The Scottish Government
Riaghaltas na h-Alba

Marine Scotland Science

Solway Cockle Fishery Management Study

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Marine Analytical Unit

Marine Scotland Science

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1. Executive Summary

In response to requests at two public meetings for a sustainable cockle fishery in the Scottish Solway, it was decided that a scientific investigation of a potential management regime in the Solway Firth would be undertaken. This management study set out to collect data over a three months fishing season during which cockle beds were harvested at a commercial scale to test the suitability and viability of the management approach. This management regime was based on the principles associated with a Territorial Use Right for Fisheries (TURF) model, which allocates an area of sea to a specified group, who then undertake further allocation within that for a set period of time to sustainably manage the stock. For this study ran from November 2013 to July 2014.

Due to poor cockle yields, the commercial extraction of cockles did not fulfil its full potential and had to be suspended after a 4 week operational period. It was re-started in summer 2014 and ran for a further two weeks before the project was terminated due to difficult market conditions.

Whilst the study was unable to test the full range of management approaches to the harvest of a commercial volume of cockles over a sustained period of time, it was able to: 1) develop a range of harvesting controls; 2) develop a training scheme which improved Health & Safety awareness; 3) develop an integrated, multi-agency approach for dealing with non-compliance with the full support of all local enforcement agencies; 4) test a new method of End-Product Testing (EPT) analysis on seafood entering the food chain to lay the foundation for high-level food traceability; 5) raised awareness within both local communities and conservation organisations of the potential for a low impact sustainable fisheries model which minimises adverse social impacts.

Eleven key observations have been produced from the study and a number of significant achievements attained. The first has been the progression made in terms of enforcement agencies ability to track and police activity and the attention given to implement suitable controls and restrictions to improve the governance of this fishery. Compliance officers had the opportunity to work with fishers and see first-hand the progress of those engaged in the fishery at a local level. Taking this fresh approach has allowed each responsible agency to consider how they can develop and modernise the fishery. The second has been the procedures to improve health and safety on the beach and the ground work put in place for better food traceability which were also significant achievements in this study. Thirdly, the study has also produced basic information on the profile of pickers wishing to prosecute this fishery and developed a model to estimate licence requirements of a given Total Allowable Catch (TAC) which is a useful tool of future management.

Currently the regulatory framework required to govern this fishery is lacking and needs to be in place to take this fishery forward. The TURF model has much to contribute for producing a fair and equitable system, however traditional approaches used in other Scottish fisheries, for example individual licences, may have a place in this fishery. In the final section of this report a range of management options have been outlined which, in essence, starts with a time limited fishery and then add on layers of regulations which increases the level of controls, as well as environment and social benefits. These should be given attention by administrators and key stakeholders and the collaborations developed during this study should continue so a sustainable cockle fishery can become a reality in the Scottish Solway.

Key Observations

Observation 1 - It should be a prerequisite that all hand licences associated with a cockle fishery require completion of the basic four safety courses and an area-based training course e.g. the new Solway Shore Awareness course.

Observation 2 - The fishery should have a fully documented process which can track bags of cockles back to the picker and the beach area, all the way through the chain to the final customer. The paperwork produced during the study is fit for this purpose and should be used as a template and refined as and when required. What is key is that the process should be as streamlined and straightforward as possible to facilitate compliance.

Observation 3 - Access to the beds via the foreshore is a critical factor to success and requires significant investment of time and effort. Improving access needs to be explored further which could include working with commercial farms near commercial beds. These business have the capacity to support this type of activity and by paying a levy per ton other businesses are able to benefit from the cockling activity whilst reducing local disturbance to communities.

Observation 4 - Building in capacity to improve and develop food safety should continue with the advancement of this fishery. Given that the demand for better food traceability is only likely to increase, the Solway cockle fishery is in a good position to lead on this with the collaboration of the Food Standards Agency Scotland (FSAS) and the Local Authority (Dumfries and Galloway Council).

Observation 5 - Future management of the Solway cockle fishery should offer the opportunities for young inexperienced fishers to enter and benefit from the local resource. This could be achieved through apprenticeship schemes, however fishing opportunity needs to be monitored to ensure that new entrants have the chance to work in the fishery once apprenticeships are completed.

Observation 6 - Due to the seasonal nature of this fishery, specific opportunity could be made available to fishers who work in other fisheries but who may wish to

diversify and supplement their main fishing activity with cockling. This could be offered through a limited number of part time licences that become available once the TAC for that year fishery is known and allocation for long-term licence holders is assessed and met. *This should not affect the rights of qualified fishers who may wish to apply for a long-term licence.*

Observation 7 - A central distribution centre offers many benefits for improved compliance and food traceability and should be given serious consideration for future management. The two most promising elements from the study - the administration of landings and cockle monitoring for toxins in one location should be maintained. Whether this facility should act more like a traditional fish market, where the sales are operated by a number of individuals/agencies and a fee is charged by the centre to cover costs is an open question.

Observation 8 – Knowing the rate of pay prior to picking commencing is desirable and should be an aspiration for this fishery, however other fair payment systems should also be explored. What is important is that transparent transactions take place so that pickers know they are being suitably rewarded for their efforts.

Observation 9 - The funding of the fishery should be explored further as whilst a flat-rate levy upon each individual's harvest is a viable option, how this fund is used and re-distributed requires further investigation.

Observation 10 - As the management plan for the fishery develops markets need to be kept in mind, efforts should focus on harvesting cockle in their peak condition and at a volume and consistency appealing to a range of different markets. This requires attention to be given to the number of permanent and temporary licences on offer and whether vessels should be involved if the annual TACs support their inclusion.

Observation 11 - A conservation working group should be established to address some of the information gaps identified and support the development of a low impact fishery.

2. Introduction

The Solway Firth straddles the border between England and Scotland in the Irish Sea and is one of the largest intertidal areas in the UK. It is of great environmental importance especially for over -wintering birds and there are numerous nature conservation designations throughout the area. Cockles are important species in this ecosystem and are an integral link between primary producers (phytoplankton) and other marine fauna (crabs, shrimps, starfish, fish and birds). Cockles are also of commercial importance and have been commercially harvested periodically since 1987.

The Scottish Solway was closed to cockle fishing in 2011 and has remained so to date. This followed five years of management under a Regulating Order (RO) which was hindered by low stock levels impacting on revenue streams and along with local concerns surrounding this fishery resulted in its closure. Following reports of increasing stock abundance Marine Scotland - the Scottish Government directorate with responsibility for the management of Scotland's marine resources and environment - held a series of public meetings in 2012. At these events stakeholders demonstrated a willingness to support a position for the re-opening of a cockle fishery assuming a management regime could be put in place that provides for ecological sustainability and resilience and brings economic and social benefits for the local area. Potential mechanisms for achieving this were discussed with stakeholders including local fishers at the meetings. Building on this, it was decided that a scientific investigation of a potential management regime for a sustainable cockle fishery in the Solway Firth would be undertaken.

In developing such a management regime, Marine Scotland's primary objective was to test management mechanisms that offered increased harvesting controls to achieve sustainable extraction and encourage a long-term management ethos within the fishery. A secondary objective was to investigate potential benefits to local communities from a sustainably managed fishery. This management study set out to collect data over a three months fishing season during which the cockle beds were harvested under a science derogation for 'hand-gathered cockles' at a commercial scale, to test the suitability and viability of the management regime. The work was contracted to a local company, Deefish Ltd.

Due to poor cockle yields, the commercial extraction element of the study did not fulfil its full potential and had to be suspended in December 2013, after a 4 week operational period. It was re-started in July 2014 and ran for a further two weeks before the contractors asked to withdraw due to difficult market conditions. Whilst disappointing, Marine Scotland accepted the termination of the contract which brought the study to a close. Given the market conditions encountered by the contractor, it was felt little further could be learnt from the study in the time remaining.

Whilst the study was unable to test the full range of management approaches to the harvest of a commercial volume of cockles over a sustained period of time, it was able to: 1) develop a range of harvesting controls; 2) develop a training scheme which improved H&S awareness; 3) develop an integrated, multi-agency approach for dealing with non-compliance with the full support of all local enforcement agencies; 4) test a new method of End-Product Testing (EPT) analysis on seafood entering the food chain to lay the foundation for high-level food traceability; 5) raise awareness within both local communities and conservation organisations of the potential for a low impact sustainable fisheries model which minimises adverse social impacts. These outcomes are detailed in this report along with observations for the future development a sustainable cockle fishery in the Solway Firth.

2.1 Aims and Objectives

This study explores whether a management system based on the principles associated with a Territorial Use Right for Fisheries (TURF) model can deliver a sustainable cockle fishery in the Solway Firth. TURFs grant exclusive and secure privileges to fish an area of sea to a specific group who, within that group, define a range of access and allocation criteria for a set period of time (often of long duration) to sustainably and fairly manage the stock (Poon & Bonzon, 2013). The assigned group/s undertake the internal management, such as allocations and incentives, within the group to promote and monitor sustainable fishing. TURFs have been successfully developed in countries around the world and in some regions they have been in place for centuries (Poon & Bonzon, 2013). TURFs are especially ideal for benthic and sedentary species such as shellfish fisheries (Defeo & Castilla, 2005). In the United Kingdom, a regulatory framework known as a Regulating Order (RO) exists and can facilitate the application of a TURF system.

Research into TURFs has found that those which have been unsuccessful have often failed at the internal management stage. This was central to our investigation on how we can establish a successful and sustainable management regime in the Solway Firth. TURFs by nature are exclusive and therefore the aims of this study include investigating how to establish management criteria that are fair and equitable, which incentivise those involved to harvest sustainability and invest in the fishery over the long term whilst delivering benefits to the local area. If a TURF approach is successful it is possible to introduce these local management principles using a RO.

Specific research questions:

1. How successful was the trial management study for;
    a) creating fair and transparent involvement for fishers?
    b) incentivising fishers to harvest sustainably?
    c) improving enforcement agencies' ability to track and police activity?

d) improving local communities' understanding and perceptions of the fishery?

2. What social and economic benefits could the local area realise from a TURF system?;
3. What local capacity is there to development, monitor and manage a TURF system? and;
4. What role would government have in future management of the Solway cockle fishery?

2.2 Background: Past Problems in the Solway

Small-scale hand-gathering of cockles has taken place for decades whilst commercial cockle harvesting in the Scottish Solway started in the late 1980s (Shepard & Clark, 1994) after demand from the Dutch created a viable market for large scale extraction (Jones 1997). Methods of collection started with large teams of hand collectors (>60 men), but rapidly expanded to tractor dredgers and hydraulic dredging vessels. Within the span of four years, six local vessels and a number of distance vessels were working in the area and onshore facilities were built to process shellfish which included cockles.

As shown in Figure 1, the late 1980s saw a dramatic increase in extraction which ceased in the early 1990s with the introduction of legislation which banned vessel dredging in Scotland. Due to a loophole in the legislation tractor dredging continued until banned in 1994. From 1998 to 2002 hand collection recommenced on the Solway with reports of between 30-100 collectors at any one time (Miles 2001) however no official landing records exist for this period. During this time the fisheries opened depending on annual stock assessments but with no restrictions once open.

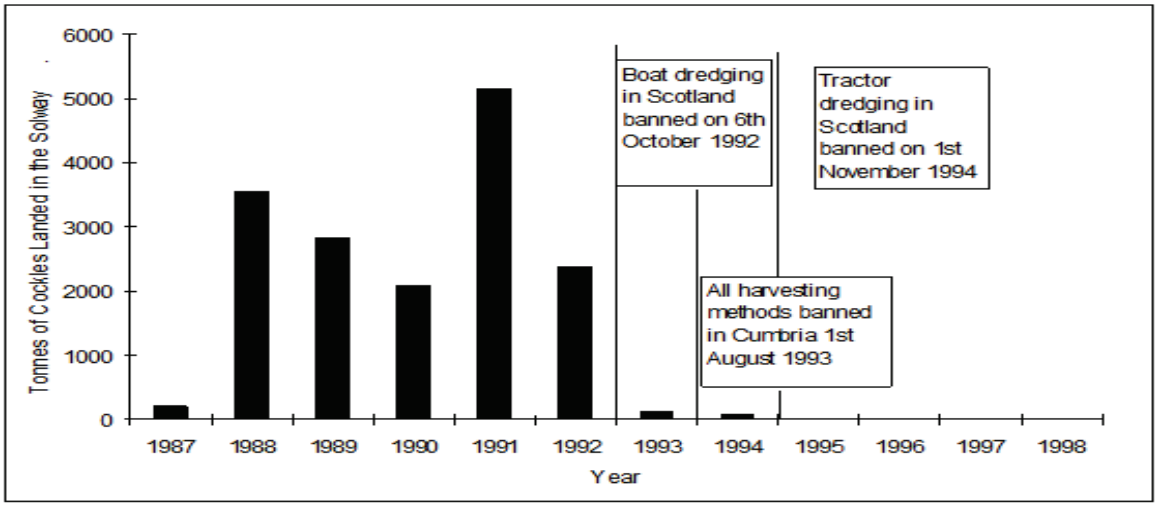

Figure 1: Volume cockles landed by UK vessels from the Solway (Ayr Fisheries Statistics and MAFF - taken from SSMA 2004 Regulating Order)

During this period a number of problems were associated with the fishery which included anti-social behaviour from large numbers of individuals coming into the area to exploit the resources. This was exacerbated by a lack of facilities to house and support pickers whilst on the sands e.g. sanitation facilities, and no management of cars and other vehicles required for working on the sands, resulting in the disruption of public services (local bus services and schools runs). The police were repeatedly required to manage and resolve disputes whilst the fishery was open.

Noise was also a concern with the dredges on vessels resulting in some complaints, but the majority of the complaints were associated with uncontrolled hand gathering and tractor dredging. Most of these were in relation to disturbances to communities and to wildfowl feeding and roosting in the area (SSMA, 2006). Finally, litter at access points frequented by locals and tourists was a major complaint with this fishery which may have been exacerbated by the transitory nature of many of the pickers who had less incentives to take care of the local area (SSMA, 2006).

Due to these and other concerns around long term stock management the fishery was closed in 2002 and a management proposal was submitted by the Solway Shellfish Management Association (SSMA) to govern the Scottish Solway under a RO. This was granted and the RO ran from 2006 to 2011. During this period the fisheries suffered many setbacks, primarily poor cockle recruitment, which impacted on the financial model of the RO which meant the fishery could not remain open and the RO could not be tested to its full potential nor could a long term management regime be fully developed. Much has been learnt from the SSMA RO that has informed the development of management options. Since the Solway Firth Regulating Order expired in 2011 the cockle fishery has remained closed under the Inshore Fishing (Prohibition of Fishing for Cockles) (Solway Firth) (Scotland) Order 2011. However, there is increasing pressure from local fishermen to re-open the fishery.

3. Territorial Use Rights for Fisheries

3.1 Managing under a TURF system - why this system?

The open access nature of local and global fisheries has been blamed for the biologically and economically wasteful manner in which fisheries resources have been exploited around the world (FAO, 2005). In other coastal nations a range of alternative management regimes have evolved, of which territorial rights based management is one which could have potential benefits for stock management in Scotland. Known as Territorial Use Right in Fisheries (TURFs), this approach allocates an area of sea to a specified group, frequently in the form of a co-operative and often community-based, who then undertake further allocation within that for a set period of time (often of long duration) to sustainably manage the stock (Poon & Bonzon, 2013). The objective is to limit capacity and encourage sustainable harvest, and these approaches have been highly successful in areas with well-defined boundaries and sedentary species, such as lobsters, snails and shellfish e.g. Quahog in Iceland, oysters in USA, mussels and scallops in New Zealand.

TURFs are widely used in Japan, Chile, the Pacific islands, and increasingly across Europe. TURF systems can help mitigate the perverse economic incentives experienced in open-access fisheries by awarding exclusive access to a spatially defined fishing area to a clearly define user-group/s. The user-group/s most often embody littoral communities with a strong history of fishing adjacent inshore stocks. The creation of user privileges under a TURF system does not award ownership rights to the area in question, but the users are granted exclusive access to harvest pre-defined stocks in the territory and the less mobile and less migratory the species the better the system (Defeo & Castilla, 2005).

TURFs are increasingly considered an appropriate tool for small-scale fisheries management due to the socio-economic possibilities they offer to local, artisanal communities. As well as mitigating the dissipation of rent. i.e. reduced economic efficiency because of the inappropriate or poor allocation of resources, that occurs in open-access regimes, TURFs channel the generated net economic gains to a specific group and its wider area. TURF systems are therefore able to produce economically and ecologically sustainable fisheries while facilitating the accomplishment of social goals and the maximisation of social net benefits.

3.2 Making TURFs Work: Governing Framework

While the allocation of the rights to a TURF is a top-down process, TURFs are most suited as a form of co-management. This encourages local self-management of the fishery and places local knowledge at the heart of the operation; allow the harvesting, marketing and distribution of the harvested stocks to complement local socio-economic, biological and technical conditions.

A general rule throughout the TURFs in operation is that the group selected to manage the TURF is responsible for the design and implementation of internal management. The regional/central government then signs off the plan and awards the TURF. Across the different TURFs in operation, the duties carried out by the awarded group vary, with all required to govern internal management but some required to carry out stock assessment and surveillance. While the design and implementation of the internal management will be influenced by the use of a TURF, it will also be influenced by the nature of harvesting and depending on the country of application, the managing authority and the way rights are allocated.

3.2.1 Scope of Rights

The scope of rights under a TURF system can be broad or narrow depending upon the management objective. In Japan, many TURFs grant rights to use any and all of the marine resources within a designated area. Conversely, in the Chilean and Galician TURFs, access rights are granted for the harvesting of a single resource within the area.

3.2.2 Ownership

Several global TURFs have been formalised from customary practices, with rights often granted on the basis of traditional tenure rather than on criteria with a specific socio-economic or ecological objective. In Chile, there are various instances of tenure granted on a basis of historical performance and TURFs established *de novo* for the association of local fishing communities. The question of ownership is as much a matter of effectiveness as it is of equity. While individuals can usually make decisions more easily than groups, given the estimated net worth of a fishery the establishment of a localised TURF represents a significant re-distribution of wealth. With regards to the objective of improving the welfare of small-scale fishing communities, a form of communal ownership of a TURF is desirable.

3.2.3 Security of Tenure

The harvest rights awarded through the TURF must be of significant duration and certainty to give the users the confidence to invest in the resource. It is through the creation of secure and durable rights that incentives for economic and ecological sustainably are facilitated. However, there is no template for TURF tenure. In Japan, tenure is indefinite, in England and Wales Regulating Orders awarding access to shellfish last between 10-20 years, while in Malta, TURF rights for dolphin-fish (*Coryphaena hippurus*) last for only one year.

3.2.4 Spatial-Tenure

TURFs are typically associated with the water column over a specific marine substrate or identified with coastal landmarks. In Japan and Chile, the delimitation of territory is based upon historically important harvest communities that have dominated the coastal system. In Chile, local fishermen were organised into local

organisations, around which the TURFs were formed. This reveals a traditionally strong socio-economic objective within the creation of TURFs as many were created specifically to protect small-artisanal fishing communities from the operation of larger, offshore vessels. In delimiting the spatial extent of the Solway TURF, the guiding objective should be the biological distribution of the cockle stocks.

3.2.5 Seasonal Tenure

TURFs can operate on a seasonal basis which allows extraction at certain times and closure at others under ecological or socio-economic criteria. Closed seasons have been used in England, Wales and Ireland for cockle management which define the time period e.g. a certain number of weeks, days in a week, and hours/time per day, that cockles can be harvested. The 'open season' can be designed to coincide with peak market demand and to mitigate the loss of stocks to adverse weather conditions such as the arrival of frost. The advantage of a closed season is that it limits the overall harvest by reducing the number of fishing days available to fishers and protecting stocks at vulnerable life stages.

3.3 Making TURFs Work: Internal Management

Whilst open access fishery have been blamed for resource overexploitation, the implementation of regulations which are capable of producing biologically sustainable harvests do not automatically mitigate economic waste (Wilen et al, 2012). In this respect, TURFs are no different. Simply identifying a closed class of users does not prevent the group from dissipating the resources inside the TURF. To make them successful TURFs require strong internal rules and mechanisms that govern day-to-day operations including: 1) the allocation of the scientifically determined catch; 2) monitoring and enforcement and; 3) regulation of processing and distribution to ensure that the proper incentives are created which led to the production of a sustainable harvest. Where strong internal mechanisms have not been implemented, TURFs have failed (Cancino, 2007).

Current cockle management systems in the UK focus on a combination of time, effort and entry restrictions. In conjunction with the TAC, daily quotas, minimum sizes and limitations on entry are often used to ensure ecological limits are not exceeded and the combination of these practices can also work to ensure that the TAC is not spread across a large number of people, rendering individuals and fishery products at risk of rent dissipation i.e. economic inefficiency due to too many people trying to access the fishery. Based upon a review of best-practice models within UK cockle fisheries and global TURF systems (see annex 8 for an overview), the following options are viable for the internal management of the Solway fishery.

3.3.1 Gear restrictions

There are a range of methods for collecting cockles and depending on the substrate and cockle density[1] some methods are preferable to others, but hand gathering may be the most effective in meeting objectives for local employment and wealth redistribution. When developing a sustainable management model, no gear should be permanently discounted as flexibility in a system is desirable - different fishing gears offer different benefits as well as impacts – environmental, social and economic criteria should be used when considering the inclusion of alternative collection methods in a fishery.

3.3.2 Licence limitation

A licensing system is the most straightforward operational approach for granting/restricting users access to a fishery. In order to establish effort controls, a strict limit on the number of gatherers should be imposed. The number of licences issued would depend upon stock levels, which would allow managers to alter effort in line with stock fluctuations. This option would work to mitigate rent dissipation amongst users, as while a TAC can be set, if entry into the fishery is left open or effort is too great, the TAC will be spread amongst too many users. Conditions may be attached to licences, for example to include specific safety training and courses designed to inform upon local natural idiosyncrasies such as tidal movements and in most cases a fee is charged on an annual basis.

3.3.3 Minimum size limit

A minimum size limit is commonly established to protect the breeding population of a fish stock. In the case of cockles in the UK, this varies across the country (cockles are sexually mature at around 18 mm - this varies regionally) where cockles are not harvested until 24 mm in the English Solway (Lancaster, 2007), 30 mm in the Scottish Solway (Solway Shellfish Management Association, 2004; Davis et al, 2006) but a small minimum landing size (MLS) - 16 mm is taken in the Thames (Kent & Essex IFCA, 2014). Cockles are easy to measure and controls on a MLS limit can be established relatively simply e.g. specifications on equipment such as a riddles to not exceed minimum size. Various management regimes are applied in different areas , and in relation to target markets. Some of these allow site specific and in season changes in MLS, providing they offer sufficient protection to breeding stock.

3.3.4 Individual (Daily) Quota Allocations

Individual quota (IQ) allocations allow monthly or seasonal TAC to be divided amongst licensed users within the organisation over a defined time period. Typically, IQs are allocated to users on a daily basis which has produced gains in terms of

[1] 'Minimum Viable Density for hand-gathering is about 300 cockles/m^2, for 'blowing' about 100/m^2, and for hydraulic dredging 50-100/m^2. The improving efficiency of pumps and dredges has enabled suction dredgers to harvest at stock densities as low as 10-20/m^2.' (Dare et al, 2004: 24)

selectivity and quality as users do not have to competitively race to take the maximum share and can instead spend time improving the quality of the catch. Criteria through which daily IQs are allocated is normally at the discretion of the management group, which could take the form of: 1) an egalitarian division of the TAC, as is practised in some cockle fisheries in Wales; 2) allocation based on workers' productivity (to account for age, ability etc.) or; 3) historical performance in the fishery (when available). These approaches have worked to not only to protect individuals against wasteful competition, and a race to the beds (in some cases to the best beds through which juvenile year classes can be damaged), but daily quotas also allow the total harvest (TAC) to be closely monitored and markets to be supplied with a steady volume of product.

3.3.5 Closed Areas

The option to close individual beds is an important flexibility that can be used for successful internal management. Cockle recruitment is unreliable and tends to be patchy which results in variability between individual beds in terms of cockle density, recruitment and growth rates. These variations can affect the viability of different fishing methods and also impact on stock sustainability. Spatial flexibility is successful in Dundalk Bay, where fishing activity is not allowed in areas unless cockle density is greater than 4 m^{-2} (Hervas et al, 2008). In other fisheries such as the Wash and Morecombe Bay specific beds and in some cases, the whole fishery, is not opened unless there is a minimum spawning stock biomass. Alternatively, beds containing significant proportions of juvenile stocks may not be opened (in the Wash beds must contain 70% adult stock to be opened).

3.3.6 Rotation of Beds

While an IQ can mitigate against some perverse economic incentives, conflicts amongst users in terms of space can occur when the area within the TURF is not allocated amongst users. The rotation of beds could be implemented on an individual or a collective basis. Individual users could be allocated equal access across the TURF on a rotating basis to avoid favouritism and avoid competitive exploitation of areas of high productivity. Alternatively, collective rotation could take place within the area, with all users working within one areas at a time, and rotating en masse. This would protect against individual user conflict and ensure that all beds are exploited, and 'hot spots' are not over exploited at the expense of more marginal areas.

3.3.7 Harvest/revenue pooling

In some international TURF systems, the pooling of harvests is promoted. This approach can help to avoid internal conflict, non-compliance with internal rules and minimise risk for individuals. Pooling arrangements have been implemented in order to protect operators from receiving bad harvests in certain areas. The aggregated revenue is then redistributed amongst the group according to prearranged rules. The criteria for the re-distribution process could include worker productivity etc. in order

to mitigate free-riding. Alongside minimising risk and conflict, the pooling mechanisms means that operators no longer have an incentive to beat competitors to better ground and intensify effort, thereby protecting against wasteful competition.

4. Solway Cockle Fishery: Legislation and Governance

Areas of the Solway Firth are subject to a number of nature conservation designations, including Special Protection Area (SPA) classified under the Wild Birds Directive, and Special Area of Conservation (SAC) designated under the Habitats Directive. The opening of the Solway Firth or the act of cockle fishing is subject to the assessment provisions of Article 6 (3) of the Habitats Directive.

4.1 Special Area of Conservation (SAC) Special Protected Area (SPA)

Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, is known as the Habitats Directive. The main aim of the Habitats Directive is to promote the maintenance and protection of biodiversity, habitats and species of European importance. Article 6.3 of the Directive states:

> *"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives…*
>
> *…the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned…"*

Council Directive 2009/147/EC on the conservation of wild birds, is known as the Birds Directive. The main aim of this piece of legislation is the preservation, maintenance and restoration of diversity and habitats for the conservation of all species of birds. Under Article 4.1 of the Birds Directive, European Member States are required to ensure that species listed in Annex I are subject to special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. Under Article 3 of the Birds Directive, Member States also have to take measures to preserve, maintain or re-establish sufficient diversity and area of habitats for all species of bird.

Both the opening of the Solway cockle fishery or cockle fishing taking place would trigger the need for an Appropriate Assessment (AA). The fishery can only be (re)opened or cockle fishing can only take place when it has been established by the AA that those activities would not affect the integrity of SACs (habitats directive) or SPAs (birds directive).

4.2 Surveys and Assessments

Determination of whether the Solway cockle fishery could be opened has in the past involved four stages. First is the cockle stock assessment, undertaken by or on behalf of Marine Scotland (MS), to estimate the cockle biomass at size and age.

Latterly the survey and assessment has included other key bivalve species e.g. *Macoma balthica* and *Mytilus edulus ,* to inform environmental and biological requirements that need to be taken into account before a TAC can be set. The survey has been undertaken or overseen by Marine Scotland Science (MSS) on behalf of the Scottish Ministers.

Information about the distribution and density of cockles from the survey is of benefit to participants in any commercial fishery that may ensue, as it can provide the basis for a harvest plan which will allow for improved management and smoother running of the fishery. Second the application of a 'bird model' (see below) quantifies the needs of particular bird species protected under SPA classification. Third, using the bird model, a TAC is set to determine the quantity of cockles which can be taken from the fishery.

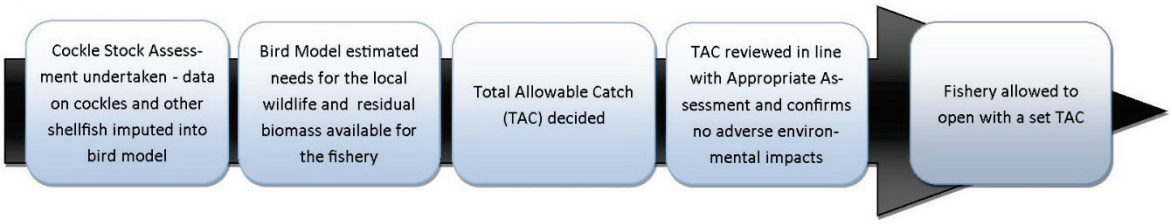

Figure 2: Current process for conducting the appropriate assessment to decide on a TAC and open the fishery

4.3 Allocation to Seabirds - the Bird Model

An AA of the Solway cockle fishery takes into account the important role that cockles play in the intertidal ecosystem through the consumption of primary production, the movement of sediment, and as prey items for predators. Two species of bird, oystercatchers (*Haematopus ostralegus*) and knot (*Calidris canutus*) both listed in Annex 1 of the Birds Directive, prey directly on cockles. The AA recognises that the overexploitation of cockles through a commercial fishery has the potential to alter biotope communities through the removal of an important food source and the sediment movement function they perform. A significant effect is therefore expected should the resource be over-exploited. An AA would further identify that where a TAC for the commercial fishery is set too high, overexploitation would occur leading to a decrease in the survival and condition of both the knot and oystercatcher populations.

Should mitigation measures, which accommodate the requirements of the key dependent bird species, be successfully implemented, the conclusions of past AAs has been that a commercial fishery, with a specified TAC, would not adversely affect the integrity of the Upper Solway Flats and Marshes SPA. There is an assumption therefore that any future fishery would be managed by a TAC established within safe biological limits of the food requirements of the bird species dependent on shellfish. To achieve this, MS commissioned work with Bournemouth University to construct a

model to predict the interaction between cockle fishing and shorebirds. The model incorporates a range of factors and parameters developed for the circumstances of the two species feeding on shellfish in the estuary. The model calculates the prey stock required to support a healthy population of birds depends on estuary-specific features like the sediment type, food items and competition factors. To build safeguards into the model an overestimation of the birds food requirements is applied The model has been used inform the AA and set a suitable TAC for cockle fisheries on the Solway. It is assumed that the model would be used as the basis for any reopening of the Solway cockle fishery in the future.

4.4 Role and Responsibility of Governing Agencies

Marine Scotland (MS) on behalf of the Scottish Government is responsible for the sustainable management of the area of the Solway that is within Scottish waters.

The Scottish Government under the habitats directive is responsible for ensuring that agreements made for the opening or closing of the cockle fishery in the Scottish Solway are consistent with the requirements of the Birds and Habitats Directives. Scottish Naturall Heritage (SNH) advise MS on whether or not a plan or project is likely to adversely affect any SACs or SPAs. The cockle stock assessments in the past have been carried out by MSS, or been undertaken by a third party and overseen by MSS. The TAC for the Solway Cockle Fishery has generally ranged from 22.5% up to 33% of cockle biomass above a prescribed MLS.

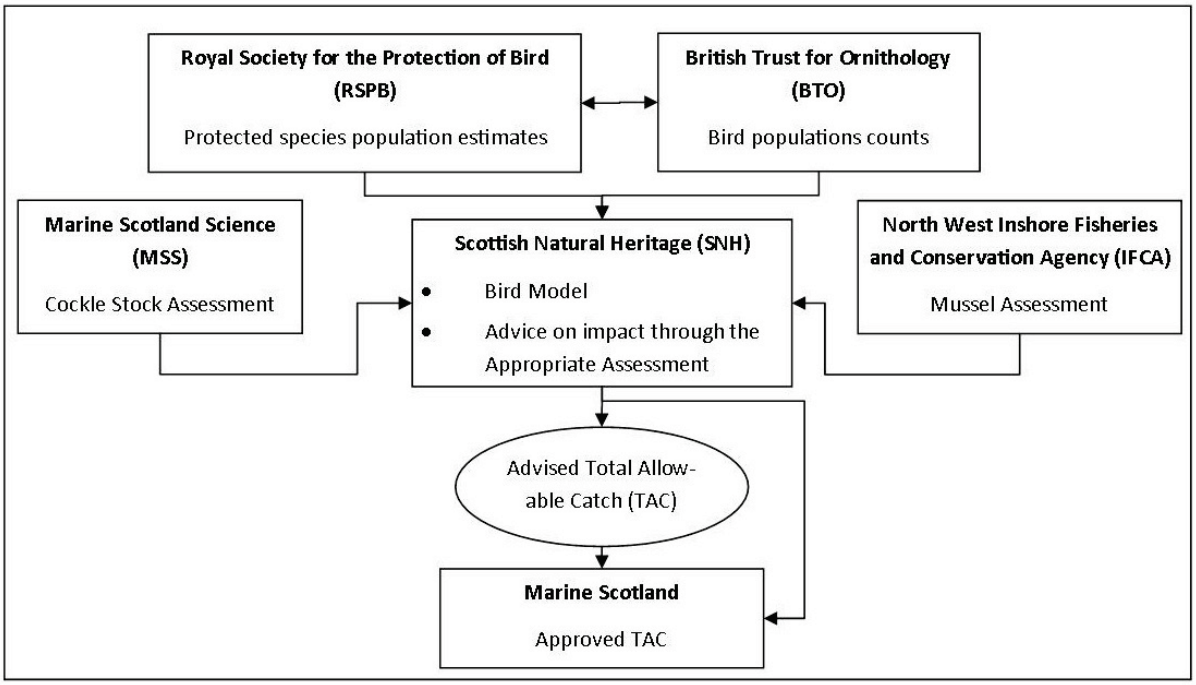

Figure 3: Roles of key governing agencies

5. The Management Study

The Scottish Government's vision is for a sustainable, safe, controlled and locally managed cockle fishery in the Scottish Solway Firth which brings longer term employment, local benefits and a high quality, safe, food product to market. Table 1 outlines the overarching objectives for the fishery in the Solway.

Table 1: Key program goals

Biological and Ecological Goals	Social Goals	Economic Goals	Development Goals
Promote sustainable harvest through collective responsibility for the resource Support ecosystem health through a low impact fishery	Provide a safe fishery Provide opportunity for local people to benefit from a local resource Develop a fishery which minimises negative impacts on Solway residents and visitors	Provide long term employment and local opportunities Develop sustainable and profitable markets where fishers and local businesses benefit	Fully traceability from beach to plate Fully documented, transparent fishery

To explore how this could best be achieved, MS put out to tender a management study which required a partner to commercially harvest cockles and assist MS in trialling a management regime that was capable of meeting the overarching goals outlined in table 1. This study proposed to test some of the internal practises outlined by the TURF system as well as a centralised distribution centre (explained in detail below) to improve compliance and food traceability. The successful contractor would assist in the delivery of the management study in exchange for a commercial volume of cockles (known as a concession contract which allows the contractor to benefit from the sale of the harvested product). In line with procurement rules, the invitation to tender was posted in the European Journal, which advertised the project at a European scale because the potential value of the contract exceeded £113,000 (€120,000).

5.1 Requirements for Testing under the Management Study

The tender offered the opportunity to extract a commercial volume of cockles whilst testing a range of mechanisms practised under the TURF model to reduce rent dissipation and unsustainable practises. For this management study no restrictions were mandated by MS except the method of collection which was limited to hand collection[2], an upper limit on removals i.e. a TAC and the need for a central

[2] This is was due to specific concerned raised in the stakeholder meetings which took place in April and October 2012 for the request for benefits of hand gathering to be explored and due to the short nature of the study to limit the requirements needed from enforcement agencies to manage

distribution centre. Tenderers were expected to outline how they planned to manage the internal running of the contract and what type of approaches they would use to meet the criteria outlined in table 1. The main objective for taking this approach was to gather practical ideas from experienced fishers and other key stakeholders to explore the running for the fishery and not 'rule out' any innovative ideas to improve on current/future cockle management. The four sections below outline the key requirements which applicants needed to fulfil.

5.1.1 Safe and Controlled Extraction of Cockles on the Beach

The health and safety of all pickers was the primary concern, so key criteria for bidders were: the controlled movement of pickers on and off the beach; planned collection with local authorities informed; and training opportunities for increasing knowledge of the area (trial of the Solway Shore Awareness course). As the controlled and safe removal of cockles is a key consideration, the mechanisms and capacity within the management team to harvest only cockles designated for collection (no removal of under sized, from closed beds etc.) needed to be explained and a formal risk assessment was required. Communication with all enforcement agencies on a daily basis was also required and bidders were asked to detail how they proposed to achieve this.

5.1.2 Transportation between Beach and Collection Point

The documented and transparent movement of cockles from different locations was required to record fishing activity and allow for full traceability of the cockles for the food agencies. This included the full, transparent documentation and administration (detailed record keeping) of cockles collected by each picker or cockle team on the beach, the transportation from the beach to a beach-side collection point and the loading and storage of cockles (safe and hygienic) prior to final transportation to the distribution point. Communication between pickers and affected local communities was required to address the local concerns raised in earlier episodes of cockle collection and how this was to be achieved needed to be outlined in the tender.

5.1.3 Fair and Transparent Treatment and Payment of Pickers

Due to repeated reports of unfair treatment of cockle pickers in past fisheries, a system which allowed pickers some security over their trade was required. One suggestion was a fixed rate of pay per kg on a weekly basis which offered security to pickers on earnings for that week. This could coincide with fair charges for the administration of the fishery, with full documentation of the process and the payment of pickers.

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mechanical methods of cockle collection. For this study cockles in the Solway Firth are to be harvested using artisanal hand gathering techniques only until other methods can be thoroughly investigated to gauge their sustainability and desire of inclusion in the management regime.

5.1.4 Single Distribution Centre

At the core of this study, a central distribution centre was to be tested. The Centre would serve four purposes: 1) improve compliance and enforcement capacity - the selling and movement of cockles is a major challenge for governing this fishery as selling from the beaches has caused social issues for the police, local communities and harvesters. Using the central distribution centre is mandatory under this study; 2) improve food safety and examine whether full traceability is a viable aspiration - cockles can be stored in a suitable environment and food safety officers have access to all cockles for certification; 3) enable premium branding as a viable aspiration and; 4) improve local wealth generation. How this was to be established and managed needed to be described in the tender and how the handling of the cockles would be documented. Value-added was not central to this model, however, methods thought feasible by the tenderer were to be outlined should they wish to test different markets. All sales to market needed to be documented.

6. Results: The Management Study

After a European-wide invitation to tender six enquiries of interest were received and five full proposals submitted. Following evaluation of the proposals by Marine Scotland, the contract was awarded to Deefish Ltd. They submitted a high quality proposal which supplied viable approaches to meeting the criteria outlined in the call to tender as well as novel ideas about how the fishery could be managed. Sub-contracting to Deefish Ltd was the Scottish Solway Firth Shellfish Growers Co-operative, who managed the shore-side activity of the contract on behalf of Deefish Ltd. The management study was expected to start in the middle of September 2013 but due to delays in the results from the cockle stock assessment and other administrative procedures the management study started on the 15th of November. It ran for four weeks before it was suspended, due to low meat yields of the cockles harvested. The suspension remained in place until the meat yields improved and the cockles could be sold. In July 2014 the contractor confirmed with MS that meat yields had recovered sufficiently and that a viable market had been identified and that they wished to work through the remaining eight weeks of the contract. The study re-commenced on the 28th of July 2014 and ran for two weeks before the contractor requested to withdraw from the contract due to the inconsistent quality of the cockles and unfavourable market conditions.

These conditions will now be explained before the data that were collected during the second phase is presented and key achievements and limitations of the study outlined. Finally observations of future management will be made.

6.1 Reasons for Suspension

To fully test this management model there was a requirement for a commercial volume of cockles to be gathered and sold via a central distribution centre. Picking commenced in early November 2013 after markets had been secured on the basis of samples sent to buyers in September 2013. Prices had been discussed based on cockles producing a cooked 'yield' of 18%-19% (the ratio of meat to whole weight including shell). 'Yield' describes the percentage return of cooked weight from a batch of uncooked whole cockles. For example, if 10 kg of whole cockles including shells returned a cooked weight of 2 kg of meat then the yield is 20%. This market was for the transportation of live cockles to Spain for the shellfish to be cooked and canned in Spain.

Once fishing commenced in November the cockle yield had dropped to 10%, from 19% in September, which was unacceptable to the buyers for hand gathered cockles, so the produce was refused. Whilst some drop off in yield is expected during the colder months (14% is a normal yield during winter months) 10% is unusually low and could not have been predicted. An additional difficulty within the market was that higher yielding cockles were available from a variety of regions e.g.

Spain, Portugal, France and Holland. This combination of low yield and alternative availability made the marketing of Solway cockles difficult and the product could not be sold at a price which covered costs. In addition to this the contractors had identified several beds of large cockles, and secured markets for a small volume to the 'live' market, which after depuration, is where the cockles are sold directly to the consumer and then cooked at home. For this market the size of the cockle in terms of pieces of meat per kg is more important than the yield, but the amounts requested were too small to make the gathering and depuration cost effective and again prices were low. The management model was therefore unable to be tested at volume so the study was suspended.

6.2 Reason for Termination

Given the desire to fully test this model, the contractors were requested to monitor the cockle yields and recommence once better yields were present and new markets sourced. MS were contacted in June 2014 with a proposal put forward by the contractor to cook the cockles in Scotland and sell directly to Spain which would reduce the transportation risks and improve the price for fishers and associated businesses. As the study was interested in different markets, MS were keen to explore this option and the contract was restarted.

After what was a positive start and much work from a range of individuals and businesses the product was graded by the Spanish buyers on arrival and the cockle quality was deemed inconsistent with too much shell left in the product. Whilst this product was processed at an International Food Safety (IFS) Higher Level accreditation processing facility, the time required to streamline the factory line was limited given the length of the contract and the waste, i.e. edible cockle meat which was 'lost' during processing, reduced the overall yields which was not deemed cost effective even though the overall quality of the meat was high.

In addition, controls on the beach were also proving problematic with some minor infractions having been identified. As discussed in section 2.3 if internal management mechanism are weak a TURF system is unlikely to be successful and whilst these were very early days in the fishery and teething problems are expected, the team did not appear to have the level of cohesion required to implement this type of model. More detail on this breakdown is discussed in section 5.6.6 and the implication for future management outline in section 6.1.2.

Given these significant challenges and the market conditions facing the contractor, Deefish Ltd requested a withdrawal from the contract. Due to the time remaining, the approaching expiry of the AA for the current TAC, and the length of time required to resubmit a call to tender under European procurement rules, MS accepted the withdrawal and terminated the contract. Whilst the early termination was disappointing there were a number of significant achievements and lessons learnt from the formulation of the study, during the set-up period and from analysis of the

data collected from the second phase which can feed into the long term management of the Scottish Solway. These are discussed below.

6.3 Health and Safety

Due to the dangers posed to participants in this fishery i.e. working in fast moving tidal areas, the presence of quick sands and shifting sand banks, health and safety is a primary concern. All pickers, if not already certified, were required to attend the four basic fishing training courses required by all commercial fishermen and then further training on a Solway specific course known as the 'Solway Shore Awareness' course, which supplied fishers with training directly related to the estuary. This was a new course designed specifically for the trial by the training manager of the South Scotland Seafish Training Association (SOSSTA) and was informed by the 'Guidelines for safe working in estuaries and tidal area when harvesting produce such as cockle, mussels and shrimps' produced by the Health and Safety Executive after the 2004 Morecombe Bay tragedy. All fishers attended the full range of courses and 100% of the 46 attendees were awarded the basic four fishing tickets (unless they already had them) and the Solway Shore Awareness ticket.

Following on from this, the Scottish Fishermen's Federation (SFF) were approached and approved the allocation of free, specially designed, Personnel Floatation Devices (PFDs) to all fishers involved in the trial and arranged for training on the use, care and maintenance for the PFDs by the Royal National Lifeboat Institution (RNLI). The RNLI were very keen to endorse sea safety of fishers working in intertidal areas, if local conditions and safety are not adhered to. This training was well delivered and received with 100% attendance and very positive feedback from attendees after the event.

6.3.1 Beach Safety

A number of methods were put in place to promote safety on the beaches during harvesting. The first was the role of supervisors on the beach which was to ensure people's safety, but in this case the supervisors were out on the beach with a team of pickers as an active picker. The supervisors were responsible for up to 20 pickers, for logging their team on and off the beach, informing rescue agencies of their location and cockling activity and monitoring pickers behaviour on the sands. This also included a paper trail which formally logged all activity. After some initial concern around the feasibility of completing the beach-based paperwork when working on the sands (wet hands, cold, windy conditions) the supervisors accurately completed the main beach-based form to the required standard. To increase the transparency and assure that pickers had a record of their activity, individual harvesting receipts for each picker were designed. These were not completed because, it was claimed, pickers were not willing to wait after returning to shore for their receipts. Overall feedback from the key enforcement agencies was that the

supervisors acted responsibly in monitoring and recording correctly the processes put in place to increase beach safety.

On both harvest sites cocklers walked to the beds which were close to shore with quads and crew cab 4x4s available on the sands for evacuation if needed, but which otherwise were ferrying equipment at the beginning of the day and later cockles. For the length of the study this was sufficient but it is apparent that some system of personnel transport is required for distance beds. This is a service often provided by Gangmasters[3] in other sites in the UK and this is clearly a challenge under the TURF model as sufficient finance needs to be available to support this. It was later stated that the aim of the contractors was to use the first few weeks activity on the near shore beds to finance the purchase of more equipment for the distance beds, but this did not take place due to the early termination of the contract.

During the second phase, access was agreed with a local farmer in an effort to simplify the logistics (movement of cockles and pickers), supply ample parking for cocklers and eliminate disturbance to local residents in the vicinity of the harvesting area. An added benefit of this agreement was the availability of heavy duty, well maintained machinery to work on the shoreline (weighing and loading cockles) which improved the efficiency of the process and reduced the demands on the pickers.

When out on the sands, all cocklers were required to wear a fluorescent bib (different colours for supervisors) and their PFDs. These PFDs were specifically designed for fishermen to minimise any restriction on mobility, therefore all men felt able to comply with a blanket rule of wearing a PFD during any cockle activity. Again it was observed by the enforcement agency that all fishers were suitably equipped with appropriate PFDs, a high-viz waistcoat and other appropriate clothing i.e. warm and waterproof.

[3] A Gangmaster is a person who organises and oversees the work of casual labourers in the agricultural, horticultural and shellfish industries and are regulated under the Gangmasters Licencing Authority.

Observation - It should be a prerequisite that all hand licences associated with the Solway cockle fishery require completion of the basic four safety courses and the new Solway Shore Awareness course. These should be arranged for the beginning of the season for all new licence holders and refresher courses run as and when required.

Observation - Due to the size of the Solway and the need for specialised equipment with significant up-front costs, a TURF approach - which take a communal approach to resource extract and therefore also to the supply of equipment to facilitate this - would require significant funds to support a group based fishery. Whilst not impossible, this level of up-front investment would require careful consideration and other charging options (levy, licence fees etc) should be considered for future management.

Observation - The benefits of working with commercial farms etc, were apparent during the second phase. Not only do these locations have the space to cater for this type of activity, but also heavy duty machinery is available and well maintained for working on the shoreline. By charging a levy per ton this would enable other businesses to benefit from the cockling activity whilst reducing local disturbance to communities. Interested parties with good access to cockle bed should be approached to explore the feasibility of getting controlled access to all key beds in the region.

6.3.2 Food Safety

The second areas of health and safety were identified as food safety and public health. Shellfish is a high risk food group and since the horse-meat scandal, food traceability has a higher public profile. As part of this study we were keen to work with the Food Standard Agency of Scotland (FSAS) to simplify the process of classifying and monitoring the cockle harvesting area. This resulted in all cockles beds being classified as category 'B' after analysing the shellfish flesh for *E.coli* in the area (please see annex 1 for details on this classification) and then weekly monitoring for *E.coli* and marine biotoxins of the harvested cockles was carried out at the certified distribution centre for the purposes of this study only.

During the establishment of the study, much work was undertaken between the relevant authorities to implement this monitor regime. Annex 1 outlines the method in detail. During the study samples were collected from Deefish Ltd. Unfortunately due to the length of the study we were unable to establish with certainty whether this method is viable for classifying cockles in an open fishery. However feedback was positive and it is believed that this is the approach required to improve traceability and provide more protection to public health.

Observation - Building in capacity to improve and develop food safety should continue with the advancement of this fishery. Given that the demand for better food traceability is only likely to increase, the Solway cockle fishery is in a good position to lead on this with the collaboration of the FSAS and the Local Authority

6.4 Composition of Fishing Team involved in the Management Study

Of the 46 fishers who were registered with the Scottish Solway Firth Shellfish Growers Co-operative, 25 pickers completed a questionnaire which was designed to gather data on the social profiles of the fishing team. Due to the two short fishing phases, it was problematic gathering this data from the full team as some members had not returned their questionnaire before fishing was suspended, therefore these data are partial and should only be viewed as an indication of the social profile of those interested / involved in cockling rather than a definitive study.

The age composition of those surveyed shows that the majority of pickers were 36-55 with a number of young pickers in the age bracket 19-25. The highest proportion of experienced pickers were in the 36-65 year old cohorts and all the younger pickers aged 19-25 and the majority of 26-35 had no past experience at cockle picking (Fig. 4).

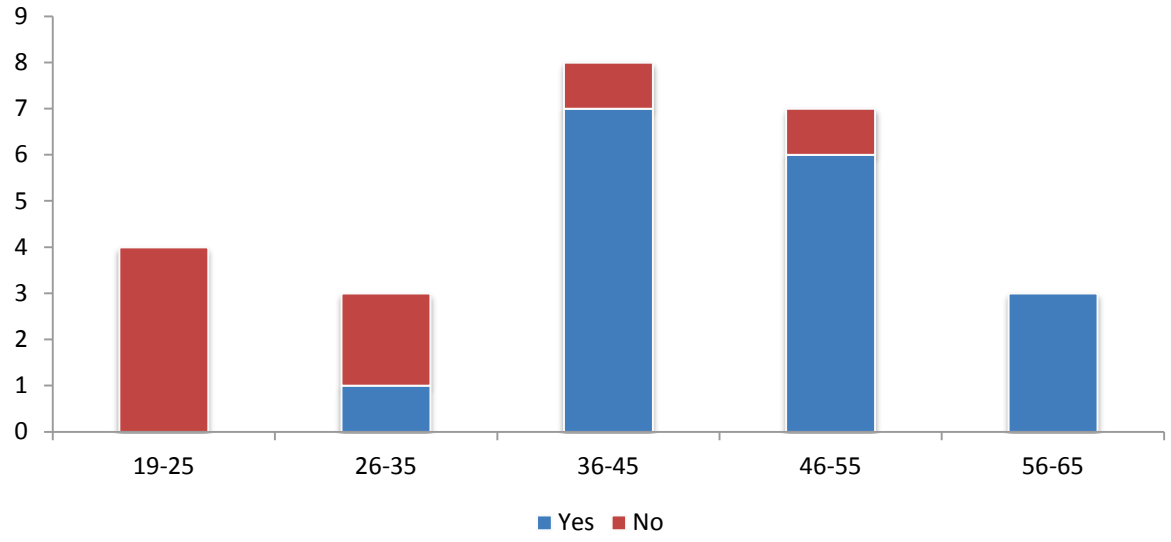

Figure 4: Age composition of surveyed pickers and breakdown of pickers with past cockling experience and those without experience (*n* = 25).

Of those who gave data about other cockle fisheries that they had worked in (*n* = 10), all had worked in Morecombe Bay in Lancashire and the majority in the Dee estuary in Wales and the Ribble estuary also in Lancashire (Fig. 5). Only the older fishers had experience in the two east coast cockle fisheries, the Wash and the Thames, which in the past had hand collection but are now dominated by boat fisheries (Moore, 1990).

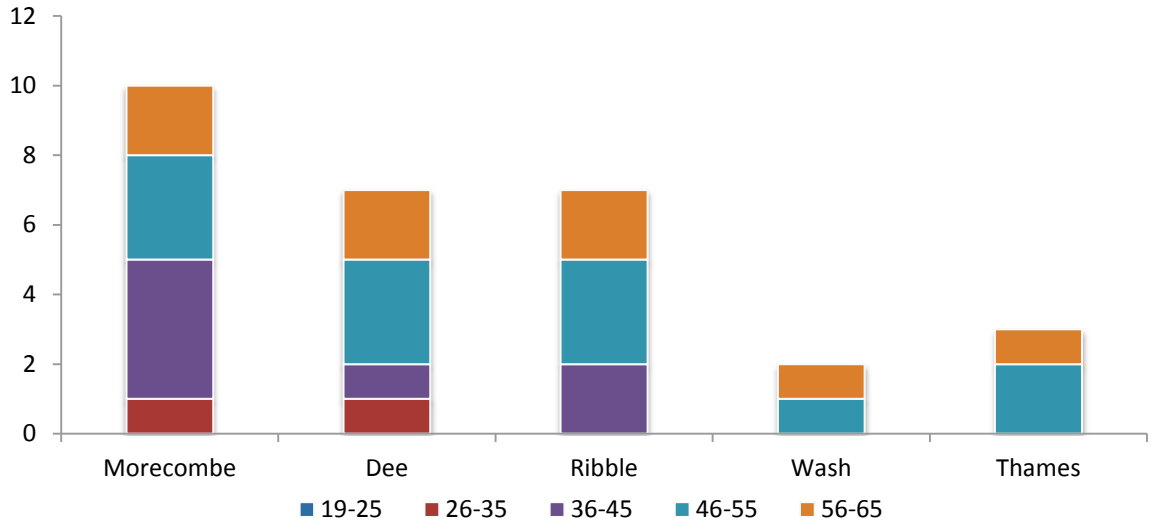

Figure 5: Age profile by other fisheries that pickers had experience of working in (*n* = 10).

Of the fishermen who responded, the highest proportion had 11-20 years picking experience followed by those who had none to very limited experience in the 0-2 years cohort (Fig. 6). This indicates that the team was relatively inexperienced with almost half of those surveyed having less than five year experience in cockle picking.

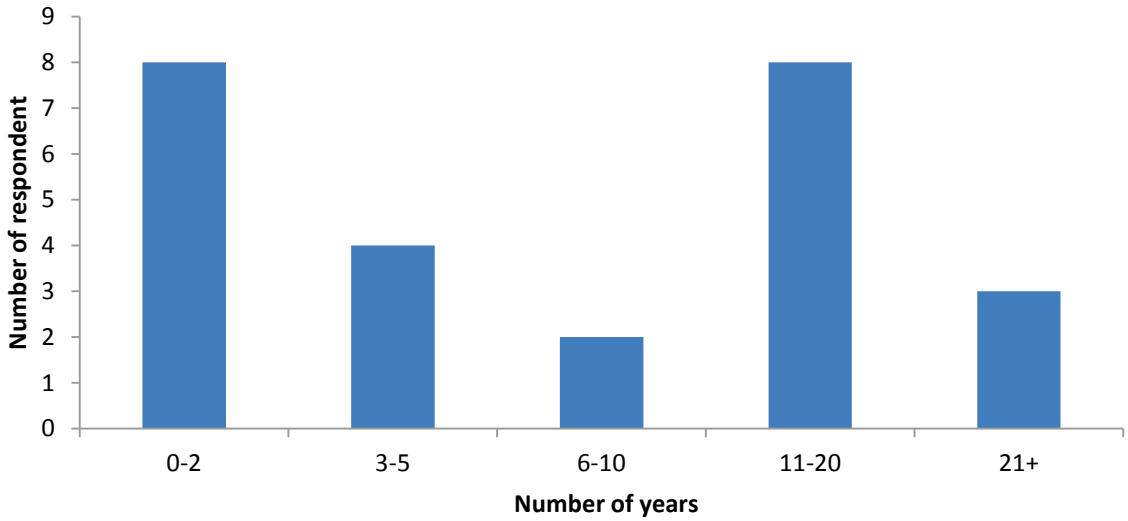

Figure 6: Number of years experience at cockle picking

One of the objectives of this study was to measure the potential local benefits from opening the fishery. Just under half of those who responded, or 11 people stated that this was their only current form of employment (Fig. 7) and for a couple of fishers this was their first opportunity after being long term unemployed. This proportion however should be treated with caution as many surveys were not returned, most likely due to people being unavailable outside of fishing because of other forms of employment.

For those that had other employment this included construction work, fisheries (mussels and lobster), seasonal council contracts and bar management . A number of harvesters had other qualifications which were either general construction qualifications or a specific trade which included bricklaying, plastering, painting and decoration and roofing.

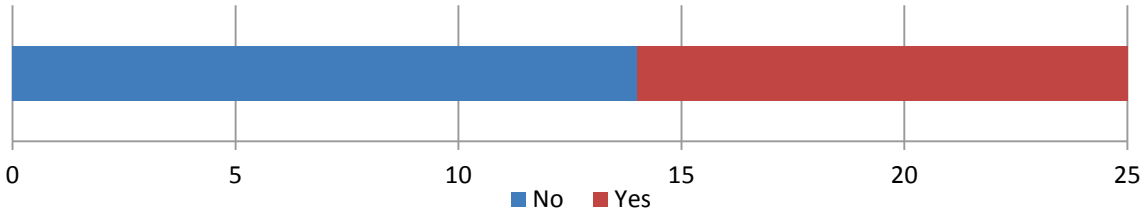

Figure 7: Number of pickers who stated whether this study was their only current form of employment

6.5 Fishing Activity under the Management Study

Fishing on a commercial scale under the management study took place for 12 days - 6 days in November 2013 and 6 days in August-Sept 2014. Samples of cockles between 200-500 kg were also collected on a number of days around these main fishing dates by 3-4 pickers to measure yields and supply buyers with samples. A total of 32,302 kg of cockles over 25 mm were removed during the study.

The main sub-contractor to Deefish Ltd, the Scottish Solway Firth Shellfish Growers Co-operative, had 46 registered pickers which under the management study had permission to collect cockles. Of these an average of 22 pickers fished most days, with 30 pickers as the highest attendance and 14 pickers as the lowest.

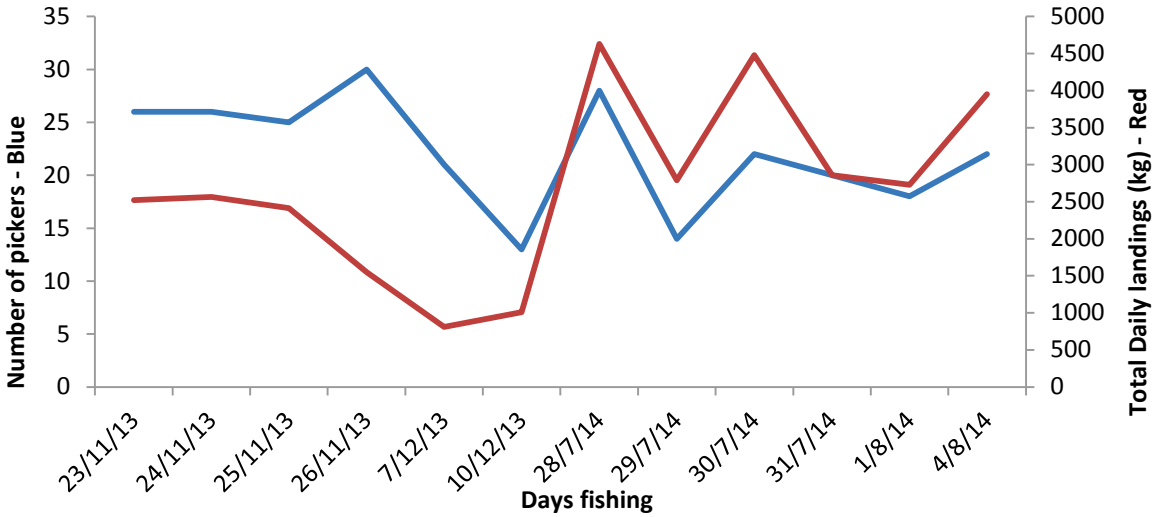

Figure 8: Number of pickers (blue) and total daily landings (red) on each main fishing day

As demonstrated in figure 8 efficiency in the collection of cockles per picker in the first period was low, with daily harvest ranging from 810 kg to 2,560 kg, whereas this improved in the second period where kilograms landed increased significantly, to between 2,787 kg to 4,630 kg, per day whilst the number of pickers was slightly less during this period - average 23 pickers in the first period and 21 pickers in the second period.

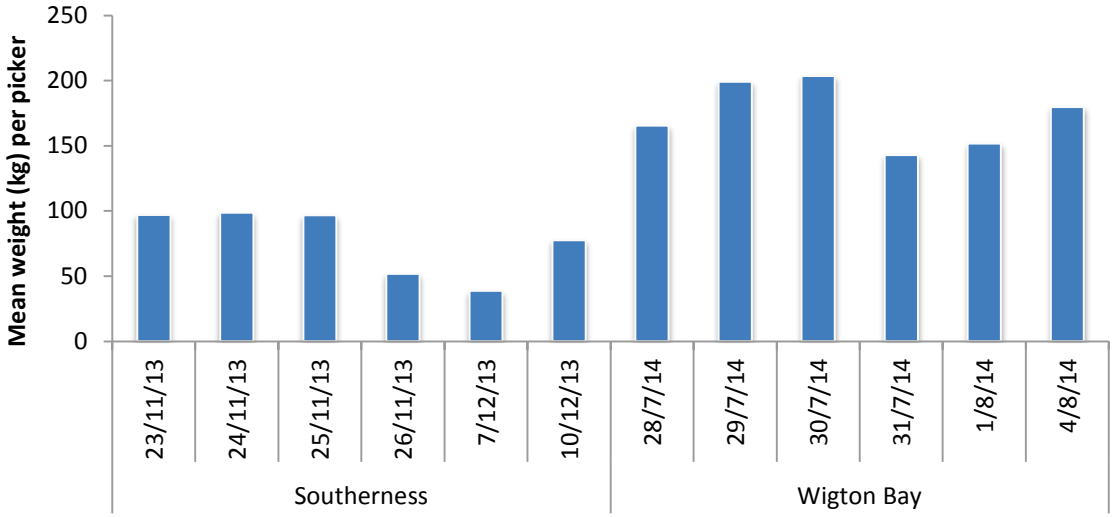

Figure 9: Mean weight per picker per fishing day.

This is further demonstrated in figure 9 which shows the average collection rate per picker with collection at Southerness, at 78 kg per day per picker, much lower than at Wigton Bay at 159 kg per day per picker. This is most likely due to the experience of the picking teams - a number of highly experienced and well equipped pickers came onto the team at Wigton Bay, but also due to the density of the cockles at Wigton Bay and improved logistics - good access point close to the harvesting area.

As harvest rates varied substantially between pickers, the data which was collected during the second phase, was analysed in detail. To capture the variation in picking rates the data was grouped into thirds and analysis conducted on picking teams and then on individual pickers. In the lowest performing third an average of 5 bags per tide were collected per team with an average weight per tide of 205 kg. This increased to 10.8 bags with an average weight of 351 kg per tide per team as the mean and the highest performing third had picking rates of 13.3 bags and an average weight of 590 kg per team. This resulted in the lowest third having picking rates of 106 kg per person, the mean 182.4 kg and the highest third 305 kg per person per tide[4] (Table 2).

[4] These figures are the total landed tonnage divide by the number of pickers. This is slight lower than the two person team as in some case one picker worked alone.

Table 2: Data based on the six tides picking in August 2014 (data from the second phase only)

	per picker			
	Lowest third	Middle third	Highest third	Mean
Mean number bags per tide per team	5.0	7.0	13.3	10.8
Mean weight (kg) per tide per team	205.0	298.7	589.8	351.0
Mean number bags per tide per picker	2.6	3.7	6.9	5.6
Mean weight (kg) per tide per picker	105.6	156.8	305.1	182.4
Mean weight (kg) per bag	30.6	33.7	34.3	32.5
SD weight per bag	29.7	34.8	32.4	6.8

The lower picking rates were associated with new, inexperienced pickers who had yet to develop the technique and fitness levels required to harvest cockle at the higher rates. These rate are however comparable to other fisheries in the UK were the Dee cockle fishery limited daily harvests to 150 kg in 2013 down from 300 kg in 2012. This lower rate in the Dee was put in place to protect stocks whilst accommodating all current licence holders, however this is far from ideal due to the high level of inefficiency and rent dissipation between a high number of pickers for the available resource.

To understand potential earning per picker the rate that fishermen were paid during the Solway cockle study which was £0.80 per kg (£1.15 - £0.35 costs = £0.80p per kg) were used to establish average earning per group. The average earning per tide per picker was £84.80 for the lowest performing third, £151.20 for the mean and £244 for the highest performing third. Figure 10 indicate potential harvest rates and earnings that pickers could take depending on the length of the season. So assuming 20 tides per month, fishing incomes would range from £3,024 after costs (3,650 kg) for the mean picker at £1.15 per kg and up to £4,880 after costs (6,100 kg) at the highest picking rate per month.

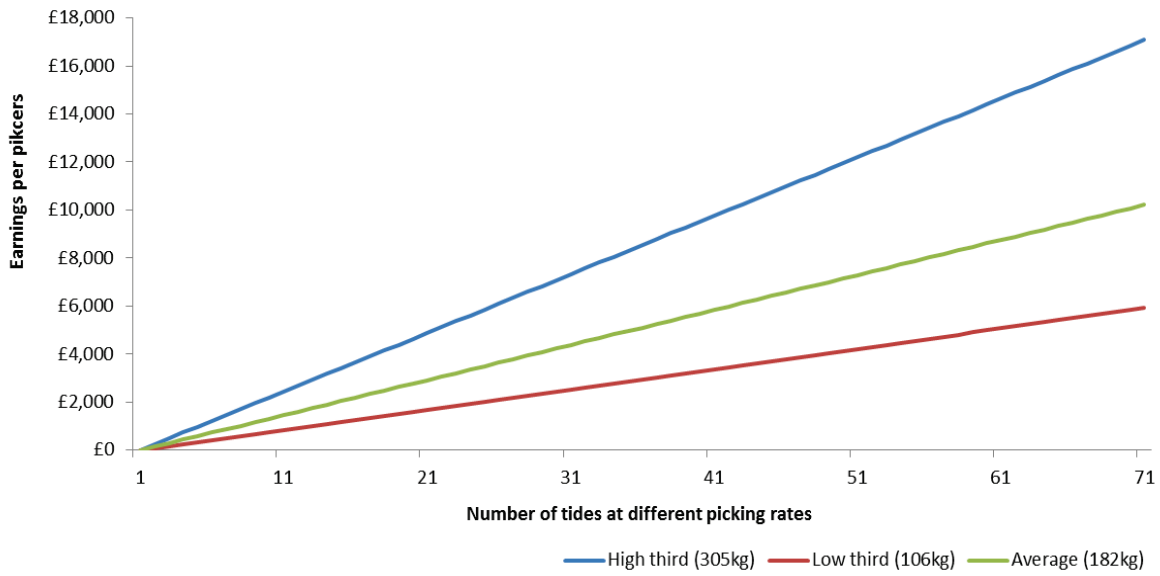

Figure 10: Potential earning and the number of tides required at different picking rates

Whilst this work is seasonal[5] and income would only be obtainable for the months that the fishery was open, to put this in some context table 3 describes hourly, month and annual earning at these rates and compared them to the minimum and living wages for the UK.

Table 3: Based on an 8 hour day and 20 working days (tides) per month

	Minimum wage	Living wage	Low harvest rate	Mean harvest rate	High harvest rate
Hours	£6.50	£7.65	£10.60	£18.90	£30.50
Monthly	£1,040	£1,224	£1,696	£3,024	£4,880
Annual	£12,480	£14,688	£20,352	£36,288	£58,560

This is based on relatively moderate earnings per kg, which was paid during the study, and as will be described in section 5.7 the price paid per kg fluctuates greatly so the opportunity to earn higher wages per tide is likely.

[5] In the case of cockling days could be longer (over 8 hours) but equally in the summer months, two tides could be fished on the same day which would double income in a 24 hours period.

Observation - Future management of the Solway cockle fishery should offer the opportunities for young inexperienced fishers to enter and benefit from the local resource. This could be achieved through apprenticeship schemes, however fishing opportunity needs to be monitored to ensure that new entrants have the chance to work in the fishery once the apprenticeship is completed.

Observation - Due to the seasonal nature of this fishery, opportunity should be made available for fishers who work in other fisheries (e.g. creeling) but who may wish to diversify and supplement their main fishing activity with cockling. This could be offered through a limited number of annual licences that become available once the TAC for that year fishery is known and allocation for long-term licence holders* is assessed and met. *This should not affect the rights of fishers who wish to apply for a long-term licence.*

*Conditions and terms surrounding any long-term licence will need to be defined and should not assumed to function as an assets or to be tradable/transferable by licensees.

6.6 Compliance and Enforcement

Enforcement is problematic in the Scottish Solway due to the size of the estuary and an abundance of isolated entrance and exit points onto the sands along the coast. Because of the financial rewards and potentially low barriers to entry, cockling is an attractive activity which in the past has attracted people from far and wide. There is substantial anecdotal evidence to suggest that uncontrolled access in the past has resulted in direct financial costs and social disturbance for affected communities in Dumfries and Galloway, for example as a result of littering, damage to property and disruption to public services i.e. local bus and school runs, which has created a negative legacy which any future management of the Solway cockle fishing needs to take into account.

To start addressing this, a key achievement under this study was the establishment of a multi-agency enforcement working group to take an integrated approach for dealing with non-compliance and enforcement. Through this working group, past and present problems with the fishery were discussed, and viable solutions proposed and debated between the enforcement group. Agencies involved in this working group included: Marine Scotland Compliance, Police Scotland, the Gangmasters Licencing Authority (GLA), Food Standard Agency Scotland (FSAS), Dumfries and Galloway Council and Scottish Natural Heritage. Non-enforcement members were Marine Scotland Science, Solway Firth Partnership, South West Inshore Fisheries Group, and the Maritime & Coast Guard Agency. Invitations were also extended to the NW-IFCA who were keen to support the group but unable to attend meetings during the study.

In addition to the general discussions on past and present problems in the Solway, good practice from other UK and European cockle fishery and suggestions from the contractors application were discussed and integrated to devise a viable enforcement plan. Those related to the management study are now discussed.

6.6.1 Reporting to Enforcement Officers on Daily Fishing Activity

A weekly harvest plan was sent on the Friday before fishing commenced detailing the forthcoming week. This informed all enforcement agencies about the location and composition of daily fishing activity and meant that any non-notified activity could immediately be identified as non-compliant / illegal. Daily notifications were then emailed on the morning of fishing to confirm start times and the number of pickers on the beach. These emails (example below) would be sent to a central email account and then forwarded to all enforcement agencies, ensuring all were aware of the location and size of the fishing team operating under the study.

Example of notification:

Date of Harvest – 10/12/2013
Point of Access - Southerness Lighthouse
Point of Egress - Southerness Lighthouse
Time on – 7:30
Time off – 12 noon
Shore Manager - AA
Supervisors - AA, BB, CC
30 fishers on the beach

Initially emails listed the actual ID numbers of the fishers on the beach but this was revised to the number of fishers, due to the difficulty of obtaining this information with the required accuracy. A second issue arose when the start times were in advance of the email received - before the administration office was open - however retrospective email alerts were sufficient to state egress times which was suitable for compliance inspections. This reporting process allowed Marine Scotland Compliance to build and test a distribution list with various agencies as well as local fishery officers. A further safety requirement was to call the Liverpool coastguard to inform them of pickers being on the beach. To begin with there was some prompting required for the supervisor to call the coastguard, but that soon became a matter of routine, as did notification when fishers returned to shore. Overall the process worked well and it was reported as not too arduous for the contractors.

6.6.2 Identifiable Teams

All fishers were required to wear coloured bibs, with the supervisors in a different colour to make the teams easily identifiable to compliance officers and local residents. The benefits of this were clearly demonstrated when a member of the public rang MS to report what they perceived as illegal fishing activity and were able to report with ease the number of fishers, their location and time on which was

crossed referenced with the daily email and they were confirmed to be the fishing team working under the study.

All harvesters were required to carry identification cards with them at all times which demonstrated that they were permitted and qualified fishers. The documentation was easily recognisable as belonging to the study and hard to imitate as they were produced by a professional card company. In addition, as in the Bury Inlet cockle fishery, registration numbers of all vehicles involved in the study were supplied to all enforcement agencies. This increased the agencies' ability to regulate access in the area and monitor the transportation of legal cockles under the study and therefore to identify illegal cockles gathered external to the study.

Under the management study, cockles were transported from the beach in pre-approved coloured bags. As in most UK cockle fisheries, the bags were designed based upon the weight they can hold (i.e. 30 kg bag) with the pickers ID number attached to each bag. This allowed close monitoring of the catch being taken by picking teams, which enabled: 1) individual fishers to be warned if the product was not to the desired quality; 2) the protection of the stocks by monitoring the removal of undersized fish; 3) improved compliance with fishing regulations and; 4) allowed the fair and transparent payment of harvesters. During both fishing periods, bags were monitored and in the second period a number of smaller cockles were detected in the catch. This was fed back to the fishing teams and corrective action was taken to grade the animals more closely. Unfortunately fishing was terminated before improvements were verified.

6.6.3 Documentation for Compliance Officers

To improve enforcement and establish processes to improve the traceability of the seafood, tailored documents were produced and approved by the enforcement group. For data collection and record keeping at the shore 'Daily Harvest' sheets (annex 2) were completed by the supervisors prior to work commencing and then after fishing had ceased to record all activity that has taken place during that day. This sheet was developed by Marine Scotland and the contractors and training was undertaken with all supervisors and the staff at the central distribution centre. Feedback was taken after the first few day's fishing to check the ease of the process. It was pointed out that the sheets were likely to get wet and muddy and therefore it was best to complete the first stage whilst at the car, then take notes in small note books whilst on the sands to complete the final section when back at the car after the work was completed.

A second document was designed to increase transparency and in response to reports of unfair treatment of pickers in the past. This was a duplicate book (annex 3) for supervisors to distribute receipts for bags landed at the shore side so all pickers had a record of their activity should dispute arise at a later date. It was however stated that tired, cold fishers are not very keen to wait around once finished for

paperwork, therefore these books were rarely completed and receipts were not given. The third form was the 'Beach Movement' sheet which accompanied the cockles from the beach to the distribution centre. This sheet (annex 4) detailed the composition of the catch being transported from the beach, so should a vehicle get stopped it would be easy for an enforcement officer to check that all the catch in the vehicle was correct and accounted for.

Every attempt was made by the supervisors to ensure that the main documentation described in the TURF process was adhered to (with the exception of the receipt books) and all documents leading from the beach to the final movement document covering transportation to the distribution centre were completed accordingly.

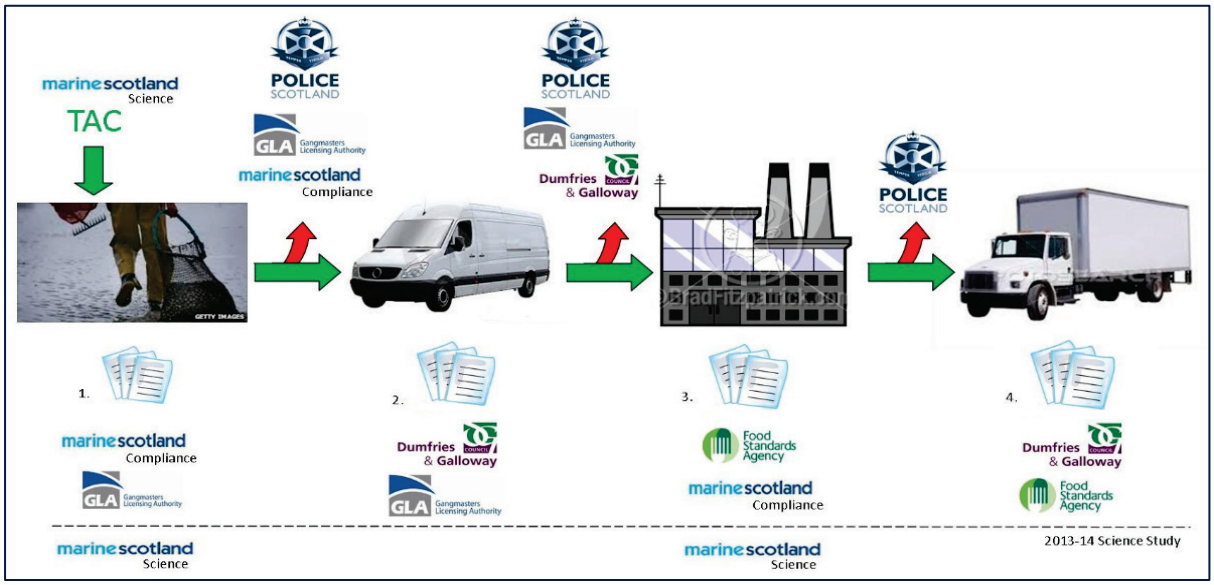

Figure 11: Diagram of the business model and responsible agencies for a fully documented fishery. Green arrows are the legal movement of cockles, red arrows are the illegal movement of cockle and the responsible enforcement agency.

On arrival at the distribution centre an intake sheet (annex 5) recorded the arrival time, the conditions (e.g. temperature) and quality of the cockle. This was linked to the other documentation so each batch of cockles could be accurately tracked in the distribution centre. This was completed accordingly by the distribution staff and all other data collection required under the study was undertaken after this paper trail was completed.

Observation - Any future fishery in the Solway should have a fully documented process which can track bags of cockles back to the picker and the beach area, all the way through the chain to the final customer. The paperwork produced during the study is fit for this purpose and should be used as a template and refined as and when required. What is key is that the process should be as streamlined and straightforward as possible to facilitate compliance.

6.6.4 Centralised Distribution Centre

Deefish Ltd supplied the premises which acted as the central distribution centre for the study in Kirkcudbright. The facility is audited to SALSA (Safe and Local Supplier Approval) standard and outside of the study was a primary processing factory for queen scallops. The facility is fully certified for the primary processing of seafood and also had a temporary packing licence for cooked produce.

The distribution centre had two main duties, the first was to intake all cockles collected under the management study for audit and quality control. This involved the unloading and appropriate storage of the cockles, as well as data collection for the study. The second was to support the FSAS and follow protocols to test the new methods for food classification. The centre under Deefish Ltd also managed the sales and marketing element of the contract, which involved sourcing viable markets for cockles and negotiating with buyers who wished to purchase cockles as well as administering all payments received and processing all payments to the sub-contractor, the Scottish Solway Firth Shellfish Growers Co-operative.

Beyond these tasks, a key objective in having this central distribution centre was for improved compliance and enforcement. As the selling of cockles on the beach was prohibited, all catches went through the centre which facilitated the transparent monitoring of catch, and mitigated almost all of the social problems attached to the open-access regime of the past (for example the blocking of public roads by large volumes of buyers and pickers and the anti-social behaviour associated with groups conducting business transactions at the shore). Fishery Officers and other enforcement agencies were able to conduct inspections of landings at the distribution centre and check all records which gave assurance of quantities harvested and the quality and health of the product going into the food chain. As all paperwork associated with the fishery was held in one location, enforcement agencies had a single point of call and ready access to anything they needed. This was especially important for Environmental Health and the FSAS.

Observation - A central distribution centre offers many benefits for improved compliance through auditing as well as for the development of improved food traceability and should remain an important consideration for future management.

This should not necessarily be limited to one centre and the future fishery may consist of more should a viable case be made for multiple centres.

6.6.5 Rules violations

Clear rules were established at the beginning of the study. All fishers signed an agreement to abide by these rules and all supervisors were aware of their specific responsibilities as pickers and team leaders. In the first phase no internal violations of the rules were brought to the attention of compliance officers and all enforcement agencies commended the behaviour of all of the fishing teams. During the second phase some minor infractions were brought to the attention of fisheries officers, the first by a member of the public who contacted Marine Scotland directly and the second was an internal report on unlicensed activity. Due to the termination of the study neither of these violations were taken further but they demonstrate the need for clear rules on the sands to manage behaviour.

6.6.6 Policing of Unlicensed (illegal) Fishing

During the study compliance officers and the police patrolled various areas know to be used by unlicensed cockle pickers, however, no signs of poaching were present. In one case some harvesting paraphernalia was discovered and retained but the local view was that the yields and near shore stock densities did not warrant any illegal activity. Therefore new powers available to fisheries officers have, to date, not been tested[6].

One approach that the enforcement working group would like to develop further involves the seizing of cockles which lack appropriate paperwork. Currently due to the cost and logistics in handling cockles which once they leave the beach are considered to be a food product, compliance officers are less inclined to seize cockles without considerable proof that they have been obtained illegally. However this would be less problematic if a facility was available to store and process the cockles so they can be classified by Environmental Health and transferred into the

[6] Under the Aquaculture and Fisheries Act 2013 section 49 - "A person commits an offence if - (a) the person is found in, or in the immediate vicinity of, the area specified in an order under section 1 of this Act; (b) the person is found there at, or about, a time at which the prohibition under the order applies; (c) when so found, the person is in possession of such equipment, vehicle, apparatus or other gear or paraphernalia (including clothing) as may be used for the purpose of fishing in contravention of the order; and (d) it is reasonable to infer from those facts (either by themselves or taken together with other circumstances) that the person intends to fish in contravention of the order."

food chain. Cockles could therefore be seized and held for a short period of time or sold and the money retained whilst the persons who the cockles were seized from had the opportunity to prove their legality. Currently this system is a complex process but much has been achieved in moving this closer to reality and a central distribution centre of some sort would be key in making this a viable option of policing illegal activity.

6.7 Transparency and Fairness

A key objective of this study was to investigate how this fishery could be managed for improved transparency and fairness to the individuals who contribute the most, the cockle pickers. Past reports (The Guardian, 2011; Marine Scotland, 2012) have detailed cases where fishers have been disadvantaged and mispaid i.e. not paid the agreed rate or not being advised of the rate of pay in a timely manner, therefore we were keen to understand this further and build in procedures that eliminate this practice.

Data from the social questionnaire showed that of those who have harvested cockles in the past the majority were informed on their rate of pay per kg after they had landed their catch or on the morning before picking commenced. A few were informed the week before and in one case at the end of a set of tides (Fig. 12). Within the management study, the aim was for pickers to be informed by the primary contractor at the beginning of week of the net price per kg which they would receive. The pickers then were able to make an informed decision as to whether to fish or not. This was achieved for the study and all fishers were informed of the rate at the beginning of the week which was £1.35 per kg less a £0.35 per kg levy during the first fishing phase and then £1.15 per kg less a £0.35 per kg levy in the first week of the second period. During the final days of the study, Deefish Ltd informed the subcontractor (SSFMPC) that the available rate had decreased to £0.70 per kg less a £0.35 per kg levy . The harvest teams indicated that they were unwilling to work for that rate. This was indeed their prerogative and this system allowed the fishers to take this action should they wish.

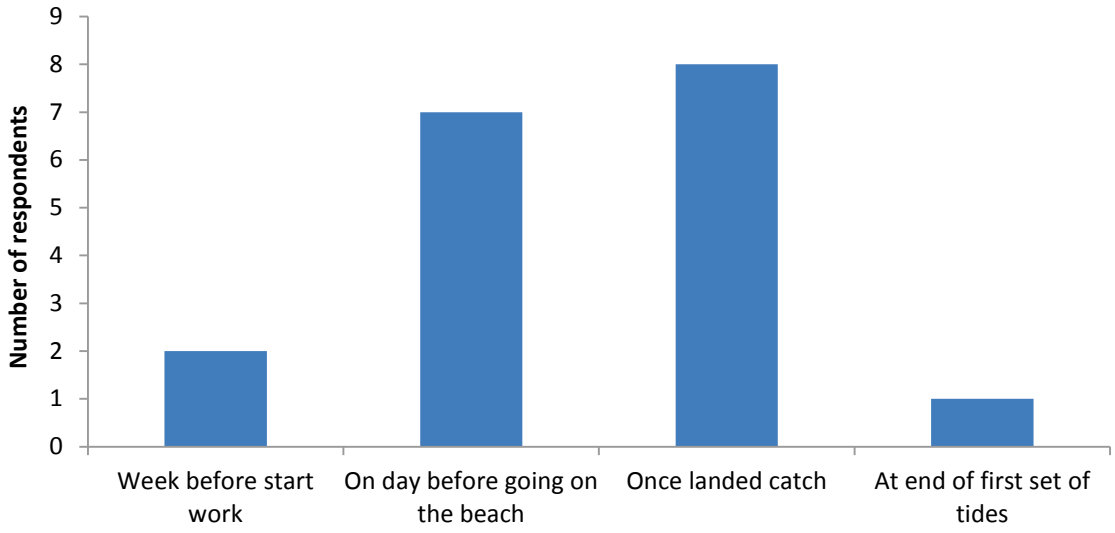

Figure 12: Responses to 'when do you know what rate you will earn from cockle collection?"

Data from the questionnaire showed that in the past the majority of fishers had received £0.60 as a minimum pay per kg and £2.00 as a maximum pay per kg, but that some had received pay as low as £0.20 and as high as £2.40 (Table 4). Under the study a rate of pay of £0.80 after expenses was on the lower side, but as demonstrated in section 5.5 can still deliver a good weekly wage if picking rates are high and tides and other conditions are favourable.

Table 4: Minimum and maximum rates of past pay from respondents

Minimum (£)	*n*	Maximum (£)	*n*
<0.2	4	1.2	2
0.3	1	1.5	1
0.4	1	1.6	1
0.5	1	1.8	2
0.6	5	2	7
0.7	1	2.2	1
0.9	2	2.4	1

When asked about a minimum monthly wage pickers would need to earn for the activity to be a viable option, the majority of respondents stated that £2,000 per month would be required (Fig 13). This rose to £3,600 for two pickers and was as low as £300 for one picker who was alternating this form of fishing with creel fishing. As detailed in table 3 in section 5.5, even at the lower rate paid (£0.80) during the study, £2,000 would be achieved at a mean picking rate within 14 tides.

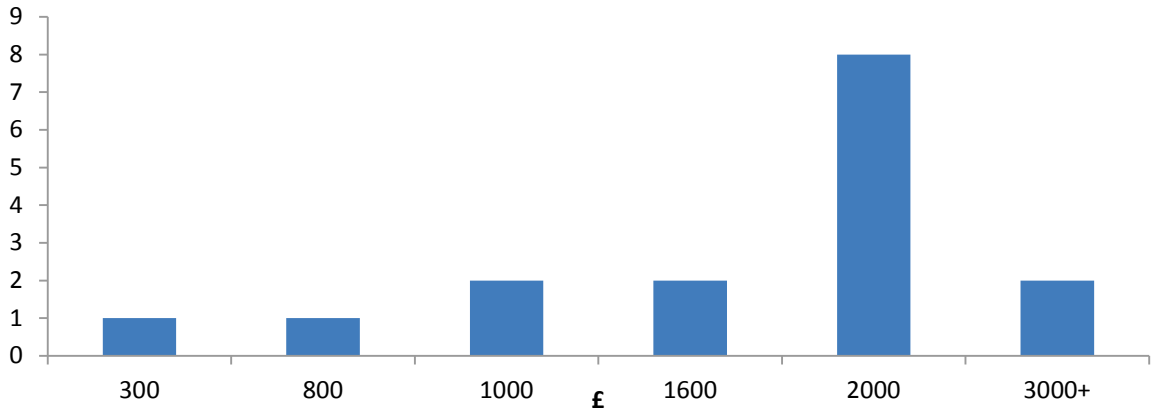

Figure 13: Minimum monthly wage required to make cockling a viable option

To understand what fishers felt would be a fair contribution toward supporting a cockle fishery, they were asked what rate/levy would they be willing to pay to support management.

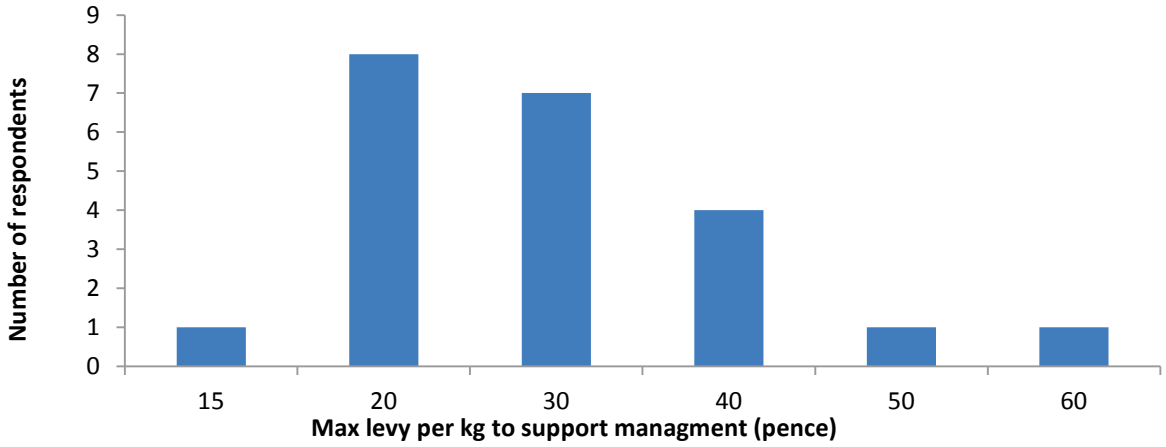

Figure 14: Maximum levy pence per kg that pickers felt should be paid to support the fishery

The majority who responded stated that £0.20 per kg was a suitable contribution with the second largest respondent group saying £0.30 per kg. This rate went as a low as £0.15 and in one case as high as £0.60 per kg, but clearly a rate between £0.20-0.40 was considered most suitable. It is worth noting that the pickers, the levy on the study was 35p per kg and the majority were still willing to fish. In the second phase a number of self-equipped fishers came onto the team, and they felt their levy should be renegotiated given that they were not using the contractor's equipment but using their own. This is clearly a challenge within a communal system such as TURF regime and therefore a multi-levelled levy system maybe more appropriate given the unequal resources that different fishers bring to the fishery.

Observation - To inform pickers in advance of the rate per kg is desirable and should be an aspiration for this fishery however because this was trialled over a very short period of time, it is not recommended at this time and other fair payment systems should be explored. What is important is that transparent transactions take place so that picker know they are being suitable rewarded for their efforts.

Observation - The funding of the fishery should be explored further as whilst a flat-rate levy upon each individual's harvest is a viable option along with licence

Data on the financial set-up undertaken by Deefish Ltd showed that after costs the fishery was profitable, with profits of £40.60 per tonne. As table 5 demonstrate the bulk of the expenses were in pickers' wages, followed by transport and then processing. The transportation of the cockles was an influencing factor on profit margins as any shipments under 10 tonnes were reported by Deefish Ltd as costing £0.70 per kg, whilst shipment over 10 tonnes would be able to go in a single container and therefore decrease in price down to £0.15 per kg. The shipments made during this study were all under 10 tonnes which resulted in relativity high costs - around 11%.

Table 5: Details of the expenses and income from the management study

Expenses	Detail	One off expenses/ income	Per tonne	% expenses/ income
Set-up costs	Training, printing and packaging, insurance, safety equipment and licences	£14,431.93		31%
Transportation and handling of cockles	Access, transportation from beach and to customers, levy		£157.21	11%
Miscellaneous	Quad bike repairs, expenses (fuel)		£52.06	4%
Wages	Pickers wages minus expenses		£670.47	46%
Processing	Cooking and onshore labour		£130.31	9%
Total			£1,010.05	100%
Income				
Non-sales*	Memberships and grants	£10,130.00		23%
Sales	Sold cockles		£1,050.65	77%
Profits	Income minus expenses	-£4,301.93	£40.60	

The start-up cost were calculated separately as on-off costs for the operation of the fishery as this was funded through a different route. As described in the tender Deefish Ltd worked with a co-operative of cockle pickers which was a separate organisation. To fund the establishment of the co-operative, pickers were charged a membership fee of £500 which was to fund the administrative set-up of the fishing teams and supply training for all pickers. This is not uncommon as most cockle

fisheries charge user fees and cost range from £300-£500 for hand picking. In this case, the £500 was initially taken (from the majority of pickers) and then £260 refunded to all pickers who had paid once the final costs and earnings had been calculated. Net revenue after the refund totalled £10,130. This also included a small grant but not all fees as a small number of pickers did not pay the initial fee. The fees collected from licence holders were insufficient to cover all of the one-off set-up costs of £14,431.93, falling short by £4,301.93. This deficit was offset during the course of the fishery by the profits on sales of cockles and by Deefish Ltd's proportion of the levy which was not collected for the last weeks activity.

When asked for their views on licence conditions, the majority of fishers who responded said that all pickers should have the basic fishing qualification as well as the Solway specific training and that they should sign up to the specific rules governing this fishery. A few respondents felt that no condition should be attached to the licence. The majority felt that as the ultimate penalty for the violation of rules fishers should loss their licence but there was a variance of views over the conditions leading up to that lose of a licence with a number quoting warnings or 'three strikes and you're out' up to instant disqualification at one violation.

Views were divided on daily limits per picker with many saying there should be no limits, whilst others felt limits would be acceptable as long as the allocation was financially rewarding. A few felt that limits should be dependent on TAC and length of season. All pickers agreed with a minimum landing size (MLS) and a number noted that only shellfish over 20 mm should be harvested, whilst other cited high MLS at 25-28 mm.

Finally all fishers agreed that there should be licence limitations for the Scottish Solway with most fishers stated that between 20-50 would be optimal with 30-40 being the most commonly mentioned number.

6.8 Markets

A key challenge facing this study was securing profitable and reliable routes to market. Cockle selling is well-established through networks in the UK which involves a number of middle agents who have considerable control over the market. Anecdotal evidence suggests that these networks use this control to secure favourable conditions and in some cases block routes to markets for new businesses wishing to enter the sector.

During the period of this study a number of overseas customers were sourced directly by Deefish Ltd for live cockles and, later, cockles that had been processed in Scotland with the benefits of securing better prices. These customers were sourced directly which navigated around the established UK networks. This approach required time and a high quality product; the latter was the main factor lacking in the first phase of fishing when the yields went down to 9%. Quality again became an

issue when a solid market was secured for the second phase, but rather than the quality of the cockles this was due to the underdeveloped cooking process in Scotland and time did not allow this process to be improved before the contract was terminated.

Marine Scotland were informed a number of times during the study by observers of the fishery that marketing opportunities exist for cockles throughout the year, yet because local markets and pre-existing sales networks proved unwilling to engage with the study participants, Deefish focused on trying to find foreign markets. These foreign markets demanded a relatively high quality product, but this became problematic during the trial given the unusually low cockle yields in November, the under-developed processing capacity in the following June and the stop - start nature of the contract which affected the flow of fish. Feedback from the contractor was that whilst there was limited ability to sell to domestic markets at this time, this had little influence on the study as the foreign markets offered good, reliable buyers who are very keen to engage with a well-managed fishery, but more time was required to develop a quality product than was offered during the management study, given the need to suspend the study in November 2013 due to the low yields.

Observation - As the management plan for the fishery develops, markets need to be kept in mind, but efforts should focus on harvesting cockle (within the TAC) in their peak condition and at a volume and rate that is appealing to a range of different markets. This requires attention to be given to the number of permanent and temporary licences on offer and whether vessels should be involved if the annual TACs support their inclusion.

Whilst beyond the scope of this study, how value-added processes and markets can be developed in the local area should be explored for the development of this fishery.

6.9 Awareness Raising

Media: The study generated a lot of interest from local communities and the local and national media. This included interviews by: the Solway Firth Partnership with Border TV and BBC Radio Scotland; an interview by the Cabinet Secretary for Rural Affairs and the Environment Richard Lochhead with ITV Borders; articles were published on the BBC website and fishnewseu.com and; two local publications were produced by Solway Firth Partnership - a four-page leaflet and a two-page spread in Tidelines, a bi-annual publication. BBC Scotland were also interested in doing a short film on the shore with the fishers however this was delayed and then declined due to the suspension of the study. Local media also reported on the suspension of the study following a press release from Marine Scotland.

Local Communities: The main method for communicating with local communities was a four page cockle leaflet. Hard copies were disseminated to local council offices, community centres, conservation offices and local coastal towns and villages to inform people of the study. Overall this was well received, it was reported that villagers were happy that they were being considered and included and that responding to their concerns given past episodes of anti-social activity related to the fishery was central to this management study. In some villages leaflets were posted door-to-door and copies laminated and displayed on notice boards. Some communities still have concerns and written communications were received from specific communities along the coast.

The Solway Firth Partnership approached local conservation organisations to keep them informed of the study. General feedback was that they were pleased to have been contacted direct which has not happened previously and most were very supportive on the aims of the study. These meetings also functioned as an opportunity to understand conservation organisations' views on the fishery and it became apparent that there were a number of needs that they have which are yet to be properly addressed. Key points which came out of these initial discussions were:

1. Sensitive habitat mapping is needed along the shoreline especially around access points.
2. Documentation of sensitive periods for wildlife e.g. goose roost and locations mapped would be useful to input into a fishery harvest plan.
3. Identification training for fishermen on sensitive plant species e.g. *zostera* (seagrass) and habitat is required and was offered by the National Trust of Scotland.
4. An opportunity should be made for knowledge exchange between conservation groups and fishermen to understand each other needs and mitigate potential conflict from a fishery.
5. Conservation groups should be informed on what legal fishing activity looks like so enforcement teams are notified about illegal activity rather than licenced activity.

Just prior to fishing, the contractors met with the National Trust for Scotland (NTS) to discuss a number of concerns, which included access to the beds and vehicles access. A range of solutions were found should the fishing teams need to access through NTS grounds which assured the NTS but also allowed the fishing team to work effectively.

Taking a direct approach of engaging with conservation groups has been positive and there would be benefits to establishing a conservation group for achieving a sustainable fishery. Key members of this group could include; Marine Scotland Science, Solway Firth Partnership, Scottish Natural Heritage, National Trust for Scotland, Royal Society for the Protection of Birds, Scottish Wildlife Trust and

Wildfowl and Wetland Trust to name a few, who help address key areas of concern for wildlife protection and habitat conservation when the need arises.

Observation - A conservation working group should be established to addressing some of the information gaps identified in this section and support the development of a low impact fishery.

7. Discussion and Observations for Developing the Fishery

7.1 Specific Research Questions

As outlined in the introduction this management trial set out to test four key questions; the first was how successful was the trial for;

- creating fair and transparent involvement of fishers?
- incentivising fishers to harvest sustainably?
- enforcement agencies to track and police activity?
- improving local community's understanding and perceptions of the fishery?

Due to the low cockle yields in November 2013, the trial did not deliver sufficient data to answer all of these questions. In early meetings, fishers expressed their views on the fair and transparent involvement of fishers with many declaring their discontent with the way the cockle fishery had been managed in the past and the lack of input and control that pickers had in the management. The questionnaire also provided a platform for fishers to express their views on the way the fishery should be managed and most agreed with the principles surrounding a restricted fishery.

The mechanism behind a restricted fishery will disadvantage those who are not included and therefore access criteria are important. Health and safety training should be a minimum requirement and all fishers involved stated the value of this training and ethos for improving the image of cockle fishing. Other access criteria were explored during the literature review stage of this project and are detailed in section 2 and in the annex, but because of the duration of this study, little evidence was collected which would promote one approach over another. This will need to be explored further as the management of this fishery develops.

The incentives for fishers to harvest sustainably were, we believe, apparent in this management approach and supported by the literature i.e. secure and exclusive access, as awarded through a contract incentivises fishers to harvest in a sustainable manner as the competitive race to fish is removed and fishers are able to prioritise profits by selling a better quality product (Wilen et al, 2012). However, in the short period that the study ran, pickers behaviour did not reflect that. The minor infractions though detected and dealt with demonstrated an internal breakdown. Exacerbating factors to this breakdown were likely due: 1) the inconsistent quality of the cockles so cocklers did not feel confident in high prices; 2) the time limitation on the study so pickers did not feel as if they had a secure tender and behaved in the short rather than long term; 3) the start and stop nature of the study creating an immediate sense of insecurity that the fishing could finish at any time, which; 4) at the later stages of the study, had by the end, eroded pickers' belief in the system. Unfortunately the length of this study did not allow these issues to be resolved.

Much progress has made been in terms of the enforcement agencies ability to track and police activity and all agencies support the approach to governing this fishery and the attention to suitable controls and restrictions were well received. Compliance officers have had the opportunity to work with the fishers and to see first-hand the progress of those engaged in the fishery at a local level. Taking this fresh approach has also allowed responsible agencies to consider how they can develop and modernise the fishery and work with other agencies in other UK cockle fisheries.

Much work has taken place to improve the image of the cockle fisheries in the local community which involved many organisations but especially the efforts of the Solway Firth Partnership. The multi-media approach of direct leafleting coastal communities, direct approaches to key coastal contacts (including emails and meetings), press work and online information informed a wide audience. This work has resulted in the majority of communities understanding the key objectives of a safe and controlled fishery and whilst there is still concern around how this will be achieved, most communities and local organisations have welcomed this direct approach. It is worth noting the particularly helpful response from the National Trust for Scotland which helped distribute information leaflets door to door as well as putting laminated copies on noticeboards in the area to keep local residents informed.

While it was observed that there is still some negativity towards the cockle fishery amongst some coastal communities, there appears to be the potential to build confidence and encourage a broader sense of ownership of the fishery. For example, the common interest in the natural environment shared by cockle pickers and countryside rangers was clearly evident in site meetings and there was a willingness on both sides to share information of interest and listen to each other needs and concerns. This shared approach needs to continue.

7.1.1 What are the social and economic benefits to the local area?

Due to the suspension and early termination of the project, the study was unable to generate the data required to quantitatively explore the economic benefits to the local area. It did however demonstrate that the model would be profitable had it continued for a longer period of time which would have allowed the start-up costs to be off-set by higher tonnage. It was unfortunate that pickers were not able to benefit more from the study and it is understood that expectations were not met by those who invested their time in the study.

What was demonstrated by the work was that by working with a defined group of fishermen within an organisational structure it was possible to engage and develop solutions regarding specific issues e.g. access and avoidance of sensitive habitats which would have been much more difficult had the fishing group been larger or without a unified structure. The need for increased dialogue between those

interested in developing this fishery and local organisations and community representatives is apparent and needs to continue to improve the negative image cockling still has in the area and to build a sense of pride and purpose to harvesting this local resource. Depending on how this fishery is governed in the future, a closely defined group of pickers as supported under the TURF model offers many benefits, yet as discussed below, whether this is the ideal model for this fishery is questionable. This will now be explored.

7.1.2 What local capacity is there to develop, monitor and manage a TURF system?

One of the main challenges with the TURF system is the internal management of the fishing teams. Within this study, on-beach supervisors were appointed and in this case they rotated their management so each supervisor had the opportunity to harvest cockles. This was a demanding role as the supervisors were not only earning through harvesting, but were also in charge of the workers, and the supervision of daily landings limits and equipment which at times was highly pressurised. Given the time frame and the divergence of this system from the management regimes in other cockle fisheries, the significant challenges of getting a team to work appropriately and together are recognised and the supervisors efforts appreciated. However, it is widely acknowledged that this fishery has been dominated by fragmented and fractious groups with low levels of social capital for many years (Nautilus Consultants Ltd, 2013) and this study produced little evidence to counter this. We acknowledge that the study was short lived and any new management approach will have a bedding-in period, however the strains and mistrust between the picking and operations team was apparent very soon after the selling of the cockles become challenging. This tension undermined the ethos of the TURF model and demonstrated a shortfall in the social capital required to implement this type of model. This is not to suggest that this model could not be implemented in the future once those involved in the cockling have adapted to a more communal approach to harvesting, but under the current conditions, internal management is insufficient to implement a successful TURF approach to fisheries management.

Whilst a number of the key elements which are promoted through a TURF system are useful in shaping how eligibility criteria can be set and defining privileges, this study has not sufficiently proven that a TURF system would be the best approach for assigning exclusive access to a particular group for internal management (bottom-up approach), as opposed to a general licensing system where pickers apply with a predefined set of rules (top-down approach). What was clear was that industry stakeholders who were not directly involved in the trial worked hard to undermine this system. Due to the fractious nature of social networks and the well-established practises of individual fishers working for individual gain, the fishery requires a governing structure that can accommodate this situation whilst working to improve social cohesion.

7.2 Observations Based on Results from this Period

7.2.1 Management Observations

Observation 1 - It should be a prerequisite that all hand licences associated with a cockle fishery require completion of the basic four safety courses and an area-based training course e.g. the new Solway Shore Awareness course.

Observation 2 - The fishery should have a fully documented process which can track bags of cockles back to the picker and the beach area, all the way through the chain to the final customer. The paperwork produced during the study is fit of this purpose and should be used as a template and refined as and when required. What is key is that the process should be as streamlined and straightforward as possible to facilitate compliance.

Observation 3 - Access to the beds via the foreshore is a critical factor to success and requires significant investment of time and effort. Improving access needs to be explored further which could include working with commercial farms near commercial beds. These businesses have the capacity to support this type of activity and by paying a levy per ton other businesses are able to benefit from the cockling activity whilst reducing local disturbance to communities.

Observation 4 - Building in capacity to improve and develop food safety should continue with the advancement of this fishery. Given that the demand for better food traceability is only likely to increase, the Solway cockle fishery is in a good position to lead on this with the collaboration of the FSAS and the Local Authority (Dumfries and Galloway Council).

Observation 5 - Future management of the Solway cockle fishery should offer the opportunities for young inexperienced fishers to enter and benefit from the local resource. This could be achieved through apprenticeship schemes, however fishing opportunity needs to be monitored to ensure that new entrants have the chance to work in the fishery once apprenticeships are completed.

Observation 6 - Due to the seasonal nature of this fishery, specific opportunity could be made available to fishers who work in other fisheries but who may wish to diversify and supplement their main fishing activity with cockling. This could be offered through a limited number of part time licences that become available once the TAC for that year fishery is known and allocation for long-term licence holders is assessed and met. *This should not affect the rights of qualified fishers who may wish to apply for a long-term licence.*

Observation 7 - A central distribution centre offers many benefits for improved compliance and food traceability and should be given serious consideration for future management. The two most promising elements from the study - the administration of landings and cockle monitoring for toxins in one location should be maintained,

but whether this facility should act more like a traditional fish market, where the sales are operated by a number of individuals/agencies and a fee is charged by the centre to cover costs is an open question.

Observation 8 – Knowing the rate of pay prior to picking commencing is desirable and should be an aspiration for this fishery however other fair payment systems should also be explored. What is important is that transparent transactions take place so that pickers know they are being suitably rewarded for their efforts.

Observation 9 - The funding of the fishery should be explored further as whilst a flat-rate levy upon each individual's harvest is a viable option, how this fund is used and re-distributed requires further investigation.

Observation 10 - As the management plan for the fishery develops, markets need to be kept in mind, but efforts should focus on harvesting cockle in their peak condition and at a volume and consistency appealing to a range of different markets. This requires attention to be given to the number of permanent and temporary licences on offer and whether vessels should be involved if the annual TACs support their inclusion.

Observation 11 - A conservation working group should be established to address some of the information gaps identified and support the development of a low impact fishery.

7.2.2. Number of fishing licences

Using the harvest data presented in section 5.5, preliminary estimates can be made to establish the number of hand collection licences which could be awarded on the Solway given an available TAC. Using the high harvest rates (305 kg) and given the desire to harvest over 10 tonnes per day to improve economic margins by working at volumes that lower shipment cost etc., Table 6 presents the number of licences that could be made available given the TAC and expected length of season. For example should it be expected that the season will last for 50 tides (around 2.5 months) and the agreed TAC is 800,000 kg (800 tonnes), 52 licences would be awarded. Should the season expect to be shorter e.g. 30 tides (1.5 months) because of bad weather then 87 licences would be made available to collect the 800,000 kg. Assigning the licences in this way would indicate that a daily TAC would be assigned to stop the overall TAC from being removed too soon. However, given the variability in picking rates, this form of management may only be required towards the end of the season as the TAC becomes exhausted.

Table 6: Number of licences awarded under the high picking rate depending on TAC and length of season. Dark red indicate number of licences which would generate less than 10 tonnes per tide which should be avoided and the broken red indicates the number of licences which may result in social problems from a high volume of pickers and therefore may require the inclusion of vessels.

	Length of season (number of tides) at high picking rate (305 kg per day)							
	20	**30**	**40**	**50**	**60**	**70**	**80**	**90**
TAC (kg)								
200,000	33	22	16	13	11	9	8	7
400,000	66	44	33	26	22	19	16	15
600,000	98	66	49	39	33	28	25	22
800,000	131	87	66	52	44	37	33	29
1,000,000	164	109	82	66	55	47	41	36
1,200,000	197	131	98	79	66	56	49	44
1,400,000	229	153	115	92	76	66	57	51
1,600,000	262	175	131	105	87	75	66	58
1,800,000	295	197	148	118	98	84	74	66
2,000,000	328	219	164	131	109	94	82	73
2,200,000	361	240	180	144	120	103	90	80
2,400,000	393	262	197	157	131	112	98	87
2,600,000	426	284	213	170	142	122	107	95
2,800,000	459	306	229	184	153	131	115	102
3,000,000	492	328	246	197	164	140	123	109

Under 10 tonnes

Boat Licences (?)

As stated in section 4.1.1 when developing a sustainable management model, different harvesting methods can add flexibility in a system which is desirable as different fishing methods offer different benefits as well as different impacts. Whilst there is a clear preference at a local level for hand collection only, at this time there is no reason to state that vessels should be excluded should a suitable TAC be available. Vessels can operate in areas inaccessible to hand collectors and can harvest a significant volume which can improve profit margins, which if managed correctly can benefit the local region through fees and levies to contribute to the financial stability of the fishery (Southall & Tully, 2013). As stated in section 1 the problems of having a large number of pickers operating from the shore are well understood and therefore a limit of around 100 pickers may be desirable to mitigate these social issues and the remaining TAC allocated to vessel on an annual basis once the TAC is known.

As described in section 2.2.3 it is important to offer security of tenure to facilitate long term investment in the fishery which given the social objectives of this fishery, one option would be to 'ring fence' for example, the first 1,400,000 kg (1,400 tonnes) for hand collection and the remainder to be offered on an annual basis to other fishing groups (e.g. vessels). To build in a buffer for short seasons, 40-50 long term (e.g. 3 - 5 years) licences could be permitted and then annual hand licences to collect any additional TAC could be permitted e.g. 42 if there is a 1,400,000 kg TAC and an expected season of 50 tides. This would offer a core group of pickers secure

tenure[7], as well as offering opportunities to other pickers on an annual basis and potential opportunity to vessels in the year when there is a large TAC. How these thresholds would be decided upon is a managerial decision but table 6 is a useful guide to aid these discussions.

7.3 Recommendations for Future Work

Much work has been undertaken to improve understanding of the Solway cockle fisheries and the challenges with long term management. This is one of a recent suite of work along with the Southall and Tully (2014) report and the Nautilus consultant Ltd (2013) report. There are however still gaps which should be investigated whilst real efforts are made to open the fishery under the ecological, social, economic and development criteria outlined in table 1.

The first gap is the fair and transparent allocation of permits and licences and the eligibility criteria under which to award permits. This was one of the study's aims, but data was insufficient to inform on this criteria. The criteria outline for TURFs in Poon & Bonzan's (2013) handbook supplied a solid foundation and should be used to inform on this process once the management framework is put in place.

A second area identified by some of the conservation groups was that high quality maps need to be available to harvesters which illustrate habitat types and providing clear information about sensitivity and the activities that should and should not take place. In conjunction, there is a clear opportunity to provide training to improve identification of habitats on the ground and better understanding of their ecological value. Offers for partnerships to provide training in the future have been received.

7.4 Role of Government in the Future Solway Cockle Fishery

Currently the responsibility for the opening and closing of the Solway cockle fishery is with Marine Scotland. Assurances given at the stakeholder meetings that the fishery would only be open if a management regime is in place still hold, but there are a range of approaches which could be used, each adopting increased layers of regulation. As stated in the Nautilus report (2013) it is easy to over-simplify the issues associated with the management of this fishery. This fishery has been surrounded by conflicting views for many years, with groups arguing for the fishery to be open and with equal ferocity, those arguing for it to remain closed. Therefore developing this fishery needs to take into account not only the economic performance of the fishery, but also the impacts of this fishery on other key stakeholders in the region.

[7] Rules around holding this tenure would need to be defined but licences should not necessarily be considered as owned or viewed as an asset by the licence holder.

Table 7 presents these options and reviews how each option meets the objectives outline in table 1. The role of government decreases as each layer is implemented whilst the involvement of local organisations and stakeholders increases.

Table 7: Management Options of the Solway Cockle Fishery with grades on level of benefits - High benefit/results to low benefit/results.

Management Options	Implementation Period	Sustainability (environmental and economic)	Safety (pickers and food)	Controlled (compliance and policing)	Local benefits (economic and social)	Resources required
Closed - No cockle fishing permitted	Immediate	High - no fishing mortality so stocks remain at natural biomass - this is assuming limited poaching. No need for stocks assessments so data deficient for understanding and monitoring stock dynamics. No economic dependence.	Medium - no legal fishing related risks - less people exposed. High risk linked to poaching activity e.g. fishing at night, fishing in small groups for illegal cocklers. Risk to food safety from unclassified cockles in the market.	Medium - facing similar past challenges with compliance e.g. large area with many access points. New powers and multi-agency approach may reduce these challenges significantly.	Low to Medium - no direct economic benefits from resource. Potential social benefits from limited to no disturbance from fishing activity and to wildlife conservation areas.	Compliance only Low burden to other agencies
Under scientific advice with an allocated Total Allowable Catch (TAC) and Appropriate Assessment (AA)						
Open - Time limited fishery (Olympic fishery model)	After TAC, AA and water classification (Sept 2015)	Low to Medium - fishing mortality as guided by TAC but significant control issues - see controlled section.	Low - being time limited resources could be made available for short periods but unrestricted access would carry safety risks due to the size of the Solway. Medium food safety risk due to localised threats from blanket classification.	Low - control on opening and closing only with estimates on catch rates per day to manage TAC. High risk of overshooting TAC. Due to the volume of access points low control on fishers activity throughout the area.	Low - Economic benefits to some local fishers but value unknown - high potential for value to leave the area. High risk of disturbance to local community, businesses and other Solway user, but time limited and could be managed.	Compliance and site management during opening Medium burden - long term
Under scientific advice with an allocated TAC and AA, with new legislation e.g. fishery bill or a Regulating Order (RO)						

Management Options	Implementation Period	Sustainability (environmental and economic)	Safety (pickers and food)	Controlled (compliance and policing)	Local benefits (economic and social)	Resources required
Open - Time and licence limited fishery (Olympic fishery model - with restrictions)	After TAC, AA, water classification and licences (earliest Sept 2016)	Medium - fishing mortality as guided by TAC and number of licences. Reporting of illegal active should improve if access is restricted.	Medium - being time and licence limited, resources could be made available for short periods. Restricted access should improve safety - but risks still associated due to the size of the Solway. Medium food safety risk due to localised threats from blank classification.	Medium - control on opening and closing and number of fishers. Reduced risk of overshooting TAC. Due to the volume of access points low control on fishers activity.	Medium - Economic benefits to some local fishers but dependent on licence conditions. Less risk of disturbance to local community, businesses and other Solway user, but risk is time limited and could be managed.	Compliance and site management during opening. Licence administration Medium burden - long term
Open - Time, licence and area restricted (beds open in stages) fishery	After TAC, AA, and licences. Water classifications in stages (earliest Sept 2016)	Medium to high - as above but beds fished individually so more accountability to local stock levels. Economic sustainability low risk as spread through the fishery.	High - being time and licence limited, resources could be made available for short periods. Restricted access through licences and location should improve safety. Low food safety risk due to beds surveyed during collection.	Medium to High - control on opening and closing and number of fishers. Reduced risk of overshooting TAC. Due to the volume of access points low control on fishers activity.	Medium to High - economic benefits to local area but dependent on licence and access conditions. Low risk of disturbance to locals as access managed and numbers restricted.	Compliance and site management. Licence administration . Also guidance of opening of bed Medium to high burden - long term

Management Options	Implementation Period	Sustainability (environmental and economic)	Safety (pickers and food)	Controlled (compliance and policing)	Local benefits (economic and social)	Resources required
Open - Licences with Distribution Centre (DC)	After TAC, AA, licences and DC. Water classifications in stages (earliest Sept 2016)	Medium - assurances that TAC is met due to no time limit (AA restrictions only). Economic sustainability medium risk due to tight controls on the market which may effect demand.	High - internal management through one/two centres which prioritises pickers and product safety - full traceability is a viable aspiration.	High - fully documented fishery with multi-agency approach. Methods to control high, but dependent on internal capacity.	High - economic benefits to local area no matter the licencing composition - onshore business can benefit. Social benefits as above.	Compliance and process managed. Licence administration . Also guidance of opening of bed. High burden - long term

8. Conclusion

This study faced a number of challenges in its implementation, most significant was the low cockle yields. It has however enabled a large amount of work to take place on improving the capacity of key enforcement agencies and raised awareness in the local region of a commitment to a sustainable low impact fishery. Procedures to improve health and safety on the beach and ground work put in place for better food traceability were significant achievements in this study. The study has produced basic information on the profile of pickers wishing to prosecute this fishery and produced a model to estimate licence requirements of a given TAC which is a useful tool of future management. In the final section of this report a range of management options have been outlined which, in essence, starts with a time limited fishery and then add on layers of regulations which increases the level of controls, as well as environment and social benefits. These all however carry increased level of administrative burden which needs to a balanced with available resources.

Whilst not covered in any detail in this study an available biomass of harvestable cockles is what drives the opening of this fishery. The cockle assessments undertaken in 2013 showed an increase in biomass from previous years (Stamp et al, 2013), but as described in detail in the Southall and Tully (2014) report, cockles experience periodic recruitment which creates a high level of uncertainty around a year on year fishery. The burden of management needs careful consideration given this inescapable limitation.

This report has developed 11 key observations specific to the Solway fishery but which are also applicable to other cockle fisheries around the UK. These have been informed by the TURF model for fisheries management, but given the fractious nature of the groups working in this area, implementing a TURF model in its entirety is some way off. Local management should still be an aspiration, but more capacity and better cohesion between stakeholders will need to be built for this to become a reality.

It is well recognised that the cockles in the Scottish Solway are a valuable resource that has the potential to offer real benefits to the local region but it is also very clear that there is no intention of returning to the anarchic fishery of the past. Regulations need to be put in place and whilst the TURF model has much to contribute for producing a fair and equitable system, traditional approaches used in other Scottish fisheries, for example individual licences (rather that the TURF model of community licences) may have a place in this fishery. The options presented in table 7 should be given attention by administrators and key stakeholders and the collaborations developed during this study should continue so a sustainable cockle fishery can become a reality in the Scottish Solway.

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10. Annex

Annex 1: Information on Shellfish Classification

Background

1. Bivalve shellfish, which includes cockles, mussels and oysters, are filter feeders. They feed on phytoplankton but they can also accumulate microbiological and viral pathogens as well as naturally occurring toxins at levels which can cause illness in humans if found in sufficient quantities.

2. Because of this, all shellfish harvesters must comply with the food safety requirements set out in legislation[8]. This includes the requirement to ensure that the bacteriological and toxin health standards are met before the product is sold, and that product must be sold via a premises that the local authority has approved for that purpose. In addition full traceability throughout the supply chain is essential and it is the food businesses' responsibility to ensure that those requirements are met.

3. The Food Standards Agency in Scotland (FSAS) is responsible for the classification and monitoring of all shellfish production areas in Scotland and those requirements are also set out in food hygiene legislation[9]. These requirements mean that regular shellfish samples from classified areas must be submitted for analysis on a routine basis. These samples must be taken at a frequency and location specified by the FSA, overseen by authorised Shellfish Sampling Officers (SSOs) using the agreed protocol.[10] Further details on how this applies to the Solway for the duration of the study can be found below.

4. Local authorities are responsible for enforcing food law. This means that if anyone harvests, handles or processes shellfish in a manner other than that set out in food law, the shellfish can be seized, destroyed and the responsible person prosecuted by the local authority concerned.

Solway Management Study – Initial Classification

5. The classification area for the purposes of the management study is the area which is permitted to be fished by Scottish Government. It will in effect cover the areas which remain subject to The Inshore Fishing (Prohibition of Fishing for Cockles) (Solway Firth) (Scotland) Order 2011. For the purposes of the

[8] EC Regulation 853/2004 on rule for products of animal origin: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:226:0022:0082:EN:PDF
[9] EC Regulation 854/2004: On official controls: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:226:0083:0127:EN:PDF
[10] Sampling protocols can be found on the Cefas website here: http://www.cefas.defra.gov.uk/media/600472/shellfish%20sampling%20and%20transport%20protocol%20final%20version%204%20may%2013.pdf

management study only, the initial classification award for the area fished will be 'B'. Under food hygiene legislation this means that all cockles fished from the area must be dispatched for depuration or cooking. They cannot be sold to the open (unapproved) market (either in the UK or abroad) without this treatment taking place first.

6. It is intended that for the duration of the study, pre depurated weekly samples identified with the appropriate grid reference will be collected from DeeFish Ltd in Kirkcudbright, by authorised SSOs. 2 samples will be required – one for microbiological analysis (this is used for classification purposes) and the other for toxin analysis per week. The specified amounts and the packing and dispatch requirements can be found in the sampling protocol. The classification and toxin health standards for shellfish are set out in law (summarised below).

Ongoing *E. coli* monitoring and classification

7. See **Annex 1**. If any classification sample is found to be out with the initial 'B' classification up to 46,000 *E. coli* per kg shellfish flesh, then the classification will immediately be downgraded to 'C' by FSAS. This will require to be reflected in all documents accompanying the shellfish from the premises. 2 samples at least a week apart at either 'A' or 'B' would be required before the classification will be re-established at 'B'.

8. Under no circumstances for the duration of the study will the area be considered 'A' class.

9. Any result >46,000 *E. coli* per kg shellfish flesh will mean that harvesting is suspended until 2 results below that level are found at least a week apart.

Toxin monitoring

10. See **Annex 2**. Any breach of the toxin limits will mean that all harvesting must cease until 2 samples can be collected at least 48 hours apart from the area being harvested.

Product found over the regulatory limit

11. Given that samples from the premises may be used not only as official control samples but also as end product samples by the harvester/processor then the harvester/processor must act on any results above any of the limits set out in law. In effect any shellfish found in breach of the health standards for either *E. coli* or toxins need to be destroyed. Liaison with the local authority environmental health department should take place immediately if that is found to be the case.

12. Please contact FSAS if you wish to receive shellfish results directly. Otherwise information can be received by your local authority.

Classification

Live bivalve molluscs (LBMs) shellfish harvesting areas are classified by monitoring the levels of E. coli in shellfish flesh. Treatment processes are specified according to the classification status of the area.

In all cases, the health standards in Annex III of EC Regulations 853/2004 and the microbiological criteria adopted under EC Regulation 2073/2005 must be met.

Live bivalve molluscs (LBMs) shellfish harvesting area classification

Category	Result (Per 100g Flesh)	Action
A	<230 E.Coli/100g of flesh	May go directly for human consumption if end product standard met.
B	<4,600 E.Coli/100g of flesh	Must be subject to purification, relaying in Class A area (to meet Category A requirements) or cooked by an approved method.
C	<46,000 E.Coli/100g of flesh	Must be subject to relaying for a period of at least 2 months or cooked by an approved method.
	>46,000 E.Coli/100g of flesh	Prohibited. Harvesting not permitted.

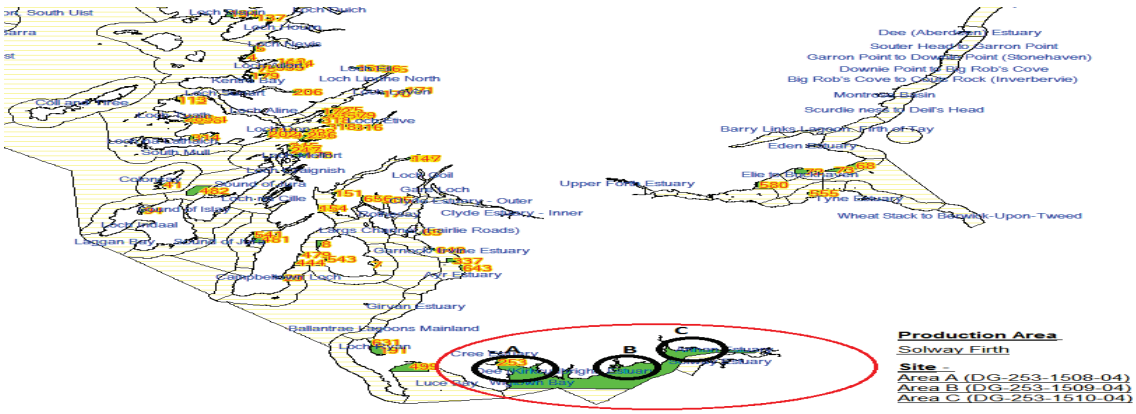
Biotoxin limits:

The maximum permitted levels of biotoxins in shellfish are as follows:
Paralytic Shellfish Poisoning (PSP): 800 micrograms/kilogram
Amnesic Shellfish Poisoning (ASP): 20 milligrams/kilogram

Lipophilic toxins (tested by LC-MS):

i. OA/DTXs/PTXs: 160 micrograms of okadaic acid equivalents/kilogram
ii. YTXs: 3.75 milligram of yessotoxin equivalent/kilogram
iii. AZAs: 160 micrograms of azaspiracid equivalents/kilogram

Diarrhetic Shellfish Poisoning (DSP) (for species not tested by LC-MS): DSP toxins must not be present



Annex 2: Beach-based Daily Harvest Sheet

DAILY HARVEST SHEET No. 10,001

Date					CO-ORDINATES HARVEST AREA		CO-ORDINATES ACCESS AREA	
Shore Supervisor ID					Latitude		Latitude	
Shore Supervisor					Longitude		Longitude	
Signature					Beach Name		Access Name	
Start Time					End Time		Loaded onto	
TEAM	I.D. NUMBERS	NAMES	ROLL CALL ON	ROLL CALL OFF	# 25KG SACKS	GROSS WEIGHT (KG)	RECEIPT NUMBER	INCIDENT RECORD
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								Fisheries Office informed YES / NO Coast Guard informed YES / NO

Annex 3: Receipt Book

Scottish Solway Firth Shellfish Grower's Co-operative No. 10,001

LANDING DECLARATION FOR COCKLES
(CERASTODERMA EDULE)

Permit Holder's Name(s)	No.	Date

No. of Bags	Total Weight kg	Area Caught

Supervisor Signature .....

Permit Holder's Signature .....

Annex 4: Beach to Distribution Centre Movement Sheet

SCOTTISH SOLWAY FIRTH SHELLFISH GROWERS CO OPERATIVE						
Movement Document - Shore to Distribution Centre (DC)					**No.**	**1001**
Food Authority where shellfish landed:		**Dumfries & Galloway Council**				
Date of Harvest:						
Destination & EU No:	Dee Fish WD044	Date of Issue of EU No:	27/07/2013			
Vehicles Registration:						
Drivers name:		Drivers licence no:				
Load 1		Load 2		Load 3		
Access Point		Access Point		Access Point		
Shore Supervisor		Shore Supervisor		Shore Supervisor		
SS Signature		SS Signature		SS Signature		
Daily Harvest Sheet No.		Daily Harvest Sheet No.		Daily Harvest Sheet No.		
						Total
No of bags		No of bags		No of bags		
Gross weight kg		Gross weight kg		Gross weight kg		
Time of dispatch beach:		Time of arrival at DC:		Booked in by:		
		Drivers signature:		DC Signature:		
		Route undertaken:				
		Fisheries Officer informed		Yes / No		
		Coast Guard informed		Yes / No		

Annex 5: Intake Sheet

INTAKE SHEET						
Date						
Time						
Supplier No / Movemnt Doc No.						
DeeFish Intake no.	DD633	DD634	DD635	DD636	DD637	DD638	DD639
Boat Name / Area worked						
Delivery Vehicle Reg.	YK00 WWW	YK00 WWW	YK00 WWW	YK00 WWW	YK00 WWW	YK00 WWW	YK00 WWW
Delivery Vehicle condition Absence of pests & foreign bodies	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory
Vehicle Temp 2 - 4 °C							
Product Temp 4 - 8°C							
Product							
Product Condition	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory	Good / Unsatsisfactory
Quantity							
Corrective Action Received by:							
							VV ?/?/? CCP Record - Authorised : GG

Annex 6: Publications Surrounding the Management Study

Annex 7: Number of picking licences at mean picking rate.

	Length of season (number of tides) at average picking rate (182 kg)							
	20	**30**	**40**	**50**	**60**	**70**	**80**	**90**
TAC (kg)								
200,000	55	37	27	22	18	16	14	12
400,000	110	73	55	44	37	31	27	24
600,000	164	110	82	66	55	47	41	37
800,000	219	146	110	88	73	63	55	49
1,000,000	274	183	137	110	91	78	69	61
1,200,000	329	219	164	132	110	94	82	73
1,400,000	384	256	192	154	128	110	96	85
1,600,000	439	292	219	175	146	125	110	97
1,800,000	493	329	247	197	164	141	123	110
2,000,000	548	366	274	219	183	157	137	122
2,200,000	603	402	302	241	201	172	151	134
2,400,000	658	438	329	263	219	188	164	146
2,600,000	713	475	356	285	238	204	178	158
2,800,000	768	512	384	307	256	219	192	171
3,000,000	822	548	411	329	274	235	206	183

Under 10 tonnes

Boat Licences (?)

Annex 8: In Practice: TURFs from around the World

TURF systems in operation today have originated through two processes. In Japan and various western Pacific Island communities, TURFs have evolved from long-standing customary practices dating back to the 16th century that have gradually become formalised into law. Conversely, the adoption of TURFs in Chile and Galicia, Spain represented a top-down process and a desire for innovation and improvement in management systems following biological decline and overexploitation. In terms of institutions and design the TURF systems in Chile and Galicia are of particular relevance to the Solway as the TURF concept was used as an innovative tool to deal with the problems of effort controls and the presence of open-access conditions. Older TURFs in Japan and the Pacific have proved valuable in informing internal management mechanisms.

Chile: TURFs were introduced as a co-management measure in Chile in response to a crisis surrounding the management of the economically value species known locally as 'loco' (*Concholepas concholepas)*, a small-scale dive fishery target this species of abalone. Following an initial crisis in the 1980s and the subsequent failure of command-and-control measures, from 1991 a new law created spatial TURF units known as Management and Exploitation Areas of Benthic Resources (MEAs).

In 1993, when the fishery was opened, divers with historical rights in the fishery were granted licences. The loco fishery was divided into 12 Units of Fisheries, each one having a regional TAC, which was then subdivided by the number of divers. Licences were only granted to registered and recognised fishing associations as opposed to individuals, with the allocation granted at a federal level. It is the responsibility of the association to develop a management plan at their own expense, which is then approved federally. It is the responsibility of the MEAs to conduct annual stock assessment and file harvesting plans. In addition, a rental fee based upon the size of the MEA is paid in order to cover the costs of federal oversight.

In Chile, the managerial responsibility was devolved to local organisations as while the project had specific biological objectives; it also had strong socio-economic objectives. The artisan sector in Chile is important, providing 87% of the employment in the industry in 1992 (Bernal et.al 1999). The local associations are issued the MEAs for an undefined time period, and the organisations are constrained by a TAC and technical and conservation guidelines that are set at a federal level. The Chilean loco TURF system represented a completely closed system, as the only legal way to gain access to the fishery is through participation within the MEA project.

In terms of internal management measures, practices vary across the MEAs. In some, effort is allocated and assigned to specific areas in order to optimise the exploitation of space within the TURF. Others adopt rotating harvest zone policies, and other pool harvests and revenue to avoid economic waste and issues of inequity. Most MEAs organise with buyers to operate a short period of harvesting,

this allowed revenues to be maximized as effort is concentrated when prices are at their highest. As the loco fishery is characterised by numerous small production units spread over the coast, the harvest is coordinated between the various production units so that the total harvest is distributed evenly over the marketing period.

There is a broad tendency to see the whole Chilean system as a success. The Chilean MEA system has acquired worldwide attention, and it has been reported that catch per unit of effort is higher, the mean size of individual locos are higher, and prices received are higher under the MEA system. Moreover, it is reported that the operational costs of the fleet are must less within the MEA than in the historical fishing grounds (Castilla et al. 1997). However, due to the initial success of the loco TURF system, the management framework was intensely promoted by the government and quickly applied to other benthic resources. This process occurred with little concern for the natural variability of the different species and has led to a series of socio-economic problems along the coastline. For instance, TURFs were created for species that naturally migrated along the coastlines with harvesting practices mirroring the coastal migration. As the internal management of the TURFs did not account for the natural migration of the stocks or the fishers, TURFS have been abandoned and serve socio-economic problems remain.

Japan: Japanese TURFs developed in an ad-hoc manner in an attempt to protect areas resources from outside poachers. In Japan, the TURF boundaries are generally associated with historical or municipality boundaries, which encompass fishing villages. Exclusive access to the resources within 5 km of the shoreline is awarded through Japanese Law which grants access rights and responsibility directly to Fishery Cooperative Association (FCAs). The FCAs are administrative bodies who manage a particular TURF, with government providing the scientific advice and overseeing regulations. There are 1300 FCAs in Japan which are responsible for a large number of species including complex multi-species TURFS using a wide array of gear types. Each FCA has an individually developed administrative structure and operations that govern the management of each fishery. Japanese FCAs have far reaching responsibilities, including providing credit to fishermen, provision of landing and handling facilities, marketing and the purchasing of inputs.

Within the FCAs, sub-organisation of Fishery Management Organisations (FMOs) carry out all the decisions on a local basis. The FMOs represent a group of fishermen, usually pursing a particular species or using a specific gear. Scientists set the TAC, and the prefecture government licences the participants through a limited entry scheme. It is then the responsibility of the fisheries cooperative - the FMOs - to determine the actual details of management. Examples of practice in this micro-management system include: rotation systems that spread effort over space and ensure equal access to hotspots; and use of restrictions on gear and effort in each

area. Many TURFS in Japan operate harvest and revenue pooling arrangements in order to install a sense of fairness and minimalize conflict and risk for fishers in each area of the TURF. The pool is then redistributed on a pre-arranged basis.

Galicia, Spain: As within Japan and Chile, TURFs in Galicia in Spain (also located in Cantabria and Andalucía) have evolved from historical practices and the allocation of fishing areas to users is based upon long-standing relationships between specific artisanal communities and their coastal waters (Boan et al. 2012). In 1993, the regional government created community-based fishing licences and divided the Galician coastline into 9 fishing areas. Spanish TURFS, such as those for the goose barnacle in Galicia, award exclusive access to fishing territories to Cofradias, compulsory organisations that represent fishing areas, with eligibility based upon the historical presence of the Cofradia in the given area. The intention behind the Spanish TURFs was a response to biological crisis in some stocks, but also an attempt to protect inshore fishing interests by awarding the Cofradias exclusive access up to 5 nautical miles from the coast, thus protecting them from competing with larger, offshore vessels.

Each Cofraria submits an annual plan for the resources its aims to exploit, which is evaluated by fisheries biologist within the Fisheries Authority. In Galicia, where the Confrarias have scarce financial resources, one or two people often design the annual management plans. The annual plan details the internal management of the stocks by authorising a set number of fishers, it allocates the areas to be fished, sets economic and production targets, carries out stock assessment, designated the number of working days and sets individual daily quotas (Molares and Freier 2003). The Confrarias are also responsible for the financial programming of the TURF and the marketing of the product. Occasionally, monthly or annual rotations are employed in order to allow areas to repopulate (Bosan et al. 2003). Each unit also has its own surveillance system, while poaching is guarded against in conjunction with national authorities. The Galician TURF for the barnacle fishery has been highlighted as ushering in significant beneficial changes in terms of fisheries management in the area (Molares and Freier 2003).

Malta: In Malta, a TURF system was introduced in order to control fishing effort on the highly migratory dolphin fish. The rights are allocated via a lottery and award the user with the exclusive right to fish for dolphin fish in the 11 maritime districts in which there are 130 fishing sites. There is a seasonal fishery as capture is only permitted between August and December, and sales are highly regulated, as all landings must be sold through regulate commercial channels in the wholesale market. Length of tenure lasts for one year.

Annex 9: Overview of Current Cockle Management Programmes in the UK

The River Dee Estuary: The River Dee cockle fishery is located in an estuary between North Wales and the Wirral. The fishery has five main cockle beds that vary spatially according to spatfall, exploitation and other external factors. Before the implantation of a regulation order (Dee Estuary Cockle Fishery Order 2008), the beds were periodically closed between 1997-2005 as the open-access nature of the fishery had created a 'boom and bust' operation. Now, the fishery is management in line with a short-term objective of annual stock monitoring and the setting of the annual TAC, with the long-term objective to create a sustainable fishery providing regular income. Due to the implementation of a successful management plan, in 2011 the fishery is said to have added £2.5 million to the local economy and in 2012 the Marine Stewardship Council certified the Dee estuary.

Since 2001, a TAC has been implemented, with access to the fishery permitted through a licence. However, as the number of licences was not restricted, in the intermittent years in which the fishery was opened, the length of the season decreased from 34 days in 2001, to 7 days in 2002, 16 days in 2003 and 3 days in 2005. In order to combat the economic problems experienced within the fishery (continued rent dissipation and seasonal shortening), a management plan placed strict controls on entry. A licence is required to fish for cockles in the fishery and the management plan sets a limit on the total number of licences to be distributed, with the cap set at 50. The maximum annual exploitation rate (the TAC) is then sub-divided between the license holders to create individual quotas. The IQs are allocated on a daily basis, based on an established number of fishing days. Typically, the daily quota has been set at 300 kg.

Eligibility of licence holders:

- Licences issued on a point systems
- Applicants must have a track record in the commercial cockle fishery on the Dee estuary - licences were allocated on the basis of experience of active and material participation in the commercial fishery.
- Apprenticeship scheme: A maximum of 3 apprenticeships are awarded annually to enable new entrants to participate in the fishery.
- Allocations are unable to legally favour locals.

Other regulations:

- Size limits: A 'take-able' cockle is defined as having a square opening of 20mm measures across each side. Cockles of this length are in their second years of growth.
- Gear restrictions: The fishing method is restricted to hand-gathering only, with a rake head not exceeding 30 cm in width.
- Time restrictions: annual season is closed from 1st Jan to 30th June. No fishing on a Sunday or one hour after sunset and one hour before sunrise.

Monitoring and enforcement:

- Daily landings declarations are required when beds are open. Details required are: date, beds from which cockle were taken, weight harvested and buyer details. Failure to complete valid landings declarations within the specified time period results in immediate suspension from the fishery.
- Landings are made directly from the fishery in pre-approved Environmental Agency Wales sacks. Along with the identifiable sacks, referencing of sales notes and daily landings records are used to make sure there is no addition of cockle from outside the estuary during transportation to grading yards.
- Illegal cockling prosecuted and licence holders issued with formal caution - warning letters and suspensions.
- Overnight surveillance operations put in place, including the use of helicopters with heat sensors to identify illegal activity.

Thames estuary: The Thames Estuary Cockle Fishery Order was established in 1994 in response to heavy pressure on the fishery in the early 1990s created by increased pressure and technology-induced efficiency within the fishery, notably the replacement of hand gathering by continuous delivery hydraulic dredging of cockles.

In order to produce a sustainable fishery, a series of byelaws were created which limit certain inputs and output and access is granted through a permit. As dredges exploit the fishery, the fishery focuses upon limiting effort through controlling: maximum vessel size, engine power and dredge size. As this form of exploitation is more believed to be more destructive than hand-picking, a maximum damage rate is imposed to ensure that cockles are not damaged during harvesting. This is often referred to as a ‘smash rate’.

While there are imposed limits to fishing times and upon the quantities that are landed (no info on how allocated between vessels), only 14 vessels are licensed to fish for cockles within the area. Monitoring of the harvest takes place through a requirement that skippers must return catch data showing: area fished, quantity taken and time spent fishing. Licences are issued at a cost of £1,000 per annum.

The Wash: The Wash cockle management plan lays emphasis on stakeholder involvement in order to promote co-management of the fishery amongst the local fishing industry. In terms of regulation, the Local Authorities have created and enforced byelaws that regulate access and effort. The main management measures for this fishery are:

Biological controls:

- The fishery will not be opened unless there is a minimum spawning stock biomass (3,000 tonnes of adult cockle of >14mm) is identified in surveys.
- A TAC (of up to 33.3% of the total adult stock) is set.
- Selection of areas: Beds containing a significant proportion of juvenile stocks will not be opened. Cockle beds must contain 70% adult stocks to be open.

Effort controls:

- Licence limitation: A licence grants access to the fishery and a maximum of 68 licences are awarded.
- Holders of entitlements may also have to purchase a dredging or handwork licence.
- This quota is sub-divided into separated allocations for the dredging and handwork sectors. Allocations alter according to stock and socio-economic conditions - no information on criteria for allocation.
- Daily vessel quota: a maximum of four tonnes of cockles per dredging vessel taken per day.
- Time closures: The dredged fishery is limited to 4 days a week from an opening date; the handwork fishery is open 7 days a week.
- A fishing vessel may target only one fishery in one calendar day.

Additional controls:

- Minimum sizes: No minimal size is defined but only adults (approx. 19-21 mm in length with a minimum width of 14 mm) can be harvested.
- All fishing gear must be approved by governing Joint Committee
- Smash rate limit - no more than 10% (by weight) may be smashed during dredging operations.
- Gear restrictions: hydraulic suctions head inside opening must not exceed 76 cm, no vessel may deploy more than one dredge, no vessel over 14 m.

Monitoring and enforcement:

- Fishery Officer conduct quayside inspections of landings.
- Licence holders must provide catch returns on a weekly basis.

Dundalk Bay: The cockle fishery in Dundalk Bay was closed in 2006 and 2007 to allow the Irish Sea Fisheries Board to implement a management plan following a period of intense fishing activity that led to overexploitation. Initially, the management plan did not limit entry into the fishery. While access was restricted through the use of a licensing system, no limit was put on the number of vessels allowed to operate. This led to the economic viability of the cockle fishery being put at risk. A permit system, with eligibility awarded through track-record, with a set number of 33 permits issued has been put in place for 2011-16.

Biological objectives are met through the implantation of a TAC, a minimum landing size of 17 mm, and fishing activity will only be allowed in areas where cockle density is greater than 4 per square meter. The fishery is also regulated by additional management measures in order to promote economic viability. The TAC is allocated between the vessels, with a daily IQ set at 1 tonne per vessel per day. However, in order to avoid rent dissipation if the allocation falls before 250 kg per vessel, the fishery is closed. Gear restrictions set a maximum dredge blade width of 0.75 for suction dredges and 1.0 m for non-suction derides.

Bury Inlet: The Burry Inlet is a large estuarine complex located between the Gower Peninsula and Llanelli in South Wales. The cockle fishery is managed by a series of byelaws that attempt to limit and manage effort.

Regulations:

- Access is regulated through a licence, and a fixed level of effort is determined by a limited number of licences.
- TAC is allocated amongst users through a daily individual quota. This can vary depending on stock levels, but was typically established at 100 kg but between 2013-14 increased to 300 kg.
- No harvesting on a Sunday and a minimum landing size implemented.
- Closed areas: The cockle beds are managed in a flexible spatial approach. Individual beds can be closed for a variety of reasons to account of different growth rates of cockles on different beds.

Monitoring and enforcement:

- Control of vehicles is used to reduce unregulated access to beds by removing the means of transport for illegally gathered cockles.

Ribble Estuary: In August 2012, the cockling bed in the Ribble Estuary between Lytham and Southport was re-opened after a period of closure following 26 incidents of the coastguard being called out to rescue poorly equipped and unlicensed boats in a two month period. The North West Inshore Fisheries Conservation Authority (NWIFCA) issued commercial permits for cockling under strict new regulations. The new measures restricted cockle fishing to one tide per day from Monday to Thursday only, require that boats that travel to and from the bed must have qualified skippers and specify that all cockles must be sold direct to the merchants on the bed and landed at Preston docks.

A restricted fishery in the Foulnaze Bank in the outer Ribble Estuary in August 2012 was successful. The beds were opened for 5 weeks in July-August, for 4 days per week (Mon-Thurs). It yielded the permitted Total Allowable Catch (TAC) of 800 tonnes in 9 days without incident. Between 130 and 180 permit holders fished each day.

Aside from the licensing and TAC restrictions, other regulations included:

- A £500 charge for the permit.
- Applicants using boat had to complete the recommended safety training and carry recommended safety equipment.
- All cockles must be transported from the beds using registered fishing vessels and landed at Preston marina.
- All boats must have safety equipment and all boat skippers are required to have the necessary qualifications to operate a boat in darkness.

Belfast Lough: A pilot cockle fishery was initiated in Belfast Lough in 2008. Under this, the fishery was operated by two small under 12 m vessels, one which operated a suction dredge and the other a standard cockle dredge. In 2009, 13 vessels were in operation, each given a seasonal quota of 8 tonnes and each vessel was designated with two specific days of operation between the 5th and 23rd October in which they could fish. This ensured that only two vessel were fishing at any given time. In 2010-12, no fishery took place due to a lack of recruitment.

Dutch Cockle Fishery: This hand-raked cockle fishery is located in the Dutch North Sea coastal region of the Wadden Sea and Oosterschelde. There are 31 licences for the fishery and the members of the Dutch Organisation of Cockle Fishermen catch between 400 and 700 tonnes (shelled cockle meat) annually. The fishery is only deemed economically viable if there are 600-800 cockle per square meter, a licence is required and a closed season is set, with fishing taking place between 1 July and 1 September.

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