farms. It deals with issues such as parasites, containment and escape, law enforcement and code of practice (including monitoring). It does not deal directly with the process of EIA and consents.

- The Environmental Impact Assessment (Scotland) Amendment Regulations 2006

These Regulations are set down as applying to 'Marine Fish Farms'. They amend the Environment Impact Assessment (Fish Farming in Marine Waters) Regulations 1999 so far as they apply to Scotland. As such, they do not apply to shellfish farms or other non-fish aquaculture facilities. These Regulations also lay down general rules for ensuring public participation rights in the preparation or review of relevant plans and programmes as set out in the EIA Directive.

- The Surface Waters (Shellfish)(Scotland) Regulations 1997

This piece of legislation lays down the requirement for monitoring and regulation of shellfish waters in accordance with the Quality Required of Shellfish Waters Directive. As such, these regulations are directly relevant to the proposal of a shellfish aquaculture facility.

- Shetland Islands Council Works Licence Policy 2005

There is a difference in the policy framework in the Shetland Islands. Under the Zetland County Council Act 1974, the Shetland Islands Council has a duty to promote the conservancy of, and control of development in, the coastal area of Shetland, with the exception of those areas under the jurisdiction of Lerwick Port Authority or Broonies Taing Pier Trust. In general terms, it applied to the placing of works in the sea, on the seabed, or on the foreshore below the Mean High Water Springs (MHWS) mark. Therefore, any aquaculture facilities planned for the inter-tidal and sub-tidal areas (excepting areas of exemption) will fall under this legislation.

## 2.5 Guidance and Process

### 2.5.1 Guidance

There are numerous sources of guidance available for aquaculture activities, such as web site, guidance documents, and help lines. A selection of these sources is provided below:

- Policy Guidance Note: Location Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters.
- The NetRegs web site ([www.netregs.gov.uk](http://www.netregs.gov.uk)).
- Defra forms and guidance web page (<http://www.defra.gov.uk/corporate/regulat/forms/fish/index.htm>).

### 2.5.2 Process

The Scottish Executive Procedure Guidance Note of 2000: 'Interim Scheme for the Authorisation of Marine Fish Farms in Scottish Water' announced the non-statutory transfer of responsibilities for consent for aquaculture farms from CEC to the local authorities in Scotland. The document stood until the approval of the Town and Country

Planning (Marine Fish Farming) (Scotland) Order 2007 (see above). In addition to planning, the old seabed lease arrangement with CEC has also been replaced by the 2007 Order.

Adapted from Evans (2005), any aquaculture site (either fish or non-fish) requires:

- Discharge Consent from SEPA (or the EA in England and Wales) (See Environment Act 1995 above).
- Navigational Consent from the Scottish Executive Enterprise, Transport and Lifelong Learning Department, or the Marine and Fisheries Agency (MFA), as required by the Coastal Protection Act 1949 Section 34. This is usually following the grant of the works licence or seabed lease (SEPA webpage).

It is at the consent and licenses stage that an Environmental Statement would be submitted to the Relevant Authorities under the EIA (Fish Farm) Regulations 1999, though this is currently only for marine fin-fish farms.

The First Minister for Scotland has overall responsibility for coordinating the regulation of the marine fish farm industry, and to ensure that the relevant European Legislation is transferred into the Law of Scotland (Henderson and Davis, 2000).

In SEPA's review of the regulations governing aquaculture in Scotland (2001), it states that it is aware that under certain circumstances shellfish culture can result in the accumulation of enriched sediment and shell debris below structure, but that the activity essentially involves the provision of a substrate for the shellfish to settle and grow naturally. It does not involve feeding with an artificial diet or the use of therapeutic chemical treatments. SEPA has not sought applications for discharge consents under the present regulatory regime, but it has pointed out that future changes may have implications for the shellfish sector in aquaculture.

In the Shetland Islands Council and Orkney Islands Council harbour areas, works and installations on the seabed require a Works Licence from the relevant local authority. Providing a Works Licence is granted, The Crown Estate will generally issue a lease for the same area and equipment approved by the Works Licence (Crown Estates webpage, 2007).

In England and Wales, shellfish aquaculture farms also need to register with the Fish Health Inspectorate of the Centre for Environment, Fisheries and Aquaculture Science (CEFAS). In Scotland, Fisheries Research Services (FRS) an Executive Agency of the Scottish Executive Environment and Rural Affairs Department (SEERAD) maintains a register of fish and shellfish farms.

Once the licences are granted then SEPA, the EA, and the other Regulatory Bodies monitor the fish and shellfish farms to ensure compliance with the licences granted (SEPA website, 2007). Other issues monitored include the health of the fish and shellfish, for example, by the Fish Health Inspectorate staff from FRS who carry out statutory fish and shellfish farm inspection and sampling programmes and implement the aquaculture health regulations (SEPA website, 2007).

## 2.6 Proposed Legislation and Guidelines

EIA regulations for shellfish and non-fish aquaculture are not implemented in the UK, and such farms are also not included in the FRS water categories (although SEPA water quality categories apply) (SARF, 2005). Though such considerations have recently come to light, there is little best practice guidance available for the implementation of such an assessment. As the growth of this industry continues to increase in both density and scale, it has been suggested as appropriate to consider such farms in the same manner as that of finfish farms (SARF, 2005), and such short-falls in the environmental regulation should therefore be addressed.

DEFRA is currently circulating a consultation document for the Marine Works (EIA) Regulations 2007. The proposed regulations will transpose the Environmental Impact Assessment Directive, as last amended by the Public Participation Directive, to provide a statutory framework for carrying out EIAs where required, and for public participation as part of the assessment of the environmental impact on the marine environment. The works that will be covered under these regulations are the same works already covered under the existing legislation. For example, aquaculture is listed as an Annex II project in the EIA Directive (discretionary determination by Member States as to the thresholds to determine the need for EIA). These regulations will transpose the EIA Directive so the requirement for EIA will be considered in a statutory framework.

ICES published their draft recommendations for the information that should be included in an Environmental Statement for shellfish farming in their Working Group on Environmental Interactions of Mariculture report of 2002. The suggestion of information to be used in such an assessment included:

- Location and dimensions of proposed farm.
- Description of project.
- Site characteristics.
- Production process.
- Potential impacts.
- Mitigation measures.
- Monitoring.
- Difficulties in completion.
- Consultation.

Legislation for the regulation and monitoring of shellfish and non-shellfish aquaculture has already been developed by other countries to manage the environmental implications of such farms. Such countries include Canada and Norway (Environment Canada, 2001; Directorate for Nature Management, 1999).

There are also the implications of new and future European policies that can be applied to the aquaculture section. One of the key recommendations in the paper by Read *et al.* (2001) is the utilization of the WFD, the Integrated Coastal Zone Management (ICZM) Demonstration Programme and other EU and national initiatives by the EU and national fisheries authorities for the improvement of policy, investment of policy, investment and

environmental management as such that sustainable aquaculture can be further developed within a comprehensive and integrated planning framework.

Comments received from anonymous referees have revealed that plans have been discussed to set up area based 'inshore fisheries groups' in Scotland that may manage the exploitation (dredging) of wild juvenile seafish (including mussel seed), to be re-laid onto seabed cultivation sites. The European Water Framework Directive has been described as the most substantial piece of environmental legislation produced by the European Commission. It requires that all naturally occurring Scottish inland and coastal waters to three nautical miles will achieve 'good environmental status' by 2015. Heavily modified and artificial water bodies must achieve 'good environmental potential' by 2015. The Water Framework Directive is likely to have some influence on the environmental management of aquaculture in Scotland and elsewhere.

### 3 AQUACULTURE AND PLANNING

A previous SARF project investigated the planning process for aquaculture sites and identified the typical reasons for refusals. This included all aquaculture applications (i.e. finfish, shellfish and undefined). This project was titled SARF05 'Site Optimisation for Aquaculture Operations' (2005). The findings of this report relating to this topic have been summarised in this section. It should be noted that the majority of information collected relates either directly or indirectly to finfish aquaculture, and is therefore not always applicable to shellfish and non-fish aquaculture, though does provide a good overview of the scope of issues in this industry.

#### 3.1 Planning submissions for fish farms in Scotland: SARF05

Between 1985 and 2004 approximately 50% of planning applications for aquaculture sites (keeps, shellfish, salmon, undefined) in Scotland were rejected. In most cases more than one reason was cited for rejection. Disruption of navigation and/or anchorages is the most commonly cited reason for rejection (56%), followed by impacts on landscape/amenity (34%), impacts on fishing interests (31%), proximity to other farms (30%), and wildlife conservation (21%). Issues of pollution do not figure significantly, as they are adequately dealt with through the EIA and discharge consent process (EIA undertaken for finfish only).

##### 3.1.1 Navigation and anchorages

Despite the importance of navigation and anchorages there is relatively little strategic guidance available. For purely physical-environmental reasons farmers will often select sites which are also important anchorages and navigation channels. Different users are competing for a scarce resource, and it is understandable that existing users are often afforded priority.

##### 3.1.2 Landscape

Since the introduction of the interim measures in December 1998, landscape has become more frequently cited as a reason for rejection of planning applications. Three factors tend to make the physical development of marine fish farms contentious. The first is the close correspondence between the best fish farm development sites and those landscapes deemed to be of national or regional importance. The second is the introduction of development for the first time to areas that previously were almost totally undeveloped. The third is the industrial character of some fish farm installations, which may intrude on surrounding areas. Local authorities need to develop clear policy and strategy relating to aquaculture and landscape: an issue which undoubtedly has substantial subjective dimensions, is open to controversy, and where priorities will differ substantially in different locations.

##### 3.1.3 Proximity to other farms

Guidance on siting in relation to other farms includes a "rule of thumb" that sites should be at least 18km from an important river mouth, to site well away from the head of sea lochs (where sea lice tend to accumulate) and to site farms in separate lochs or hydrographic systems.

#### 3.1.4 Socio-economics

When evaluating applications for development consents for new farms or lease renewals Local Authorities also look at local social and economic implications, but the process is not transparent and there is not always consistency of approach or policy between the Scottish Local Authorities.

### 3.2 Previous findings of SARF05

While some guidance is available on the siting of proposed aquaculture facilities in relation to the issues mentioned in **Section 3.1** above, SARF05 concluded either:

- a) This is inadequate to ensure that conflicts of interest do not arise (this is the case with respect to wild fishery interests for example) or;
- b) Guidance is adequate but there are a limited number of suitable sites available, and many of these are likely to infringe these other interests (e.g. landscape and navigation interests).

SARF05 recommended better guidance, including agreed criteria, on the siting of aquaculture farms in relation to the issues identified in **Section 3.1** is required to clarify and simplify the site selection, assessment and approval process and enhance the likelihood that any application for a site is well informed and likely to be approved. They stated that this will minimise costs and risk to farmers and create a positive environment for sustainable development.

It should be noted that this investigation included both finfish and shellfish/non-fish planning applications, and that the results above include a number of issues that are more relevant to one type of aquaculture than the other. This means that these results are not directly transferable to this project in terms of 'ranking' key issues for shellfish and non-fish farms, however, they do provide a good overview of the important issues in terms of the industry as a whole when considering the planning process.

## 4 SHELLFISH AND NON-FISH AQUACULTURE

Shellfish and non-fish aquaculture covers the culture of a number of species, and a number of different culture techniques. When considering Scotland, England and Wales, the main commercial species are the bivalve molluscs:

- Mussels.
- Pacific and Native Oysters.
- Queens and Scallops.

However, other species are also cultured around the globe, and could also be cultured in UK waters. Therefore such species also fall under the remit of this investigation. These species include macro-algae (seaweeds), sea urchins and other echinoderms, crustaceans (e.g. crabs and lobsters), polychaete annelids (e.g. ragworm and lugworm), and gastropod molluscs (e.g. whelks and abalone) amongst others. However, the majority of the information that exists in relation to the UK and Europe covers the main bivalve mollusc species listed above, thus forming the main focus of this review.

Many studies have shown shellfish farming to have little adverse effect on the environment (Crawford, 2003), while others have shown such farming techniques to also have greater adverse effects (Giles *et al.*, 2006, Cristensen *et al.*, 2003). However, such studies are dependant on the site characteristics, farming techniques, species cultured, biomass, and culture densities, and therefore such statements are highly site specific. Concern for the potential impact of the establishment of non-native farmed species in natural environment outside those managed for shellfish production through aquaculture has increased following recent reports of Pacific oyster reefs becoming established outside farmed sites, especially in England and Wales.

The most ecologically efficient forms of aquaculture are those operations culturing plants and lower trophic level animals, such as bivalve molluscs (Gibbs, 2004). Of all the cultures species, bivalve molluscs are the most efficient in terms of their ability to convert consumed food (phytoplankton) into body tissues (Kaiser, 2001). Furthermore, cultivated bivalves are filter feeders that require no additional input of feed (Kaiser, 2001).

The Scottish Executive in 2003 stated that environmentally sensitive farming such as shellfish should be encouraged. It was also stated that the expansion of the shellfish industry, including diversification of species (both molluscan and crustacean) is to be encouraged in Scotland, with support as appropriate from the relevant planning authorities and development agencies.

In 2006, shellfish farming amounted to approximately 3.2% of Scotland's total aquaculture production. Shellfish production has remained relatively small by comparison to finfish production, producing 4,594 tonnes comprising 4,219 tonnes of mussels; 40 tonnes of scallops; 60 tonnes of queens; 24 tonnes of native oyster; and 251 tonnes of Pacific oyster in 2006 (FRS, 2007). In 1997, the shellfish farming sector accounted for 1,100 tonnes of oysters and 13,000 tonnes of mussels at a market value of £8.5 million (IntraFish website, 2007). The total value at first sale for all species was estimated to be in the region of £5.4 million in 2006 (FRS, 2007).

The Assistant Director of the Shellfish Association of Great Britain was recorded as stating that the UK does not receive EU Grants and does not have a state development body such as that in Ireland for example (Irish Bord Iascaigh Mhara (BIM)) to develop the farmed shellfish sector. He also stated that there has been no central or coherent policy for shellfish and that the industry is largely under-funded (IntraFish, 2007).

In 2006, the results recorded from the returns of an annual questionnaire sent to all registered Scottish Shellfish companies showed there were 156 shellfish sites producing shellfish out of a total of 327 active farm sites in Scotland (FRS, 2007).

In Scotland in 1997, approximately 2.8 million oysters, 1.4 million scallops and queens, and 1,307 tonnes of mussels were produced for the table (FRS, 2007). By 2006, these figures had increased to 3.4 million, 1.8 million, and 4,219 tonnes respectively; however, these figures remain as a small proportion when compared to the overall European production levels. Production levels can vary greatly from year to year as a result of changing market trends, and on the increasing restrictions on sales due to environmental effects on product quality e.g. the accumulation of high levels of algal toxins in tissues caused by harmful algal blooms (HABs).

#### 4.1 The Aquaculture of Molluscs

The label 'shellfish and non-fish aquaculture' covers a variety of farming methods. A number of different farming techniques are used for the culture of bivalve mollusc alone, and each method has the potential for different environmental effects. The rest of this section provides details of the different aquaculture methods employed for the culture of shellfish and non-fish species.

Bivalve molluscs are the main species farmed in the UK. Nearly all cultivated molluscan species are bivalve molluscs; gastropod molluscs only accounted for 4% of the world aquaculture in 1991 (Kaiser, 2001). Bivalve mariculture is mainly restricted to coastal areas within several kilometres of the shoreline (Kaiser, 2001). Commercial cultivation of bivalve occurs in 3 stages (Kaiser, 2001);

##### 4.1.1 Seed collection

The seed may be collected by sub-tidal dredging, where the adults (with the exception of mussels) are collected to provide spat for the aquaculture farms. Such techniques may cause environmental damage through disturbance and over-exploitation of the stock. In the UK, licences are issued for the collection of 'seed' mussel once a year when the layer of 'mussel mud' (accumulated faeces, pseudo-faeces and shell debris under the mussel bed) has built up (Kaiser, 2001).

Seed are also collected through inter-tidal collection by hand, and spat collectors (frayed ropes of loose netting in a bag) or clutch (shell material that encourage the settlement of spat).

Seed can also be provided by hatcheries. Such hatcheries also have environmental effects, such as the use of antibiotics to some extent, and the subsequent released in their discharge effluents. As such hatcheries also class as non-fish aquaculture, and also fall within the remit of this report. However, in 2001 there were only two hatcheries supplying the whole UK (Kaiser, 2001).

#### 4.1.2 On-growing

The on-growing stage in bivalve cultivation occurs in the natural environment, making use of natural resources. Mussels can be grown on weighted rope suspended from either buoyed line (long lines) or from rafts (SEERAD, 2003). The blue mussel (*Mytilus edulis*) is the main product of shellfish mariculture in the Northeast Atlantic and Baltic Sea, with approximately one third of the harvest cultured using suspended longlines within sheltered marine areas (Roycroft *et al*, 2004).

Oysters can be grown in trestles in the inter-tidal zone, in stacks of trays below the low water mark, or in net bags suspended from rafts (SEERAD, 2003). Scallops are grown in nets hung from rafts and lines, or suspended on ropes through a hole in their shell; a practice known as ear-hanging). They can also be grown on the seabed (SEERAD, 2003).

#### 4.1.3 Harvesting

Sub-tidally grown bivalve cultures are usually harvested with a towed dredger or suction pumps. The harvesting of trestles and suspended bivalves has little or no effect on the surroundings as it does not directly interfere with the environment (Kaiser, 2001).

### 4.2 The Aquaculture of Crustaceans

The aquaculture of commercially popular crustaceans typically occurs in warmer waters, and so such farming techniques are not readily applicable to the European climate and conditions. Crustaceans are a highly commercially valuable resource, and their value per unit weight exceeds that of both finfish and molluscan species. Consequently, there are great financial incentives to invest in crustacean aquaculture systems (Kaiser, 2001). As such, the commercial aquaculture of crustaceans is a potential industry for growth in the UK.

The main farmed species are penaeid shrimps (89% of freshwater and marine farmed species globally by weight in 2001) and are mainly farmed in ponds in the tropics (Kaiser, 2001). As such they are not considered further in this review; except to add that the environmental impact of aquaculture in reclaimed areas (e.g. cleared mangrove in coastal margins) has been significant and well publicised.

Though crustaceans may be farmed in Europe, little information is available on such techniques or current successful farms. Therefore, crustacea not mentioned further in this review, though such species (e.g. crabs and lobsters) remain on the list of potential species for future commercial development, and should be considered in any future development of policy or environmental legislation.

### 4.3 The Aquaculture of Algae and Seaweeds

Globally, Europe only accounts for 4.3% of the total production of all seaweed species (National University of Ireland website, 2007). China is the main global producer of seaweeds having accounted for 78% of the total global production by weight in 2002 (Fish online webpage, 2007). In general, farming techniques of macroalgae are more developed in China, Japan and south east Asia.

The techniques used for algal aquaculture vary depending on the demand. If demand is low and natural resources adequate, cultivation is unnecessary. If demand is greater than the natural supply, then the production can be increased by resource management techniques such as improving harvesting techniques, removing competing species, adding artificial habitats and seeding cleared areas (National University of Ireland website, 2007).

The next level of algal aquaculture is the use of artificial structures for higher yields; for example, fragments of adult plants, juvenile plants, sporelings or spores are seeded onto ropes or other substrata, and the plants grown to maturity in the sea (National University of Ireland website, 2007). Seaweeds can also be grown in land-based aquaculture farms in artificial impoundments.

Seaweeds are among those species being trialled for polyculture (also known as integrated aquaculture); where two or more species are cultured together. The seaweeds are being trialled along with finfish to see if the seaweeds are able to reduce the nutrient inputs into the water resulting from the finfish farming techniques. Trials for polyculture of mussel and finfish are also being undertaken (locations undisclosed) to determine any positive effects on the water quality as a result (Fish online webpage, 2007).

#### 4.4 The Aquaculture of Other Species

Other species for consideration within the topic of non-fish aquaculture in UK waters include echinoderms, such as sea urchins, and polychaete annelids, such as lug worms (*Arenicola spp*) and rag worms (*Nereis spp*).

Sea urchins are one of the newer species utilised in aquaculture, and farming techniques are fairly new. They are also a species that are being studied with regard to potential polyculture initiatives as it is thought that these grazes will maintain the seabed adjacent to fish cages (Fish online webpage, 2007).

Polychaete annelids are also a fairly new cultured species. Such species are cultured for use as angling and fishing bait, but also as a source of food for farmed fish. Use of such cultured polychaetes in fish pellets also holds the potential to help alleviate the pressures on wild food sources, and help combat the 'fishing down the food web' problems as currently experienced. As such, this is an area which may be developed further in the future.

Currently, the main shellfish and non-fish aquaculture in the UK and Scotland are bivalve molluscs. As a result, the majority of studies, information, and general descriptions of best practice relate to this sector. This report includes all shellfish and non-fish species that were present in the aquaculture literature encompassed in the review and, therefore the bias towards bivalve mollusc aquaculture is reflected in its content. However, this bias is also discussed in the conclusions and recommendations in **Section 8**.

## 5 SITE SELECTION

Site selection is one of the main criteria used when looking at an application for a marine fin-fish aquaculture farm. Location guidelines for fish farms are available from FRS. These guidelines designate areas into 3 categories depending on their estimated environmental sensitivity, and could also be used in assessing areas for shellfish and non-fish aquaculture when considered with a number of other factors. The Strategic Framework for Scottish Aquaculture (Scottish Executive, 2003) stresses a number of considerations that should be taken into account when considering an appropriate site for a finfish or shellfish farm. Such considerations as regard shellfish and other non-fish farms are presented below.

### 5.1 Hydrography

The hydrography of a site is one of the main factors for consideration of the location of an aquaculture facility. The currents, transport, depth and characteristics of a site all contribute to its suitability.

Depth is an important consideration. Deeper water under a farm may lead to less scouring, less waste accumulation, and generally more stable conditions (temperature, salinity, etc.). However, there is a trade off as greater depth also presents greater constructional and operational challenges for the farm structures; e.g. the greater costs that would be associated with deeper anchorage of longlines.

Excepting other variables such as dissolved oxygen and nutrition, higher water temperatures are generally acknowledged to contribute to higher growth rates. This would appear to be especially true for shellfish. However, large temperature fluctuations as seen seasonally in coastal waters can also cause adverse effects. Sheltered, shallow situations, where water temperatures may become elevated during the summer months, can be particularly attractive locations for shellfish cultivation, but such sites often have poor tidal flushing and may be prone to low oxygen levels, low salinity, low natural food levels and poor dispersion of waste (Scottish Executive, 1999).

Strong currents through a site can disperse the waste materials, and bring in new oxygenated waters and fresh supplies of planktonic food (Scottish Executive, 1999, SARF, 2005). However, greater cost is associated to the structures needed to withstand strong currents, and it may be technically unfeasible to situate farms in areas where the currents are particularly strong. There are also the consequences of effects upon the stock if located in a particularly exposed environment.

### 5.2 Water Quality

Shellfish farming is thought to cause considerably less environmental impact when compared to salmon farming. This is often attributed to the general principle that shellfish are grown in the natural environment without the need for therapeutic chemical or supplementary food (Kaiser, 2001). However, mussels are known to produce significant dissolved metabolic products such as ammonia. They also have a high oxygen demand and can reduce the dissolved oxygen content of the water (SARF, 2005).

As bivalves are filter feeders, they are not considered to be net contributors to nutrients in the water column, rather, they remove nutrients by way of their feeding process (WWF, 2001b). It has been suggested that for each tonne of mussels produced, approximately 0.5kg of phosphorus, 6.6kg of nitrogen and 32.5kg of carbon are removed from the water column (WWF, 2001b).

Unpolluted and well-oxygenated water is essential for the culture of marine species. Salmonids and shellfish farms require to be carefully sited to minimise the risk of stock contamination (Scottish Executive, 1999). Cultivation sites located close to untreated sewage effluent may yield high growth rates, but the bivalves produced would be unlikely to be fit for human consumption as they will be loaded with pathogens from those effluents (Kaiser, 2001). The laws in place in the UK ensure the quality of the shellfish growing waters and the shellfish they produce. The waters and shellfish of cultured and wild populations are monitored accordingly.

### 5.3 Sedimentation

The main particulate wastes from shellfish farms are faecal matter, pseudo-faecal matter, and shell debris. No supplementary food is used in their culture. The eventual settlement of these particles depends of the bathymetry, water movement, and flocculation characteristics of the site.

It has been found that faecal matter has a high solubility potential (Tlustý *et al.*, 2000); however, the settlement of such organic waste has been recorded as causing organic enrichment beneath shellfish farms, and subsequently causing a shift in distribution of the benthic and epi-benthic communities. The farming of mussels has been stated as being constrained by high rates of sedimentation (Holmer *et al.*, 2001) and that enhanced pools of organic matter have been found in the sediments surrounding the farms. Negative trends have been recorded through the biogeochemical analysis of these sediments, and the benthic macrofauna have been recorded as being often impoverished (Holmer *et al.*, 2001).

Giles *et al.*, (2006) investigated the sedimentation from mussel cultures at a farm in New Zealand. They found that sedimentation under the farm was increased by  $106\text{g m}^{-2}\text{ d}^{-1}$  compared to that of the reference site. They also found that sediments under the farm had elevated organic carbon, nitrogen, chlorophyll *a* and phaeo-pigment concentrations which indicated additional organic input due to bivalve biodeposition. However, the oxygen consumption was only found to be higher under the farm in the summer where ammonia release rates were only ever less than that of the reference site in the summer. Nitrate fluxes were continuously and significantly higher at the farm site for all seasons.

Oxygen and nutrient fluxes generally demonstrated the typical response to increased organic input due to sedimentation from mussel culture, though the unusually low nitrogen release rates in summer may indicate enhanced denitrification under the farm. They concluded that this study demonstrates the importance of benthic nutrient regeneration in this region, and that mussel culture can lead to a redistribution of nutrients. The farm studied was small and located in a high energy environment. Therefore, impacts from larger farms or in areas where biodeposit dispersal is limited are likely to be even more significant and they suggest that site-specific hydrodynamic and biogeochemical conditions need to be taken into account when planning new

mussel farms to prevent excessive modifications of nutrient dynamics due to sedimentation.

In addition to bathymetry, flow and the structure of the water column, depth will modify the extent to which by-products (especially from bivalve farms) will spread, and therefore also modify the area to which it could be expected to find an impact from the culture (ICES, 2002). The comparatively limited levels of local wastes from shellfish production (compared to fish farms) can be attributed to the fact that in shellfish aquaculture, a significant proportion of solid waste is intercepted and consumed by animals on the farm. As a result, the sedimentation reported is usually considerably less than that for finfish farms (WWF, 2001b).

The material of the seabed beneath shellfish farms should also be a consideration when assessing the suitability of the site as sedimentation onto previously rocky sediment will change the bed type, and therefore change the associated biological communities. The impacts of waste from shellfish farming at different sites has rarely been considered, which clearly shows an anomaly in the difference in approach when compared to that of finfish farming, where a very high level of assessment and regulation is the standard (SARF, 2005).

#### 5.4 Benthic Communities

It has been stated that a number of studies have shown the sedimentation of faeces and pseudo-faeces beneath mussel farms has led to organic enrichment of the sea bed and thus altered macrofaunal communities (ICES, 2001).

The effects of increased sedimentation on the macrobenthic community were studied by Chamberlain *et al.*, (2001). This study focused around the sedimentation, physical structure, and biogeochemistry of the surface sediment around two farms in southwest Ireland. The characteristics of the currents in the area were also considered. Both farms were of a reasonably large size, and also located in low energy environments and operational for over 8 years. At one site, the benthic community was subjected to bulk sedimentation and organic enrichment; reduced macrobenthic infaunal diversity and elevated levels of organic carbon were recorded close to the farm. In general, effects were restricted to a radius of 40m around the farm. However, at the second site there were no observed effects of mussel biodeposits on the benthos, and a diverse macrobenthic community was present. This study concluded that variations in the dispersion of biodeposits caused by local current patterns had a significant influence on the impacts observed, and that this could also account for the differences reported in other studies looking at sedimentation impacts due to shellfish farming.

Christensen *et al.*, (2003) also investigated the benthic implications of shellfish farming. Sediments beneath mussel long line farms in New Zealand were reduced sediments which contained low microphytobenthic biomass and few subsurface macroinvertebrate species. It was found that more oxygen was being consumed due to the increase in organic sediment, but also that ammonium fluxes were 14 times higher under the lines when compared to unaffected sediment 250m away. Denitrification rates were also low under the farm as the coupled nitrification-denitrification process was inhibited by the presence of sulphide in the form of H<sub>2</sub>S. It was concluded that the described local condition associated with mussel farming should be taken into account when new areas are considered for development.

A study carried out by Crawford *et al.*, (2003) investigated the effects of shellfish farms on the benthos in Tasmania, Australia. Distances of 100m upstream to 100m downstream were considered for three farms, each having been well established in the area with a relatively high shellfish production. It was found that there were significant differences between the farms, but not between the sites outside or at the farm boundaries, and sites within the farm. This applied when considering sediment deposition, redox values, sediment sulphide concentrations, organic carbon content and water turbidity levels near the sea bed.

The farms themselves had clear differences when directly compared; one had a dense coverage of fine filamentous algae and patchy bacterial mats directly under some longlines, while another had dense beds of seagrass both under trays of oysters and outside the farm. The benthic infauna did not show clear signs of organic enrichment, and neither univariate nor multivariate measures of benthic infauna were significantly different between sites either inside or outside the farm; however, there was a difference between farms. The study concluded that shellfish farming is having little impact on the benthic environment in Tasmania, and certainly less than that of salmon farming; therefore, extensive monitoring of shellfish farms would appear to be not necessary.

The benthic effects of sedimentation related to mussel culture were also investigated by Stenton-Dozey *et al* (2001). They stated that organic enrichment and anoxia had been recorded for sediments located under rafts of cultured mussels in a South African bay. They found that high Carbon: Nitrogen (C:N ) ratios were a result of the accumulation of refractory particulate organic matter (POM) derived mainly from the faeces, decaying mussels and other marine foulers. POM was highest under the rafts, and ammonia levels were the highest and most variable under the rafts. They could not conclusively state the trends in Nitrogen: Phosphate (N:P) ratios, or identify the oxygen uptake from the raft and control sediment samples. They also stated that macrofauna and organic debris were the main oxygen consumers under the rafts, rather than the macrofauna in the unaffected areas. They also recorded that the macrofauna biomass was reduced below the rafts, and that the trophic groups (and taxa) had changed.

The studies highlighted show how variable the recorded impacts on the benthos can be, and highlight the importance of consideration of the characteristics of each individual when considering the potential impact on the benthos. Another aspect of such aquaculture practices is the physical damage and disturbance the farming methods can cause to the surrounding biological communities. For example, the damage caused by the trestles, lines, rafts and other structures when being constructed and dismantled, but also during their operation due to the physical habitat space removed by their presence, and also the hydrodynamic effects that they may cause (e.g. scour).

## 5.5 Wildlife and Protected Species

The Common Fisheries Policy was updated in 1992 to have greater regard to biodiversity (Smythe, 2002). The European Action Plan on Fisheries also identifies measures to preserve/ rehabilitate biodiversity where it is under threat from fisheries. This includes the prevention of aquaculture from having impacts on surrounding ecosystems (Smythe, 2002). However, biodiversity is yet to be central to aquaculture policy in Scotland (Smythe, 2002), though it is a consideration when licensing discharge

consents, or assessment under the Fish Farm EIA Regulations. Neither of these apply currently to shellfish and non-fish aquaculture farms.

If bivalves are cultured at a high enough density, there may be implications for the planktonic larvae of other species which may become ingested by the cultured bivalves themselves, or entrained in the organic debris (mainly pseudo-faeces) released by the cultures (Baldwin *et al.*, 1995, cited by Kaiser, 2001).

The presence of aquaculture farms may actually be beneficial to some natural wildlife. It has been reported that long-lines used in mussel culture may be beneficial to the avian community; for example, through the potential use of suspension buoys as perches; the availability of epifauna and young mussels as a food source; and the use of other aquaculture infrastructure as shelter (Roycraft *et al.*, 2004).

Many species of birds interact with aquaculture sites in the UK. The main predators of bivalve cultures are diving ducks and predation by eider ducks (*Somateria mollissima*) on mussel farms is well documented. This can be a key factor in the site selection process for a mussel farm. In the UK, all wild birds, their nests and their eggs carry legal protection, and so the exploitation of stock and resources by birds needs to be handled in a sensitive way by aquaculture operatives. Such predation has been the focus of many investigations, including that of Ross *et al.*, (2001) where the use of recordings of engine noise were tested for their ability to deter birds. They were able to show that reductions of 50-80% in the numbers of eider ducks could be achieved using this method. They also determined that the long term habituation of the eider duck to this noise was negligible so long as the response was occasionally reinforced by boat chasing.

There are many methods used for the exclusion of diving ducks on bivalve aquaculture sites. Such methods include; nets, strings, gas guns and scarecrows (SARF, 2005). If such methods fail, and predatory birds can be proved to be causing major stock damage, a SEERAD license to destroy the birds may be granted in certain cases; however, this does not apply to a number of protected species (SARF, 2005) such as those listed under Schedule 1 of the Wildlife and Countryside Act (1981) as amended, or Annex 1 of the of the EC Birds Directive.

As well as the avian predators, a number of other predators also feed on cultivated shellfish. Otters (*Lutra lutra*) are both Annex IV and Annex II (EC Habitats Directive) species, and the UK government is required to establish SAC areas for their conservation (Nimmo, 2004). It is estimated that some 90% of the UK otter population is located in Scotland, with a significant proportion of this number being found in coastal areas to the north and west of the country (Nimmo, 2004). There is potential overlap with Scottish aquaculture facilities that are similarly distributed and there are reports of some conflict between marine aquaculture facilities and otters; although this is not thought to be in breach of their legal protection and the distribution of otters is therefore not fundamental when considering locations for new aquaculture sites (Nimmo, 2004).

Among the protected species of sea mammals, common seals (*Phoca vitulina*) have also featured in appropriate assessments for shellfish proposals in the vicinity of European Marine Sites in Scotland (e.g. the Sanday SAC, Orkney). Shellfish farming has the potential to cause disturbance, injury or mortality to seals through entanglement in anti-predator nets. Use of Acoustic Deterrence Devices (ADDs) or other predator

control methods (e.g. sonic canon and boat chasing) to prevent grazing by eiders also has the potential to cause disturbance to seals. Boat activity associated with shellfish farming also has the potential to cause disturbance to seals, particularly during breeding and pupping and moulting seasons.

Shellfish aquaculture also has the potential to cause deterioration of the qualifying habitats and communities through physical damage (e.g. installation of mooring blocks and continued scouring by riser chains) and changes in community structure caused by smothering from pseudo-faeces (undigested waste products) and debris (including dead shells) falling from the farm. There is also potential for accidental introduction of new non-native species and increasing the spread within the UK of existing non-native plants and animals (e.g. *Sargassum muticum* (Wireweed)), through importation or translocation of shellfish stocks. Invasive species have the potential to cause deterioration of the qualifying interests by altering community structure and quality (SNH, 2006).

Other potential species that may use the shellfish culture beds as a food source include species of fish such as wrasse spp. (Labridae) and wolf fish (*Anarhicas lupus*). Some gastropods such as the dogwhelk (*Nucella lapillus*), and the necklace shells e.g. *Polinices pulchellus* and *Euspira catena*. and echinoderms e.g. *Asterias rubens*, the common starfish.

The disturbance caused by farming methods, such as collection of the cultures during harvest, could have impacts with regard to disturbance on the surrounding bird populations. This impact would need to be considered separately for individual farms, taking into account the avian species present at the times of the disturbance (for example, during nesting periods).

Location selection in relation to aquaculture facilities should also take into account the proximity of any Biological Action Plan (BAP) species recorded in the area. The UK Biodiversity Action Plan is the UK Government's response to the 1992 Convention on Biological Diversity. UK BAP covers the conservation of the UK biological resource (UK BAP website, 2007). An example of a BAP species includes the tall sea pen (*Funiculina quadrangularis*) which is found in Scottish sea lochs, and in deeper water offshore waters (BAP website, 2007). The native oyster (*Ostrea edulis*) that forms a significant proportion of shellfish production in the UK is also a BAP species. Native oyster fisheries are subject primarily to UK shell fisheries conservation legislation, though the species is not named in any national or international nature conservation legislation or conventions (BAP website, 2007).

## 5.6 Proximity to Protected Areas

If it is deemed that a plan or project is likely to have an affect on a European site; e.g. SAC, SPA, the plan or project will be subject to an Appropriate Assessment as required under regulation 48 of the Habitats Regulations. This also includes any plan or project that is not situated within a European site, but is deemed likely to have an influence upon a European site.

In 2001, the UK had at least 67 candidate or possible marine SACs, and more than 100 SPAs in inter-tidal areas (WWF, 2001a). The majority of these have now been adopted by the EU as fully designated. In addition to these European designations, there should also be consideration of the Scottish statutory designation of 'Marine Natural Heritage

sites', however, such sites do not cover a significant proportion of the Scottish marine environment. It should also be noted that the absence of statutory designations in any area in Scotland or the UK does not necessarily mean that the marine biology of the receiving waters is not of high quality (Nimmo, 2003).

Proximity to BAP habitats should also be a consideration in the assessment of a proposed farm's location. Examples of BAP habitat include littoral and sublittoral chalk, mudflats, sublittoral sands and gravels, and *Sabellaria alveolata* reefs (UK BAP, 2007).

## 5.7 Escapes and Non-Native Species

Escapes are not so much of a problem for shellfish and non-fish aquaculture when compared to finfish farming as the majority of seed stock for such activities is sourced from the wild populations. Therefore the impacts associated with the release of non-native species are not so significant. However, if non-native (or alien) species were being farmed, then the potential for escapes may become more significant concern.

With regard to new species, the main risks to fish health associated with the interaction between both shellfish and finfish farming are those arising from passive transmission from depuration plants and re-laying (Scottish Executive, 2004). Current regulations/best practice to prevent such interactions include risk assessment and shellfish growers should also be involved wherever Area Management Agreements are in prospect (Scottish Executive, 2003). Area Management Agreements were introduced to take into account cumulative impacts in a particular area due to salmon farming, and provide a mechanism for the cooperation of the farmers to achieve the best environmental outcomes.

The release of non-native species into Scottish waters is carefully regulated to prevent ecological damage and the introduction and spread of serious pests and diseases (Scottish Executive, 1994) and the problems associated with the establishment of pacific oyster beds outside aquaculture installations, especially in England and Wales has already been mentioned in this review (see; previous section). The introduction of exotic species into the wild requires a licence from SEERAD. Scottish Natural Heritage has powers to control the introduction of species under the Wildlife and Countryside Act 1981 (as amended), and so is consulted by SEERAD before any licence is granted (Scottish Executive, 1999).

The import of species for aquaculture also poses a potential problem. For example, mussel (*Mytilus edulis*) seed (i.e. juvenile mussels) grows naturally in many international waters, but the import of such seed from one location to another also poses the risk of transportation of non-native species and diseases within the seed stock. In addition, even though the introduction of non-breeding species such as the Pacific oyster (*Crassostrea gigas*) has been relatively benign (at least directly), there is a risk of introducing other associated alien species (WWF, 2004). It has been established that such transportation has already occurred through the transportation of bivalve mollusc seed (Kaiser, 2001). The culture of the Pacific oyster, for example, has resulted in the introduction of the invasive seaweed *Sargassum muticum* into many parts of Europe and America (WWF, 2004) and Pacific oyster is now been recorded in the UK. However, legislation now exists in Europe such as restrictions on movements of shellfish (Directive 95/70/EC) to prevent such transportation issues, though such potential

impacts should still be considered as a means of presenting a risk of other alien/invasive species being released into UK waters.

The culture of 'novel' species (i.e. species that haven't previously been cultured in the area before) also poses a possible threat to the biodiversity of the area. Such species may also be species that are currently present in the natural system, though they have previously not been cultivated there. Such concerns include the availability and sustainability of both brood stock for the cultures and the food that would be required from the natural system, the possibility of genetic intergradations between the wild and cultivated stocks, and reduced water quality due to the excretion and the respiration from the cultured organisms (SARF, 2006). The biodiversity implications of farming novel aquaculture species in Scotland was addressed by SARF in 2006, and a framework was established to assess the possible risk to biodiversity from the introduction of farming of a novel-species.

## 5.8 Proximity to other Farms

Unlike finfish farming, there is little or no risk of disease interactions between shellfish and non-fish aquaculture farms, or any chemical interactions between farms through discharge waste.

Salmon farmers in Scotland need to work together and cooperate if their farms are located within a Management Agreement Area (Nimmo, 2005). Shellfish farmers should also be included in this collaboration under best practice guidance (Scottish Executive, 2003). Salmon farms also need to consider 'environmental capacity' when looking at the chemical and feed discharges before it exerts any toxic effect on the receiving ecosystem (SEPA, 2003). This is currently not the case for shellfish, mainly because it is considered that as there are no feed of chemicals used in bivalve aquaculture, and so the impacts on the receiving ecosystems are negligible.

The possibility of the nutrient discharges from fish farms, namely salmon aquaculture, has been raised in relation the increases in the occurrence of harmful algal blooms (HABs). Cultured bivalves, and other cultured filter feeders, may feed on the organisms responsible for HABs, and subsequently carry the toxins to vertebrate consumers, therefore becoming a human health hazard (Homer *et al.*, 2001). Lack of long-term monitoring programmes over the last 30 years has made it difficult to judge whether the perceived increase in HABs is real, and whether it is indeed related to the expansion of the fish farm industry (Scottish Executive, 2002).

Different species that can form HABs have different toxic effects upon the shellfish. These include;

- Amnesic Shellfish Poison (ASP).
- Paralytic Shellfish Poison (PSP).
- Diarrhetic Shellfish Poison (DSP).

The presence of ASP in the flesh of cultured scallops has been the cause of major closes to the industry in Scotland (MacGavrrin, 2000). Though the increase in the cases of shellfish poisons being discovered appears to be on the increase, such records may be the result of wider monitoring or the spread of toxic strains amongst existing

populations (Scottish Executive, 2002), and so there is no evidence that the causative organism is becoming more abundant at new or traditional sites for PSP cases.

Increased cases of ASP may also be attributed to increased levels of toxin monitoring (Scottish Executive, 2002). The report concluded that the present level of fish farming is having a small effect on the amounts and the growth rates of the Scottish coastal phytoplankton, and that this small effect should not be a cause for concern except in a few heavily loaded sea lochs.

In Scotland, a monitoring programme for such algal toxins is undertaken on behalf of the Food Standards Agency by the Marine Laboratory, Aberdeen (FRS). If toxins exceed permitted levels, enforcement action and interventions can be introduced on the affected seawater, prohibiting the fishing or harvesting of shellfish by The Scottish Executive (SCIEH, 2000). Such measures include the closure of the shellfish waters.

With regard to shellfish farming; the proximity of installations and facilities to salmon farms needs to consider toxic algae, but the close association between the two cultures could also be beneficial in maintaining good water quality. It is likely that the cultivation of non-fish species can, to some extent, help reduce the nutrient inputs from other activities including fish culture i.e. polyculture (Scottish Executive, 2002). Polyculture is currently being trialled for its effectiveness and feasibility.

Indicative Separation Standards for both finfish farms and shellfish farms were presented by the Scottish Executive in 1999. **Table 5.1** below presents these guidelines.

**Table 5-1 Separation Standards (Scottish Executive, 1999)**

	Distance to:		Qualifications
	Finfish farms	Shell fish farms	
Finfish farms	8 km	3 km	Closer siting may be possible between small-scale farms, and in large loch systems or open water
Shell fish farms	3 km	1.5 km	as above
Public viewpoints, tourist centres and popular tourist routes	1.5 km	0.8 km	Screening by buildings, landform or woodlands may permit closer siting
Houses (other than those related to the development)	0.8 km	0.5 km	Attitudes of residents should be taken into account; closer siting may be acceptable in some areas.
Vulnerable wildlife	0.8 km	0.5 km	Assuming adequate anti-predator measures
Anchorage / approaches	0.5 km	0.5 km	Subject to the assessment of the DETR Marine Division.
Fishing grounds / netting stations	0.5 km	0.5 km	Assuming specific productive areas in frequent use

## 6 ENVIRONMENTAL AND ASSIMILATIVE CARRYING CAPACITY

Carrying capacity is often used as an overarching term that includes many facets. The Scottish Transport and the Environment Committee's Phase 1 report defines carrying capacity in terms of the carrying, environmental and assimilative capacity of the system.

The environmental carrying capacity of an area describes an inherent property of the environment to support a population level for an organism, given the ecological and physical characteristics present; e.g. quantity of food, habitat, water and other supporting mechanisms.

The assimilative capacity of the environment is often overlooked when considering shellfish and non-fish aquaculture. This capacity is the ability of the environment to assimilate the changes brought about by man's activities to the point where little or no adverse effects are experienced. If this point is exceeded, then the environment is no longer able to assimilate the changes, and adverse impacts will be experienced.

### 6.1 Environmental Carrying Capacity

#### 6.1.1 Biology and Ecology

When considering shellfish culture, the biological carrying capacity of the site relates mainly to the supply of planktonic organisms in the waters, and ensuring that the supply is great enough to support the level of biomass production planned for the farm without seriously depleting the resource (SAMS, 2002). The significance of shellfish farms consuming plankton which would otherwise support the natural communities is site-specific, and every farm needs to be considered both individually and in-combination with other aquaculture interests. Over-exploitation of this carrying capacity may result in poor growth rates and an inability to achieve marketable size (Scottish Executive, 2003).

Similarly, the aquaculture of macro-algae and other marine plants also requires natural supplies of nutrient from the water column, and also reduces the light levels experienced by the benthic communities. However, little research has been carried out to investigate the possible impacts of such effects on the wider environment (ICES, 2002).

There is also the possibility that the transport of the organic-rich by-products of shellfish (bivalve) culture could improve the coastal areas and enhance the fisheries production (Nimmo, 2005) as juvenile stages may benefit from consuming the harpacticoid copepods or annelids that are favoured by the organic conditions (ICES, 2002). Such possibilities could be considered in models representing the potential carrying capacity of an area.

Various models exist for predictions of growth of the various aquaculture species (McKindset *et al*, 2006) and, in particular, for the bivalve molluscs (Dowd, 1997, Campbell and Newell, 1998, Ferreira *et al.*, 2000, Newell *et al.*, 1998, McKindsey *et al.*, 2006). Such models take into account the weight, numbers in the culture, plankton biomass, other seston, and limiting nutrients. These models can be used in assessing the carrying capacity of a particular system. However, many models have their limitations and such weaknesses should be accounted for and balanced if a truly robust approach to shellfish and non-shellfish farming is to be developed. In France, aquaculture is regulated by a number of mechanisms, however the rules can be

adjusted to respond to common risks and the level of adjustment can be determined by estimates of holding and carrying capacities of the area for both fin and shellfish (Dosdat and Pomelie, 2000).

A study by Gibbs (2004) looked at the decisions of resource allocations in the coastal zone based on cost and benefit for all with the aim to develop a framework for understanding of the interactions between shellfisheries and commercial fisheries. Though this case study was carried out in New Zealand, it highlights the potential for interactions between the two parties in terms of the attraction and displacement of adult fish, recruitment reduction through the direct consumption of eggs and larvae by the cultured shellfish, and food web effects.

### 6.1.2 Disease

Disease is also a factor to consider when assessing carrying capacity. Infectious diseases of fish and shellfish that are in the host will remain healthy as long as the optimum environmental conditions are sustained as the culture organisms maintain their immune systems and defend against such pathogens, but if the environmental conditions deteriorate (such as experienced during overstocking), this allows for the prevalence of disease (Holmer *et al.*, 2001).

If outbreaks of diseases occur in a cultured species, there is also a risk of the pathogens spreading to the wider environment and infecting native species. This is particularly important in areas where the distribution and abundance of species, and the habitats that support them are legally protected; e.g. those identified under the European Habitat and Birds Directives, or those identified under national biodiversity and habitat action plans (BAP and HAP respectively). Increased competition for resources between cultured species and native species in the natural environment may lead to an increased susceptibility to pathogens (increased competition may also lead to negative effects on growth rates of cultured species also; hence affecting profitability). As such, carrying capacity of the area is important for both the profitability of the farm as well as the safeguarding of the natural ecosystem.

### 6.1.3 Potential for Polyculture

The potential for polyculture is an area that is the focus for much of the current research. It has been stated that such polyculture may be a means of reducing the impact on water quality from the more intensive farming techniques, such as salmon farming (ICES, 2002; Fishonline webpage, 2007).

The Scottish Executive (2003) has stated that polyculture techniques to intercept and recycle nutrients should be encouraged. Such potential for joint farming techniques will not only benefit the water quality, but may also increase the carrying capacity of an area by providing more resources for the cultures. A framework published by the Scottish Executive in 2004 identifies that a mix of shellfish units and farming integrated with finfish farming are options for the future that are currently being piloted. An EU project has also looked at the potential for polyculture techniques, and has developed a unique polyculture model for the cultivation of sea urchins alongside salmon cages, though the potential for the urchins to bioaccumulate the anti-seallice agent is being addressed. The juveniles are hatchery reared. 5 tonnes were produced in Ireland in 2001, and that figure was expected to double in 2002. Such technology is also available in Canada,

though it is based on the collection of wild juveniles and also faces market constraints (ICES, 2002).

Other investigations into the opportunities provided from polyculture include the study by Matos *et al.*, (2006) where the potential for integrated aquaculture of fish and red seaweeds was investigated in Northern Portugal. One of the main aims of this study was to investigate the potential of the economically valuable (both realised and potential) seaweeds as biofilters. It was found that the potential was there though the use would need to be balanced with the seaweeds economic value.

The Scottish Association for Marine Science (SAMS) is undertaking a project to assess the ability of commercially important seaweeds, cultivated in the immediate vicinity of caged fish, to reduce the impact of nutrient releases. This project includes investigation of the heavy metal content of the cultured seaweeds to ensure levels are well within those recommended by the Food Standards Agency and similar overseas agencies, for human consumption (Aquaculture Today website, 2007). If such a trial is successful, it will present the opportunities for farmers not only to reduce the environmental impacts of the caged fish farm, but to also produce a second income through the seaweed culture increasing the farms economic viability.

## 6.2 Assimilative Capacity

When assessing carrying capacity with regard to a shellfish farm, the focus of the capacity determination is on the availability of planktonic organisms to support the biomass of the culture, and the ability of the region to assimilate the waste by-products of the farm is rarely considered (SARF, 2005). In the SEPA 2001 review of the regulations governing aquaculture in Scotland, SEPA is aware that under certain circumstances, shellfish culture can result in the accumulation of enriched sediment and shell debris below structure, but that the activity essentially involves the provision of a substrate for the shellfish to settle and grow naturally. It does not involve feeding with an artificial diet or the use of chemical supplements. Therefore, SEPA has not sought applications for discharge consents under the present regulatory regime, but it does identify that future changes may have implications for the shellfish sector.

The cumulative effects of farms also need to be considered. The environmental impact experienced in an area is dependant on the total production in hydrographically distinct regions that may be cumulative from many farms (SARF, 2005). This should be borne in mind when considering any farm planning application.

The interaction between marine cultured mussels (*M. edulis*) and the ecosystem in Oosterschelde (an estuary in Zeeland, the Netherlands) was investigated before and after the construction of a major coastal engineering project by Smaal *et al.*, (2001). This engineering project caused changes to the hydrodynamics and water-quality in the area, causing a shift in the phytoplankton species distribution, though the total primary production remained the same. The carrying capacity of this ecosystem was evaluated, and after the implementation of the works, the correlation of the mussels' condition to the standing stock became positive, suggesting the previously fully exploited system had become overstocked although yields were maintained. This was explained by;

- Feedback through the large filtration and nitrogen regeneration capacity of the mussels leading to increased phytoplankton turn over.

- Adaptation of husbandry techniques and management to the new conditions.

It was concluded that the feedback by filter feeders and the farmers should be addressed when estimating the exploitation capacity of the receiving ecosystem.

The work of Grant and Bacher (2001) showed that the structure and placement of the aquaculture farm itself can have implications on the circulation and flow of the waters surrounding the structures. They stated that disregard for physical barriers associated with cultures can result in a serious over estimation of the carrying capacity, and that the characteristics of the cultures need to be investigated further to provide information on quantifying and modelling such effects.

Examples where farms have exceeded the assimilative capacity of the area in which they are situated have previously been recorded in Europe, notably for mussel and oyster farms. Where hydrological conditions couldn't support such high densities of cultures, the carrying capacity of the area was exceeded (Castle *et al.*, 1989, cited by Kaiser, 2001). This indicates that lessons should be taken from such case studies to improve the knowledge base in this area and feed into the regulatory mechanisms for such activities.

Recent studies have looked at the inertial components for shellfish cultivation. For example, a study by Carswell *et al.*, (2006) looked at the use of spatial analysis for the environmental assessment of shellfish aquaculture in Baynes Sound, British Columbia. Aerial photographs and GIS techniques were used to assess the seabed coverage of farms in the area. This method was found to be a cost effective method of assessing inter-tidal resource utilisation, however it should be noted that the success of such remote sensing techniques will need to be assessed when used in different geographical locations.

An investigation into the suitability of a qualitative risk assessment of shellfish farming on the environment was carried out by Crawford (2003). Environmental effects were assessed for farms in Tasmania using a risk management approach which used local information, stoking densities, the level of production and husbandry practices compared to other countries. Such an approach was found to be very applicable to the management of shellfish farms. Risks were also categorised during this study, and the risk of organic enrichment of the sea bed and also reduced food resources were found to be low, while the risk of disturbance was classed as being moderate in the lease area itself. The risks related to the spread of pathogens and pests were recorded as being high.

### 6.3 Environment Quality Standards

Environment Quality Standards (EQS) are standards for water bodies that ensure that concentrations of deleterious and potentially toxic chemicals remain well below the level at which adverse ecological effects are detectable (Scottish Executive, 1999).

Under the Shellfish Directive (EC Directive 91/492), which lays down stringent health conditions for the production and marketing of bivalve molluscs, shellfish harvesting areas have been classified according to the level of bacterial contamination present in samples of mollusc flesh (Scottish Executive, 1999).

Environmental Quality Objectives (EQOs) and their corresponding EQSs have been implemented into national legislation by the statutory authorities in an attempt to manage aquaculture production in a sustainable manner and ensure the avoidance of health hazards to consumers (Read *et al.*, 2001).

## 7 VISUAL AND NOISE IMPACTS

### 7.1 Visual Factors

Both shellfish and finfish aquaculture can impact upon the landscape, due to the location of structures such as cages and buoys in the water, and the construction of support facilities on land adjacent to farms (WWF, 2001b). Scottish Natural Heritage published guidance (Scottish Natural Heritage, 2008) addressing landscape and seascape capacity for aquaculture. It was informed by Grant (2006) which developed a method for undertaking seascape capacity assessments for aquaculture development. The method was tested in pilot studies in Argyll and Galloway in 2006. In addition, a site visit in support of the work was carried out in 2007 in order to check the applicability of the process to the Shetland Isles (Scottish Natural Heritage, 2008).

For developments for marine fish farms in sensitive sites, landscape assessments are required and should describe (SEERAD, 2003):

- The character and quality of the landscape affected.
- The impact on visual and aesthetic characteristics.
- The impact on individual landscape features.
- Where the fish farm will be seen from and how it will appear.
- Who the viewers will be.
- How acceptable the changes are likely to be.
- Any remedial measures which can be taken to reduce any impact.

Such considerations are usually considered with an Environmental Statement. As there is no formal requirement for EIA with regard to shellfish and non-fish farming at present, the aspect of visual disturbance can be easily overlooked for developments outside the relevant planning regulations.

Marine aquaculture (finfish and shellfish) continues to expand and develop predominantly along the west and north coasts of mainland Scotland and around many of the offshore islands. People have become more accustomed to seeing fish farms, but like all development, if poorly sited or designed, they can still sometimes have a negative effect on both coastal character and visual amenity. While in some places negative effects can be minimised by improving the detailed design of the individual structures, many potential landscape, seascape and visual problems can be avoided by choosing sites where fin and shell fish farms may be more easily absorbed into the landscape in the first place (Scottish Natural Heritage, 2008).

The Marine Fish Farming and Environment Advice Note (Scottish Executive, 1999a) states that there are three factors that make the physical development of fish farms contentious. The first is the close correspondence between the best fish farm development sites and landscapes deemed to be of national or regional importance. The second is the introduction of development for the first time to previously undeveloped/ almost undeveloped, and finally the industrial character of some installations that may intrude upon the surrounding areas.

As with other developments, the visual impacts of the construction and operation of shellfish and non-fish aquaculture facilities depends on the area chosen. Topography, vegetation, distance from viewing points, time of viewing, elevations, construction materials, design of the structure, and seasonal changes (light conditions, weather, vegetation etc) all have an influence on the degree of 'visual disturbance' that can be expected. Best practice in such instances for marine fish farms is presented in the Advice Note (Scottish Executive, 1999). The Policy Guidance Note 'Locational Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters' (Scottish Executive, 1999b) also states guideline distances of shellfish farms from key receptors; the guideline distance from a public viewpoint is 0.8km.

## **7.2 National Scenic Areas**

National Scenic Areas (NSAs) are applicable to Scotland only, and identify areas in Scotland's scenery which are of exceptional attractiveness, and where the need to safeguard the existing character and scenic qualities of the landscape assume a high priority (SEERAD, 2002). Such areas are often a key resource for tourism, and as such generate a substantial economic value that can be the basis of many local economies (SEERAD 2002). As such, development within these areas should not compromise the objectives of the designation or the overall integrity of the area (SEERAD, 2002).

## **7.3 Areas of Outstanding Natural Beauty**

Areas of Outstanding Natural Beauty (AONB) are designated areas in England, Wales and Northern Ireland. There are 49 AONBs in the UK, each designated for special attention by reason of their high qualities (ANOB website, 2007). These include their flora, fauna, historical and cultural associations as well as their scenic views. AONB landscapes include many coastline areas, and as such should also be a consideration when locating a shellfish farm. The Countryside and Rights of Way Act 2000 provides regulation and protection for AONBs, and should be a consideration in the development of any EIA regulations for shellfish and non-fish aquaculture in the future.

## 8 SOCIO-ECONOMICS

### 8.1 Proximity to Settlements

The construction, operation, and eventual decommissioning of an aquaculture installation inevitably brings new employment opportunities to an area, the extent of which is directly related to the size, nature, and capacity of the facility. This may have significant impacts for smaller rural communities as in addition to job creation, it may also affect the current unemployment rates and/or bring more people into the community for both the short and long term time frames. Such impacts may not be so pronounced in larger towns or settlements, though this would be a factor of the size of the farm (in terms of both direct and indirect employment).

The aquaculture industry is of vital importance to many rural and remote communities where it makes a significant contribution to promoting rural employment diversity (Scottish Executive, 2003). There may be few job opportunities in some communities, and up to 30% or more of the work force could possibly be dependant upon aquaculture (Scottish Executive, 2003). Aquaculture activities can also provide a foundation for the essential infrastructure of everyday life in such communities, such as the local hall, shops, petrol station or primary school, as well as the development of new housing, all of which will serve to keep these and other services in the community. The employment opportunities it generates are often complementary to the needs of crofters and others (Scottish Executive, 2003). The publication in 2004 by the Highlands and Islands Enterprise (HIE) 'Smart, Successful Scotland: the Highlands & Islands Dimension' recognises the inter-relationship of economic and social development in a rural environment and the importance of considering any sector, particularly in more remote areas, in the context of its impact on the wider local community and economy (Scottish Executive, 2003).

An aquaculture installation may also affect the local community through increases in economic activity in the area during its operation, but also during construction and decommissioning in the short-term. It is also worth bearing in mind that shellfish and non-fish aquaculture is often not undertaken on such a commercial scale compared to salmon farming, and that a higher percentage of the farms will be individually owned, and not part of a franchise/large company. As such, the economic activity of a shellfish or non-fish farm is more likely to be directly related to the local economy. However, the FRS Production Survey of 2002 showed that the industry was dominated by small producers, but that a continued trend toward larger companies contributing significantly to the annual production of all species was apparent. Such a change in the industry's composition will have effects on the socio-economics as, although operating on a smaller scale than finfish farming, shellfish farming is nonetheless economically important and more likely to be locally owned, providing local people with more of a direct stake in aquaculture and its benefits (WWF, 2001b).

The availability of housing in the local areas is also an important consideration. The workers on such aquaculture farms are permanent residents, and as such require housing. In the more rural areas of Scotland, the availability of suitable accommodation can be scarce (Nimmo, 2005). Planning permission for the development of onshore facilities for a farm does not imply that permission for a related housing development will automatically be forthcoming (Scottish Executive, 1999).

There may be potential conflict between the aquaculture farm and the existing industries in an area; for example, tourism. Such issues with visual impacts have previously been discussed in **Section 5**. However, if such impacts are applied to the turnover generated by the tourism in an area they may also have an impact on the socio-economic climate for the local community.

The proximity to settlements usually ensures a well-maintained transport infrastructure which would be essential for the running of the installation. However, impacts upon the local traffic and transportation network should also be evaluated to ensure that there will not be any conflicts with the existing users. The extra traffic on these roads should also be considered with regard to the maintenance of the roads, and it should be established if the local authority has the budget to maintain such routes in light of the consequences of extra usage.

SARF (2005) states that the underlying issues of social and economic impacts are that of sustainable prosperity and the long term viability of a vital and cohesive local society. This depends partly on the following:

- Population structure.
- Economic activity rates/unemployment.
- Housing availability.
- Skills profile of the community.
- Community capacity/confidence.

Such background information is considered essential in determining the impacts of a proposed aquaculture installation on the local community.

## 8.2 Social Activity

Across the world, the coastal zone is a popular area. In developed and developing countries, there are many demands placed on the coast in relation to; e.g. recreation, tourism, and business. Conflicts between aquaculture, natural communities, fisheries, and recreational users have been experienced in the past as a 'fight for water space' (Gibbs, 2004). With such high demand for usage of the coastal areas, there is also high demand for space, both above and below the high water tide mark.

The European Recommendation for Integrated Coastal Zone Management (ICZM) was adopted by the EU in 2002. The objective of ICZM is to establish sustainable levels of economic and social activity in our coastal areas while protecting the coastal environment. It brings together all those involved in the development, management and use of the coast within a framework that facilitates the integration of their interests and responsibilities. The implementation of this Recommendation into a UK National Strategy is still under consideration, but ICZM is planned to be a Government Policy of the near future. It is widely accepted that coastal aquaculture should be developed within such a framework (Read and Fernandes, 2003).

### 8.3 Economic Viability

The economic viability of an aquaculture farm will be the primary concern of the owner and operator/ manager, and will be a value related to the individual business. Overall, a viable and successful farm will also influence the local community both directly and indirectly by providing employment, and supporting other industries, businesses and services (Evans, 2005).

### 8.4 Farm Structures

Navigational routes are an important consideration when locating an aquaculture facility. It is essential to ensure that marine fish farm development does not constitute a hazard to navigation (Scottish Executive, 1999). It must also be ensured that care is taken to safeguard any established anchorages and harbours of refuge.

The shellfish aquaculture industry has grown in recent years. Though, originally, shellfish aquaculture was a 'cottage' industry, success has led to economic growth and the industry has become increasingly driven commercially. It is generally accepted that such growth has led to farms operating on larger scales as the demand for its products and investment increases.

It should be appreciated that the effects of such large-scale farms can be greater than that of their smaller predecessors, and that such farms require more elaborate designs to guard against structure induced sedimentation. There are currently no UK guidelines to provide advice on the appropriate structures for use in shellfish aquaculture; however, following a number of losses of cultured oysters due to smothering by sediment, a set of criteria governing the immediate layout of the farms themselves has been implemented in France (Kirby, unpublished).

The work by Grant and Bacher (2001) shows the impact that structures built for the culture of shellfish can have on the surrounding environment. They investigated the circulation and flow around a site of dense bivalve and kelp aquaculture in Sungo Bay, China. They found that the culture caused a 20% flow reduction in the main navigation channel, a 54% reduction in current speed in mid-culture, and that the presence of the culture caused a 41% decrease in the exchange rates seen. Though this work is site specific, it clearly shows the potential for physical farm structures themselves to have a major impact on the surroundings, and that the characteristics of the culture (such as the spacing, length and scale) should be investigated further to quantify the magnitude of their effects.

### 8.5 Possible interactions with other Farms

In an example from Shetland, SARF (2005) identified that local competition could stand in the way of practical and cooperative working. Such cooperation was found to not always be part of cultural tradition and there were potential indications of territorial behaviour in the industry. Despite this, the culture of shellfish and non-fish aquaculture provides opportunities for cooperation to the benefit of all parties; e.g. through the potential for development of polyculture techniques.

The effects of farm structures on the hydrography of the area should also be considered as structures in the water can alter the dynamics of flow at varying scales. Fish cages

and other structures can act as barriers to the flow of the water and reduce the water movements (SARF, 2005). This may have impacts on shellfish and non-shellfish cultures in the near vicinity the structures, and the introduction of new farms into a previously established system may also have possible implications for the farms (both fish and non-fish) that are already present.

## 8.6 By-Products of Production

The culture of bivalves themselves has been suggested as a method of alleviating adverse environmental impacts arising from other activities in the coastal zone (Kaiser, 2001). It has already been stated that fish farming, particularly that of salmon in Scotland, releases effluents of high nutrient content, and such nutrients can lead to eutrophication, and an increased potential for algal blooms, some of which may potentially even be toxic.

It has been proposed that integrated fish and bivalve (namely mussel) polyculture may be a possible solution to ameliorate such high nutrient concentrations as the bivalves would reduce the algal densities and nutrients which will be effectively removed when the product is harvested (Folke and Kautsky, 1989; Shipigel *et al.*, 1993, cited in Kaiser, 2001).

It has also been suggested that bivalve cultivation could be used as a means of returning already polluted water to a good quality status (in eutrophic and enclosed waters) (Kaiser, 2001). The quantity of nutrients removed would vary seasonally and will depend upon the species being farmed, the size of the farming operation, the siting of the farm and the prevalent physical and biological conditions (WWF, 2001b). In such cases, the harvested bivalves would not be suitable for human consumption, and would themselves become a by-product of the aquaculture technique though they represent a cost-effective and self-perpetuating means of maintaining water quality (Kaiser, 2001).

## 9 KEY ISSUES

A number of key issues are apparent when considering EIA for shellfish and non-shellfish aquaculture. Under the current absence of legislation addressing EIA on shellfish and non-fish aquaculture it has been stated that the environmental effects of operations are much less than that of a caged fish farms of similar size or production capacity; however, it has been shown that there are still environmental impacts from shellfish and non-fish production the effects of which are likely to require consideration within an existing or future statutory framework. As with EIA processes for other plans and projects, thresholds will need to be established to determine the need for EIA for individual developments. These may include:

### **15) Simplification of the process.**

The process of consenting and licensing an aquaculture farm is fairly complicated, with many different organisations involved at different stages of the process. If new regulations were to be put in place for shellfish and non-fish aquaculture, there may be an opportunity to tie in the consents and licences process within this procedure to simplify the process and therefore produce easy-to-use guidelines for growers in Scotland (also England and Wales).

### **16) Acknowledgment of the need for public consultation (as shown in the new EIA Regulations (Scotland) 2006 and by the EU) in the EIA process.**

The EIA Amendment Regulations (Scotland) 2006 integrate the encouragement of public participation into current EIA Regulations (namely the EIA (Fish Farming in Marine Waters) Regulations 1999 with regard to aquaculture). The purpose of this amendment is to transpose Article 3 of the European Commission Directive 2003/35/EC on Public Participation (the PPD) into the EIA Regulations in Scotland. As such, the need for public consultation when considering such developments should also be integrated into the consideration of the thresholds that would be required to assess the need for EIA.

### **17) Lack of EIA Regulations applicable to shellfish and non-fish production can mean that factors such as the assessment of landscape and visual impacts, and noise can be overlooked.**

As shellfish and non-fish farms are not currently included within EIA Regulations, their activities are basically regulated through the issue of licences and consents. As such, issues such as the visual impact of the farm are not always considered in this process, and can be overlooked. Such shortfalls may need to be addressed.

### **18) Balanced approach for the overview of the proposal.**

There have been many comments in the literature that suggest that certain areas/receptors are the focus for the environmental investigations when considering aquaculture facilities. For example, the hydrology of an area is a very important aspect when considering a proposal, and as such receives much attention and detailed consideration. However, other aspects such as visual and noise disturbance etc. do not receive as much attention. All possible environmental effects should be discussed within an ES; however, proportionality should be applied to ensure that all issues are considered in the appropriate detail.

**19) The weighting of each receptor should be given in the consideration of the suitability of a site for shellfish or non-fish aquaculture.**

In previous applications, weighting has considered the use of proportionality when approaching the assessment of a proposal. This is an important issue in the determination of consent as each receptor needs to be considered both individually and in conjunction with the other possible impacts. Such decisions are made by the Statutory Bodies; however, the thresholds which determine the need for EIA can also influence this weighting by including sites that are significant under all receptors; i.e. not focussing just on the traditionally important aspects.

**20) Any EIA Regulations implemented will have to be robust enough to also consider the more potentially environmentally damaging practices of seed production etc.**

The terms of 'shellfish' and 'non-fish' aquaculture cover a vast amount of species and culture techniques. The culture of molluscs, crustaceans, and algae are all fundamentally different and use completely different farming techniques. Even when considering just one species; e.g. the mussel, there are farms using either/ both longline and/ or raft techniques, or even facilities specialising in the production of spat for other mussel farms. As such, any regulations produced for assessing environmental impacts of shellfish and non-fish aquaculture need to be robust enough to include all forms of such aquaculture, and provide a framework which will be applicable to all such facilities.

**21) Need to consider the whole process from seed stock to on-growing and harvesting in the evaluation on the potential impacts of the farm on the environment.**

EIA Regulations normally consider construction, operation, cumulative and in combination effects, and decommissioning. In addition, when considering shellfish and non-shellfish aquaculture, the whole aquaculture process should also be considered including the seed collection, on-growing and harvesting stages.

**22) Methods; the innate differences between trestles, suspension and bottom culture.**

As raised in point 6, there are many different methods for the culture of shellfish and non-fish. The development Regulations will need to take into account the differences in these methods within the threshold levels that will be established.

**23) Species differences; e.g. some bivalve molluscs may produce more pseudo-faecal matter than others etc.**

There are many species that fall within the categories of shellfish and non-shellfish. With such a wide ranging sector, there is the danger of generalisation and grouping of aquaculture types. For example, all bivalve species may be considered as the same for assessment purposes; however, although they belong to the same class, it is not necessarily the case that all bivalve molluscs will have comparable effects on the environment.

**24) The means of determining the carrying capacity of a particular area should be defined through monitoring or numerical modelling to ensure a cohesive and coherent approach to evaluating each proposal.**

One of the benefits of having an EIA framework in place is the ability to provide a standard method of assessment with the purpose of facilitating a cohesive and coherent approach at national level. Any European Directive will affect wider spatial and political scales that will require further assessment, the details of which are beyond the scope of this study (see: Section 4 Consultation). The assessment of carrying capacity for an area is an example of approach that can be integrated into the Regulations to ensure consistency.

**25) Regulation of the farm layout to stop sedimentation and scour.**

The layout of the farm itself has been shown to be a major factor in the cause of adverse environmental impact to the surrounding area. Poor organisation of farm structures can lead to sedimentation and the smothering of cultures themselves, as well as scour. The Statutory Framework that would be provided by EIA Regulations would offer the opportunity to also regulate the placement of the farm structures. There is also the opportunity for the publication of best practice guidelines on the spatial development of a farm, which could also reflect any possible thresholds as determined for the EIA process.

**26) Possible use of GIS when determining available space for shellfish/non-fish farms.**

Guidelines currently exist for the siting of fish farms, and sensitivity maps are produced to identify their most appropriate location. Though such maps can also be applied to shellfish and non-fish aquaculture, they are primarily used for the determination of fish farm sites. The difference in the environmental impacts of the different aquaculture types has been discussed in detail throughout this report, and it is clear that different priorities exist. As such, the potential for location guidelines specifically for shellfish and non-fish farms exists. There is also the potential for new methods to be used in this assessment. For example, the successful use of GIS was recorded by Arnold *et al.*, (2000) when looking at aquaculture in Florida. It was stated that such a methodology would be applicable to any process requiring grow-out life stages, such as that seen for bivalve molluscs. However, when applying such techniques to the UK, considerations such as cloud cover (aerial photos, CASI etc) should also be considered.

**27) Although there are lobster reseeded programmes in operation in the UK; i.e. the supplementation of wild stocks with juveniles reared in hatcheries, no full term commercial crustacean (shrimp/crab/lobster etc) aquaculture was identified in the UK through the literature review. Despite this, such cultures would fall under any non-fish farm policy.**

The most popular form of shellfish aquaculture in the UK is that of bivalve molluscs (including: mussels, scallops and oysters). The majority of crustacean (namely penaeid shrimp) aquaculture occurs in warmer (sub-tropical and tropical) climates. However, with the financial inventiveness for the production of these species, and the ever progressive development of new techniques, it is probable that in the future farming of crustaceans will develop further in the UK. As such, any Regulations developed for shellfish and non-fish farming need to be robust within a flexible system of administration that will allow such future developments to be addressed.

**28) Lack of information for non-shellfish farms. Policy should be developed with broad enough applications to cover any of these techniques.**

There was a general lack of information with regard to non-fish farming. Some minor groups; e.g. macroalgae and gastropod species and sea urchins were poorly represented. Such applications are likely to range in scale and, therefore impacts. The development of thresholds to determine the need for EIA should consider such operations. Further investigation into the likely development of this sector in Scotland (and the rest of the UK) would be beneficial, as well as further investigation into the culture techniques that are likely to be utilised.

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**Appendix B**

**'Regulator' Details- List of Statutory Consultees and Organisations**

<b>'Regulator' Group Breakdown</b>	<b>Name</b>	<b>Response</b>
Statutory Consultees	Crown Estate	Yes
	Scottish Natural Heritage	Yes
	Fisheries Research Services (and Scottish Executive Environment and Rural Affairs Department)	Yes
	Food Standards Agency	No
	Joint Nature Conservation Committee	No
	Scottish Environment Protection Agency	Yes
Organisations	Marine Conservation Society	No
	Napier University	No
	Marine Biological Association	Reply received, but questions not answered (i.e. blank response).
	World Wildlife Fund	No
Associations	Scottish Association for Marine Science	Yes
	Scallop Association	No

## **APPENDIX C**

### **Example Regulator and Stakeholder Questionnaires**

## **APPENDIX D**

### **Summary of Responses Received from the Consultation Exercise**

## LIST OF QUESTIONS

For the analysis of the consultation responses, the questions within the questionnaire were separated into their respective sections and given numbers. A list is presented below for both the regulator and the stakeholder questionnaires.

### Regulator Questionnaire

<b>Legislative Requirement</b>	
1	Do you feel that the current legislation for shellfish and non-fish aquaculture needs to be addressed and updated?
2	Do you agree that shellfish and non-fish aquaculture needs to be included within an EIA framework?
3	Do you believe that the introduction of EIA regulations for shellfish and non-fish aquaculture provides an opportunity to simplify the current consents and licences procedure?
4	Do you believe such an EIA process should cover all shellfish and non-fish aquaculture projects that meet the appropriate thresholds?
5	Do you feel that such legislation should group shellfish and non-fish projects together?
6	Do you believe the implementation of new EIA regulations for shellfish and non-fish aquaculture should acknowledge the need for public consultation? (With regard to aquaculture, the EIA Amendment Regulations (Scotland) 2006 integrate the encouragement of public participation into current EIA Regulations, namely the EIA (Fish Farming in Marine Waters) Regulations 1999).
7	Do you believe that cost would be a prohibitive barrier for commercial stakeholders when developing any shellfish and non-fish aquaculture projects under new EIA Regulation for the industry?
<b>Threshold Levels</b>	
1	Please indicate which of the following factors you believe should determine the need for EIA for shellfish and non-fish aquaculture (i.e. the threshold considerations):
a	size of farm
b	biomass held within sensitive areas
c	non-native crop
d	proximity to other farms
e	other
2	Do you believe that the EIA of all shellfish and non-fish aquaculture should be dealt with in the same fashion?
3	Do you believe that overarching threshold levels for shellfish and non-fish aquaculture production (in both tonnage and area) can be applied universally for all project types (for example, mussel, algae, oyster etc?)
4	Which of the following do you believe to be the most appropriate EIA threshold level for tonnage of biomass of shellfish and non-fish aquaculture farms:
a	>5 tonnes
b	>20 tonnes
c	>50 tonnes
d	>100 tonnes
5	Which of the following do you believe to be the most appropriate EIA threshold level for surface area (hectares) of both inter-tidal and marine areas occupied by shellfish and non-fish aquaculture farms?
a	>0.01 hectares
b	>0.1 hectares
c	>0.2 hectares
d	>0.5 hectares
6	Which of the following do you believe to be the most appropriate EIA threshold level for proximity (km) of the shellfish and non-fish aquaculture sites to other aquaculture (fish, shellfish and non-fish) facilities:

a	<1km
b	<5km
c	<50km
d	<100km
<b>Relevant Issues</b>	
1	Which of the following do you believe to be key issues which would require consideration during an EIA process for shellfish and non-fish aquaculture:
a	water and sediment quality
b	benthic communities
c	protected areas
d	escapees (remote colonisation) and non-native species
e	protected species and wildlife (nature conservation)
f	proximity to other farms
g	carrying capacity
h	layout and design
i	site location
j	in-combination effects
k	landscape and visual
l	air and noise
m	socio-economic
n	archaeology
o	life-cycle analysis
p	climactic factors
q	hydrography
2 (i)	Do you believe that it is important to regulate the layout of the shellfish and non-fish farm structures to prevent excess sedimentation and scour?
2(ii)	If yes, do you believe the best way of achieving such regulation through:
a	best practice guidance
b	active regulation through relevant authority
3	Do you believe a LCA (Life Cycle Analysis) approach is the best way to ensure all activities (such as seeding, on-growing and harvesting) are taken into account during this process?
4	Do you believe certain receptors need to be given more weighting in the EIA process?
5	Do you believe all shellfish and non-fish farming techniques should be included within this process?
6	Do you believe the assessment of an area's carrying capacity needs to be standardised?
7	Shellfish and non-fish aquaculture techniques are developing continuously; do you think that the mechanism of including shellfish and non-fish aquaculture within an EIA framework would need to be robust enough to deal with any possible future issues (for example, the significant development of crustacean farming in the UK?)
8	Do you feel that more information and regulation is needed for the non-fish aquaculture sector?
9	Do you feel there is potential for site location maps to be produced for shellfish and non-fish aquaculture facilities (as currently seen with fish aquaculture), and that such a resource is needed?

## Stakeholder Questionnaire

Your General Opinion	
1	In your opinion, should the marine environment at existing shellfish and non-fish aquaculture operations and locations be monitored?
2	Do you feel that shellfish and non-fish aquaculture proposals need to be assessed for environmental impacts?
Your Operation	
1	What is your main product?
a	mussels
b	native oysters
c	pacific oysters
d	scallops/queens
e	other
2	What is your main method of production?
a	ropes/suspended systems
b	seed beds
c	open lays/traps
d	purpose built hatchery
e	hand gathering e.g. cropping seaweeds
f	other
3	What is your average annual production (tonnes)?
4	What is the size of your site (hectares)?
5	Where is the location of your operation?
a	South West
b	Orkney
c	Western Isles
d	Shetland
e	West Coast
f	East Coast
g	North Coast
h	other
Legislative Requirement	
1	Do you think that shellfish and non-fish aquaculture should be subject to a formal environmental impact assessment (EIA) process?
2	Do you feel that the current legislation for shellfish and non-fish aquaculture needs to be addressed and updated?
3	In your opinion, is the current legislation and the consents process for shellfish and non-fish aquaculture representative in terms of EIA?
4	Do you believe that the introduction of formal EIA for shellfish and non fish aquaculture will provide an opportunity to improve the current consents process?
5	Do you think that environmental regulation should group the production of shellfish (molluscs and crustaceans) and non-fish (algae, echinoderms etc) together?
6	Do you think that any new regulations for shellfish and non-fish aquaculture projects should specifically include public consultation as a mandatory condition?
7	Are you concerned that any new environmental requirements (such as investigations, assessment and reporting) would cost too much or be a poor investment?

<b>Legislative Requirement</b>	
8	On the following scale, what kind of budget would you be prepared to invest on environmental investigations? (please tick relevant box).
a	<£1000
b	<£5000
c	<£10000
d	<£20000
e	>£20000
<b>Threshold Levels</b>	
1	Please mark which factors you think are important in determining the need for EIA for shellfish and non-fish aquaculture (i.e. the threshold considerations):
a	size of farm
b	biomass held
c	the farm is in a sensitive or protected area
d	the introduction of non-native species
e	proximity to other farms
2	Do you think that all shellfish and non-shellfish aquaculture should be graded under the same (i.e. a common) system?
3	Do you think the threshold levels set for shellfish and non-fish aquaculture production (in both tonnage and area) can be applied to all aquaculture types (for example, mussel, algae, oyster etc) in the same way?
4	Which of the following in relation to annual production capacity do you think should be used to decide if an EIA is required?
a	>5 tonnes
b	>20 tonnes
c	>50 tonnes
d	>100 tonnes
5	Which of the following in relation to site area do you think should be used to decide if an EIA is required?
a	>0.01 hectares
b	>0.1 hectares
c	>0.2 hectares
d	>0.5 hectares
6	Which of the following distances in relation to proximity to other aquaculture facilities do you think should be used to determine if an EIA is required?
a	<1km
b	<5km
c	<50km
d	<100km
<b>Relevant Issues</b>	
1	If you agree with EIA, which of the following are the key issues to be included:
a	EIA is not relevant to shellfish and non-fish culture
b	water and sediment quality
c	benthic communities
d	protected areas
e	escapees and non-native species
f	protected species and wildlife
g	proximity to other farms
h	carrying capacity
i	farm layout

Relevant Issues	
j	site location
k	cumulative and in-combination effects
l	visual, air and noise
m	socio-economic
n	archaeology
o	life cycle analysis
p	climactic factors
q	hydrography
2(i)	Do you think that it is important to regulate the layout of the shellfish and non-fish farm structures to prevent impacts e.g. excess sedimentation and scour occurring?
2(ii)	If yes, do you believe the best way of achieving such regulation through:
a	best practice guidance
b	active regulation through relevant authority
3	Do you think a Life Cycle Analysis (LCA) approach is the best way to make sure all activities (such as seeding, on-growing and harvesting) are taken into account when assessing environmental effects?
4	Do you think a balanced approach is essential for assessment of environmental impacts of a shellfish or non-fish farm (i.e. assessing all relevant factors in preference to one topic)?
5	Do you think certain things need to be given more 'weight' in the assessment of environmental impacts?
6	Do you think all shellfish and non-fish farming techniques should be subject to EIA?
7	Do you believe the assessment of an area's carrying capacity needs to be standardised?
8	Do you feel that the regulators require more information about the methods and impacts of shellfish and non-fish production under the current legislative regime?
9	Do you think that there is potential for site location maps to be produced for shellfish and non-shellfish aquaculture facilities (as currently seen with fish aquaculture), and that such a resource is needed?

## CONSULTATION RESPONSES

### Regulator Questionnaire

The responses to the regulator questionnaire are shown below. A total of 12 consultees were contacted (6 regulators, 4 organisations, and 2 associations), and a total of 6 replied. It should also be noted that 1 reply contained no comments or opinions about this consultation, and therefore no positive answers have been recorded in this analysis.

The table shows how many positive answers were received for each of the questions posed. Responses have been grouped according to the consultee background. Comments from this process can be found in **Appendix D**.

#### KEY

- 0 negative answer/box not ticked
- 1 positive answer/box ticked
- n/a question not answered

Question	Statutory Regulators	Organisations	Associations
<b>Legislative Requirement</b>			
1	3	n/a	1
2	3	n/a	1
3	1	n/a	0
4	3	n/a	1
5	3	n/a	0
6	3	n/a	1
7	2	n/a	0
<b>Threshold levels</b>			
1a	3	n/a	1
1b	2	n/a	1
1c	2	n/a	1
1d	1	n/a	1
1e	0	n/a	0
2	0	n/a	1
3	0	n/a	0
4a	0	n/a	0
4b	0	n/a	0
4c	0	n/a	1
4d	3	n/a	0
5a	0	n/a	0
5b	1	n/a	0
5c	1	n/a	1
5d	1	n/a	0
6a	3	n/a	1
6b	0	n/a	0
6c	0	n/a	0
6d	0	n/a	0
<b>Relevant Issues</b>			

Question	Statutory Regulators	Organisations	Associations
1a	3	n/a	0
1b	3	n/a	0
1c	3	n/a	0
1d	2	n/a	1
1e	1	n/a	1
1f	2	n/a	0
1g	3	n/a	1
1h	3	n/a	0
1i	3	n/a	0
1j	2	n/a	0
1k	3	n/a	0
1l	1	n/a	0
1m	3	n/a	1
1n	1	n/a	0
1o	1	n/a	1
1p	1	n/a	0
1q	3	n/a	1
2(i)	4	n/a	1
2(ii)a	3	n/a	0
2(ii)b	0	n/a	1
3	3	n/a	1
4	3	n/a	1
5	1	n/a	1
6	2	n/a	0
7	4	n/a	1
8	3	n/a	1
9	3	n/a	1

## Stakeholder Questionnaire

The Stakeholder Questionnaire was distributed electronically through the distribution list of the industry publication 'The Grower'. It was estimated by the publication that 48 of its subscribers were shellfish or non fish growers operating in Scotland. A total of 3 replies were received from the consultation exercise. The table below shows how many positive answers were received for each of the questions posed. These comments have not been summarised due to the small sample size, but have been presented as individual answers. Comments from this process can be found in **Appendix D**.

### KEY

- 0 negative answer/ box not ticked.
- 1 positive answer/ box ticked.
- n/a question not answered.

Question	Stakeholder Replies		
	a	b	c
<b>Your Operation</b>			
1a	0	1	1
1b	0	0	0
1c	1	0	0
1d	0	0	0
1e	0	0	0
2a	0	1	1
2b	0	0	0
2c	1	0	0
2d	0	0	0
2e	0	0	0
2f	0	0	0
3	30	100	110
4	4.5 ha	12 lines	8 ha
5a	0	0	0
5b	0	0	0
5c	0	0	0
5d	0	0	1
5e	1	0	0
5f	0	0	0
5g	0	0	0
5h	0	1	0
<b>Threshold Levels</b>			
1	0	0	0
2	0	0	0
<b>Legislative Requirement</b>			
1	0	0	0
2	1	n/a	0
3	n/a	1	1

Question	Stakeholder Replies		
	a	b	c
4	0	0	0
<b>Legislative Requirement</b>			
5	0	n/a	0
6	0	0	0
7	1	1	1
8a	n/a	0	1
8b	n/a	0	0
8c	n/a	0	0
8d	n/a	0	0
8e	n/a	0	0
<b>Threshold Levels</b>			
1a	n/a	0	1
1b	n/a	1	1
1c	n/a	0	1
1d	n/a	1	0
1e	n/a	0	0
2	0	n/a	0
3	0	0	0
4a	n/a	n/a	0
4b	n/a	n/a	0
4c	n/a	n/a	0
4d	n/a	n/a	0
5a	n/a	n/a	0
5b	n/a	n/a	0
5c	n/a	n/a	0
5d	n/a	n/a	0
6a	n/a	n/a	0
6b	n/a	n/a	0
6c	n/a	n/a	0
6d	n/a	n/a	0
<b>Relevant Issues</b>			
1a	1	1	1
1b	0	0	0
1c	0	0	0
1d	0	0	0
1e	0	0	0
1f	0	0	0
1g	0	0	0
1h	0	0	0
1i	0	0	0
1j	0	0	0
1k	0	0	0
1l	0	0	0
1m	0	0	0

Question	Stakeholder Replies		
	a	b	c
1n	0	0	0
<b>Relevant Issues</b>			
1o	0	0	0
1p	0	0	0
1q	0	0	0
2(i)	0	n/a	0
2(ii)a	n/a	1	n/a
2(ii)b	n/a	0	n/a
3	0	0	0
4	0	1	0
5	0	n/a	0
6	0	0	0
7	0	1	1
8	1	0	n/a
9	0	1	0

## **APPENDIX E**

### **Summary of Comments Received during the Consultation Exercise**

## REGULATOR COMMENTS

Question	Associations	Statutory Regulators				Organisations
<b>Legislative requirement</b>						
3. Do you believe that the introduction of EIA regulations for shellfish and non-fish aquaculture provides an opportunity to simplify the current consents and licenses procedure? Please provide additional comments	I think there may be some streamlining possible but that requiring an EIA for a mussel farm for example will inevitably be an additional level of complexity. However this may work to the industry's benefit as there will be an opportunity to put a more rounded case of environmental/socio-economic costs and benefits.	EIA effectively addresses significant environmental effects of an aquaculture development. Shellfish and non-fish aquaculture enterprises to date have not been considered to have such effects, and these developments involve mainly planning issues relating to other marine users and possible visual effects. These could be dealt with without recourse to formal EIA, but on the basis of specific information submitted to deal with these specific matters, as the scope of a 'normal EIA' covers a far wider remit than the effects emanating from such developments.	By including shellfish and non-fish aquaculture in the EIA regs, all aquaculture development will be treated similarly (although with different thresholds) and therefore simplified.	It is hard to see how this will simplify things. The great opportunity for simplification of procedures came with extension of planning controls to local authorities. It is hard to see how considering shellfish etc could simplify the existing mechanisms.	n/a	n/a
4. Do you believe such an EIA process should cover all shellfish and non-fish aquaculture projects that meet the appropriate thresholds? If no, please specify exceptions	n/a	See above - the actual environmental effects of such developments are relatively narrow and therefore could be addressed by specific information related to their mitigation and avoidance, without subjecting developers to the not considerable cost of a full EIA	n/a	n/a	n/a	n/a
7. Do you believe that cost would be a prohibitive barrier for commercial stakeholders when developing any shellfish and non-fish aquaculture projects under new EIA Regulation for the industry? If yes, do you have any suggestions for the remediation of this barrier?	I do not think EIAs need be expensive! What is required is a standard format for such EIAs with good advice on where to source the relevant existing information and clear indications of what new information needs to be collected.	Many of this type of development are undertaken by small owner/operator businesses, often with tight budgets. The planning application fees now in place with Local Authorities will already present a significant cost, and the costs of undertaking a formal EIA will only add to this issue, and quite likely act as a deterrent to many potential incomers to the industry by presenting 'up front' costs that have to be borne without any indication that any development might actually proceed.	I am unsure if cost will be a barrier or not, although hopefully if the correct thresholds are made then this shouldn't be so. However, there should still be due regard for environmental impacts, whatever the size of development.	Thresholds should be set high since shellfish are relatively environmentally benign. Therefore only largest developments should be subject to EIA. EIAs should be targeted at the key environmental issues, rather than 'all encompassing' as has been the case for finfish in the past.	The aim should be to ensure that where EIA is required for such projects that the process is tailored and targeted to ensure that costs are limited. It is likely that given the lower range and scale of impacts from non-fish aquaculture that the costs associated with an EIA process for this sector should be cheaper. It is imperative given the lower turnover and profitability of non-fish aquaculture that the costs are minimised.	n/a
8. Please provide any additional comments you wish to make	n/a	n/a	n/a	I would recommend that thresholds for EIA are set at high levels based on maximum standing biomass that could be supported by the recommended equipment. I would suggest a biomass threshold of say 400 T standing stock from mussel farms. In addition where the activity may influence a sensitive area or feature and an appropriate assessment has not been carried out; an EIA should be required regardless of size of development	n/a	n/a

Question	Associations	Statutory Regulators	Organisations
<b>Threshold levels</b>			
2. Do you believe that the EIA of all shellfish and non-fish aquaculture should be dealt with in the same fashion? Please give your reasons	If by this ,the same basic principles should apply is meant then Yes. But different culture types may need different thresholds depending on their impacts.	I feel that developments should be dealt with on their merits with regard to any EIA provision. As mentioned earlier, most issues will be planning related rather than strictly environmental, and so should be dealt with on this basis, case by case	EIA should be targeted towards issues where environmental impacts are likely to be significant, and these maybe different between shellfish and non-fish aquaculture.
7. Please provide any additional comments you wish to make	n/a	In considering EIA thresholds, should the EIA path be chosen, I would caution in the application of a blanket treatment for applications without taking into account specific circumstances that pertain to location, species (both of the development and of neighbouring developments and nature of the development. In my experience, addressing such specific circumstances in considering an application lends itself to a more thorough investigation of the specific issues, if any are present. Having an EIA requirement in place, particularly with 'low' threshold criteria can often lead to what I would describe as a 'knee jerk' reaction in requesting an EIA from consultees, simply because this provision exists and be exploited without the need for recourse to the detailed consideration of issues mentioned above. In the case of shellfish and non-fish aquaculture, many operators and business are small, often with only a couple of employees, which would not have the expertise to conduct an EIA, and could neither bear the costs of one carried out by a consultant. Care needs to be taken in setting a regulatory regime that is not a disincentive to industry development and growth, particularly as such costs will have to be borne without any assurance of approvals being forthcoming. This will restrict development opportunity to larger companies with more resources, and so risk losing some of the diversity of producers within the industry.	Q1. Biomass thresholds should not just be relevant in sensitive areas, environmental impacts should be considered in all areas. I am reluctant to fill in questions 4, 5 and 6, as I believe they should be chosen on carefully considered science looking at the impacts made by farms of varying biomass and size, and the potential risks associated from proximity to other farms. I had thought the SARF project would provide informed answers to these questions and not obtain them simply from stakeholders views.
Different thresholds should be applied depending on species / type of aquaculture.	I would suggest species dependant biomass based thresholds for shellfish cultivation would be best. Area and proximity based thresholds have little scientific basis, nor are they closely related to environmental impact.	Difficult to be certain depending which species are to be cultured.	Thresholds in terms of tonnage and area very difficult to define dependant upon species cultured and the method of culture. I have therefore merely specified the current thresholds as in the salmon farming regulations. I do not think that proximity is a significant consideration under EIA unless farms are extremely close.
n/a	n/a		

Question	Associations	Statutory Regulators				Organisations
<b>Relevant Issues</b>						
2. Do you believe that it is important to regulate the layout of the shellfish and non-fish farm structures to prevent excess sedimentation and scour? If yes, do you believe the best way of achieving such regulation through best practice guidance or active regulation through the relevant authority? If other, please list	n/a	n/a	n/a	Indirectly, through approval or otherwise based on the assessment of impacts from the proposed equipment layout. Layout should of course be considered in the assessment process. No new regulation is required to achieve this.	n/a	n/a
4. Do you believe certain receptors need to be given more weighting in the EIA process? Please explain your reasons for this view	Anything that has potential for irreversible change should be given highest priority e.g. disease, aliens	This is difficult to answer without knowing what the impacts are of such developments that might be considered significant. Undoubtedly, this will depend on the nature and proposed location of the development - again something to be considered on a case by case basis rather than across the board. Planning issues are the most likely to apply universally, and as noted above, I do not consider that EIA is necessarily the best means of addressing these, for what on the whole are relatively environmentally benign operations	The EIA itself should pick out certain receptors which need more attention, and for each farm and location this maybe different.	For shellfish hard to answer, since they are not currently covered by EIA and we can't see what receptors are poorly covered yet! Important not to forget Benthic smothering by shells, shellfish as well as POM. Carrying capacity critical. Impacts on native filter feeders, effects of anti predator control approaches (ducks, echinoderms etc).	Clearly shellfish farming would be expected to have a significantly lower impact upon water quality in relation to nutrients, suspended solids etc than finfish farming and thus less emphasis would be required in this area. There are potential impacts upon the benthos and clearly carrying capacity is a significant consideration.	n/a
5. Do you believe all shellfish and non-fish farming techniques should be included within this process? Please explain your reasons for this view	n/a	Again the nature of the development and its location need to be addressed. IF EIA requirement is in place, this will need careful and considered screening/scoping to avoid the pitfalls described in point 7, page 4 above.	All aquaculture developments have the potential to impact on the environment and as such should be included in the process. The process should be such to allow development with little or no environmental impacts, whilst allowing further consideration to developments that may cause impacts by going through the EIA process.	n/a	Certain type of culture may be very low impact, visually or in other ways meaning that the EIA process is superfluous.	n/a
6. Do you believe the assessment of an area's carrying capacity needs to be standardised? If yes, please explain your preferences:	I do not know what standardised means. Carrying capacity should be assessed for each basin (hydrodynamically distinct water body).	Carrying capacity will to a large degree depend upon the nature of the developments under consideration, and account must always be made of industry's ability to progress with technology and techniques that address carrying capacity issues. The question will always be whether any standardised assessment regime will account for and keep pace with such.	Carrying capacity models are complicated and require a large amount of input data to perform accurately, which costs time and money. Standardising the technique, if test run properly, should provide a more fair system, although as with all modelling there will be inaccuracies, and the more the model is simplified, the more this is so. There maybe instances therefore, when conclusions on carrying capacity issues will have to take the precautionary approach, if environmental issues were of great concern.	Carrying capacity estimates will be very uncertain. Methods for estimating them will necessarily vary by type of location. One way of handling the uncertainty is to consider a variety of tools and adopting a precautionary approach based on the output of all. In the first instance this would be best. As the science develops, uncertainty reduces and we can take a less precautionous approach with standardised methods.	There has been a good deal of recent work in this area e.g. the REDRISK and SMILE projects that may yield useful standardised approaches. In the absence of a standardised approach, cost to the applicant are likely to be higher as consultants will probably develop their own methodology at higher costs.	n/a

Question	Associations	Statutory Regulators			Organisations	
<p>7. Shellfish and non-fish aquaculture techniques are developing continuously; do you think that the mechanism of including shellfish and non-fish aquaculture within an EIA framework would need to be robust enough to deal with any possible future issues (for example, the significant development of crustacean farming in the UK?). Please provide any additional comments</p>	n/a	<p>See my comments in point 6 above, and also the fact that if robust = fit for purpose, that purpose must incorporate a mechanism that is not seen as prohibitively onerous and/or costly, if significant industry development of any nature is to take place.</p>	<p>All measures should be made to try and include possible future issues within the EIA framework, however there will always be cases that will fall outwith this and the framework should be able to deal with these on a case by case basis as and when they occur.</p>	<p>Crustacean farming requires feed input and on a large scale will have significant impacts. It should not be considered or assessed in the same way as molluscan farming. I do not think that we are sufficiently familiar with the impacts of this industry, to for example set EIA thresholds at this stage.</p>	<p>Yes, although in the development of a new sector it is likely to be some time before production would approach the threshold.</p>	n/a
<p>10. Please provide any additional comments you wish to make with regard to relevant issues</p>	n/a	<p>Site maps - depends on the use they might be put to. I do not consider that prescriptive zoning maps are necessarily the way forward as they tend to be exclusive rather than inclusive, and provision should always exist for various marine users to be able to resolve conflicts to mutual satisfaction themselves, rather than resorting to lines on maps. With respect to planning, any such maps should always be flexible enough to take account of mitigation measures, developments in technology and techniques that might make certain operations possible in areas where previously they were considered not to be. In this regard, I prefer the use of marine user groups, with appropriate regulatory presence, set up on a regional or even more localised basis to examine development proposals of whatever nature, to attempt to accommodate rather than restrict development, with suitable environmental protection if this is seen to be an issue. Flexibility and inclusiveness are essential in any regulatory framework that is not seen t</p>	<p>Q1 - All of the listed issues have the potential to be key issues within the EIA, it is up to the EIA process to determine which ones are likely to cause significant impacts for that particular farm and location, and to concentrate on those. Q9 - Do you mean the location guideline maps? If so then in certain areas this already happens e.g. Shetland, and are of great benefit, where many voes are at or near their carrying capacity. As the shellfish and non-fish aquaculture industry continues to grow, having lochs modelled for carrying capacity will assist the EIA process.</p>	<p>Currently, very large shellfish developments clearly have the potential to cause significant environmental impacts and are exempt from any real regulation of environmental information provision requirements. In 2004/5 we saw a large number of development applications for very large farms (&gt;400 T of mussels) particularly in Shetland that i would have liked to see EIAs for. This needs to be changed, but done so in a way that doesn't impact financially on smaller 'environmentally benign' operators. I think biomass thresholds are the way forward for this, but I think they need to be set somewhat higher than is currently being proposed (100 T is the maximum figure presented). I don't think the impacts from a typical 100 T mussel farm warrant the resources required by an EIA. Exceptions to this would be when sites are in sensitive areas or in heavily used sea lochs where cumulative effects may be impinging on biological carrying capacity, perhaps to the detriment of native filter feeders. A system that allows monitoring requirements to be considered would also be useful. With shellfish operators not requiring a licence under CAR (registration only) there is no provision for monitoring, yet this may be an important part of reducing risks from uncertainty in assessments.</p>	<p>As regards this final question, SEPA is in favour of a Marine Spatial Planning approach to define areas favoured for shellfish production to minimise the likelihood of conflicts between farmers and other water users.</p>	n/a

## STAKEHOLDER QUESTIONNAIRE

Question	A	B	C
Your operation			
3. What is your average annual production (tonnes)?	110	100	30
4. What is the size of your site (hectares)?	8	12 lines at 200m	4.5
Your general opinion			
1. In your opinion, should the marine environment at existing shellfish and non-fish aquaculture operations and locations be monitored?	1. Benthic survey fieldwork has been carried out at nearly all salmon sea sites in Shetland for about 10 years. Even the largest finfish sites show very little evidence of impact, which may appear surprising given most of the sites produce in excess of 1,000 tonnes of fish per cycle. Extensive shellfish culture is carried out at very much lower stocking rates per square area; there is no artificial input of feedstuffs, and there is absolutely no use of medicines or other chemical therapeutants. The probability of any significant impact is therefore extremely low. 2. The cost of finfish environmental monitoring is borne by the site operator. The costs are significant, and the results of monitoring often show that the monitoring could be made less frequent or less onerous. The cost of unnecessary monitoring for shellfish farms would be an additional unnecessary burden on a low-profit industry which exists entirely in fragile, remote locations. 3. Shellfish farms are environmentally self-regulating.	There is little advantage in this to the farmer.	n/a
2. Do you feel that shellfish and non-fish aquaculture proposals need to be assessed for environmental impacts?	I am concerned that consultants and lobbyists are pushing for monitoring unnecessarily, with no true idea of the type or extent of the industry or appreciation of the difficulties and financial constraints it faces. Existing regulations give the appropriate authorities all the means necessary to deal with any difficulties which may arise on a local basis.	For large shellfish sites over 500 tonnes, maybe. But there is no advantage to the industry	
<b>Legislative requirement</b>			
2. Do you feel that the current legislation for shellfish and non-fish aquaculture needs to be addressed and updated?	Shellfish aquaculture is an easy "sitting target ". Consideration for EIAs in this industry should only be considered once EIAs have been considered for the unregulated shellfish fishing industry and land-based agriculture.	Not sure and would be concerned about cost implications to us.	shellfish farming needs a much higher level of environmental protection
4. In your opinion, is the current legislation and the consents process for shellfish and non-fish aquaculture representative in terms of EIA? Do you believe that the introduction of formal EIA for shellfish and non fish aquaculture will provide an opportunity to improve the current consents process? Please provide any comments you may wish to make	n/a	EIAs are can be very costly. Suspect they are inevitable but industry should resist.	Do not understand the question C3
9. Please provide any additional comments you wish to make regarding this section	I do not view unnecessary expenditure on unwarranted "monitoring" to be an investment.	You have assumed we'd be prepared to invest which is incorrect. Suspect we may have to but will resist if possible.	Not prepared to spend anything on environmental investigation
<b>Threshold levels</b>			
2. Do you think that all shellfish and non-shellfish aquaculture should be graded under the same (i.e. a common) system? Please give your reasons	How can you suggest treating say algae and mussels the same? Introduction of non-natives is dealt with by Marine Lab. Inspectors.	n/a	What is meant by non-shellfish aquaculture? Dose this include fish? I do not think EIA are needed at all.
7. Please provide any further views on this section	These are leading questions. SIC Works Licence separation distance is 500 meters, and some earlier sites have operated for nearly 30 years with no problems at lesser distances than this.	You are kind of pre-determining these questions by the possible answers. I don't consider 100 tonnes of mussels any where near a level that should trigger an EIA	I do not think EIA are required at all.

Question	A	B	C
<b>Relevant issues</b>			
2. Do you think that it is important to regulate the layout of the shellfish and non-fish farm structures to prevent excess sedimentation and scour? If yes, do you believe the best way of achieving such regulation through best practice guidance or active regulation through the relevant authority? Please add any further comments and views	The variation between sites is too great to consider blanket legislation. Pre-development applications already consult and assess satisfactorily, and any potential problems are raised at that stage by the relevant body.	We would have to pay for regulation and straight off the bottom line. Not supportable in my case.	the less regulation the better.
5. If you wish, please give examples and explain your reasons relevant to the first 5 questions of this section	It will be very easy for any environmental lobbyist to tick all these boxes with no real consideration of what each one means or involves.	Lice cycle is one approach but is only part of the picture; if one agreed with the need for any approach.	I do not think EIA will help either the environment or the industry in any way
6. Do you think all shellfish and non-fish farming techniques should be subject to EIA? Please explain the reasons for your view	SNH have already proved themselves lacking in knowledge; impractical and illogical in trying to set restrictions on anti-bird predation netting in Shetland. None of the environmental lobby group are qualified to dictate how shellfish farms should be run.	EIA in finfish aquaculture has not been effective but has been extremely costly, bureaucratic.	It is known that shellfish farming has no long term environmental impact
7. Do you believe the assessment of an area's carrying capacity needs to be standardised? Please explain the reasons for your view	The existing assessment is an example of pseudo-scientific meddling. "Fag packet" calculations affect whole business viability and limit the economic use of productive areas. I think the pre-assessment should be considered as indicative guesswork and consents should allow experimental operation to determine the actual performance in situ.	May be a more preferable approach than EIA	no assessment required
9. Please provide any additional comments you wish to make on questions 6 - 9 in this section	It has taken me several hours to consider and complete this questionnaire. This has done nothing to help support this developing industry, which is located entirely in rural locations which are typically economically fragile. The simple development of a shellfish farm is difficult enough without further obstacles being placed in your way. I sincerely believe there is absolutely no need for the development of EIA legislation and yet another tier of inefficient bureaucracy and another cost burden, and I hope this ill-considered demand (from whatever source) is nipped in the bud.	n/a	n/a