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Appropriate Assessments & Shellfisheries: Adaptive Management Protocol

Report to Shellfish Industry Development Strategy

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NATURAL ENGLAND

Shellfish Association of Great Britain

SEAFISH
the authority on seafood

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"One must learn by doing the thing. For though you think you know it,
you have no certainly until you try",

Sophocles 496-406 BC

Executive Summary

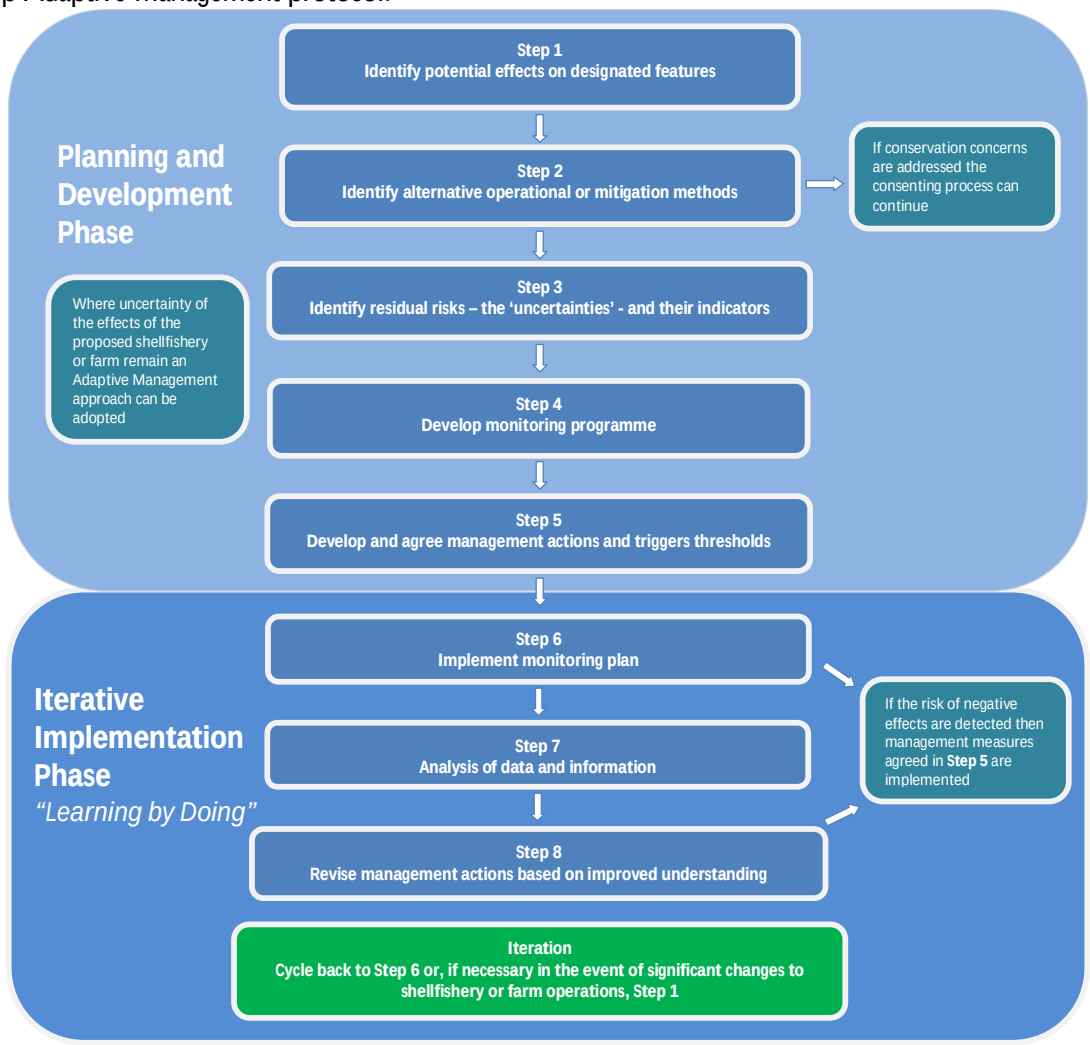
This report provides shellfishermen and shellfish farm operators developing new harvest or cultivation operations with an introduction to the **Adaptive Management** approach and outlines a **step-by-step protocol** produced to enable its application to new developments in European Marine Sites. The protocol aims to address concerns over negative effects or impacts on the environment raised during Appropriate Assessments which could prevent the operation from proceeding.

This report is a joint publication produced in partnership between the Shellfish Association of Great Britain (SAGB), Natural England (NE) and Seafish. The development of the Adaptive Management protocol is a direct result of requirements identified in the Memorandum of Understanding (MoU) signed by SAGB and NE in 2007. The MoU aims to deliver protection and sustainable use of the natural environment in European Marine Sites through a joint commitment to developing more sustainable exploitation patterns in shellfishery and farm operations and the adoption of an ecosystem-based management approach.

Adaptive Management is a key component of ecosystem-based management. Adaptive Management applies a scientifically rigorous approach to address 'uncertainty' by developing knowledge from the results of trials of alternative management measures, essentially '**learning by doing**'. When applied to shellfisheries or cultivation developments this approach may enable a shellfishery or farm operation to begin while developing best practice operational and management measures affording the protection to the environment.

The report draws upon a series of Case Studies to illustrate examples of the use of the Adaptive Management approach in the establishment and management of shellfisheries and cultivation operations in UK European Marine Sites.

The 8 step Adaptive Management protocol:



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1. Introduction

In 2007 the Shellfish Association of Great Britain (SAGB) and Natural England signed a Memorandum of Understanding (MoU) which aims to deliver protection and sustainable use of the natural environment through the use of appropriate and measured management decisions regarding shellfisheries and farm operations in European Marine Sites such as Special Areas for Conservation (SAC) or Special Protection Areas (SPA). The MoU stated a joint commitment to developing more sustainable exploitation patterns in shellfishery and farm operations and the adoption of an ecosystem-based management approach.

The ecosystem-based approach to management, which integrates conservation and shellfishery or farm management objectives, is central to achieving sustainable development of the shellfish industry in European Marine Sites. A key component of ecosystem-based management is the use of Adaptive Management. The Adaptive Management approach provides a means of enabling a shellfishery or farm operation to commence whilst developing best practice operational and management measures that will afford the best protection to the designated site features.

This report provides shellfishermen and shellfish farm operators with an introduction to the Adaptive Management approach and outlines a step-by-step protocol that will assist and enable its application to new shellfishery or farm developments in European Marine Sites particularly where Appropriate Assessments have raised uncertainties over their effects on the environment.

1.1. Uncertainty in the Marine Environment

The marine environment is inherently complex, dynamic and often unpredictable. This complexity results in limitations to scientific understanding of potential negative effects resulting from anthropogenic activities such as shellfishery or farm operations. Although a body of literature exists on the recorded effects of shellfishery and farm operations on marine communities and habitats (SAMS, 2002; Sewell *et al*, 2007), site specific conditions make accurate predictions of negative effects difficult. Conservation and fisheries managers are frequently presented with varying degrees of 'uncertainty' when attempting to assess or consenting new shellfisheries and shellfish farm developments in European Marine Sites. This uncertainty and lack of knowledge often precludes effective management, and can cause significant delays or prevent the consenting process of new shellfishery or farm developments in European Marine Sites, (Lake, 2007; Woolmer, 2007).

Management Options When Faced with 'Uncertainty'

When faced with 'Uncertainty' managers have a number of options for action (adapted from Taylor, 2000):

1. **Discount the uncertainty.**

Managers may wish to discount uncertainties and base management decisions on the best available information and knowledge. This approach may lead to negative fishery and conservation outcomes particularly where there is no monitoring of the potential effects or impacts.

2. **Postpone consents until uncertainties are addressed.**

Managers may delay consenting or management actions until uncertainties can be addressed. It may be scientifically difficult, and the costs impractically high for the shellfish industry to address these

uncertainties. This option leaves the 'uncertainty' unaddressed and the consenting process stops which would result in significant socio-economic impacts on the shellfish industry.

3. **Overly cautious decision making.**

Managers may make decisions based on the worst case scenario leading to overly restrictive outcomes for the shellfish industry. With insufficient understanding of the potential effects of developments Appropriate Assessments are unable to proceed and where the risk of disturbance to site features is judged to be unacceptable the 'Precautionary Principle is applied.

4. **Adaptive Management or 'Learning by Doing' approach.**

Managers can adopt an adaptive management approach and consent to the development under strict and agreed management regime. Managers and developers work in partnership to design a monitoring plan which provides information that resolves key uncertainties and guides adaptation of the shellfishery or farm operations, which ultimately means:

- The designated site features remain protected;
- The shellfishery or farm development proceeds, and;
- A better understanding is developed about the site and the effects of operations.

The Adaptive Management approach is favoured by both SAGB and NE when dealing with 'uncertainties' over the effects of shellfishery or farm developments in or close to European Marine Sites.

1.2. What is Adaptive Management?

> "Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. It's most effective form, 'active' adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed."
>
> From Nyberg, J.B. 1998.

Adaptive management is an iterative process which applies a scientifically rigorous approach to address 'uncertainty' by developing understanding from the results of trials of alternative management measures. The approach combines existing knowledge, investigates alternative management options and makes predictions about their effects on the environment. Management options and monitoring programs are designed to produce accurate and robust information in order to test the predictions and to provide information on the environmental effects of alternative management options. Management options and objectives are then adjusted based on this information and improved understanding.

Adaptive management has its foundation in approaches developed by the ecologists C. S. Holling and C. J. Walters at the University of British Columbia in the 1970s (Holling, 1978; Walters, 1986). The approach has gained broad acceptance by resource managers over the past three decades, particularly in the US and Canada, and provides the foundation to conservation management approaches dealing with uncertainty advocated by wildlife Non-governmental Organisations (NGOs). Most recently a partnership of wildlife NGOs including the World Wildlife Fund (WWF) and the International Union

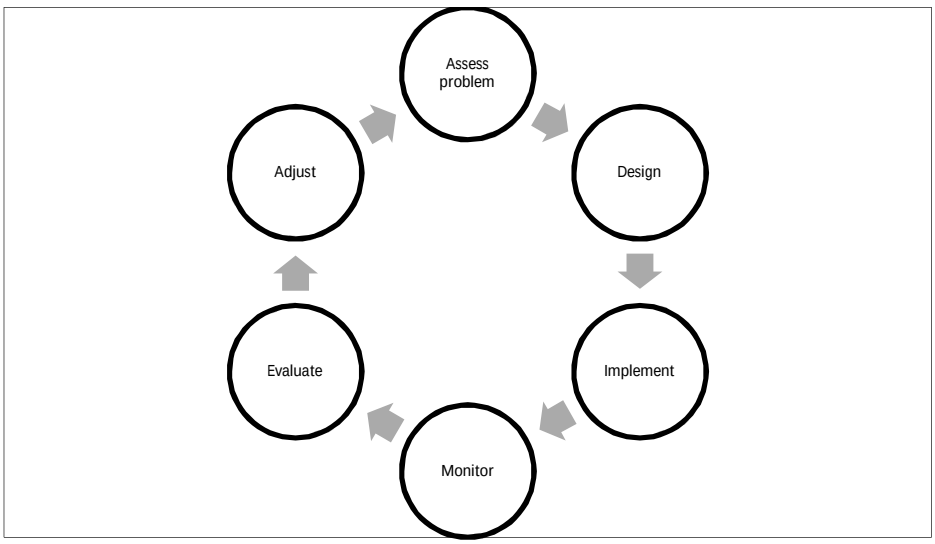
for Conservation of Nature (IUCN) have published the 'Open Standards for the Practice of Conservation' that places adaptive management at its heart (CMP, 2007). Adaptive management, although initially applied to terrestrial resource and conservation management, has been successfully applied to the management of marine fisheries, e.g. the system of real time closures to protect cod stocks in the North Sea, and is widely promoted for the management of marine reserves (McCook *et.al.* 2009; Rowell, 2009).

Adaptive management is one of the five core principals of Defra's Ecosystem Approach Action Plan, 'Securing a healthy natural environment' which outlines Defra's action plan for embedding an ecosystems approach into policy-making and delivery on natural environment matters (Defra, 2007). The European Parliament and Council adopted a Recommendation on implementing Integrated Coastal Zone Management in Europe in 2002. The Recommendation asked Member States to develop strategies to implement an integrated approach to management of coastal areas following eight key principals of which included the use of adaptive management.

1.3. The Adaptive Management Framework

This basic framework presented here largely follows that of Nyberg (1999) and has been popularised by other authors. The basic adaptive management framework follows 6 fundamental steps. These steps can be applied to all situations where the adaptive management approach is applicable. Figure 1 provides a schematic of the adaptive management process.

Figure 1. Conceptual framework for Adaptive Management (after Nyberg, 1999)



Assess Problem – managers (Statutory Nature Conservation Advisors (SNCAs)/Regulators) and stakeholders (shellfishermen/farmers) define the conservation or management problem. At this stage existing knowledge about the site is collated and from this the participants can consider the potential effects or outcomes of alternative management or operational actions. The predicted outcomes enable participants to identify the most likely actions that will meet conservation or resource management objectives.

It is during this stage that the key information gaps and sources of 'uncertainty' that limit the ability to predict effects or outcomes are determined.

Design – managers and stakeholders design a management and monitoring plan that provides accurate and robust information on the effectiveness of the chosen management options. This stage establishes and enables a learning ethos to the project. The monitoring plan should be designed to address the key 'uncertainties' and knowledge gaps by testing predictions using scientific approaches such as hypothesis testing.

Implementation – the management plan is implemented and the development or resource management operations begin.

Monitoring – the monitoring plan is put into operation and data is gathered to determine the effectiveness of the management actions in meeting resource or conservation management objectives. The data is used to test the predicted outcomes in order to better understand the system.

Evaluation – the results of the monitoring programme are evaluated and compared to the predicted outcomes of the management plan.

Adjustment – this stage allows managers and stakeholders to adjust management actions, operational details and revise objectives based on increased understanding of the site. Revised predictions of environmental effects can be developed to address further or remaining uncertainties that should be resolved. The cycle continues, acting to increase understanding of the system and long-term processes.

1.4. What can the shellfish industry and managers achieve by adopting an adaptive management approach?

There are multiple benefits to be gained by adopting an adaptive management approach when developing new shellfishery or farms in or close to European Marine Sites. The key advantage of this approach is its capacity to enable a development to proceed where the alternative would be the failure to gain consents or licences. The costs incurred in participating in a monitoring programme and management plan will most likely outweigh those of not proceeding with a shellfishery or farm development.

In addition to the commercial benefits of adopting this approach all participants will benefit from a well designed adaptive management programme. Such a programme could:

- Develop better ways of meeting conservation and shellfishery or farm management objectives;
- Identify key gaps in understanding that lead to uncertainty and prevent effective shellfishery, farm and conservation management;
- Improve understanding of ecosystem responses, thresholds and dynamics, in order to adapt shellfishery and farm practices to fit changing socio-economic and ecological conditions including climate change;
- Produce reliable feedback about effectiveness of alternative shellfishery and farm practices helping the industry to optimise their operations through for example, better husbandry practices or sustainable exploitation;
- Encourage innovation, learning and understanding between managers and shellfish industry stakeholders;
- Adaptive management may also help detect and address cumulative, long-term, large-scale, and emergent effects of shellfishery and farm operations.

1.5. Key Points

- Adaptive management acknowledges that there is uncertainty about how marine ecosystems function and how they respond to shellfishery and farm operations.
- Adaptive management aims to improve understanding of alternative shellfishery and farm management actions and their effectiveness in achieving fishery and environmental management objectives.
- Adaptive management makes use of shellfishery and farm management actions and follow-up monitoring to address 'uncertainty' promote understanding and improve subsequent management actions.
- Adaptive management can improve the performance of shellfish fishing and farming operations.

1.6. The Precautionary Principle and Adaptive Management

Advice from the European Court of Justice (C-127/02, September 2004) has provided a very precautionary interpretation of Article 6 of the EC Habitat's Directive, for example on deciding when an Appropriate Assessment is required and the level of certainty required before permitting certain activities following appropriate assessment.

The need to demonstrate 'certainty' that there will be no adverse effect on the integrity of a site, and 'no reasonable scientific doubt' of adverse effect, means that fishery and aquaculture authorities must be 'convinced' that there will not be an adverse effect, and that where any doubt remains as to the absence of adverse effects, the activity must not be authorised.

However, there is a risk that on some occasions there will be insufficient scientific information available to fully explain and predict all impacts. Adoption of the precautionary principle could prevent many activities from proceeding under these circumstances.

Adaptive management however provides the solution to some instances where there is scientific doubt so that the precautionary principle can still be upheld but through a practical approach. This can be achieved through applying judicious and responsible management practices that should include scientific assessments, monitoring and mitigation measures to reduce environmental risk where necessary, and periodic reviews of any restrictions and their scientific bases.

2. Step-by-step Adaptive Management protocol

The Scoping Key can be used to determine if the adaptive management approach is applicable for use to help a shellfishery or farming proposal to pass the legal environmental requirements and gain consents.

Scoping key for Adaptive Management of a shellfishery or farm development

If the answer to any question in the key is negative, then an approach other than adaptive management is likely to be more appropriate.

1. **Is the proposal within a European Marine Site or does the proposal have the potential to affect a European Marine Site?**[1]

No – the adaptive management approach may still have positive shellfishery and environmental benefits but is less likely to contribute to achieving a license or consent.

Yes – go to question 2.

2. **Does the proposal require any form of consent, permission or licence from an authority?**

No – the adaptive management approach could still be used for environmental benefit but cannot be formally recognised through a consenting or licensing scheme

Yes – go to question 3.

3. **Are there uncertainties about the potential environmental impacts of the shellfishery or farm development which are preventing consenting?**

No – In the absence of uncertainty or if uncertainties are not related to environmental impact, adaptive management cannot resolve the consenting issues

Yes – go to question 4.

4. **Can the environmental effects of the shellfishery or farm development be predicted based upon the outcomes of previous cases?**

No – adaptive management cannot proceed without definite predictions of effects.

Yes – go to question 5

5. **Can monitoring programmes and experiments be designed to test the predictions and fill the gaps in knowledge?**

No – if targeted monitoring or data collection it is not logistically possible, it will not be possible to resolve uncertainty regarding impacts of the proposal.

Yes – go to question 6.

6. **Can shellfishery methods or farm operations be adjusted in response to the information generated during monitoring?**

No – adaptive management is not possible without the flexibility to adjust.

Yes – all of the basic conditions are met, and adaptive management is appropriate for this problem.

The step-by-step Adaptive Management protocol is laid out as a flowchart in **Error! Not a valid bookmark self-reference.** and Table 1 outlines the respective actions and responsibilities of participants at each step of the Adaptive Management protocol. (see below)

[1] Local Natural England marine officers can answer this question if uncertainty arises.

Figure 2. Step-by-step flowchart of the Adaptive Management protocol. The protocol is split into two parts; a planning and development phase and an iterative implementation phase.

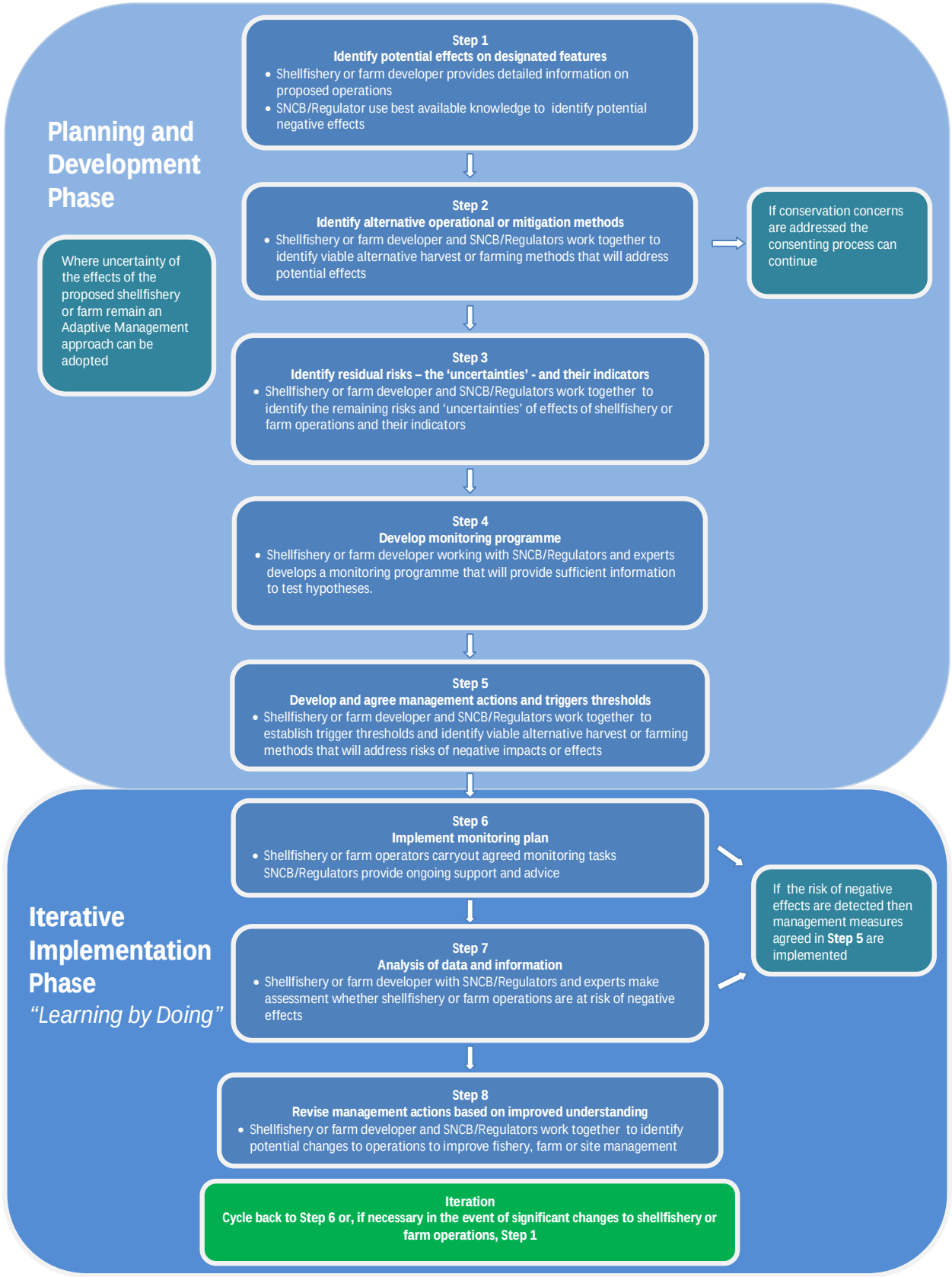


Table 1. Actions and responsibilities of shellfishery or farm developers, and Statutory Nature Conservation Advisors/Regulators at each step of the Adaptive Management protocol

Adaptive Management Steps	**Shellfish Industry Actions and Responsibilities**	**SNCA/Regulator Actions and Responsibilities**
Planning and Development Phase	*It is vital the if the adaptive management approach is to succeed that good regular communication and therefore understanding between participants is developed*	
Step 1 – Identify potential effects on designated features	• Provide detailed information on proposed shellfishery or farm activities	• Provide information on site features and conservation objectives • Identify potential impacts/effects on designated site features based on evidence base
Step 2 – Identify alternative methods and potential mitigation methods	• Identify viable alternative harvest or farming methods that will address or reduce potential effects.	• Assess and provide feedback on suggested alternatives • Provide information of mitigation methods that have been successfully employed in other sites
The outcome of Step 2 may resolve conservation concerns. In the face of continued 'uncertainty' of the effects of the proposed shellfishery or farm operations continue to Step 3. ***There may be a requirement for shellfish industry developers to engage independent expert advice as indicated by ******		
Step 3 - Identify residual risks- the 'uncertainties' – and their indicators*****	• Identify the remaining risks and 'uncertainties' of effects of shellfishery or farm operations	• Provide advice on residual risks of effects or impact
Step 4 – Develop monitoring programme to address risks and 'uncertainties'*****	• Develop with experts and SNCA/ Regulators a statistically robust monitoring programme that will provide information to monitor risks or address 'uncertainties'***** • Identify potential resources to assist or carry out monitoring, e.g. manpower or transport such as vessels or 4 x 4	• Provide feedback and advice on proposed monitoring programme
Step 5 – Develop and agree management actions and trigger thresholds	• Identify potential changes to harvest or farming operations that address potential negative effects for which a risk or 'uncertainty' exists	• Engage with stakeholders to provide feedback on potential changes to shellfishery or farm management
Iterative Implementation Phase *The shellfishery or farm operation begins alongside monitoring programme – learning by doing*	*The shellfishery or farm operators work with SNCA/Regulator in carrying out monitoring programme*	
Step 6 – Implement monitoring plan*****	• Shellfishery/farm operators (or consultant) carry out agreed monitoring tasks***** • Provide data, information or samples to SNCA/Regulator	• Provide ongoing support and advice to monitoring programme participants • May participate in surveys and monitoring work
Step 7 – Analysis of data and information*****	• Undertake statistical analysis and test predictions of negative impacts and effects***** • Work with SNCA/Regulator to provide interpretation of results and review	• Review statistical analysis and test predictions of negative impacts and effects • Review whether shellfishery or farm operations are negatively affecting site features/conservation objectives
Step 8 – Agree revised management actions based on improved understanding	• Identify potential changes to harvest or farming operations that address negative effects or to improve fishery or farm management • Agree revised management changes and revise monitoring plan*****	• Engage with stakeholders to provide feedback on potential changes to shellfishery or farm management • Agree revised management changes and revise monitoring plan
Step 9 – Follow-up monitoring	*The shellfishery or farm operators work with SNCA/Regulator in carrying out monitoring programme*	
Iteration - Cycle back to Step 6 and, if necessary, to Step 1		

2.1 Planning and development phase

The first phase of the Adaptive Management process is the collation of information on the proposed shellfishery or farm development and information on the conservation features of the site. This information can then highlight any potential negative impacts and residual risks (the 'uncertainties') surrounding potential negative effects. The likely potential impacts are addressed where possible and a monitoring programme is designed to address the 'uncertainties'. A set of agreed changes to shellfishery or farm operations are developed to ensure that the conservation site features are protected once operations begin.

Many of the tasks outlined in Steps 1, 2 and 3 will have been carried out under the Regulation 48 and the Appropriate Assessment processes but are included here to demonstrate their place in the Adaptive Management process. A list of government agencies or official bodies likely to be engaged with during the Adaptive Management process is provided in Table 2.

Table 2. Examples of official bodies likely to be involved in the Adaptive Management process

Statutory Nature Conservation Advisors (SNCAs)	**Regulators**
Natural England Countryside Council for Wales Council for Nature Conservation and the Countryside (Northern Ireland) Scottish Natural Heritage	Sea Fisheries Committees Defra Welsh Assembly Government The Scottish Government Department of Agriculture and Rural Development (Northern Ireland) Loughs Agency (Northern Ireland)

Step 1: Identify potential effects on designated features

The aim of this step is to identify any likely significant effects on European Marine Site features caused by the development of a new shellfishery or farm development. In order to achieve this it is essential that all available information on the proposed shellfishery or farm proposal and information on the European site features and their conservation objectives are available.

Shellfish industry operators can find guidance on developing new shellfishery and farm operations in or close to European Marine Sites in the Seafish **'Environmental Toolkit'**[1] at the Seafish website[2]. Of relevance to this step is the **'Appropriate Assessment Proforma'**[3] which can assist in bringing together all of the relevant information required.

There is a large body of scientific literature on the potential effects of shellfishing and farm operations on the environment. A recent review of the impacts of fishing methods common to the UK was carried out by the Marine Biological Association and the University of Plymouth and can be downloaded from the Seafish **'Environmental Toolkit'** website.

It is important that there is an evidence base to support concerns of likely or possible impact or effects proposed by the SNCA/Regulators as this will enable the identification of indicators in Step 3 and enable the Adaptive Management 'Iterative Operational Phase.

[2] The Seafish 'Environmental Toolkit' provides information and guidance on the legal and practical aspects of fishery and aquaculture operations within protected areas website: http://www.seafish.org/b2b/subject.asp?p=326

[3] 'Appropriate Assessment Proforma': http://www.seafish.org/upload/b2b/file/r__d/How%20to%20prepare%20for%20an%20impact%20assessment_Protected%20wildlife%20site.pdf

Example 1. Case Study 2: Hand-gathered mussel fishery in the Solway Firth.

The proposal for a hand-gathered mussel fishery was documented jointly by the shellfishermen and Cumbria Sea Fisheries Committee. The proposal outlined the key operational details:

- Location – presented in coordinates and related to a chart of the area
- Amount and size of mussel stock to be harvested
- Method of harvest
- Method of access

The potential impacts or negative effects were directly related to the site Conservation Objectives and based on well established and documented cases of similar operations:

Designated Features	Potential significant impacts at this site
Mudflats/sandflats	• Physical loss through removal • Biological disturbance through translocation • Biological disturbance through the selective extraction of species
Slightly covered sandbanks	• Physical loss through removal • Biological disturbance through the selective extraction of species
Reefs	• Damage to Sabellaria, found on the channel side of the bed
Bird species	• Visual/noise disturbance • Biological disturbance through the selective extraction of species

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Provide detailed information on proposed shellfishery or farm activities	• Provide information on site features and conservation objectives • Identify potential impacts/effects on designated site features based on evidence base

Step 2: Identify alternative operational or mitigation methods

The aim of this step is to identify viable alternative harvest or farming methods that will address potential effects on European marine nature conservation site features caused by the development of a new shellfishery or farm development. This step would usually be undertaken during the Regulation 48 process when the proposal is undergoing a test for 'likely significant effect'.

During this step the shellfishery or farm developer and SNCA/Regulators work together to address the conservation concerns. The shellfishery or farm developer may be able to suggest or develop alternative harvest or operational methods that will reduce or negate any potential negative effects or impacts to the site features. The Seafish **'Environmental Toolkit'** website contains a series of case studies of Appropriate Assessments and example of mitigation methods that have successfully been employed to reduce or negate negative effects of shellfishing or farm operations in European marine sites. The MBA report '*An Assessment of the Impact of Selected Fishing Activities on European Marine Sites and a Review of Mitigation Measures*'[4] contains a review of potential alternative shellfishing and farming methods that may address conservation concerns.

The SNCA/Regulators may be aware of examples of mitigation or alternative approaches that have been employed in other European marine sites. This information should be introduced to discussions in order to increase fishery stakeholder understanding of issues and alternatives approaches.

Example 2. Case Study 4: Hand-gathered & vessel dredge seed mussel fishery Whiteford Point, Burry Inlet

In response to the potential negative effects and impacts identified in Step 1 the shellfishermen working with the local SFC proposed a series of mitigation measures that addressed many of the concerns:

Designated Features	**Potential significant impacts**	**Mitigating measures**
Dunes system (primarily embryonic shifting dunes)	Physical damage by vehicular access	• Agreed access routes along the foreshore and to the shore were established.
Intertidal habitats	Loss or physical damage of habitat through removal or damage by dredges Damage to physical habitat by vehicles	• Dredge fishery restricted to flat areas of site where physical disturbance to habitat (and gear damage) would be minimised. • Access routes to mussel beds agreed to avoid sensitive habitats
Bird species	Visual/noise disturbance to overwintering waders Biological disturbance through the selective extraction of species	• Fishing was scheduled to take place before the arrival of overwintering wading birds. • Designated routes of access were put in place. • TAC was agreed through discussion with CCW ornithologists and was related to other bird prey resources in the Burry Inlet. The TAC ensured that a significant proportion of mussels at the site remained as a food source for key bird species

[4] MBA report: http://www.seafish.org/upload/file/about_us/Final%20AA%20Report%20Complete%20PDF.pdf

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Identify viable alternative harvest or farming methods that will address or reduce potential effects.	• Assess and provide feedback on suggested alternatives • Provide information of mitigation methods that have been successfully employed in other sites

The outcome of Step 2 may resolve conservation concerns. In the face of continued 'uncertainty' of the effects of the proposed shellfishery or farm operations continue to Step 3

Step 3: Identify residual risks – the 'uncertainties' – and their indicators*

The aim of this step is to identify any residual risks of effect or impact (the 'uncertainties') of the proposed shellfishery or farm operation on the site features or wider marine environment and to make predictions of how these effects could be observed. The risks identified during this step are informed by the information and understanding of the site and potential effects developed in Steps 1 & 2. This step formalises the various 'uncertainties' about negative effects and enables the development of a scientific and robust monitoring program in Step 4.

This step will require expert knowledge and advice in order that the predictions are able to be tested in a scientific monitoring programme to address risks of effects or 'uncertainties'. This expertise may reside within the SNCA/Regulator who may be able to provide advice, or alternatively the shellfishery or farm developer may need to engage an independent expert[5].

Once a risk of an effect or impact has been highlighted an indicator of that effect should be identified. This may be some environmental factor that can be determined either direct measurement or by proxy indicators. For example, in the case of a shellfish farm operation, a potential increase in sediment deposition can be directly measured whereas a reduction of the carrying capacity of an estuary may be reflected in changes to meat yields or growth of other shellfish species.

The indicators enable the establishment of 'triggers' or 'thresholds' that enable intervention (the revised management measures developed in Step 5) before any environmental impact takes place..

Example 3. Case Study 5: Oyster and mussel cultivation trial, Beckfoot Flats, Solway Firth

The developer of the cultivation operation followed Steps 1-2 which resulted in a positive Appropriate Assessment but there remained some uncertainty over certain aspects of the effects of the operation specifically:

a. Risk of damage to Sabellaria and associated communities
b. Risk of community change from escaped non-native species (Pacific oyster).

Indicators for these were:

a. Fishermen operating out of designated areas or travelling outside of agreed access routes
b. Settlement of oyster spat on adjacent hard ground.

These potential effects and impacts were relatively straightforward to assess as they were readily detected visually by SFC officers and by the monitoring programme. As no other oyster cultivation took place in the area, any settling outside of the farm would be directly attributable to the operation.

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Identify the remaining risks and 'uncertainties' of effects of shellfishery or farm operations*	• Provide advice on residual risks of effects or impact

There may be a requirement for shellfish industry developers to engage independent expert advice for this step

[5] Seafish and SAGB may be able to provide assistance with experts in this field

Step 4: Develop monitoring programme to address risks and 'uncertainties'*

During this step shellfishery or farm operators work together with the SNCA/Regulators to design a monitoring programme or set of field experiments to monitor the indicators of risks and uncertain effects developed in Step 3.

Where a risk of an effect is identified, the monitoring regime must be refined enough to identify the risk as high BEFORE the adverse effect occurs. If this cannot be achieved, monitoring is insufficient and the adaptive management process is not applicable.

The success of this step hinges on close communication and partnership working between shellfishery and farm developers, and the SNCA/Regulators. During this step the shellfishery or farm developer should suggest the level of logistical support that they are able to provide to the monitoring programme. For example, monitoring of the site may necessitate the collection of sediment or water samples and the shellfishermen or farmer may offer to either collect these themselves or, if specialist methods are to be employed, provide transport and access via vessels or 4 x 4 vehicles. If the monitoring programme has wider site management benefits the SNCA/Regulators may be willing to participate or undertake some of the tasks themselves.

A series of Seafish Standard Operating Procedures have been developed to enable shellfishermen and farmer to collect a variety of intertidal and subtidal habitat data, these are a available from the Seafish '**Environmental Toolkit**' website

Examples of sampling methods:

- Collection of water samples
- Placement of sediment traps to monitor sedimentation
- Placement of settlement tiles to monitor enhanced settlement of farmed species
- Recording meat yields to assess changes in carrying capacity
- Collection of core samples for sediment and fauna analysis
- Regular photographs of site to collect photo monitoring information

In some cases shellfishery or farm operators may not have the technical expertise to undertake the monitoring tasks and may consider engaging an independent expert as a cost-effective solution.

The monitoring programme or field experiments should be designed to provide sufficient statistical power to adequately test the predictions made in Step 3. This is crucial if the uncertainties about alternative fishery or farm management actions are to be addressed and if resources are to be used efficiently. The monitoring programme should be developed or assessed by an expert with statistical knowledge. This expertise may be available to the SNCA/Regulator but if it is not the shellfishery or farm developer could engage their own independent expert.

When shellfishery or farm operators are carrying out the sampling themselves it is essential to agree regular communication and transfer of data and information with the SNCA/Regulator.

Example 4. Case Study 3: Oyster cultivation trial on the River Teifi, Carmarthenshire

In order to address a number of uncertainties a series of monitoring actions were proposed by the developers:

- Changes in sediment composition where to be monitored by the operator using:
  - Regular photographic monitoring of sediment around structures
  - Regular sediment sampling (Seafish carried out a pilot study to develop a protocol based on accepted geological field techniques)
- Changes to the sediment infauna community where to be monitored by the development of an infauna monitoring programme using expertise a local University
  - Logistical support (use of vessels and manpower) provided by operator

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Work with SNCA/Regulators to develop a statistically robust monitoring programme that will provide information to monitor risks or address 'uncertainties'* • Identify potential resources to assist or carry out monitoring, e.g. manpower or transport such as vessels or 4 x 4	• Provide feedback and advice on proposed monitoring programme

There may be a requirement for shellfish industry developers to engage independent expert advice for this step

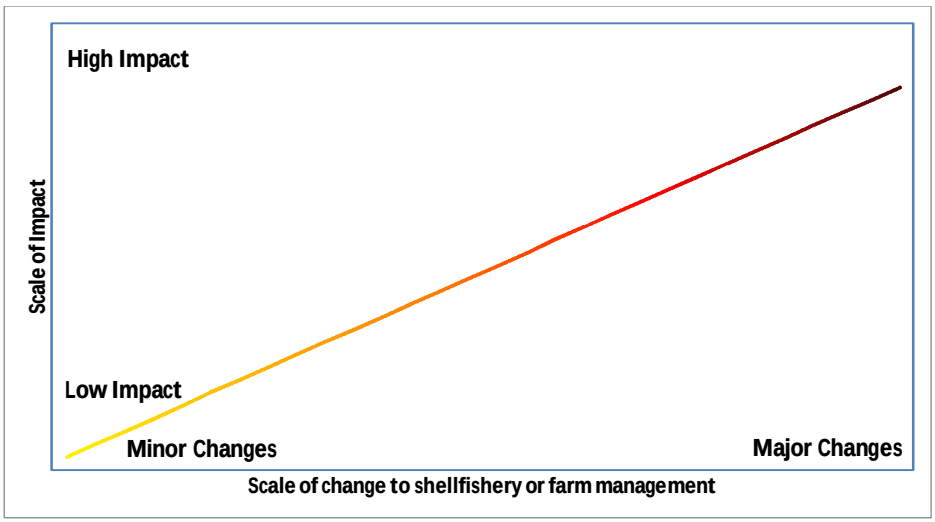
Step 5: Develop and agree management actions and trigger thresholds

The aim of this step is to develop and agree alternative shellfishery or farm procedures or methods that must be implemented in the event that the monitoring plan establishes that the operation has a high risk of a negative environmental effect or impact. This step is essential in ensuring that the European marine site is afforded the highest level of protection from negative impacts and that shellfishery and farm operators are able to rapidly implement changes to their operations.

During this step SNCA/Regulators should work with the shellfishery or farm operators to establish and agree thresholds or triggers which instigate appropriate management measures or changes to operations. For example, at a site where sedimentation is a concern the trigger may be the detection of certain changes in sediment settlement, or in sites where wildlife disturbance is an issue the movement or exclusion of birds from an area may trigger changes to the timing of operations.

The range of changes to the operations of a shellfishery or farm can range from cessation of the operation to minor changes in harvest or husbandry methods (Figure 3).

Figure 3. Figurative scale of changes to shellfishery or farm management in relation to severity of negative impact.



Examples of potential changes to shellfishery or farm operations in the event of a negative impact being detected:

- Changes to access route or method in the event of wildlife disturbance if birds or other wildlife were displaced as a result of vehicle access.
- Changes to times of day or year that shellfishery or farm operates to avoid wildlife disturbance such as disturbance to over wintering birds
- Changes to stocking density of shellfish farm to mitigate against carrying capacity effects
- Siting of shellfish farm in area of higher current flow to mitigate against sedimentation effects

Example 5. Case Study 2: Hand-gathered mussel fishery in the Solway Firth

A series of permit conditions were applied to any gatherer wishing to gather mussels at the site. These ensured that the mussel bed and surrounding habitats were subject to minimal disturbance through compliance of a code of conduct.

Permit conditions (Permits would be revoked should conditions not be adhered):

- all CSFC byelaws must be adhered to;
- permit cards must be carried at all times;
- daily records of catches must be made and submitted to the CSFC;
- any riddling of mussels must take place on or near the bed from which they were removed;
- undersized mussels must be re-deposited;
- no mechanical devices, except those approved by CSFC, can be used to remove mussels; and
- the voluntary code of conduct must be respected

In order to protect the bird prey resources at this site a Total Allowable Catch threshold was agreed with Natural England which once reached the fishery would be closed

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Identify potential changes to harvest or farming operations that address potential negative effects for which 'uncertainty' exists	• Engage with stakeholders to provide feedback on potential changes to shellfishery or farm management

2.2 Iterative implementation phase – learning by doing

The second phase of the Adaptive Management process is when plans are put into action and the shellfishery or farm operation begins. The agreed monitoring plan is begun and carries on alongside the shellfishery or farms day-to-day functions.

This phase is when shellfishery and farm operators and the SNCA/Regulators learn about the effectiveness of their management actions and the effects of the operations on the site and wider marine environment.

This phase is described as **iterative** as it provides a means of making a series of informed changes to shellfishery or farm management or methods to minimise any negative impacts on the marine environment and to improve working efficiency responding to improved understanding.

Step 6: Implement Monitoring Plan

This step begins with the start of a shellfishery or farming operation. There may be a requirement in the monitoring plan to undertake sampling immediately before the start of operations but that will be outlined in the monitoring plan.

The shellfishery or farm operators carry out agreed monitoring tasks or provide logistical assistance to SNCA/Regulators carrying out monitoring work.

It is important that agreed communication and submission of data, information or samples is adhered to as these will inform the monitoring plan and enable the SNCA/Regulator to make assessments in Step 7.

In the event that the predicted negative effects or impacts are detected then the alternative management measures agreed in Step 5 are implemented.

Example 6. Case Study 4: Hand-gathered & vessel dredge seed mussel fishery Whiteford Point, Burry Inlet

In order to monitor the potential effects of the hand-gathered mussel fishery and to generate more information about the seasonal cycles at the site a monitoring programme was agreed between fishermen, the SFC and CCW. This consisted of:

- Compliance monitoring of TAC, adherence to access routes surveillance and avoidance of *Sabellaria* (buyers/processors marshalling traffic and SFC officers)
- SWSFC undertook regular mussel surveys
- SWSFC established a series of photo monitoring sites at Whiteford Point in order to record the succession of recruitment, growth and fate of the mussel beds
- SWSFC officers carried out rigorous TAC and size compliance monitoring

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Shellfishery or farm operators (or consultant) carry out agreed monitoring tasks • Provide data, information or samples to SNCA/Regulator	• Provide ongoing support and advice to monitoring programme participants • May participate in surveys and monitoring work

Step 7: Analysis of data and information*

The data and information gathered and produced during the monitoring programme is analysed and reviewed during this step. It is during this step that the predictions made in Step 3 are evaluated and the 'uncertainties' over negative impacts or effect of the shellfishery or farm operation are addressed.

This step may take place after an extended period of sampling and monitoring to account for seasonal factors or, if particular impacts or effects are predicted in a short time, there may be an ongoing need for continual assessment.

In order to accurately test the predictions of possible negative impacts and effect made in Step 3 there is a requirement for statistical expertise and analysis of the results of the monitoring which may be carried out by the Regulator. However, the role of the SNCA's/Regulators is to review the results of the analysis to inform their opinion on management decisions. As a result, the shellfishery or farm operators may consider engaging their own independent expert or possibly working with Universities and students to undertake the analysis of data to present results if this requires technical expertise.

Although the shellfishery or farm operators may not have the capacity to carry out the analyses themselves they do however have an important role in assisting the SNCA/Regulators with interpreting the results. As the shellfishery or farm operators are regularly working at the site, often daily, they will be able to provide key insights into the processes and factors affecting the site.

The results of the analysis and interpretation will reveal whether the shellfishery of farm operation is having a negative effect on the site features and conservation objectives.

Example 7. Case Study 4: Hand-gathered & vessel dredge seed mussel fishery Whiteford Point, Burry Inlet

The monitoring programme at Whiteford Point has provided extensive body information:

- The photo monitoring programme has produced a extensive time-series data set which has addressed key uncertainties about the mussel beds at Whiteford Point revealing that they are ephemeral due to storm action and wave exposure
- The improved understanding of the dynamics of the site has enabled the consenting Appropriate Assessment process to be carried out more quickly
- The regular mussel survey information has provided important information for the management of both fishery and bird food resources

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Undertake statistical analysis and test predictions of negative impacts and effects* • Work with SNCA/Regulator to provide interpretation of results and review	• Review statistical analysis and test predictions of negative impacts and effects • Review whether shellfishery or farm operations are negatively affecting site features/conservation objectives

There may be a requirement for shellfish industry developers to engage independent expert advice for this step

Step 8: Revise management actions based on improved understanding

The step brings together the information from the Planning and Development Phase (Steps 1-5) and the new information produced in the Steps 6 and 7 to revise the management and operations of the shellfishery or farm operation. By undertaking the monitoring work in Steps 6 and 7 both shellfishery or farm operator and the SNCA/Regulators can now make adjustments to the operation based on an improved understanding and the removal of 'uncertainty'.

In the event that the high risk of a negative effect or impact is detected then the alternative management measures agreed in Step 5 can be implemented. Alternatively the information and better understanding of the site and associated processes may enable the development of more appropriate conservation management measures or changes to operations.

The improved understanding of the site may enable changes to the shellfishery or farm operation that improves its operational efficiency or increases its production. All proposed changes should be developed and agreed with the SNCA/Regulator.

Once a revised management plan for the shellfishery or farm has been agreed it may be necessary to adapt or revise the monitoring plan.

Cycle back to Step 6 or, in the event of significant changes to shellfishery or farm operations, Step 1

Example 8. Case Study 1: The Wash Mussel Fishery Management Policies.

The information and data routinely collected in the monitoring programme now informs the management of the following years fisheries which are considered annually.

Mussel fishery management policies outlining the agreed management actions first drawn up in 2007 are reviewed in partnership between fishermen, ESFJC and Natural England as appropriate according to environmental and socio-economic drivers.

Industry Actions and Responsibilities	SNCA/Regulator Actions and Responsibilities
• Identify potential changes to harvest or farming operations that address negative effects or to improve fishery or farm management • Agree revised management changes and revise monitoring plan*	• Engage with stakeholders to provide feedback on potential changes to shellfishery or farm management • Agree revised management changes and revise monitoring plan

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Appendix 1. Adaptive Management Case Studies

Case Study 1: The Wash Mussel Fishery Management Policies 2007			
Proposal:	The Wash Mussel Fishery Management policies outline management actions and policies concerning commercial harvesting of mussels from intertidal mudflats in The Wash.		
SNCA:	Natural England		
Regulator	Eastern Sea Fisheries Joint Committee		
Site Designation:	Special Area for Conservation, Special Protection Area, Ramsar, SSSI		
Description:	The Wash is the largest embayment and the most important wetland site in the UK. Its vast expanses of mudflats and saltmarsh contain huge numbers of shellfish and other invertebrates, and support large populations of wintering and passage waterfowl. The saltmarshes are important for breeding waders. The Wash supports a significant Common seal population, and subtidal colonies of the reef-building Ross worm (Sabellaria spinulosa).		
Step 1. Potential effects on designated site features	Potential hazard (only those that may result from the proposed activity are listed)	Feature / Sub-feature	Vulnerability
	Physical damage (i.e. abrasion)	Sand and gravel communities	Low
		Muddy sand communities	Moderate
		Mud communities	Low
	Non-physical disturbance (noise and visual presence)	Common seals / SPA species:	High
	Physical loss (removal e.g. by harvesting)	Sand and gravel communities	High
		Muddy sand communities	High
		Mud communities	High
	Biological disturbance (selective extraction of species)	Sand and gravel communities	Moderate
		Muddy sand communities	Moderate
		Mud communities	Low
Step 2. Mitigation or operational alternatives identified	Technical measures limit size and number of dredges that may be used, to minimise physical damage • Fishing restricted to marked, open area and prohibited on older, more diverse part of mussel bed, to minimise physical damage and protect diversity of bed. • Individual daily quota limits daily effort, to minimise physical damage. • Seasonal quota limits seasonal effort, to minimise biological disturbance through selective extraction of species. • Requirement for licence (from limited licence pool) limits total effort, to minimise biological disturbance. • Quota allocated reflects mussel bed's ability to withstand fishery: minimum bed density identified to ensure bed integrity is maintained. • Fishery takes place over high water so no disturbance to hauled out Common seals or wader birds feeding on mussel bed at low water. • Mussel cultivation (using imported or locally sourced seed) is encouraged as an alternative to reliance on natural stocks for harvestable fishery.		
Step 3. Predicted effects of development	The preceding step resulted in a positive Appropriate Assessment some key uncertainties were identified: • Localised reduction in mussel density • Changes in distribution of seals		

	• Changes in distribution of wildfowl and waders
Step 4. Monitoring program	To address these issues an extensive monitoring programme was developed: • Mussel beds surveyed annually to assess stock abundance, bed extent, coverage of mussels (bed density), and mussel population composition. • Mussel fishery monitored via compulsory landings returns, and on-site enforcement of spatial measures. • Common Seal and bird distribution and abundance monitored by SNCA
Step 5. Agreed management actions	• Mussel stocks surveyed and acceptable quota set; • Technical and spatial restrictions agreed via consultation with fishing industry, SFC and SNCA. • Common seal and bird disturbance considered in Appropriate Assessment of fishery.
Steps 6-8. Outcomes of implementation phase	Mussel beds are re-surveyed to ascertain stock losses, juvenile recruitment and bed density. This data informs the management of future fisheries which are considered annually; measures applied depend on findings of post-fishery surveys. Mussel fishery management policies (that outline the agreed management actions) drawn up in 2007; are reviewed as appropriate according to environmental and socio-economic drivers.
Further information	http://www.esfjc.co.uk/ems/pages/ems.htm http://www.esfjc.co.uk/management%20policies%2008.pdf

<table>
<tr><th colspan="3">Case Study 2: Hand-gathered mussel fishery in the Solway Firth, 2004 – present</th></tr>
<tr><td>Proposal:</td><td colspan="2">A proposal was made to open a mussel bed to hand-gathering in Beckfoot Flats in the upper Solway Firth. The shellfishermen wished to harvest ~180 tonnes of mussels with a minimum landing size of 45 mm. The mussel bed was considered to be ephemeral and susceptible to loss due to the sites exposure susceptible to strong onshore winds and extreme tidal currents.</td></tr>
<tr><td>European Marine Site</td><td colspan="2">Solway Firth SAC and Upper Solway Flats and Marshes SPA and SSSI</td></tr>
<tr><td>Site Designation:</td><td colspan="2">Special Area for Conservation, Special Protection Area, Ramsar Site, (and nationally designated Special Site of Scientific Interest)</td></tr>
<tr><td>Site Description</td><td colspan="2">The Solway Firth SAC is designated for its estuaries, mudflats and sandflats that are not covered by seawater at low tide, and its sandbanks, which are slightly covered by seawater at all times.

The Upper Solway Flats and Marshes Special Protection Area (SPA + SSSI) and Ramsar Site, is designated for its internationally important populations of regularly occurring Annex 1 species, assemblage of waterfowl, populations of regularly occurring migratory species, and over-wintering populations of migratory waterfowl.</td></tr>
<tr><td>SNCA:</td><td colspan="2">Natural England (NE)</td></tr>
<tr><td>Regulator</td><td colspan="2">Cumbria Sea Fishery Committee (CSFC)</td></tr>
<tr><td>Step 1. Potential effects on designated site features</td><td colspan="2"><table>
<tr><th>Designated Features</th><th>Potential significant impacts</th></tr>
<tr><td>Mudflats/sandflats</td><td>• Physical loss through removal
• Biological disturbance through translocation
• Biological disturbance through the selective extraction of species</td></tr>
<tr><td>Slightly covered sandbanks</td><td>• Physical loss through removal
• Biological disturbance through the selective extraction of species</td></tr>
<tr><td>Reefs</td><td>• Damage to Sabellaria, found on the channel side of the bed</td></tr>
<tr><td>Bird species</td><td>• Visual/noise disturbance
• Biological disturbance through the selective extraction of species</td></tr>
</table></td></tr>
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Step 2. Mitigation or operational alternatives identified

Designated Features	Potential significant impacts	Mitigating measures
Mudflats/Sandflats Slightly Covered Sandbanks	Appropriate Assessment revealed that there would be 'no significant effect' on these features	N/A
Reefs	Damage to *Sabellaria*	• Fishermen restricted to gathering on the landward side of the bed avoiding Sabellaria reefs. • A voluntary code of conduct will increase awareness regarding the need to avoid damage/disturbance to *Sabellaria*.
Bird species	• Visual/noise disturbance • Biological disturbance through the selective extraction of species	• TAC and daily catch restrictions were set to ensure that the fishery was either executed by a large number of people for a short time or, as was the case, by a small number of people for a longer time. This limited the amount of disturbance. • Designated routes of access were put in place. • TAC aimed to remove a maximum of 33% of the total biomass of >45 mm mussels. This ensured that sufficient mussels remained as a food source for key bird species such as bar-tailed godwit, turnstones and oystercatchers • CSFC's previous Mussel Stock Assessment surveys indicated that thinning commercial sized mussels from the beds in the Solway creates a better platform for seed/spat to settle and therefore provides a steady food source for bird populations in the area

Step 3. Predicted effects of development	Although the preceding steps resulted in a positive Appropriate Assessment outcome concluding that "The proposal…will not adversely affect the integrity of the site", there remained some uncertainty over the effects of the shellfishing operation and certain conditions were attached to hand-gathering permits issued by CSFC.
Step 4. Monitoring program	A monitoring programme was agreed and consisted of: • Compliance monitoring of TAC, adherence to access routes surveillance and avoidance of Sabellaria • CSFC undertook regular stock assessment surveys to provide information on settlement and bird food levels

Step 5. Agreed management actions	Addressed through fisheries management measures of: • Total allowable catch threshold after which the fishery would be closed • Permits would be revoked should conditions not be adhered. Permit conditions: - all CSFC byelaws must be adhered to; - permit cards must be carried at all times; - daily records of catches must be made and submitted to the CSFC; - any riddling of mussels must take place on or near the bed from which they were removed; - undersized mussels must be re-deposited; - no mechanical devices, except those approved by CSFC, can be used to remove mussels; and - the voluntary code of conduct must be respected
Steps 6-8. Outcomes of implementation phase	• The shellfishery has operated annually since 2004 • During the 2005-2006 mussel harvesting season 190 tonnes were removed and ~140 tonnes during the 2007-2008 season by up to 30 hand gatherers • No damage to site features has been reported • The improved understanding of the dynamics of the site has enabled the consenting Appropriate Assessment process to be carried out more quickly

Case Study 3: Oyster cultivation trial on the River Teifi, Carmarthenshire, 2008

Proposal:	The proposal was to trial the cultivation of Pacific oysters (Crassostrea edulis) using oyster trestles on an intertidal sandbank in the River Teifi in Carmarthenshire. In the event that the trial was successful an application for a several order would be made. The oysters were to be held in plastic mesh bags suspended from four inch larch posts 1.5 ft above the sediment surface. The total area of sandbank covered by the oyster trestles was 75 m^2
SNCA:	Countryside Council for Wales
Regulator	Welsh Assembly Government
European Marine Site	Afon Teifi SAC
Site Designations:	Afon Teifi SAC & Afon Teifi SSSI
Site Description:	The Afon Teifi SAC is designated for its tidal rivers, estuaries, mud flats, sand flats and lagoons. It also has adjacent Salt marshes, salt pastures and salt stepps. The remaining designated features are terrestrial or freshwater habitats. The Teifi is designated along its length as a SSSI (Afon Teifi SSSI) in regard to the range of river types and associated riverside habitats and a diverse assemblage of species including otters and waterbirds.

Step 1. Potential effects on designated site features

Designated Feature	Potential Impacts
Otters (A feature of the Afon SAC & Afon Teifi SSSI)	• **Disturbance to otters** - Activity during construction of the trestles; and - Repeated access to the trial site for on-going maintenance.
Estuary (A feature of the Afon SSSI)	• **Changes in sediment distribution, movement and composition:** - Changes to local sediment deposition and scour pits around the trestle legs - Deposition of faeces and pseudofaeces beneath the trestles, resulting in localised organic enrichment and input of fine sediment; - Establishment of estuarine plants and animals, which in turn will increase localised organic input into sediments; - Deposition of operational debris associated with the oyster trial, such as old timber and mesh bags; - Accumulation of shell debris; and - Compaction of the sediment caused by repeated access across the shore could change sediment composition and structure and damage the saltmarsh vegetation. • **Disturbance to intertidal communities** - Construction and maintenance of the oyster culture will result in localised disturbance to intertidal communities, with greatest detrimental effect to communities in soft sediments.
Wading birds and wildfowl (A feature of the Afon SSSI)	• **Disturbance to wading birds and wildfowl** - Repeated access to the site for on-going maintenance
Local biodiversity	• **Change to local biodiversity** - Introduction and establishment of adult Pacific Oysters escapees from the farm site; and

		- Settlement of juvenile Pacific Oysters outside the farm site that have spawned from the farm stock.	
Step 2. Mitigation or operational alternatives identified	**Designated Features**	**Potential significant impacts**	**Mitigating measures**
	Otters	Disturbance to otters	• Construction of the trestles will take place at times when disturbance to otters is least likely, for example during daylight hours • Access to the site will be by boat from the floating pontoon at Coronation Drive, Pen yr Ergyd. To minimise disturbance to otters, access times and frequency will be agreed with CCW and other members of the advisory group
	Estuary	Changes in sediment distribution, movement and composition Deposition of operational debris associated with the oyster trial, such as old timber and mesh bags Accumulation of shell debris; Compaction of the sediment caused by repeated access across the shore could change sediment composition and structure and damage the saltmarsh vegetation Disturbance to intertidal communities	• **A source of uncertainty to be addressed by the monitoring programme** • Site to be checked and cleared every spring tide – this is a routine operational procedure • Site to be routinely checked and cleared of any live or dead oyster shells • Access only by small boat from a floating pontoon adjacent to the site. Only foot access on the actual site • **A source of uncertainty to be addressed by the monitoring programme**
	Wading birds and wildfowl	Disturbance to wading birds and wildfowl	• Proposed a code of conduct to address any issues surrounding the operation of the site. • Infrequent visits from a heavily used pontoon to ensure minimal disturbance to wildfowl and waders • Cold weather contingency to minimise disturbance
	Local biodiversity	Change to local biodiversity	• Spills of oyster or escapes through damage to be immediately cleared • Adherence to Pacific Oyster Protocol • Possibility of the use of triploid stock to negate spawning risk

Step 3. Predicted effects of development	The preceding steps describe CCWs concerns and the mitigation methods suggested by the developers there remained some uncertainty over the effects of the development that could not be easily addressed. These were: • Changes in sediment composition, specifically; - Formation of scour pits around posts - Deposition of faeces and pseudofaeces • Disturbance of intertidal fauna - Disturbance to soft sediment fauna
Step 4. Monitoring program	In order to address these uncertainties a series of monitoring actions were proposed by the developers: • Changes in sediment composition - Regular photographic monitoring of sediment around structures - Regular sediment sampling (Seafish carried out a pilot study to develop a protocol based on accepted geological field techniques) • The development of an infauna monitoring programme using expertise from local universities • In addition, the developers proposed a photographic log of the site to ensure compliance with key mitigation measures such as site clearing.
Step 5. Agreed management actions	This process is ongoing but is delayed while the developers consider whether to proceed.
Steps 6-8. Outcomes of implementation phase	N/A

Case Study 4: Hand-gathered & vessel dredge seed mussel fishery Whiteford Point, Burry Inlet, 2004 – present

Proposal:	A proposal was made to undertake the removal of seed mussels from Whiteford Point in the Burry Inlet by teams of hand gatherers. Anecdotal reports suggested that mussels were regularly swept away from this site during winter storms and therefore the mussel bed was ephemeral.
European Marine Site	Carmarthen Bay and Estuaries SAC, Carmarthen Bay Dunes SAC and Burry Inlet SPA/Ramsar
Site Designation:	Special Area for Conservation, Special Protection Area, Ramsar Site
Site Description	The Carmarthen Bay and Estuaries SAC is designated for its estuaries, mudflats and sandflats that are not covered by seawater at low tide, and its sandbanks, which are slightly covered by seawater at all times. Carmarthen Bay Dunes SAC is designated for its sensitive coastal sand dunes and machair (low-lying grassy plain). The Burry Inlet (SPA) and Ramsar Site, is designated for its internationally important populations of regularly occurring Annex 1 species, assemblage of waterfowl, populations of regularly occurring migratory species, and over-wintering populations of migratory waterfowl.
SNCA:	Countryside Council for Wales (CCW)
Regulator	South Wales Sea Fisheries Committee (SWSFC)

Step 1. Potential effects on designated site features

Designated Features	Potential significant impacts
Dunes system (primarily embryonic shifting dunes)	• Physical damage by vehicular access
Intertidal habitats	• Loss of physical habitat through removal or damage by dredges • Damage to physical habitat by vehicles • Biological disturbance through the selective extraction of species
Bird species	• Visual/noise disturbance to overwintering waders • Biological disturbance through the selective extraction of prey species

Step 2. Mitigation or operational alternatives identified

Designated Features	Potential significant impacts	Mitigating measures
Dunes system (primarily embryonic shifting dunes)	Physical damage by vehicular access	• Agreed access routes along the foreshore and to the shore were established.
Intertidal habitats	Loss or physical to habitat through removal or damage by dredges Damage to physical habitat by vehicles	• Dredge fishery restricted to flat areas of site where physical disturbance to habitat (and gear damage) would be minimised. • Agreed access routes to mussel beds agreed to avoid sensitive habitats

	Bird species	Visual/noise disturbance to overwintering waders Biological disturbance through the selective extraction of species	• Fishing was scheduled to take place before the arrival of overwintering wading birds. • Designated routes of access were put in place. • TAC was agreed through discussion with CCW ornithologists and was related to other bird prey resources in the Burry Inlet. The TAC ensured that a significant proportion of mussels at the site remained as a food source for key bird species specifically oystercatchers and knot.
Step 3. Predicted effects of development	Although the preceding steps resulted in a positive Appropriate Assessment outcome concluding that, there remained some uncertainty over the ephemeral nature of the mussel beds at the site and of the effects of the shellfishing operation.		
Step 4. Monitoring program	A monitoring programme was agreed and consisted of: • Compliance monitoring of TAC, adherence to access routes surveillance and avoidance of Sabellaria • SWSFC undertook regular mussel surveys • The regular mussel survey information has provided important information for the management of both fishery and bird food resources • SWSFC established a series of photo monitoring sites around Whiteford Point in order to record the succession of recruitment, growth and fate of the mussel beds. • SWSFC officers carried out rigorous compliance monitoring		
Step 5. Agreed management actions	Addressed through fisheries management measures of: • Total allowable catch threshold after which the fishery would be closed • Access routes would be reviewed		
Steps 6-8. Outcomes of implementation phase	• The shellfishery has operated annually since 2004 • The photo monitoring programme has produced a extensive time-series data set which has addressed key uncertainties about the mussel beds at Whiteford Point • No damage to site features has been reported • The improved understanding of the dynamics of the site has enabled the consenting Appropriate Assessment process to be carried out more quickly		

Case Study 5: Oyster and mussel cultivation trial, Beckfoot Flats, Solway Firth, 2007 – present

Proposal:

The proposal was to trial the farming of Pacific Oysters (*Crassostrea gigas*) and mussels (*Mytilus edulis*) using the Boddington BST longline system and Bouchot posts respectively at Lowhagstock Scar, Beckfoot Cumbria over 10 years. The trial included the erection of five 100 m long Boddington longline-systems, each carrying 4 lines, and 3 double rows of 200 bouchot poles.

European Marine Site

Solway Firth SAC and Upper Solway Flats and Marshes SSSI and SPA

Site Designation:

Special Area for Conservation, Special Protection Area, Ramsar Site, (and nationally designated Special Site of Scientific Interest)

Site Description

The Solway Firth SAC is designated for its estuaries, mudflats and sandflats that are not covered by seawater at low tide, and its sandbanks, which are slightly covered by seawater at all times.

The Upper Solway Flats and Marshes Special Protection Area (SPA + SSSI) and Ramsar Site, is designated for its internationally important populations of regularly occurring Annex 1 species, assemblage of waterfowl, populations of regularly occurring migratory species, and over-wintering populations of migratory waterfowl.

SNCA:

Natural England (NE)

Regulator

Cumbria Sea Fishery Committee (CSFC)

Step 1. Potential effects on designated site features

Designated Features	Potential significant impacts
Mudflats/sandflats	• Physical damage from vehicle access • Repeated vehicle traffic causing change in substrate and infauna.
Perennial vegetation of stony banks	• Damage from access vehicles and foot traffic
Reefs	• Damage to Sabellaria and associated communities • Damage to mussel reefs and associated communities • Community change from escaped non-native species (Pacific oyster) • Introduction of invasive non-native species such as slipper limpets (*Crepidula fornicata*)
Bird species	• Visual/noise disturbance from access: o during installation o during routine operation • Disturbance from infrastructure • Loss of feeding resource

Step 2. Mitigation or operational alternatives identified

Designated Features	Potential significant impacts	Mitigating measures
Mudflats/sandflats	Physical damage from vehicle access Repeated vehicle traffic causing change in substrate and infauna.	• Restriction of normal access to the aquaculture site to 1 vehicle visit per month using a vehicle fitted with low pressure tyres • Following an access route that has been agreed before hand with NE • Following an access route that corresponds to that already used by the occasional fishery in the area
Perennial vegetation of stony banks	Damage from access vehicles and foot traffic	• See above

	Reefs	Damage to Sabellaria and associated communities Damage to mussel reefs and associated communities Community change from escaped non-native species (Pacific oyster) Introduction of invasive non-native species such as slipper limpets (*Crepidula fornicata*)	• Access routes agreed to avoid areas where Sabellaria occurs • Addressed by adaptive management approach • Seed mussels to be sourced locally to negate the risk of introductions from other areas
	Bird species	Visual/noise disturbance from access Disturbance from infrastructure Loss of feeding resource	• Installation to be staged over a 3 year period outside of over wintering bird residence period • Limit agreed of 4 staff on site during construction and 2 during routine operation • Buffer of 50 m from nearest rocky scar (bird feeding/roost site) • Access routes to avoid bird aggregations • No vehicle access during winter • Short access periods (2 hours per visit) • Infrastructure to be sited on margins of scar in order to avoid disturbance • Infrastructure to be sited on margins of scar in order to avoid loss of feeding habitat

Step 3. Predicted effects of development	Although the preceding steps resulted in a positive Appropriate Assessment outcome concluding there remained some uncertainty over certain aspects of the effects of the operation specifically: • Damage to Sabellaria and associated communities • Community change from escaped non-native species (Pacific oyster).
Step 4. Monitoring program	A monitoring programme was agreed and consisted of: • Monitoring of Sabellaria reefs • Monitoring for escapee/settlement of pacific oysters This work is being undertaken jointly by the operator and Stirling University facilitated by funding from Seafish
Step 5. Agreed management actions	• Prompt removal of, any escaped pacific oysters o Possible use of triploid seed which pose a reduced spawning risk • An annual review of effects and of monitoring programme • Revise access methods and routes in response to any impacts on site features
Steps 6-8. Outcomes of implementation phase	The shellfish cultivation operation has begun and the monitoring programme is underway and no damage to the site has been detected to date.

Case Study 6: Oyster cultivation trial, Cuthill Sands, Dornoch Firth, 2007

Proposal:	The proposal was to trial the farming of Pacific Oysters (*Crassostrea gigas*) using the Boddington BST longline system at Cuthill Sands over 10 years. The trial included the erection of fifteen 100 m long Boddington longline-systems within an area of 4 hectares (a rectangle of 400 x 100 m)
European Marine Site	Moray Firth SAC, Dornoch Firth and Morrich More SAC, River Evelix SAC, Dornoch Firth and Loch Fleet SPA
Site Designation:	Special Area for Conservation, Special Protection Area
Site Description	The Moray Firth SAC is designated for its sandbanks, which are slightly covered by seawater at all times but it is primarily designated for the only known resident population of bottlenose dolphin (*Tursiops truncatus*) in the North Sea. The Dornoch Firth and Morrich More SAC, is designated for tidal rivers, estuaries, mud flats, sand flats and lagoons. It also has adjacent Salt marshes, salt pastures and salt stepps and sand dune systems. The remaining designated features are terrestrial or freshwater habitats. River Evelix SAC is a freshwater and terrestrial site designated for the only remaining freshwater pearl mussel) (*Margaritifera margaritifera*) population in an east coast small river. River Oykel SAC is a freshwater and terrestrial site designated for the a large population of freshwater pearl mussels (*Margaritifera margaritifera*) and the atlantic salmon (*Salmo salar*). Dornoch Firth and Loch Fleet SPA is designated for its tidal flats which support internationally important numbers of waterbirds on migration and in winter and for its importance as a feeding areas of locally breeding Ospreys (*Pandion haliaetus*).
SNCA:	Scottish Natural Heritage
Regulator	Highland Council

Step 1. Potential effects on designated site features (initially identified by SNH / Highland Council)

Designated Features and Species	Potential significant impacts
Mudflats/sandflats Reefs Sandbanks	• Habitat loss • Change in sediment and infauna communities within site • Damage to reefs • Damage to habitats from nutrient increase/waste material
Atlantic salmon	• Physical barrier to migrating Atlantic salmon • Construction noise may interfere with migration patterns and viability of species undermined
Freshwater mussel	• Viability of species undermined as a consequence of effects on Atlantic salmon population (the larvae of pearl mussels depend on fish species to act as a host during a semi-parasitic larval development/dispersal stage)
Bottlenose Dolphin	• Unspecified
Common Seal	• Habitat loss and disturbance
Otter	• Barrier to otter movement
Bird species	• Visual/noise disturbance: o during installation o during routine operation • Loss of feeding resource

Step 2. Mitigation or operational alternatives identified

Designated Features and Species	Potential significant impacts	Mitigating measures
Mudflats/sandflats Reefs Sandbanks	• Habitat loss • Change in sediment and infauna communities within site • Damage to reefs • Damage to habitats from nutrient increase/waste material	• The use of structures with minimal footprint (larch posts rather than mooring blocks or riser chains) • Access to the site primarily by vessel to avoid damage to sediment or other seabed/shore features • Site to be located away from reef or other sensitive site features
Atlantic salmon	• Physical barrier to migrating Atlantic salmon • Construction noise may interfere with migration patterns and viability of species undermined	• Installation to be carried out using a hydraulic technique avoid noise disturbance • Size and orientation of farm site unlikely to pose a barrier to Atlantic salmon
Freshwater mussel	• Viability of species undermined as a consequence of effects on Atlantic salmon population (the larvae of pearl mussels depend on fish species to act as a host during a semi-parasitic larval development/dispersal stage)	• See above
Common Seal	• Habitat loss (haul outs) and disturbance	• Site to be located away from established seal haul-outs • A management plan outlining agreed times and seasonal activity levels accounting for breeding season was proposed • Commitment not to use Acoustic
Otter	• Barrier to otter movement	• management plan outlining agreed times and seasonal activity levels was proposed to reduce likelihood of disturbance
Bird species	• Visual/noise disturbance: o during installation o during routine operation • Loss of feeding resource	• Installation to take place outside of migration or over wintering residence periods • Use of vessel negates disturbance to wading birds • A monitoring programme was proposed

Step 3. Predicted effects of development	Although the preceding steps addressed many potential effects or impacts some uncertainty over certain aspects of the effects of the operation specifically: • Effect on bird species • Effect on seal distribution • Effect on sediment and infaunal communities

Step 4. Monitoring program	A monitoring programme was proposed to determine the effect of operation on: • the distribution of wading birds and wildfowl • Seal distributions • Sedimentation and infaunal communities
Step 5. Agreed management actions	N/A
Steps 6-8. Outcomes of implementation phase	This proposal is ongoing and has paused while the operator considers whether to proceed