AN AQUACULTURE STRATEGY FOR THE SOLWAY

PREPARED BY

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and

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ACRONYMS

ABC..... Allerdale Borough Council
AONB ..... Area of Outstanding Natural Beauty
ASSG ..... Association of Scottish Shellfish Growers
AWG..... Aquaculture Working Group
BAP..... Biodiversity Action Plan
CCC..... Clyde Cruising Club
CITES..... Convention on International Trade in Endangered Species
CMNP..... Coastal and Marine National Park
CSFC..... Cumbria Sea Fisheries Committee
DEFRA ..... Department for the Environment, Food and Rural Affairs
DfT..... Department for Transport
DGC..... Dumfries and Galloway Council
DSFB ..... District Salmon Fishery Boards
EC..... European Commission
FTE ..... Full Time Equivalent
GDSPDS ..... Geo-Information Decision Support Processing and Dissemination System
GIS ..... Geographical Information System
HAP ..... Habitat Action Plan
IUCN ..... International Union for the Conservation of Nature
JNCC..... Joint Nature Conservation Committee
LBAP ..... Local Biodiversity Action Plan
LSMO ..... Local Shellfish Management Organisations
MarLIN..... Marine Life Information Network for Britain and Ireland
MCS..... Marine Conservation Society
MFA ..... Marine Fisheries Agency
MLWS..... Mean Low Water Spring
MNCR ..... Marine Nature Conservation Review
MPA ..... Marine Protected Area
MSC..... Marine Stewardship Council
NBN..... National Biodiversity Network
NE..... Natural England
NFFO ..... National Federation of Fishermen's Organisations
NSA..... National Scenic Area
NSRU ..... National Shellfish Resource Unit
NTZ ..... No Take Zone
RFO..... Regulating Fisheries Order
RSA ..... Regional Scenic Area
SAC ..... Special Area of Conservation (under the EC Habitat Directive)
SAMS ..... Scottish Association for Marine Science
SAP..... Species Action Plan
SEA ..... Strategic Environmental Assessment
SEDG ..... Scottish Enterprise Dumfries and Galloway
SFC..... Sea Fisheries Committee
SFO ..... Several Fisheries Order
SFP ..... Solway Firth Partnership
SIFAG ..... Scottish Inshore Fisheries Advisory Group
SNCI ..... Site of Nature Conservation Interest
SNH ..... Scottish Natural Heritage
SPA ..... Special Protection Area
SSMA ..... Solway Shellfish Management Association
SSSI ..... Site of Special Scientific Interest

Glossary

Alien species: (non-native, non-indigenous, foreign, exotic, introduced, biological pollutants) are species, subspecies, or lower taxon, occurring outside their natural range (past or present) and natural dispersal potential (i.e. outside the range they occupy naturally or could not occupy without direct or indirect introduction or husbandry by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce.

Allowable Zone of Effect: the area (or volume) of seabed or receiving water body in which a regulatory body will allow some exceedance of the relevant environmental quality standard or some limited damage to the environment

Anthropogenic: materials occurring in the natural environment which have originated from human activities.

Aquaculture: the rearing or culture of aquatic organisms using techniques designed to increase the production of the organisms in question beyond the natural capacity of the environment, the organisms remaining the property of a natural or legal person throughout the rearing or culture stage, up to and including harvesting.

Area of occupancy: is defined by IUCN as the area within its extent of occurrence which is occupied by a taxon, excluding cases of vagrancy.

Area of Outstanding Natural Beauty: to add

Assimilative capacity: the ability of an area to maintain a healthy environment and accommodate wastes.

Best Environmental Practice (BEP): the application of the most appropriate combination of environmental control measures and strategies.

Biodiversity (biological diversity): the variability amongst living organisms, including the variability within species, between species and of ecosystems.

Biological carrying capacity: the maximum natural biological productivity of a body of water; if cultivated organisms (shellfish or other species which take their food from their surroundings) exceed the carrying capacity of this water body, then the biological productivity will be depleted and the natural ecosystem damaged.

Biomass (B): is the total quantity of fish in a stock and is used synonymously with stock abundance. Biomass is usually measured as a total tonnage of fish, but could be in numbers or other units to be synonymous with stock abundance.

Carrying capacity: the potential maximum production a species or population can maintain in relation to available food resources within an area.

Chemotherapeutants: compounds used by the finfish industry to treat or prevent various diseases.

Codes of Conduct: describe guidance for aquaculture operations in broad terms.

Codes of Practice: voluntary codes designed to standardise and improve the management of aquaculture.

Depleted: is the status of a fish stock or stock assemblage driven by fishing at very low level of abundance compared to historical levels, with dramatically reduced spawning biomass and reproductive capacity.

Depuration: holding bivalve molluscs such as mussels in sterilised sea water for 48 hours under conditions that allow them to filter normally to remove any bacteria accumulated in the gut; the sea water can be sterilised by ozone or ultra-violet light although the latter is the most common method used.

Ecological footprint: the amount of natural resources required to produce one unit of farmed organisms (e.g. kgs of wild fish required to produce 1 kg of farmed fish); this can also be calculated as units of area per unit of area of farmed organisms; this concept has been applied to organisms which are provided with feed during the farming process (i.e. finfish).

Ecosystem approach: identifying and protecting critical processes in the ecosystem and the interactions between them.

Ecosystem: a community of interdependent organisms, together with the environment they inhabit and with which they interact; this complex, integrated unit exists in a fine balance, so that even small changes to one part of the system can have knock-on effects on many other components of the system.

EN 45011: European Standard for bodies operating product certification systems.

Environmental footprint: the area/volume of the environment impacted by an aquaculture unit.

Escapes: farmed organisms which have escaped from within the confined areas where they are farmed and which may interbreed with natural populations.

Eutrophication: the enrichment of water by nutrients, especially compounds of nitrogen and phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms and the quality of the water concerned.

Extensive systems: any system that requires neither supplementary feeding nor a direct input to support of the organisms reared.

Extent of occurrence: is defined by IUCN as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy.

Fallowing: practice of leaving cages empty of fish for a period of time to break cycles of disease and/or to allow the seabed to recover; this possible double meaning has created some misunderstandings in the past.

Foreshore: In Scotland, the foreshore is the area of land between the high and low water marks of ordinary spring tides. In England and Wales, the foreshore is that part of the seashore which is more often than not covered by the flux and reflux of the four ordinary tides occurring midway between springs and neaps. The foreshore may be in crown or private ownership.

FIFG (the Financial Instrument for Fisheries Guidance): Structural Funds through which the EU attempts to channel financial assistance to those regions which are less developed or in industrial decline, and to support training schemes for those seeking re-entry into employment. Will be replaced by the **European Fisheries Fund** (EFF) over 2007 – 2013.

Finfish: a cold-blooded lower vertebrate that has fins, gills and scales as distinct from a *shellfish* which has an exoskeleton (e.g. crustaceans) or molluscs (a soft unsegmented body, usually covered by a calcium carbonate shell).

Food conversion ratio (FCR): amount of food required to be provided directly to the farmed organism to produce one unit of organism (applies to finfish; needs to be calculated using the same units, i.e. dry feed compared with dried farmed organism); the biological FCR is the net amount of feed (kgs) used to produce one kg of fish, while the economic FCR takes into account all the feed used, meaning that the effects of feed losses and mortalities, for example, are also included.

Harmful Algal Blooms (HABs): concentrations of phytoplankton producing toxins which can affect human health, oxygen levels in water and which can kill or harm fish, and other vertebrate and invertebrates e.g. by damaging or clogging gills.

Integrated Coastal Zone Management (ICZM): a multi-user system designed to establish sustainable levels of economic and social activity in our coastal areas while protecting the coastal environment.

Intensive systems: any culture system that depends exclusively on manufactured inputs (and energy) to organisms.

Interbreeding: mating between two individuals with different genetic traits (e.g. different species, different sub-populations of the same species).

Introgression: incorporation of genes from one population into another leading to the breakdown of co-adapted gene complexes and thus to homogenization of the genetic structure.

Invasive species: means an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity.

ISO 14001: International Standards Organisation quality standards for environmental management systems.

Mariculture: encompasses aquaculture in brackish and sea water as opposed to freshwater

MSC: Marine Stewardship Council, an independent body set up to establish basic principals for sustainable fishing and to provide standards for certification of individual fisheries as sustainable.

National Scenic Area: National Scenic Areas are Scotland's only national landscape designation. They are those areas of land considered of national significance on the basis of their outstanding scenic interest which must be conserved as part of the country's natural heritage.

Natura 2000 sites: a network of protected areas established under the EC Habitats and Species, and Wild Birds Directives.

NGO: non-Governmental organisations.

Non-native: a species that does not originate in local waters and which has been introduced from other parts of the world by humans, either deliberately or accidentally.

OSPAR Convention: the 1992 Oslo-Paris Convention, to which the UK is a signatory, aimed at preventing and eliminating pollution of the marine environment in the Northeast Atlantic from land-based sources and by dumping from ships and aircraft.

Overexploited: is the status of a fish stock or stock assemblage exploited beyond the limit believed to be sustainable in the long term and beyond which there is an undesirable high risk of stock depletion and collapse.

Ovigerous: egg-bearing.

Polyculture: the deliberate cultivation of more than one species of aquatic organism in close proximity, where each of the organisms in question has a distinct benefit to the commercial process.

Precautionary approach: approach requiring *inter alia* (i) consideration of the needs of future generations and avoidance of changes that are not potentially reversible; (ii) prior identification of undesirable outcomes and of measures that will avoid them or correct them; (iii) initiation of corrective measures without delay, so that these achieve their purpose promptly; (iv) priority to conserving the productive capacity of the resource where the likely impact of resource use is uncertain; and (v) appropriate placement of the burden of proof by adhering to the above requirements.

Precautionary principle: the principle that all responsible parties should act prudently to avoid the possibility of irreversible environmental damage in situations where the scientific evidence is inconclusive but the potential damage could be significant.

Regulating Orders: grant the right to regulate the exploitation of a shellfishery. They are designed to improve the management of natural shellfisheries.

Relaying: the sowing out of juvenile shellfish, for example scallops, for on-growing and eventual harvesting.

Restocking: the release of juvenile in mainly coastal, sea areas, lakes or rivers. and where harvesting of the resulting production is carried out by conventional fisheries (professional or recreational). In this document the term 'fisheries' will be used with the same meaning.

River Basin Management Plans: required by the Water Framework Directive, plans subject to review every six years setting out the environmental objectives for water bodies and providing a summary of the measures that are being used to achieve them.

River basin: area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, freshwater lochs into the sea at a single river mouth, estuary or delta.

Scar ground: intertidal and subtidal areas of exposed boulders and rocks standing clear of surrounding sand - a characteristic feature of the Solway Firth with extensive areas of scar ground present on the English side. Also known as 'skears'.

Semi-intensive system: a development of the extensive system which requires supplementary feeding (and energy), depending thus both on the natural and supplied feed.

Several Order: Sever the rights to public fishery, allowing protection of shellfish stocks owned by individuals, companies or groups of fishermen.

Shellfish: include both molluscs, such as clams, and crustaceans, such as lobsters.

Special Area of Conservation (SAC): sites designated under the Species and Habitats Directive and which are part of Natura 2000 network of protected sites.

Special Protection Area (SPA): sites designated under the Wild Birds Habitats Directive and which are part of Natura 2000 network of European protected sites.

Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Transgenic: containing genetic material introduced from another species by techniques of genetic engineering.

Triploid species: normally referred to salmon; fish with three sets of chromosomes (the threads of DNA that carry genetic information) instead of the normal set of two. The extra set of chromosomes prevents development of viable eggs or sperm so, if the triploid fish escape, they can't reproduce.

Visual carrying capacity: the degree to which a particular landscape or area is able to accommodate development or change without significant effects on the character for which it is particularly valued by people or without causing an overall change to its landscape character type; this capacity will vary according to the type and nature of the development or change that is proposed. Consists of three distinct elements: (i) the impact on landscape character, (ii) the impact on visual amenity (views and people) and (iii) the impact on the integrity of areas designated for their landscape value.

Water Framework Directive: This substantial EC Directive requires that all inland and coastal water bodies reach at least "good status" by 2015. It will do this by establishing a river basin district structure within which demanding environmental objectives will be set, including ecological targets for surface waters. The Directive, therefore, sets a framework which should provide substantial benefits for the long term sustainable management of water.

Wild land or wilderness: uninhabited and often relatively inaccessible countryside, where the influence of human activity on the character and quality of the environment has been minimal.

EXECUTIVE SUMMARY

Background

This public consultation document provides a draft Strategy for marine aquaculture development in the Solway. The purpose of this Strategy is to provide a sustainable development framework that identifies potential areas for aquaculture development and indicates the possible scale and nature of seafood cultivation that might take place. The document also identifies the sensitivities involved in siting and operating aquaculture and outlines the management issues involved. It is aimed at a broad spectrum of readers, including existing and potential aquaculturists, planning authorities, developmental agencies as well as other users of the Solway. This Strategy is a framework that will guide the overall development of aquaculture in the Solway. *However, it will not replace the detailed investigations required into siting individual developments. and the required planning consent.*

The Solway is one of the largest sandy estuaries in Europe and lies across the border of England and Scotland. Largely unspoiled, it is notable for its salt marshes, intertidal sand and mud banks and rich benthic habitats, set within sweeping and often dramatic landscapes. The special nature of the Solway is recognised internationally and much of the inner Solway, as well as a number of its numerous bay areas and estuaries, are designated conservation and landscape areas under European and national laws.

The development of responsible aquaculture is an important part of the EC's Common Fisheries Policy, where it promotes long-term secure employment, high quality production and environmental sustainability. For similar reasons, it is also encouraged by UK government fisheries policy, which in particular, highlights the potential for shellfish culture.

The dynamic nature of the Solway stems from its very shallow inter-tidal nature and, for this reason, finfish aquaculture in cages is unlikely to be considered, nor is raft-suspended rope or longlines. Therefore, the potential for aquaculture in the Solway is essentially limited to the inter-tidal production of shellfish on trestles, posts or aerial long-line systems, or simply laid on the ground. At present, aquaculture in the Solway is limited to a couple of such systems which have yet to achieve full commercial production.

Consents for shellfish aquaculture development depends upon a variety of factors such as: who owns the land (i.e. the Crown or private individuals); whether it is above the mean low water mark (or 3 km offshore of the mean low water spring mark in the case of Scotland) in which case it needs planning permission; whether a Several Order is required to place legal ownership rights on the stock; and whether the site is in a designated conservation area.

Strategic Framework

The Strategy has suggested a vision for aquaculture in the Solway:

Aquaculture working in harmony with the Solway's natural character and heritage that provides sustainable social and economic benefits to local communities.

It provides a series of 'guiding principles' for aquaculture development that cover sustainability, co-existence with other users and how aquaculture might benefit local communities and the environment.

Strategy Elements

The Strategy provides five strategic elements:

- Strategy Element 1: Siting Issues and Guidelines
- Strategy Element 2: Outline Zoning Plan
- Strategy Element 3: Management Issues and Approaches
- Strategy Element 4: Business Development

- Strategy Element 5: Strategy Implementation

Strategy Element 1: Siting Issues and Guidelines

Examines the main issues that might affect the siting of aquaculture in the Solway, covering nature conservation needs and designations, landscape issues, other competing users such as capture fisheries, tourism and recreational users, cultural heritage, access and foreshore transit, as well as water quality issues. After examining the relevance of each of these to the Solway, it presents a series of guidance notes for developers and regulators. The main points in this section are as follows:

- Nature Conservation – the Solway's variety of salt marsh and inter-tidal habitats makes it an important region on a number of accounts. The inner Solway and Luce Bay have been designated European Marine Sites, with many of the Solway's bays and coastal features designated as SSSIs, as well as national and local nature reserves. Three European protected species (the otter (*Lutra lutra*), the natterjack toad (*Bufo calamita*), and the great crested newt (*Triturus cristatus*) are found here and care should be taken to ensure any terrestrial development does not impact their particular habitats. The reef-building tube worm *Sabellaria alveolata* are found on the scar grounds and it is important that both sites and access routes avoid their aggregations. The infauna is richer in the finer sediments of the sheltered bays – whilst they may be impacted by the positioning of shellfish trestles, this would be extremely localised. The Solway is an important habitat for migrating birds with numerous wintering waterfowl occurring in nationally or internationally important numbers, particularly in the Upper Solway Flats and Marshes SPA and Ramsar site. The upper Solway is also noted for populations of breeding birds. Disturbance to, and displacement of, birds in feeding, roosting and breeding areas are obvious areas of potential conflict with aquaculture. Careful consideration of the siting of aquaculture developments on the foreshore, together with careful selection of access routes, will be required to minimise this. Consideration of the seasonality and timing of aquaculture activities in relation to those of the birds will also be required. All species would, of course, potentially be sensitive to loss of important feeding resources, but it is the suggestion of this Strategy that important bird feeding areas such as scar ground are avoided and that relatively modest total areas of intertidal ground are used. It is intended that significant loss of important feeding areas should, therefore, be avoided.

- Landscape and visual amenity – the Solway provides some of the most impressive areas of both the wild and 'managed' landscapes in the UK and a number of these are designated as National Scenic Areas (NSAs), Regional Scenic Areas (RSAs) in Scotland as well as an Area of Outstanding National Beauty (AONB) in Cumbria. In particular, the coastal RSAs are designed for their various features, including the peninsulas, especially those with gorsey knolls and the coastal flats that include coastal plain areas, estuarine flats, intimate coastal parkland, coastal moss and merse. The potential impact of aquaculture upon the land and seascapes and their scenic value is a key issue in the acceptability of new farms. As a result, aquaculture development within these areas needs to ensure that it does not detract from the designation features and various guidance is given towards reducing the impact of aquaculture to acceptable levels.

- Inshore fishing and sea angling – there are a number of important capture fisheries within the Solway, such as for brown shrimp, cockles and mussels, as well as established creel fisheries in Luce and Wigtown Bays. The potential for conflict with aquaculture is low, although the shrimp trawlers might foul low-lying intertidal structures if poorly marked and lit. There is also important recreational fishing in the Solway and a number of the shore fishing marks may be suitable for shellfish culture. It is, therefore, important to ensure that farm siting takes this into account

- Tourism and Recreation - the Solway is a key asset in the draft Area Tourism Partnership Plan. Coastal walking, cycling, sailing, kayaking and bird watching are all important activities. There may be some potential for conflict with sailing over navigation but this can be mitigated through consultation during siting and appropriate marking and buoying. Other forms of recreation are less likely to directly conflict with inter-tidal aquaculture. However, it is important to recognise that beach users and recreational interests associated with the inter-tidal area will need to be consulted on the visual and possible infrastructural conflicts with aquaculture development.
- Cultural Heritage - the Solway coast is dotted with scheduled monuments, castles and coastal gardens that both enhance the life of the residents and provide a focus for the region's tourism industry. In addition, the haafnet, stakenet and the hand-gathered mussel fisheries are all considered heritage activities both sides of the border. Aquaculture development needs to be receptive to this existing heritage and ensure that it does not unduly compromise its integrity.
- Access and Support Infrastructure - foreshore access and infrastructure requirements of aquaculture are of most concern to planners. Foreshore access is limited in the Solway and often heavily used by a variety of different users, including farmers, wildfowlers, walkers, water sports participants as well as wild cockle gatherers, resulting in high levels of traffic, noise and wear of what is usually an unmetalled surface. Passage across the foreshore usually requires an all terrain vehicle, mainly tractors, quad bikes or 4x4 vehicles. This might have implications in terms of bird disturbance and damage to the substrate, as well as disturbing the 'wilderness' element of the inter-tidal zone. Aquaculture has the advantage, when compared to many other users, of permitting an orderly and manageable visit schedule to farm sites, and thus has the potential to mitigate its activities.
- Water Quality – although there are reduced limits on discharges from Sellafield and generation has ceased at Chapelcross, the Solway may act as a radionuclide deposition area so new sites should investigate local radionuclide levels in the foreshore substrates as part of the site selection process. Regarding pathogens, as most sites in the Solway are Class B on the shellfish waters classification, products will need depuration. There is a need to raise industry dialogue with the authorities over the process for designating waters in the Solway, especially those resulting from seasonal variations and driving towards lower discharges and cleaner waters.

Strategy Element 2: Outline Zoning Plan.

On the basis that aquaculture development is likely to be limited to inter-tidal shellfish culture, the zoning plan has identified the lower one-third of the intertidal zone as potentially suitable for aquaculture. The Solway has then been divided into different bay units and, based primarily upon the landscape and nature conservation sensitivities involved, each areas has been classified as suitable for either **small-scale** (oyster trestles or similar which occupy up to one tenth (10%) of a bay when the intertidal is revealed at low tide), **modest scale** (oyster trestles or similar which occupy up to one quarter (<25%) of a bay when the intertidal is revealed at low tide), and **large scale** (oyster trestles or similar which occupy more than one quarter (>25%) of a bay when the intertidal is revealed at low tide) development.

There is an automatic presumption for 'small-scale' development where a bay system includes a SSSI or is within a National Scenic Area. Given the sensitivity of the whole of the Solway coast from many perspectives, no area has been deemed suitable for 'large-scale' development. Based on this assessment, we consider that around 13 km² of the Scottish side of the Solway is suitable for aquaculture development (see table overleaf). As can be seen from the table, on this basis it is estimated that the Solway could produce up to around 21,000 tonnes of oysters or 19,409 tonnes of mussels (or a mixture of the two). However, it should be stated that this level of

production is unlikely to be achieved due to site-specific restrictions, an inadequate supply of mussel seed and market limitations.

Potential Yields for Shellfish Aquaculture in the Solway

Bay	Physical potential for aquaculture (km^2)	Allocated limit (of drying area)	Acceptable for development (km^2)	Working yield oysters (mt/ha/yr)	Working yield mussels (mt/ha/ yr)	Production option	
						Oysters (mt/yr)	Mussels (mt/yr)
Wigtown	12.15	10%	2.87	15.0	40	4,312	11,500
Fleet	2.40	0%	0.00	15.0	40	-	-
Kirkcudbright	2.21	25%	1.98	15.0	40	2,966	7,909
Auchencairn & Rough Firth	3.38	10%	1.33	7.5	0	996	-
Carse Sands	11.19	10%	7.39	7.5	0	5,543	-
Sub-total	***31.32***		***13.57***			***13,817***	***19,409***
Cumbria coast						**7,000**	**-**
TOTAL						**20,817**	**19,409**

Strategy Element 3: Management Issues and Approaches.

In comparison with finfish farming, where there is a higher level of husbandry and input use, shellfish culture is a lower management activity. As a result, the potential for conflict with other coastal users and conservation interests is relatively low, especially if rigorous site selection is undertaken to identify problems and mitigate them through siting and farm design. Management approaches to the two key problems associated with intertidal shellfish aquaculture – (i) disturbance from access and on-site activities and (ii) predator control measures – are provided.

Strategy Element 4: Business Development

The Strategy examines the market potential for shellfish production and provides an outline business Strategy. It recognises the low demand for oysters and advocates a mixture of sales to local, regional and international markets. Mussels are in greater demand, but the largely B classification of the Solway's waters puts the area at a disadvantage compared to the rope-grown mussels of the Highland sea lochs. However, this can be overcome through selling to the bulk markets in France, Belgium and Holland.

The Strategy also estimates the level of employment and income an aquaculture industry might have. Based on the production of 5,000 tonnes of bottom-grown mussels and 200 tonnes of oysters, around 46 full-time jobs could be created and a sales value of around £5.4 million achieved. Oyster farming could add a further 22 full-time jobs and sales worth around £0.5 million.

Strategy Element 5: Strategy Implementation

In order to fully implement the Strategy, a six-point action plan is suggested:

1. Develop the capacity of the *Solway Fish* Aquaculture Working Group (AWG) and ensure its long-term ability to guide sustainable aquaculture development in the Solway
2. Secure and promote investment in aquaculture
3. Improve public understanding and support for aquaculture
4. Develop the market for Solway aquaculture products
5. Maximise opportunities to add value through innovation and integration
6. Promote sustainability and environmental management.

1 BACKGROUND

1.1 INTRODUCTION

This document provides an Aquaculture Strategy for the Solway. This is the preliminary result of a ten month study, which started in July 2006, that has resulted from a growing interest in the cultivation of shellfish in the Solway and the need to guide development because of the potential conflict between this industry and other interests in the estuary.

Funding for the study has been provided by Scottish Natural Heritage, Cumbria County Council, Dumfries and Galloway Council and through the European EFF programme via the Marine Fisheries Agency.

The main purpose of the Strategy is to provide a development framework that achieves a balance between the developer and community, recreational, navigational, other fishing and conservation interests. It is hoped that the early preparation of a Strategy will facilitate the development of a small-scale aquaculture industry in the Solway that creates jobs while avoiding conflict with other activities. A key output will be a broadscale spatial zoning plan that identifies where in the Solway different forms of aquaculture might be appropriate and what management measures would be necessary.

1.2 THE SOLWAY

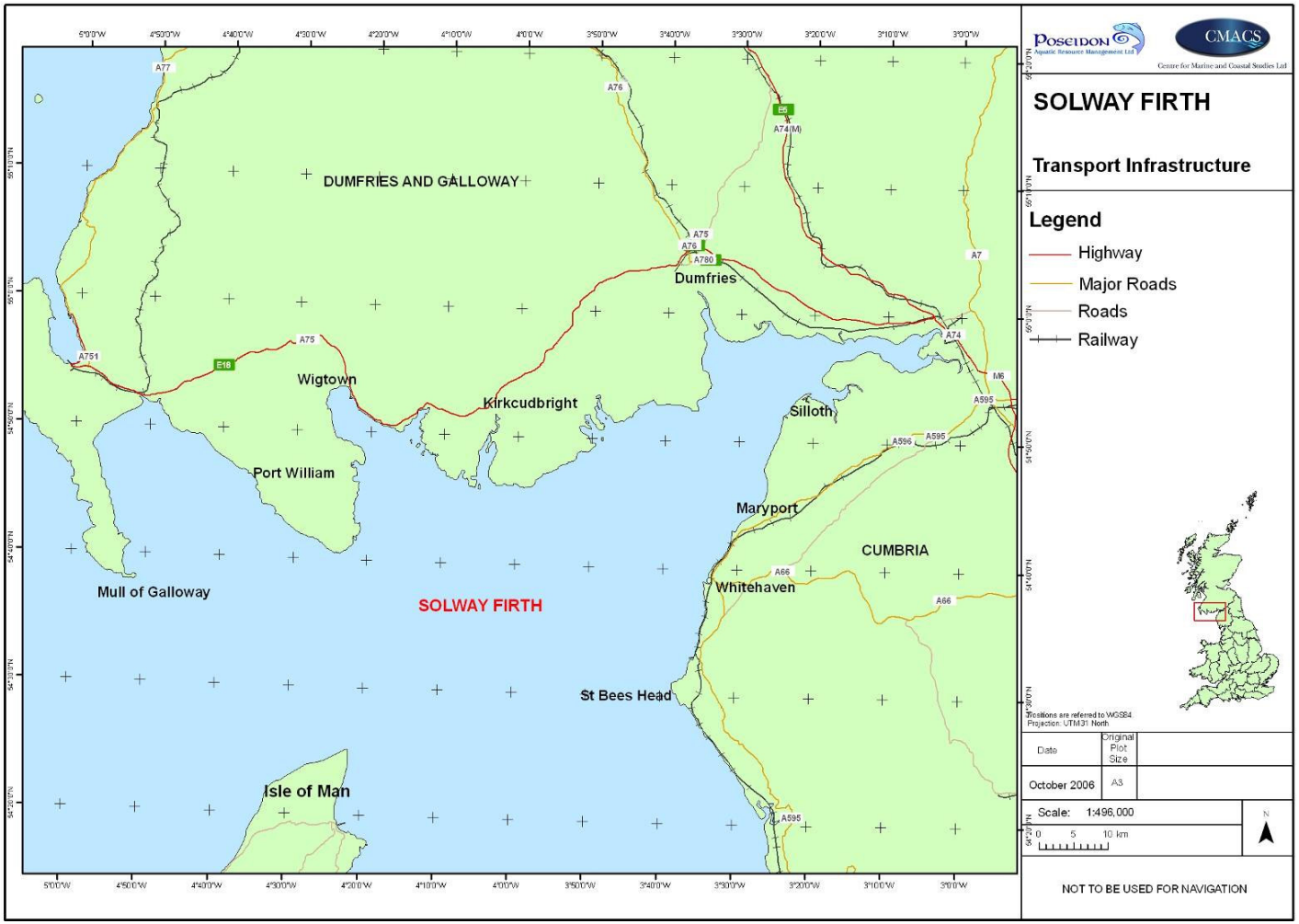
The Solway Firth, lying partly in Scotland and partly in England, is one of the largest, least industrialised sandy estuaries in Europe. At low water the Inner Solway area almost completely dries out, exposing extensive mud flats and sand banks. These form one of the largest continuous areas of sedimentary habitat in the UK. The estuary is important for migratory fish including river and sea lamprey, salmon and sea trout, while mudflats provide important nurseries and feeding grounds for invertebrates such as brown shrimp, fish and significant food sources for birds.

Intertidal and subtidal benthic habitats in the Solway include scar ground which remains clear of sand and supports well-developed animal and plant communities including seaweeds, mussels, crabs and the honeycomb worm. These are relatively rich benthic habitats within the Solway.

The presence of a number of internationally important habitats such as saltmarsh, intertidal mud and sandflats and subtidal sandbanks is responsible for the estuary's status as a Special Area of Conservation (SAC). Because of the Solway's importance for various bird species it is also a Special Protection Area (SPA). Reefs of the honeycomb worm *Sabellaria alveolata* are particularly rich and extensive in some areas and are of high conservation interest.

The Solway Firth Partnership was formed in 1994 and has successfully brought together hundreds of organisations, agencies, companies and individuals to work in partnership for the benefit of the Solway Firth. The Partnership's first task was to pull together data on the Solway Firth's habitats, wildlife, users and management, which resulted in the 1996 *Solway Firth Review*. This was shortly followed, in 1998, by an implementation guidance document, the *Solway Firth Strategy*, that provides a management action plan for the sustainable use of the Solway, covering a wide range of concerns from nuclear pollution and coastal erosion to cockle fishing and wildlife disturbance. The implementation of the Strategy's *Action Plan* is now the key priority for the Partnership, with current planning embedded in recurrent *business plans*. The latest of these runs over 2004 – 2007. This approach was introduced to help co-ordinate the implementation of the Strategy and provide an overview of the processes involved and the focus of the work programme. During 2004 the Solway Firth Partnership evolved into an independent charitable company.

Map 1: The Solway – Transport Infrastructure



1.3 AQUACULTURE DEVELOPMENT IN THE UK AND SOLWAY

The UK's shellfish aquaculture industry is relatively small, but has become an increasingly professional supplier of high quality produce to niche markets, and volume products (e.g. mussels) for export. Cultivation is market-driven and, although there is strong global competition, the industry believes that there is considerable scope for growth provided that it can overcome key obstacles (Bannister, 2006). In England, the industry comprises 118 registered shellfish farm sites run by 96 businesses. In addition, 12 Several Orders (3,000 hectares), five Regulating Orders (139,000 hectares), and two Hybrid Orders (72,000 hectares), contribute to the production from cultivation. The key products are blue mussels (*Mytilus edulis*), native (*Ostrea edulis*) and Pacific oysters (*Crassostrea gigas*), native and introduced clams, plus king scallops, and some cockles.

Table 1: UK Production of farmed shellfish in 2005 (tonnes)

	Pacific Oysters	Native oysters	Scallops	Queens	Mussels	Clams	Cockles	Est. value (£m)
England	444	61	0	0	3,185	6	5	4.1
Scotland	246	13	12	58	4,135	0	0	6
Wales	6	0	0	0	16,358	0	0	11.9
N Ireland	279	1	0	0	7,250	11	0	4.1
UK Total	975	75	12	58	30,928	17	5	26.1

Source: CEFAS

As stated in the ToR, the Solway has not yet seen the level of aquaculture development seen along the deeper sea lochs of Western Scotland. There are two disused sites on the Scottish side of the Solway, one of which still has a current sea bed lease on the Western side of Luce Bay near the Mull of Galloway (Matt Gubbins, pers. comm.).

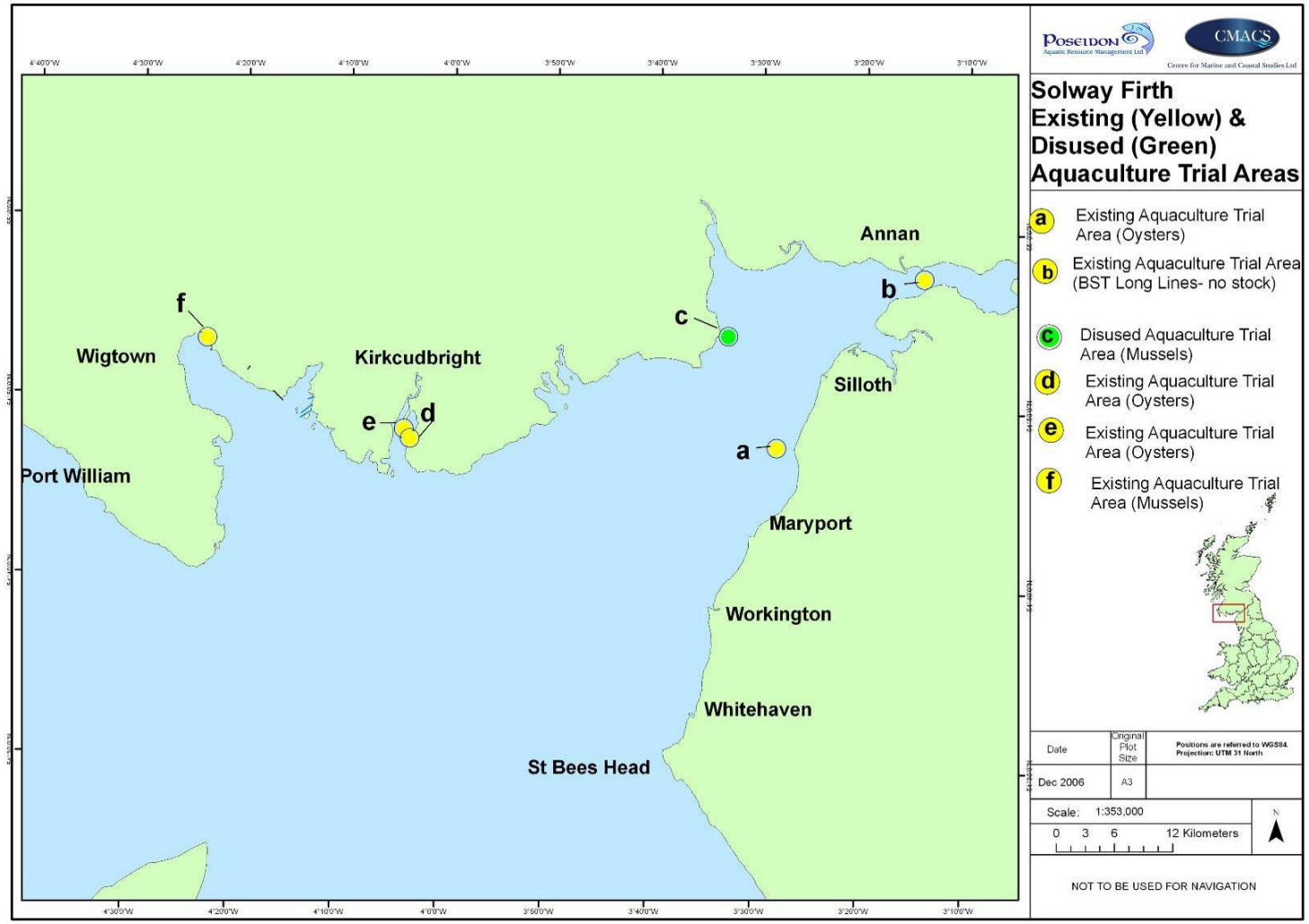
An alternative technique, using an Australian-developed 'BST' long-line system[1] for mussels and oysters, is now being trialled on a small scale at two locations on the Scottish Solway coast and one location on the English Solway coast. An application on the English Solway coast for further trial sites has recently been the subject of a planning inquiry, and permission for bouchet posts has been granted, subject to conditions. FRS has had applications for substantial shoreline trestle-based culture systems at the Fleet Bay/Kirkcudbright Bay and Gillfoot Bay but these were eventually refused after enquiries. A brief review of these enquiries (Hutchinson, 2004 and Arias, 2004) reveals that the main reasons for refusal were as follows:

- Inadequately prepared proposals, not in scale with the scope of the development
- Potential for conflict with other users, especially water-based recreation and sea angling
- Infrastructure was aesthetically unacceptable from major vantage points
- Proposals were sited in particularly sensitive locations, especially for feeding waders
- They had potential consequences for navigation routes
- Associated conservation issues

These points are very illuminating, in that they indicate some of the essential issues that might be managed at a strategic level through wider consultation and the subsequent preparation of spatial zoning according to potential impacts and sensitivities.

[1] A system with the ability to raise and lower the grow bags on the line, allowing the control of shell growth and condition, thus allowing culture in dynamic, high sediment conditions.

Map 2: Existing and Disused Aquaculture Trial Sites in the Solway



1.4 AIMS AND OBJECTIVES OF THE STRATEGY

The Project Brief for this study has been developed by the Solway Firth Partnership in consultation with the Aquaculture Working Group (AWG) of Solway Fish. The proposal for an Aquaculture Strategy has evolved from the need for a cohesive development framework that is sustainable in environmental, economic and social terms. An AWG workshop in January 2006 identified the main concerns to be conflict with other sectors (tourism, conservation, recreation and wild shellfish harvesting), local interests and uncoordinated development. However appropriate aquaculture development could lead to local job creation and income generation that would be consistent with maintenance of the Solway's natural heritage.

The extended Project Brief therefore focuses on producing a Strategy that includes:

- A coherent framework for future aquaculture development, based on a wide-ranging stakeholder consultation process;
- The identification of areas that are suitable for certain types of aquaculture, as well as those with potential conflicts and those where aquaculture is not suitable;
- Where aquaculture is identified as potentially possible, and identification of the main management issues that will arise in the development and operations of the sites; and
- The potential socio-economic benefits and value-added flowing from sustainable aquaculture development and their impact on the communities and livelihoods of the Solway

It is intended that the Aquaculture Strategy should be a practical document that includes a GIS-based framework policy map for subsequent implementation. Furthermore, it should include a time-bound 'Action Plan' for ensuring the integration of aquaculture development into the SFP's overall Solway Firth Strategy as well as the recurrent business plans. It is also important to note that the Strategy is a framework document – potential developers will still need to evaluate the merits of individual sites.

1.5 SCOPE

The *geographic scope* of this Strategy is the Solway Firth Partnership area which is defined seaward, as the area between the Mull of Galloway in Dumfries & Galloway to St. Bees Head in Cumbria (see map overleaf). The landward boundary is accepted as 1 km from Mean High Water Spring but it is recognised that many activities and features beyond this area impact on the Solway. The Solway is considered to include the tidal elements of the main River Eden and Esk estuaries, other estuaries such as Wigtown and Fleet as well as the wider bay areas of Luce, Wigtown and the north Cumbrian coast. In the Strategy itself, the Solway is sub-divided into the following bay units:

1. Wigtown Bay
2. Kirkcudbright Bay
3. Auchencairn Bay and Rough Firth
4. Carse Sands
5. Upper Solway
6. Cumbria Coast

This Strategy covers all *forms of aquaculture* (e.g. finfish, molluscs and crustacea) but, because of the estuarine nature of the Solway, focuses particularly upon shellfish farming.

The Strategy does not have a particular *timeline*. It is designed to be a framework that guides aquaculture development for the foreseeable future. As such, it will need to have a degree of flexibility so that it can adapt to changing circumstances, especially in the policy and regulatory environment. The Strategy will, however, contain an Action Plan that will be coherent with the Solway's planning, thus covering the remainder of the current period (2004 – 2007) and the next planning period (2008 – 2011).

Figure 1: Solway Aquaculture Strategy Area

1.6 USE OF THE STRATEGY

This document should be used by:

- *Developers, landowners and their agents intending to develop new or expand existing sites.* Guidance is provided on improving site selection and scale to reduce the impact of the development to an acceptable level and therefore ensure the sustainability of aquaculture in the Solway as a whole.
- *Planning and building control authorities.* Guidance is provided on aquaculture and its potential impacts, the main issues that need to be reviewed, and the mitigatory approaches that might be adopted by developers.
- *Development agencies in the Solway region.* This Strategy provides a framework for coastal aquaculture development in the Solway that should allow increased coherence with wider sustainable economic and social development initiatives.
- *Individuals and communities interested or concerned about aquaculture development in the Solway.* The document provides a description of aquaculture (inc. a glossary), together with a discussion of the issues and mitigation approaches that might be relevant to their location.

It is important to note that whilst this Strategy provides a framework for aquaculture development in the Solway, and attempts to identify the major issues surrounding the siting and operation of aquaculture, it does not attempt to offer guidance at a 'site by site' level. Therefore, it is important that all new developments undergo individual evaluation as required by local and national statutory guidance.

1.7 METHODOLOGY

This work was undertaken over a ten month period, with a Final Strategy being submitted in early June 2007. The four primary study phases are described in more detail below.

Phase 1: Background Preparation

Phase 1 first examined the policy and regulatory framework impacting upon aquaculture development in the Solway. It also reviewed the existing development and conservation strategies to ensure coherence with the developing Strategy. Two other tasks included an investigation into the culture techniques relevant for use in the Solway's environment, together with the respective siting needs, as well as the preliminary identification of key stakeholders that needed to be consulted over the Strategy development, culminating in a stakeholder consultation plan. The team then prepared a preliminary vision and set of guiding principles for the Strategy that were discussed with the Solway AWG at the first (Inception) client meeting in August 2006.

Phase 2: Site Assessment and Stakeholder Consultation

The 1996 Solway Firth Review has been updated based on (i) documents identified by Hull University in 2000 and (ii) a literature search of more recent information. Shortly before the week long site assessment visit, the GIS specialist assembled available data that was developed into a series of physical, environmental and socio-economic distribution maps of the Solway. The team then prepared some very preliminary zoning based on the siting criteria for different aquaculture systems and the conservation features of the Solway. This was then researched at a series of site visits and meetings with a wide range of interested parties over a week long field visit in early September 2006. This also included a public meeting in Castle Douglas and one in Silloth.

Phase 3: Strategy Preparation

The strategic framework essentially dictates the *scope* of the Strategy. The basic framework was discussed and agreed with the AWG at the Inception Meeting. The Strategy consists of the following components:

- A review of the existing policy and regulatory environment governing aquaculture development in the Solway (Section 2)
- A review of the aquaculture systems that might be appropriate for use in the Solway (Section 3)
- A brief summary of the environmental impacts of different aquaculture systems on sensitive coastal environments such as the Solway (Section 4)
- Vision and Guiding Principles (Section 5)
- Strategic Element 1: Siting Issues and Guidelines (Section 6)
- Strategic Element 2: Outline Zoning Plan (Section 7)
- Strategic Element 3: Management Issues and Approaches (Section 8)
- Strategic Element 4: Business Development (Section 9)
- Strategic Implementation (Section 10)

Phase 4: Strategy Development

Following review by the AWG, the draft Strategy was made available for an eight week public consultation period, which included a 'drop-in' event at Port Carlisle and Kirkcudbright. Following completion of this consultation process, the Strategy was finalised in early June 2007 for formal launch in October 2007.

2 THE EXISTING ENVIRONMENT

2.1 POLICY AND REGULATORY FRAMEWORK

It is important that the Solway's Aquaculture Strategy is set within the national /regional policy and regulatory framework that applies over this border area. This section identifies the relevant aquaculture development, regional economic growth development and environmental management policies that might shape the nature of the Strategy. In addition, we outline the regulatory framework that is used to implement these policies and, from these, derive the overarching legal and structural influences. Important cross-border sensitivities and dual jurisdictions are taken into account within this task.

2.1.1 Policy for Aquaculture Development

European and National Context

The **European Commission** (EC) recognises the importance of aquaculture as a key component of the Common Fisheries Policy (CFP) and has developed '*A Strategy for the Sustainable Development of European Aquaculture*' (EC, 2002). This Strategy is coherent with the other Community's strategies, in particular with the European Strategy for Sustainable Development and the conclusions of the Göteborg European Council of 15/16 June 2001[2]. The EU Strategy looks at aquaculture being able to "reach the status of a stable industry which guarantees long term secure employment and development in rural and coastal areas, providing alternatives to the fishing industry, both in terms of products and employment". The objectives of the Strategy are to (i) create long term secure employment, in particular in fisheries dependent areas, (ii) assure the availability to consumers of products that are healthy, safe and of good quality, as well as promoting high animal health and welfare standards, and (iii) ensure an environmentally sound industry. The EU Strategy has seven key 'actions' that are of interest to the Solway Strategy, including:

Action	Action Elements
1. Increasing production	Encouraging use of new species; providing norms for organic and/or 'environmentally-friendly' aquaculture
2. Competition for space	Interaction with ICZM and coastal zoning plans; offshore shellfish culture
3. Market development, marketing and information	Increased use of quality marks, farmer partnerships to compensate for small-scale production economies of scale
4. Training	Increase the role of women; reverse the decline in coastal communities
5. Governance	Greater stakeholder participation in policy development; greater use of Codes of Practice / Conduct in aquaculture
6. Safety of aquaculture products	Monitoring of Harmful Algal Blooms (HABs)
7. Environmental aspects	Address impact of use of alien species, guidelines for use of EIAs in aquaculture.

EU policy for aquaculture states that "increases in production that are likely to disrupt the market should not be encouraged[3]". Therefore public aid should be "redirected towards favouring modernisation of the existing farms and diversification, rather than increasing

[2] COM(2001) 264 final

[3] Communication from the Commission to the Council and the European Parliament: A Strategy for the Sustainable Development of European Aquaculture, Brussels, 19.9.2002 COM(2002) 511 final

production capacity for species where the market is close to saturation. Action should be taken on measures such as training, monitoring, research and development and clean farming technologies. The improvement of traditional aquaculture activities such as mollusc farming, that are important in maintaining the social and environmental issue of specific areas, should be encouraged".

In its response to the EC 'Strategy for the Sustainable Development of European Aquaculture', the Shellfish Association of Great Britain (SAGB) acknowledges the needs of molluscan shellfish farming, which centre on ensuring a high quality growing environment and secure tenure of cultivation sites (SAGB, April 2003). They also stress the environmentally benign nature of shellfish culture and the potential suitability of small-scale aquaculture start-up operations in the less developed areas of the coastal zone where conservation priorities may be high.

The **UK Government policy** is "to encourage the development of efficient, competitive and sustainable aquaculture industries whilst protecting the health status of UK farmed and wild fish and shellfish. Central to the policy is sustainable use of the marine and rural environment and the prosperity of the economies and communities in associated areas"[4]. The Cabinet Office Strategy Unit report '*Net Benefits: A sustainable & profitable future for UK fishing*' (Prime Minister's Strategy Unit of the Cabinet Office, London, March 2004) recognised the importance of the shellfish industry, and pledged its support for its development (Recommendation 6). As a result of this, Seafish is in the process of publishing a report entitled '*Towards a National Development Strategy for Shellfish in England*' (Bannister, 2006) that shows that development opportunities do exist but there needs to be a clear Strategy for industry development if these are to be realised.

England

Following from this, an '*English Shellfish Industry Development Strategy*' is also under final development (Sue Utting, pers. comm.). This Strategy aims to achieve sustainable development of the industry through ecosystem-based management as the industry relies primarily on natural resources and has a number of main aims:

- To identify the strategic requirements on a short, medium and long-term basis for the sustainable development of the English shellfish production industry, and devise a national development Strategy for implementation.
- Seek the adoption of, and support for, the development Strategy by all sectors of the shellfish industry.
- Facilitate action by government, restructured Sea Fisheries Committees (SFCs and including the Environment Agency when acting as an SFC) and other key players to devise and implement legislative and administrative systems in support of the Strategy objective.
- Formulate development plans to encourage uptake and implementation of the Strategy by all industry sectors at local, regional and national levels. Identify key targets for implementation and monitoring of outcomes.
- Identify key issues for government, Sea Fisheries Committees (SFCs and including the Environment Agency when acting as an SFC) and industry in relation to the drafting of the forthcoming Marine Bill.

[4] A Strategy for the Conservation and Sustainable Development of our Marine Environment (DEFRA, 2002)

The draft Strategy (Utting, 2006) includes various short and medium term recommendations which are summarised in Table 1 below.

Table 2: Summary of Recommendations for the English Cultivation Sector (Draft)

KEY RECOMMENDATIONS	**Short-term**	**Management Framework** ***Improved monitoring and integration of shellfish cultivation operations*** • Resourced through Regulated Fishery Order permit • Control of shellfish cultivation activities through Local Shellfish Management Organisations (LSMO) • Cultivation managed through Regulated Fishery Order permit • Regulated Fishery Order cultivation permit • Requirement for legislative provision for site security
		Development of Cultivation Sites ***Recognition of the environmental impact of operations*** • Cultivation operations to be subject to SEA • Protocols for best practice to be established • Management advice to be provided for LSMO
		Access to Wild Seed Resources ***Development of seed stock monitoring and management techniques*** • Distribution and stability of seed resources • Removal and relaying techniques to be subject to SEA • Management advice to be provided to LSMO
	Medium-term	**Shellfish Cultivation Sites in Transitional Waters** ***Areas designated under the WFD for economically important species*** • Provision required for cultivation site designations within 1 nm • Integration with shellfish harvesting waters Directive controls
		Shellfish Cultivation Sites within 1-12 nm Zone ***Recognition of production activities and sites in inshore areas*** • Provision required for cultivation site designations
		Shellfish Seed Resources within British Fishery Limits ***Designation and protection of natural resources*** • Shellfish seed areas to be designated
RECOMMENDATIONS	**Short-term**	**Improved Management Control and Resource Use** ***Management of cultivation activities through permit*** • Permits issued under Regulated Fishery Order conditions • LSMO permit conditions based on management objectives
		District Organisation of Shellfish Cultivation Sector ***Coordination and representation of permit holder interests*** • Formation of district association to represent views • Input to management process of LSMO
		Industry Investment ***Development of scale and efficiency of operations/businesses*** • EFF structural funds for aquaculture and products • Targeted investment by RDA's • District priorities identified through LSMO • Link to local government business support units • Advice to government and RDA

		Market and Product Development ***Improved products to enhance market opportunities*** • Native Oyster (extensive/semi intensive) o *Competition from fishery production* o *Price fluctuations and seasonal issues* • Pacific Oyster (intensive) o *Competition from wild stock/meat yield/value* o *Seasonal demand issues* • Mussel (intensive/extensive) o *Competition from processed products* o *Competition from imported products* • Pacific Oyster (extensive/semi intensive) o *Natural recruitment becoming evident* o *Quality of production variable, quantity significant*
	Medium-term	**Market Assurance** ***Expanding market opportunities through assurance schemes*** • Local/regional market opportunities o *Regional food group initiatives* o *"Farm assured" schemes* • Regional/national market development o *Commercial producers/marketing groups* o *Production standards and quality* • Accredited cultivation production scheme o *Native Oyster BAP species accreditation?*

Source: Utting, 2006 (in draft)

Points of particular relevance to the Solway include:

Management framework: the cultivation of shellfish in English waters has been largely unregulated, with the control of locations for semi-intensive production left with the seabed owners, while more extensive operations have utilised Several Fishery Orders (SFO's). The Strategy recommends that the SFCs manage all shellfish cultivation activities in their districts with (i) cultivation activities to be undertaken within an environmental management system in relation to the wider conservation objectives, (ii) a clear distinction in monitoring wild and cultivated production, (iii) the location of inter-tidal cultivation sites should be the subject of local government planning authorities, (iv) a reasonable period of tenure needs to be given to encourage long-term sustainable development and (v) provision should be made for cultivation permits to be operated under Regulated Fishery Orders (RFOs) with areas classified as registered farm sites for disease control and production reporting considerations. Furthermore, the Strategy advocates the establishment of a 'National Shellfish Resource Unit (NSRU)' to provide national co-ordination of functions undertaken by the SFC's and the establishment of environmental and fisheries best practice for shellfish production.

Development of cultivation sites: the location of existing cultivation activities within Environmental Management Systems and the need for commercial expansion provisions, together with the establishment of new ventures in such areas, necessitates that environmental impacts are minimised. In order to balance the impact of cultivation activities on the environment with the requirement for specific site conditions for successful commercial operations, the cultivation techniques might be subject to Strategic Environmental Assessment (SEA). Such technical appraisals should be combined with an assessment of the specific

location, and the environmental interactions identified. There is a need for best practice operational procedures to be developed in relation to the environmental characters of each site and, where appropriate, impact reduction techniques to be established. It is also important to note that completion of a specific aquaculture-related SEA for the Solway is a prerequisite for recognition of an aquaculture Strategy by the Dumfries and Galloway Council.

Access to wild seed: in order to ensure the environmental consequences of commercial exploitation of seed resources are established, the removal and relaying techniques should be the subject of SEA. In the context of activities being undertaken within environmental management system, dedicated protocols should be established in conjunction with best practice techniques to ensure that the wider environmental considerations are recognised. The ability for the restructured SFC's to manage the sustainable exploitation and relaying of shellfish seed stocks under RFO permit conditions will be dependent on environmental guidance from the NSRU. The management of the seed removal and relaying operations will require close monitoring as will the yields achieved from the cultivation process and, if best practice and optimal resource use is to be achieved, the NSRU will require to be involved in this process.

Shellfish Cultivation in Transitional Waters: The implementation of the Water Framework Directive (WFD) presents specific considerations for the operation and management of the shellfish cultivation sector. As production activities are currently almost solely located within the designated transitional waters (<1 nm) so the management of the sector must be integrated with the Directive's objectives. The introduction of the WFD provides the opportunity for economically important species and hence areas to be identified. Such designations apply to both molluscan and crustacean species and this should provide additional support for the cultivation sector especially in terms of any future stock enhancement initiatives. The Shellfish Growing Waters Directive also establishes a legal provision for the recognition of areas used to cultivate shellfish and this should be continued through the WFD. The designation of "economically important species" and hence areas for the cultivation sector should encompass the requirement for all cultivation operations to be classified as "Registered Farm Sites" for disease control and reporting reasons.

The implementation of the WFD places a requirement on the cultivation sector that the production techniques employed will maintain the "ecological status" or "pristine conditions" of the water environment. The potential benefits to the sector through such designations seem likely to outweigh any constraints due to cultivation operations adversely affecting the ecological status of such waters. In addition, such designations recognise the interests of the sector and serve to implement the concept of Marine Spatial Planning.

Climate change: the impact of climate and associated environmental change is likely to be most evident within the areas utilised by the cultivation sector. In this respect there is a need to ensure that designation of "economically important species" and areas provides for change and is flexible enough to encompass new sites and techniques.

Scotland

In 2003, The Scottish Executive published the '*Strategic Framework for Scottish Aquaculture*', developed by a Ministerial Working Group. The overall vision statement defined in the framework is: "Scotland will have a sustainable, diverse, competitive and economically viable aquaculture industry, of which its people can be justifiably proud. It will deliver high quality, healthy food to consumers at home and abroad, and social and economic benefits to communities, particularly in rural and remote areas. It will operate responsibly, working within the carrying capacity of the environment, both locally and nationally and throughout its supply chain." The strategic framework encourages the development of sustainable aquaculture and in particular shellfish culture (para. 2.29).

A number of other points relevant to the Solway include:

Development of new sites: the industry would like to see an integrated, multi-species approach to sharing the coastal zone with different sectors and other users (para. 3.10).

Economic objectives: expansion of the shellfish sector, including diversification of species (both molluscan and crustacean) is to be encouraged in Scotland as an environmentally sensitive activity, with support as appropriate from the relevant planning authorities and development agencies. There is scope for direct community involvement in this sector through investment or participation in small-scale, crofting shellfish farming (para. 3.18).

Carrying capacity: The shellfish sector relies on a plentiful supply of natural particulate food to sustain the growing cultured biomass. Over-exploitation of this biological carrying capacity may result in poor growth rates and an inability to achieve marketable size (para. 3.41).

Conflicts with wildlife: there is a need for an objective assessment of the scale of predation and of the measures available to control it (including the selection of sites and husbandry techniques which reduce conflict with predators) so that solutions which are both consistent with domestic and European legislation and acceptable to the public can be developed (para. 3.70).

Producer partnerships: the Strategy notes that already 75% of Scottish producers work as part of some form of cooperative structure and that organisation at local level within a distinct area is particularly suitable for bivalve producers (para. 3.76).

Research: the main vehicle for aquaculture-related research is the Scottish *Aquaculture Research Forum* (www.sarf.org.uk). A recently tendered project is the 'Scoping study for the assessment of appropriate thresholds for the potential triggers for EIAs for shellfish farms and other non-farm aquaculture' and will be of relevance to future guidance following this Strategy.

The *Association of Scottish Shellfish Growers* (ASSG[5]) is a trade association for producers of mussels, scallops and oysters in Scotland. Founded in the 1970's, the ASSG ensures that Scottish shellfish interests are represented to Scottish and UK governments, the EC, political representatives (MSPs, MPs, MEPs), to national and international committees, to research, development and regulatory agencies, to NGOs and the media. The ASSG have produced a 'Code of Practise' to "ensure that farming activities are managed in an environmentally responsible and sustainable manner that is in harmony with the needs of other marine and shoreline users". The ASSG is proactive in addressing environmental sustainability issues: the ASSG signed concordats with both Scottish Natural Heritage (SNH), and WWF Scotland in 2002 in order to outline areas of common interest, establish a general commitment to work together on issues of joint concern, and provide a non-binding framework for cooperation and communication with the ASSG. The ASSG continues to work closely with both SNH and WWF-S on issues of mutual concern.

[5] http://www.assg.co.uk

2.1.2 Regulation

The regulation of aquaculture in the UK is essentially conducted by local authorities in consultation with various other bodies with specific sectoral remits. This section examines how new and existing aquaculture development is regulated, with a specific focus on shellfish farming which is likely to be situated in the inter-tidal or sub-tidal areas of the Solway. The main regulatory or consultative bodies responsible for the Solway area are listed in the table below.

Table 3: Bodies with Statutory or Regulatory Authority in the Solway Area

Organisation	Responsibility	E	S
Allerdale Borough Council	Local planning	✓	
Carlisle City Council	Local planning	✓	
Copeland Borough Council	Local planning	✓	
Crown Estate	Foreshore and seabed leasing	✓	✓
Cumbria County Council	Local Authority	✓	
Cumbria Sea Fisheries Committee	Inshore fisheries management	✓	
District Salmon Boards	Statutory consultative body to manage salmon fisheries		✓
Dumfries and Galloway Council	Local Authority		✓
Eden & District Fisheries Association	Statutory consultative body of Eden and Esk Rivers	✓	✓
Environment Agency (NW Region)	Statutory regulatory body for fisheries/WQ	✓	
Food Standards Agency	Shellfish Hygiene Directive	✓	✓
Government Office NW	Regional Government	✓	
Marine Fisheries Agency	Coastal fisheries	✓	
Maritime and Coastguard Agency	Implements Government maritime safety policy.	✓	✓
Natural England	Statutory consultative body	✓	
Northern Lighthouse Board	Maritime navigation and safety		✓
Scottish Natural Heritage	Statutory body for wildlife and heritage conservation		✓
Scottish Environmental Protection Agency	Statutory regulatory body for environmental management.		✓
Scottish Executive Ports and Harbours Branch	Maritime infrastructure development		✓
Scottish Executive Environment Rural Affairs Department (SEERAD)	Government body regulating agriculture and fisheries		✓
Solway Coast AONB Management Unit	Solway Coast AONB	✓	
Solway Shellfish Management Association	Management of regulated shellfisheries		✓
Trinity House	Maritime navigation and safety	✓	

Key: E England; S Scotland

The *Registration of Fish Farming and Shellfish Farming Businesses Order (1985)* requires all fish and shellfish farming businesses in Great Britain to submit details for registration within two months of commencing business. The information is required specifically to help control the introduction and spread of disease throughout the aquaculture industry and into wild fish stocks. After registration, an inspector from Defra (England and Wales) or FRS (Scotland) will visit the site to ascertain whether registration is required – this depends upon the nature of the business, more specifically whether or not stock will be moved into or off the site, reflecting the disease-driven nature of registration.

Development Consent and Lease

For planning purposes, as a general rule the limit of the coastal zone in the seaward direction is mean low water spring tide (MLWS) mark. Above the MLWS, local planning authorities have powers to control the development and use of land under the Town and Country Planning Act 1990. Decisions on development proposals below MLWS are generally outside the scope of the planning system, although they are subject to control by a number of agencies, usually related to the type of activity.

The arrangements for control of development below the MLWS of **Scotland** are in the process of change. Above the MLWS, planning authorities expect to make decisions in accordance with the Development Plan unless material considerations indicate otherwise. This approach will now extend out to 3 nautical miles. It follows that planning authorities will require to include these areas in their development plans and formulate plan policies to cover them.

The application process for development consent or planning permission for shellfish farming in Scotland is now a statutory procedure – as of 1st April 2007, the new Town and Country Planning (Marine Fish Farming) (Scotland) Order 2007 came in to force and now requires shellfish farms (below the MLWOST) to apply for planning permission. The Crown Estate is owner of almost all seabed and approximately 50% of foreshore around the UK coast and now administers the seabed leasing process on a separate basis. It is required by Statute (The Crown Estate Act 1961) to grant consent for use of foreshore and seabed in its ownership (it does not administer non-Crown lands). Any permanent structure (or activity that results in equipment or moorings) on Crown foreshore or seabed requires Crown Estate consent. The Crown Estate charges a rent for both private and commercial use of its foreshore and seabed (see Appendix C for charges relating to shellfish culture).

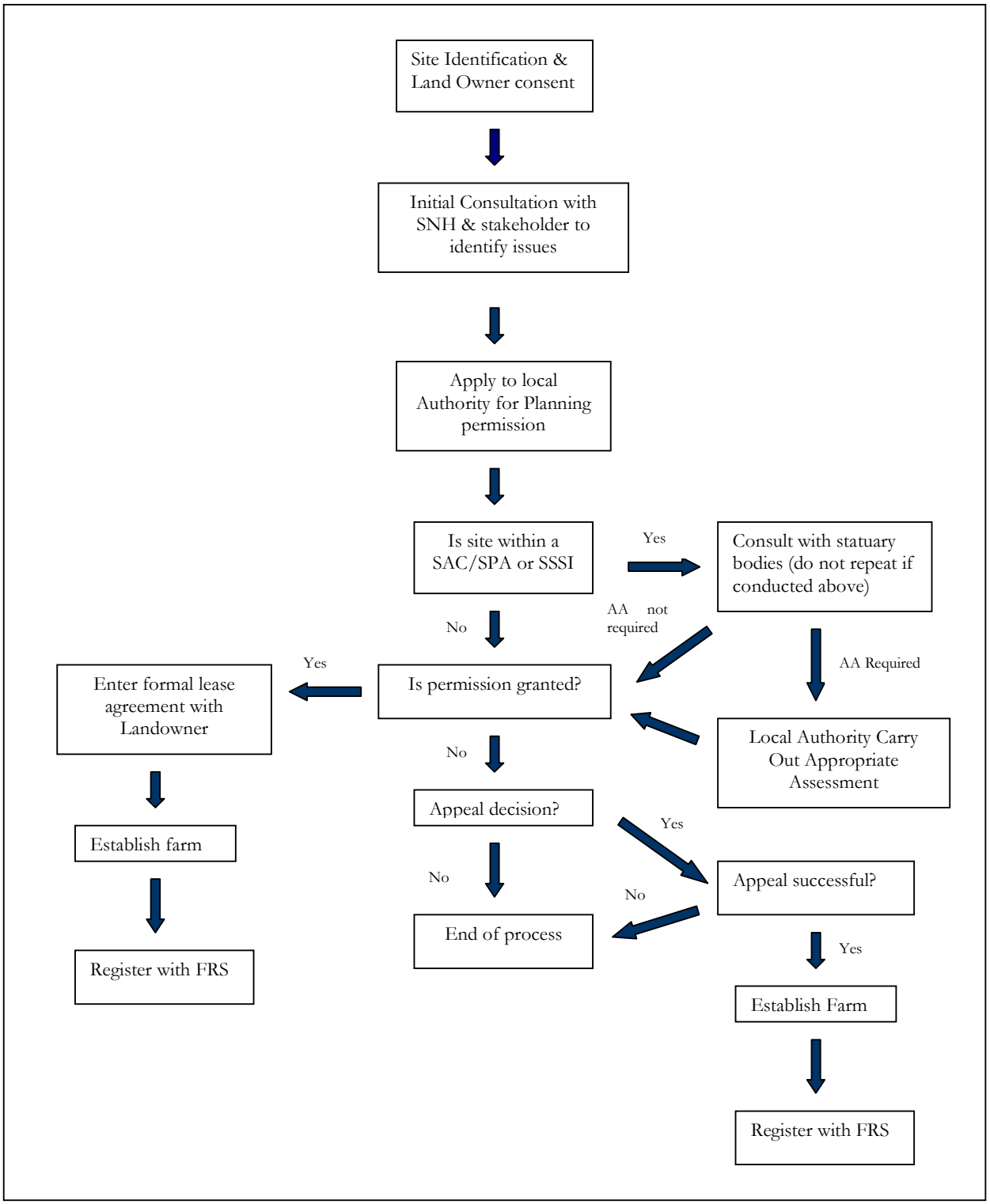
The first stage in the process is to identify a suitable site for the shellfish farm. The Crown Estate will advise whether identified sites are free from other regulated or pending development, but is not able to identify or propose sites with possible development potential. Site selection will take account of local knowledge; shore based facilities; access; current speeds and a range of other important factors. A review of these elements should be undertaken by the person who is to develop the site or his appointed agent. It is possible to reserve a site for a period of 6 months while undertaking environmental studies and collating background information prior to a formal application.

As with Scotland, in **England** it is important to obtain the permission of the land owner to develop the foreshore area. If this is obtained, the developer will be asked to enter into a lease agreement with The Crown Estate (unless it is privately owned). Lease costs vary from region to region but are usually reasonably consistent with the Scottish lease rates in Appendix C.

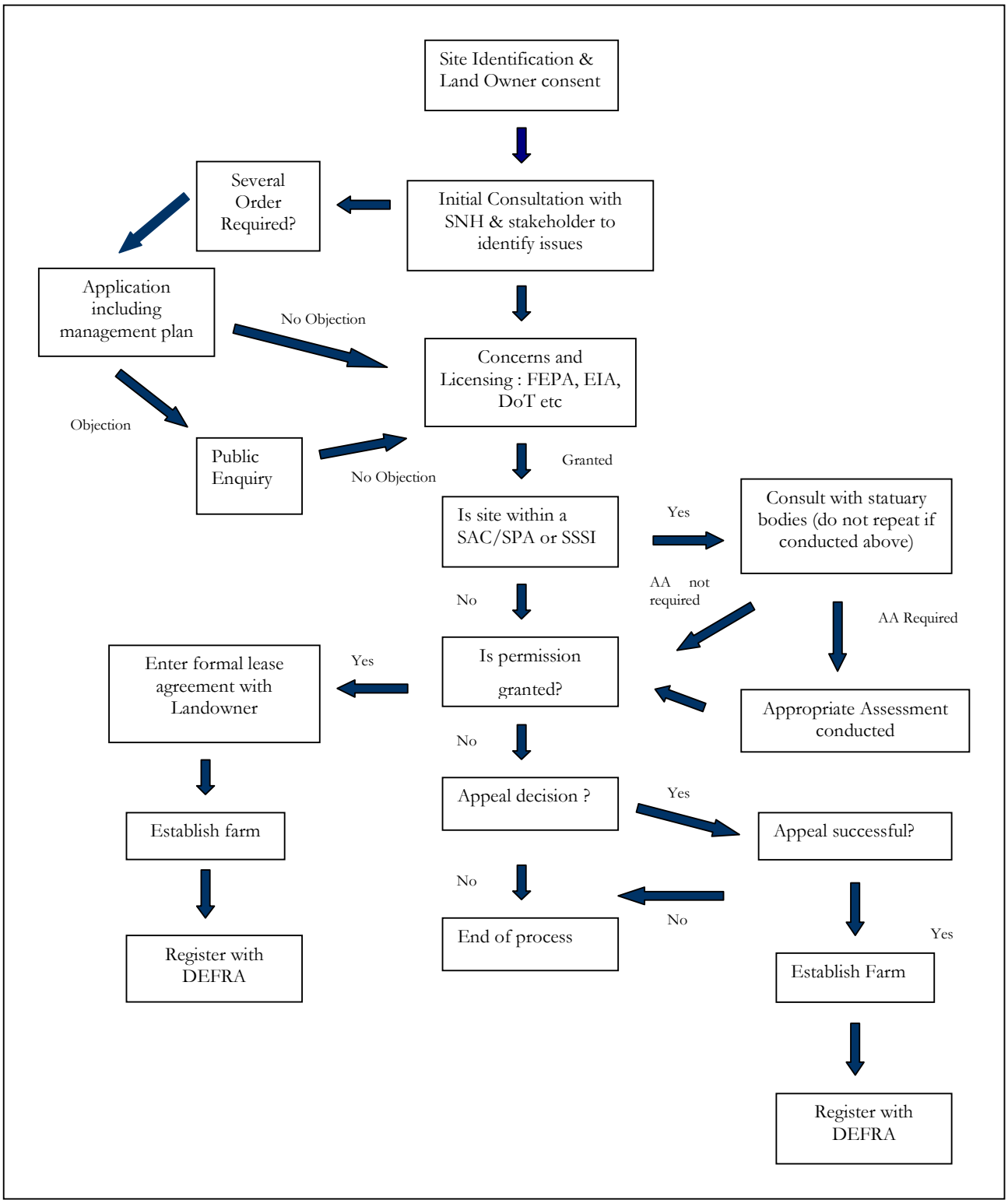
In the case of Crown Estate land in the Solway, all applications are handled by the Edinburgh office, irrespective of whether the land is north or south of the border. Once a site has been identified and potential management issues addressed, the developer makes a formal application to The Crown Estate.

Figure 2: Overview Shellfish Farm Application Process in Scotland and England

Overview in Scotland:



Overview in England:



Please note that this process is subject to change. Potential developers should seek advice on current requirements.

Following the consultation period, the local authority will review the application and correspondence received from consultees during the consultation period before making a recommendation to The Crown Estate as to whether or not the application should be approved. The Crown Estate will then issue a decision letter based on the recommendation. The local authority will submit one of the following:

a) Unqualified favourable view – approve without changes;
b) Qualified favourable view – approve but with conditions, e.g. reduction in site area or equipment; or
c) Unfavourable view – rejection.

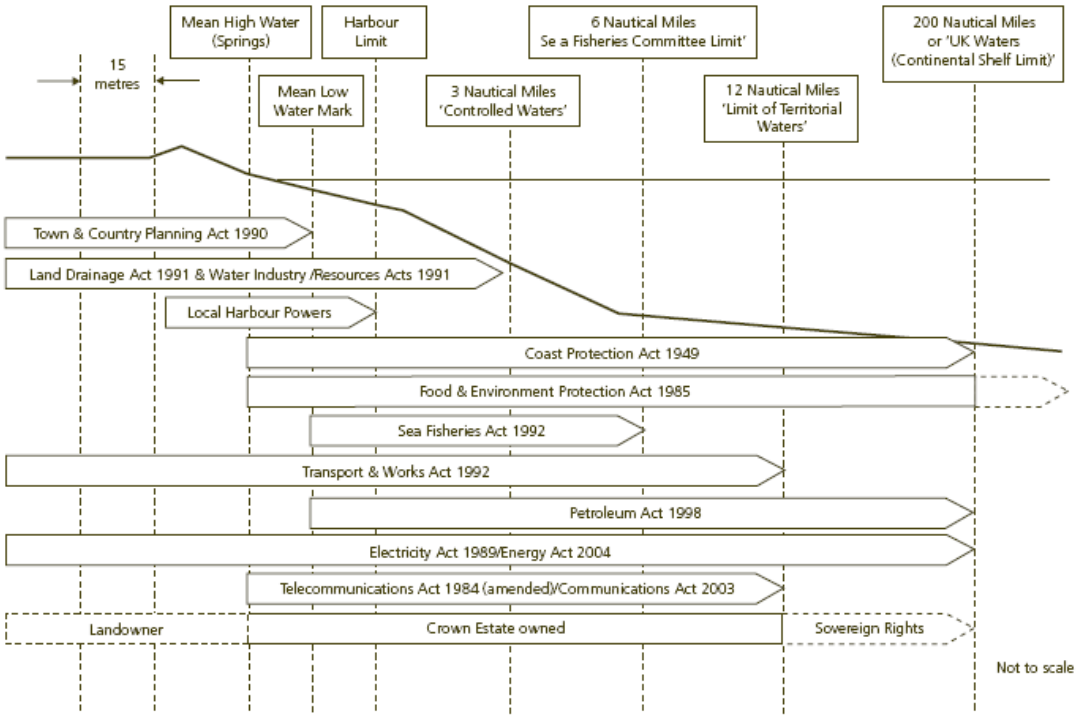
If the recommendation is to reject the application, the applicant has a right of appeal to the Scottish Executive Inquiry Reporters Unit within 6 months of the date of notification. There is no provision for third parties to appeal against a decision.

Consents and Licensing

Once landowner permission is obtained, consents or licensing may be required from various other sources. If structures are to be erected at, or in, tidal waters a licence may be required under the *Food & Environment Protection Act 1985* (FEPA). If the structures might present a navigation hazard at sea or within tidal waters, navigation consent needs to be obtained. In **Scotland** this is granted by the Scottish Executive Enterprise, Transport & Lifelong Learning Department through Section 34 of the *Coastal Protection Act 1949*, usually following the grant of the seabed lease (because the process of dealing with these other licences includes consideration of navigational issues). In **England,** works which interfere with rights of navigation require a consent from the Department of Transport and may require authorisation through the Private Bill procedure or through the proposed order-making procedure set out in the *Transport and Works Act 1992* and the *Coast Protection Act 1949*. In **Scotland**, the *Water Environment and Water Services (Scotland) Act 2003* implements the Water Framework Directive (WFD) (41). This Act adopts a holistic approach to protection of the water environment and includes controls over all discharges, abstractions and impounding works in transitional and coastal waters out to 3 nautical miles.

If the sites are within or adjacent to nature conservation areas such as Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Specially Protected Areas (SPA) then consultation with the relevant statutory organisations such as Natural England and Scottish Natural Heritage are necessary. If the development is likely, either alone or in combination with other projects, to have a significant effect on a European designated site, then an Appropriate Assessment may need to be conducted by the consenting authority (the relevant or consenting authority i.e. the local authority). On the basis of the outcome of this assessment, the authority may or may not issue a conditional consent for development. A formal appropriate assessment is only required if the site carries a European designation. If a SSSI, the competent authority would need to consult SNH and Natural England and take into account their advice.

Figure 3: Geographical extent of the main marine works controls in England & Wales



Source: Defra, 2006. Note that in Scotland shellfish aquaculture now needs planning permission out to 3 nm.

Environmental Impact Assessment

The UK essentially follows the EU Law on Environmental Impact Assessments. As of 1st April 2007, in ***Scotland*** the new Town and Country Planning (Marine Fish Farming) (Scotland) Order 2007 came in to force and now requires shellfish farms (below the MLWOST) to apply for planning permission. The main driver for this policy is to allow for more local democratic control over such developments. Planning authorities will become responsible for the consideration of applications for planning permission and will, as appropriate, consider the environmental impact of aquaculture developments. The Scottish Executive is currently working with a small Convention of Scottish Local Authorities-led group to promote a project to design better guidance on Environmental Impact Assessments. This will take account of the developing science being taken forward by the United Nations Food and Agriculture Organisation and other good practice guidance. In addition, they are further examining issues under EIA Regulations to ensure that fish farm EIAs are undertaken where required for new or modified developments. Both initiatives are expected to be completed in 2007. At present, shellfish farming is not covered by the EIA Regulations.

Informal Consultation

Once a likely site has been identified, or changes have been identified, initial informal consultation with local stakeholders e.g. local residents, loch users, environmental and wildlife interests and the statutory authorities – Scottish Natural Heritage, Scottish Environment Protection Agency, the Scottish Executive and the Local Authority should be advised.

The purpose of informal consultation is to identify and remove or mitigate, where practicable, any particular issues that might prevent an application being approved. These issues are varied but may include navigational issues, proximity to protected species, or existing development, or visual concerns.

If issues are identified these should be addressed before the application is submitted; this could be by moving the proposed site away from the feature of interest or concern, or by reducing or amending the proposed equipment specification.

Resource Access Rights

At present, the cultivator has limited legal protection of the stock. Bivalves grown in containers in public waters are protected by Theft and Criminal Damage legislation, while shellfish beds covered by private right of fishery or by Several Order are protected against theft or damage by the provision of section 7 of the Sea Fisheries (Shellfish) Act, 1967, provided that the beds are adequately marked. The Sea Fisheries (Shellfish) Act, 1967 has been one of the most important pieces of legislation to the present-day bivalve cultivation industry. It is the principle statute governing molluscan shellfisheries in Britain and its origins date back to 1868. The Act, which was last amended in 1997, introduced the concept of Regulated and Several fisheries whereby the common law right of shellfishing is removed to ensure the protection of property rights in such fisheries.

Several Orders are granted for a fixed period, to an individual, a co-operative, or a responsible body, to enable the grantee to cultivate the seabed within a designated area of water and to conserve, develop and enhance the specified stocks of shellfish thereon. Several Orders are granted in England by the Department for Environment, Food and Rural Affairs (Defra) or in Scotland by the Scottish Executive Environment and Rural Affairs Department (SEERAD). The applicant must provide a management plan, and this must show that the fishery will benefit from cultivation as the driving philosophy is that the productivity of the fishery must be enhanced (Laing and Spencer, 2006). Application for, and granting of, a Several fishery right can be a time-consuming process which may take up to 3 years. Public objections to the application can force a public enquiry, the cost of which falls to the applicant. Subletting from a Several Order held by a sea fisheries committee, where this is an option, is often a faster way of obtaining a several right. However, areas covered by existing Several Orders may only be suitable for cultivation of certain species of bivalve.

There are not public rights of access with vehicles to the foreshore. Using a vehicle on the foreshore without landowners permission is an offence under Section 34 of the Road Traffic Act.

2.2 EXISTING MANAGEMENT AND DEVELOPMENT STRATEGIES SPECIFIC TO THE SOLWAY

It is important that this Strategy is coherent with existing management and development strategies for the Solway. This section examines existing strategies relevant to aquaculture and highlights any guidance that might provide direction to this Strategy.

Solway Firth Strategy: the Solway Firth Partnership was formed in 1994 and has successfully brought together hundreds of organisations, agencies, companies and individuals to work in partnership for the benefit of the Solway Firth. During 2004, the Solway Firth Partnership evolved into an independent charitable company. The Partnership's first task was to pull together data on the Solway Firth's habitats, wildlife, users and management, which resulted in the 1996 *Solway Firth Review*. This was shortly followed in 1998 by an implementation guidance document, the *Solway Firth Strategy (SFS)*, which provides a management action plan for the sustainable use of the Solway, covering a wide range of concerns from nuclear pollution and coastal erosion, to cockle fishing and wildlife disturbance. The SFS' own vision is "*To secure an environmentally sustainable future for the Solway Firth Area which allows the economy to prosper while respecting the distinctive character, natural features, wildlife and habitats of the Firth*". The SFS does not specifically mention aquaculture, but does cover fisheries in general. Goal F1 (*To develop working arrangements which will support a sustainable fisheries resource, economically viable sea fisheries and improve knowledge of fish stocks and fishing practices in the Solway*) and F2 (*Fishing interests will examine existing and proposed practices in the light of the outstanding nature conservation interest of the Solway, with a view to improving sustainability of the industry and minimising adverse impacts on marine species and habitats*) are of particular relevance.

Solway Firth European Marine Site (EMS) 'Management Plan': the *Inner Solway Firth* has been recognised by the EC as an area of high nature conservation importance since 1996. The EMS management plan does not identify aquaculture as a specific issue related to the marine site, although it is likely to be included in the revised plan due in 2007 / 2008. However it does cover wild shellfish gathering and there are a number of common impacts, most notably disturbance through the use of machinery and additional human presence in areas of particular wildlife sensitivity e.g. SPAs. The main management mechanism is the Regulating Order and the role of the Solway Shellfish Management Association, where additional monitoring and regulation to comply with the Habitats Directive will be enabled. The existing Management Plan for the inner Solway is currently under a process of review and revision.

Luce Bay and Sands has also been designated as a Special Area of Conservation (SAC) site since 2005 and the development of a Management Plan is currently underway. Here aquaculture is recognised as an operation that "may cause deterioration of the marine natural habitats or the habitats of species, or disturbance of species, for which the site has been designated" (SNH, 2006). Shellfish farming is considered to have the potential to cause deterioration of the qualifying habitats and communities through physical damage (e.g. installation of mooring blocks and continued scouring by riser chains) and changes in community structure caused by smothering from pseudo-faeces (undigested waste products) and debris (including dead shells) falling from the farm. There is also potential for accidental introduction of new non-native species and increasing the spread within the UK of existing non-native plants and animals (e.g. *Sargassum muticum* Wireweed), through importation or translocation of shellfish stocks. Invasive species have the potential to cause deterioration of the qualifying interests by altering community structure and quality.

Strategy for Scotland's Coast and Inshore Waters: this Strategy, produced by the Scottish Coastal Forum in 2004, recognises the "economic importance of fishing and aquaculture to the country's rural periphery" although mentions that its integration, even after two or more decades, can be controversial. The Strategy identified the importance of marine spatial zoning and marine spatial planning to establish priority-use zones for activities like fisheries and

aquaculture and the need to identify area-specific objectives in a more rational way (Section 2.2). In its marine aquaculture section (2.3), points of interest include:

- Shellfish farming has traditionally been less capital-intensive and the pattern of ownership more localised, but this too is changing as the industry seeks to harness economies of scale and tap into volume markets.
- The need to bring marine aquaculture installations within the scope of the statutory planning system is now a priority, not least because statutory planning powers will provide more of an incentive for local authorities to prepare planning guidance for marine aquaculture at local and regional level.
- Local area management plans developed for aquaculture in individual sea lochs on a non-statutory basis have been generally well received. However, integrated coastal zone plans which are multi-sectoral in scope have the potential to provide guidance over broader sea areas and to generate more synergy between interests.

The main issue identified by the Strategy is how and where to accommodate expansion of aquaculture and/or species diversification so the industry can maintain its competitiveness without prejudice to: (a) other income-generating activities in the coastal zone; and (b) the environmental assets for which the Scottish coast is renowned. In addition, the Strategy calls for new designs for low-impact aquaculture installations (finfish farming, shellfish farming, polyculture, seabed ranching) to make a wider range of locations and higher production levels feasible.

Financial Instrument for Fisheries Guidance & European Fisheries Fund: until last year, FIFG was the mechanism by which EC aid is channelled into the fisheries sector in the UK and other EU Member States. This has been replaced by the *European Fisheries Fund* (EFF), which will run from 2007 - 2013 In the 2003 mid-term review, it was recognised that considerable potential exists for expansion of UK shellfish farming, which was considered to be characterised by its fragmented nature and its small, private operators. Various investment actions and priorities have been identified for shellfish aquaculture, including:

- Provision of specialist equipment to assist in identifying wild seed supply (mussels)
- Establishment of maximum sustainable yields and production capacities for key shellfisheries
- The provision of specialist equipment for hatchery and other operations
- Improved handling and grading equipment to improve product quality and efficiency
- Improvement to live holding and transportation methods
- Development of low cost testing methods for determining water quality, algal blooms and biotoxins
- Establishment of co-operative ventures to co-ordinate marketing and supply
- Investigation of the sustainability of new species (*Ensis, Venerupis* and *Glycymeris* spp.)

Strategy for Inshore Fisheries: A *Strategic Framework for Inshore Fisheries for Scotland* was published by the Scottish Executive in 2005. Under this Strategy, regional inshore fisheries groups will develop long-term, medium-term and short-term objectives for inshore fisheries which are consistent with high level strategic objectives, but which are tailored according to local circumstances. In establishing inshore fisheries groups, account will be taken of other management and planning areas (e.g. for aquaculture, river basin management). This will minimise confusion between different management arrangements for different purposes. The starting point for developing the boundaries for inshore fisheries groups is natural geographical demarcations, based primarily on habitat distribution, but there is scope to dovetail with other marine environment management arrangements. Certain species, such as scallops and nephrops, will require particular arrangements to ensure coherence across group boundaries. Inshore

fisheries groups will be expected to focus their objectives and considerations on fisheries within the 6 mile limit. Establishment of inshore fisheries management areas will be assisted by the Scottish Inshore Fisheries Advisory Group (SIFAG).

Coastal and Marine National Park: The Solway is one of eight candidate sites[6] for the first Scottish 'Coastal and Marine National Park' (CMNP). A consultation paper (Scottish Executive, 2006) has been published and a roadshow was held during October 2006. The formal consultation period finished on 10 January 2007 and if the proposals succeed, the park(s) will be designated some time in 2008.

The boundaries of the proposed park in the Solway are, as yet, undefined but would probably include the inner and outer Solway as well as the Rhins of Galloway peninsula. The seaward boundary might not extend beyond the boundary for inshore fisheries management (6 nautical miles from baseline). The landward extent of the Park is more uncertain – the maritime focus means that inland boundaries may be drawn relatively tightly in place, especially along developed coasts and industrial areas, perhaps not extending higher than low water (Mean Low Water Spring Tides) or being set even further out from the coast. As provided for in the National Parks (Scotland) Act, even the final proposal would only describe the area in general terms since the whole purpose of the process set out in the Act that would follow this consultation exercise is to provide for a process of further consultation to inform the subsequent decision of Ministers on matters such as Park boundaries. Dumfries and Galloway Council has considered the risks and benefits of a CMNP designation and has identified a number of issues involved (DGC, 2007).

In the event of such a park being designated for the Solway, it would operate under the National Parks (Scotland) Act 2000. A number of different planning options have been considered:

a) The Park Authority assumes the planning function for aquaculture but this depends on the area chosen;
b) The local authority and existing regulators would continue to manage aquaculture in the Park, but be guided by the Park Plan and local frameworks for aquaculture prepared by the local authority and endorsed by the Park Authority;
c) As (b) above, but with the Park Authority preparing the local frameworks for aquaculture jointly with the local authority; or
d) As (c) above, but with the Park Authority also becoming a statutory consultee to the local authority on casework.

In the Minister for Environment and Rural Development's view (Ross Finney, MSP), option (d) has the potential to add to the complexity of current arrangements while options (a) and (c) limit the Park Authority's role to setting the wider strategic framework for aquaculture within the National Park area. Option (b) is the minimal approach but a further option could be considered as follows:

e) The local authority and existing regulators would continue to manage aquaculture in the National Park, but be guided by the Park Plan, and the Park Authority should be consulted on local frameworks for aquaculture prepared by the local authority.

[6] The others are Argyll Islands and Coast, Ardnamurchan, Small Isles and the South Skye Coast, North Skye Coast and Wester Ross, North Uist, Sound of Harris, Harris and South Lewis

Shellfish Water Designations and the Water Framework Directive: the EC *Shellfish Waters Directive* (79/923/EEC, to be repealed in 2013 by the EC *Water Framework Directive*) protects the aquatic habitat of mollusc species of shellfish (oysters, mussels, cockles, scallops and clams), but not crustaceans like crabs, crayfish and lobsters. The *Surface Waters (Shellfish) (Classification) Regulations* 1997 and 1999 applies to all major shellfish production areas. In England, the Notice and Schedule are issued by Defra and place an obligation on the Environment Agency to ensure that designated waters meet the water quality requirements of the Directive and are monitored adequately. A similar obligation exists in Scotland under SEPA. The *EC Shellfish Hygiene Directive* (91/492/EEC) is the principal driver for laying down public health conditions for the production, and the placing on the market of, live molluscs intended for immediate human consumption or further processing prior to consumption. DEFRA is committed to improving water quality to a level where all designated shellfish waters can sustain at least Category B shellfish products. Administered by the Food Standards Agency, the hygiene directive sets microbiological quality standards for shellfish, and shellfish harvesting areas are classified (in categories A-D where A is top quality) based on the compliance of their shellfish products with these quality standards.

The EC has issued a reasoned opinion against the UK as a result of the limited objective of achieving 'B' classification, which is a lower standard than the directive requires be endeavoured to be achieved. As a result of previous infraction proceedings the UK is committed to regular reviews of shellfish waters, and it is likely that further designations within the Solway will be made before the directive is repealed (Peter Scott, pers. comm.). Therefore shellfish waters are likely to be treated as sensitive areas under the Water Framework Directive.

Marine Bill: the forthcoming UK wide Marine Bill will have considerable implications for the management of inshore areas including:

Modernisation of the Sea Fisheries Committees (SFCs), which will be given a more clearly defined purpose and duties, and will be tasked with achieving sustainable development of fisheries within their jurisdiction. They will also work to reduce the impact of fishing on the marine environment, while having regard for the economic development of the fisheries sector. SFCs will continue to be responsible for management up to six nautical miles offshore, but their jurisdiction will be extended inland to assist in the enforcement of landed stocks.

Marine Spatial Planning: a new system of marine spatial planning is proposed to enable a more rational organisation of the use of marine space and the interactions between its uses. This should take account of all sectors and activities and ensure an integrated approach at the land-sea interface. An agreed plan would provide a firm basis for rational and consistent decisions on licence applications (see below), and allow users of the sea to make future decisions with greater knowledge and confidence. The planning process should identify areas of particular suitability or unsuitability for certain types of activities and where possible, could identify preferred areas for or against specific types of activities. At present, there is no decision on the landward boundary of marine spatial planning - however the consultation document does specifically consider the Mean High Water Springs mark. This would enable marine spatial plans to consider all marine activities, including those specifically in the intertidal zone such as some shellfish farming, resulting in a small geographical overlap with the terrestrial planning system.

Licensing marine activities: The proposals aim to result in a licensing system which is more efficient and transparent, resulting in less risk, delay and cost to business. Three alternatives in addition to no change are considered – (1) merging the two principal licensing systems (Part 2 of FEPA and Part 2 of the Coastal Protection Act) which consider cross-cutting environmental and navigational issues; (2) simplifying the licensing processes within each sector; or (3) creating a single, integrated licensing system for all marine activities.

Local Authorities: discussions with some of the main local authorities around the Solway Firth (Dumfries and Galloway Council (DGC) in Scotland and Allerdale Borough Council (ABC) in England) indicated the role of local planning in the development of aquaculture in the Solway. At present DGC undertake consultation on behalf of The Crown Estate – essentially when they are notified of a planning application submitted to the Crown Estate, they take a lead role in marshalling representation and the consultation process (see Section 2.1.2). On completion of this stage, a DGC committee makes a planning recommendation to The Crown Estate, a process that takes around four months (Sue Hudson, DGC, pers. comm.). This process will shortly change (although no date has been set), whereby planning decisions will be directly devolved to the local authorities (Scotland only).

2.3 USERS AND INTERESTS IN THE SOLWAY

An essential part of preparing a Strategy for sectoral development within a multiple-user environment is the engagement of local stakeholders to both (i) determine their views on the scope and nature of the Strategy and (ii) to utilise their experience to ensure that the Strategy is relevant, practical and effective. Ensuring stakeholder participation in the Strategy development process was ensured by the following steps:

1. *Identification of key interests* within the Solway likely to be affected by aquaculture development and *disaggregation of their regional representation* within the English and Scottish sides of the border.
2. *Preparation of a stakeholder information resource forum* that was circulated by mail and via the web-based discussion forum. A web-based discussion forum was set up at http://www.consult-poseidon.com/solway.asp. This was publicised through letters and emails, including articles in *Fish Farmer*, *Aquaculture Today*, *FISHupdate*, *Fishing News* and the six monthly newsletter of the *Shellfish Association of Great Britain*. A press release, providing details of the Strategy's objective and encouraging stakeholders to engage with the process through the web-based discussion forum, was sent to the local press in the Solway area (see Appendix D).
3. *A meeting timetable for the field work period.*

2.3.1 Identification of Key Interests

It was essential that contact was established with the main stakeholders from an early stage. The first step was the identification of these stakeholders, using the SFP's 'Who's Who Directory' as a starting point, and initiating engagement through informing them of the process and nature of the Strategy's development. Liaison with the Client here was essential. It is important that the stakeholders cover the wide range of interests that might be affected by aquaculture development, including:

- Tourism and recreation
- Wildlife Conservation
- Land owners and riparian interests
- Fisheries and shellfish gathering
- Landscape and cultural heritage
- Land use, development and transportation
- Other access issues or interests

The table overleaf provides a preliminary synthesis of the main sectoral interests in the Solway that might be potentially affected by aquaculture development. This has been compiled from the SFP 'Who's Who Directory' (2000) and updated as necessary. This list was finalised during the Inception Meeting on 15 August 2006 and subsequent consultation exercises.

Table 4: Sectoral Interests in the Development of a Solway Aquaculture Strategy

Subject	Organisation	Responsibility
Coastal management	CoastNET	Charitable forum
	North West Coastal Forum	Government appointed forum
	Scottish Coastal Forum	Government appointed forum
	Solway Firth Partnership	Voluntary management organisation
Environmental conservation	British Association for Shooting and Conservation (BASC)	Recreational shooting
	Creetown Wildfowlers Association	Voluntary sport shooting association (Creetown)
	Cumbria Biodiversity Partnership	BAP implementation
	Cumbria Wildlife Trust	Operates two coastal reserves in the Solway
	Dumfries & Galloway Biodiversity Partnership	Coordinates biodiversity initiatives e.g. LBAPs
	National Trust for Scotland	Land owner and voluntary organisation
	Natural England	Statutory consultative body (also landscape)
	Marine Conservation Society	Voluntary organisation for marine conservation
	Royal Society for the Protection of Birds	Voluntary organisation for bird conservation
	Scottish Natural Heritage	Statutory consultative body (also landscape)
	Scottish Solway Wildfowlers' Association	Voluntary sport shooting association (Annan-Kirkcudbright)
	Scottish Solway LNR Advisory Committee	Advises in management of Solway LNRs
	Scottish Wildlife Trust	Voluntary environmental network
	Wigtown Bay Wildfowlers Association	Voluntary sport shooting association (Wigtown Bay)
	Wildfowl and Wetlands Trust	Voluntary organisations supporting wildfowl conservation
	WWF UK and WWF Scotland	Voluntary environmental network
Aquaculture Developers	South Solway Shellfisheries Ltd	Shellfish farmers
	Solway Marine Oysters	Shellfish farmers
	Dee Fisheries	Shellfish farmers
Fisheries and shellfish gathering	Annan Common Good Fund	Supports haafnet, poke net & stakenet fishing
	Annan Fishermen's Association	Voluntary fisheries association for the Solway.
	Cumbria Sea Fisheries Committee	Inshore fisheries management
	District Salmon Boards	Statutory consultative body to managed salmon fisheries
	Eden & District Fisheries Association	Statutory consultative body of Eden and Esk Rivers
	Galloway Static Gear Fishermen's Association	Non-mobile (pots, static nets, etc) fishermen's' organisation
	Marine Fisheries Agency	Coastal fisheries
	Nith Estuary Haafnet Fisheries Ass.	Haafnet association in the Nith Estuary
	Solway Fishermen's Association	Voluntary fisheries association for the Solway.
	Solway Haafnet Association	Protects interests of Solway haafnet fishers
	Solway Shellfish Hand Operators Federation	Promotes sustainable shellfish harvesting
	Solway Shellfish Management Association	Shellfisheries Regulating Order in Dumfries and Galloway
Landscape and cultural heritage	Carlisle Archaeological Ltd	University archaeological unit
	Cumbria Access Forum	Statutory advisory body providing advice on countryside access
	English Heritage	Statutory body
	Royal Commission for Ancient and Historic Monuments for Scotland	Statutory body
	National Trust	Heritage conservation in England
	National Trust for Scotland	Heritage conservation in Scotland (wildlife & landscape)
	Historic Scotland	Statutory body for cultural and heritage conservation.
	Solway Coast AONB	Manages the AONB on the Cumbria coast
	Scottish Natural Heritage	Statutory consultative body for environmental conservation and landscape
	Solway Heritage	Conserve and promote the Heritage of Dumfries & Galloway
	Whithorn Trust	Archaeological and historical information

Subject	Organisation	Responsibility
Land owners	Arbigland Estate	Foreshore owners Carsethorn to Southerness (to the R Nith)
	Crown Estate	Foreshore and seabed leasing
	Standish Settle Estate	Foreshore owners
	Lonsdale Settle Estate	Foreshore owners
	National Farmers' Union	Represents rural landowners.
	Scottish Rural Property and Business Association	Represents the role and interests of those involved with rural property and businesses connected with the land.
	Hoddom and Kinmount Estates	Foreshore owners Riddingdyke - Annan
Local planning	Allerdale Borough Council	Local planning
	Copeland Borough Council	Local planning
	Carlisle City Council	Local planning
	North West Regional Assembly	Promotes economic, environmental and social well-being
	Cumbria County Council	Local Authority
	Dumfries and Galloway Council	Local Authority
	Environment Agency (NW Region)	Statutory regulatory body for fisheries & water quality management.
	Government Office NW	Regional Government
	Scottish Environmental Protection Agency	Statutory regulatory body for water quality management.
	Scottish Executive Environmental and Rural Affairs Department (SEERAD)	Government body advising and promoting sustainable agriculture and fisheries
Navigation and marine safety	Scottish Executive Ports and Harbours Branch	Government department representing marine infrastructure development and management.
	Trinity House	General Lighthouse Authority aiding navigation (England)
	Royal National Lifeboat Institute	Voluntary organisation providing marine safety cover.
	Northern Lighthouse Board	General Lighthouse Authority aiding navigation (Scotland)
	Maritime and Coastguard Agency	Statutory agency for the UK's marine safety
Tourism and recreation	Angling clubs	Recreational sea angling organisations
	Cumbria Tourist Board	Tourism marketing, policy and planning guidance
	Historic Scotland	Safeguards Scotland's historic environment
	Royal Yachting Association	Voluntary organisation promoting responsible boating.
	Visit Scotland	Scottish Tourist Board
	Ramblers' Association	Right of access lobbyists
	West Cumbria Tourism Initiative	Promotes tourism in West Cumbria
Other	North West Seafoods Ltd	Development of seafood business in the NW England
	Maryport Co-op	Sea fisheries co-operative in Maryport, Cumbria
	Scottish Enterprise	Economic development body
	Distinctly Cumbria	Economic development body
	Cumbria Vision	Economic development body

2.3.2 Stakeholder Consultation

The *web-based discussion forum* was the main mechanism for allowing stakeholders to engage in discussions about the benefits and issues associated with aquaculture development in the Solway. As discussed above, this discussion forum has been publicised in both trade as well as local press.

A number of key stakeholders were also contacted during the week long field visit to the Solway over 4-8 September 2006. Where possible, meetings were held on a one-to-one (see Appendix B for persons met) or otherwise were conducted by 'phone or email.

In addition, two public meetings were held, one in Castle Douglas on 5th September and the other in Skinburness on 6th September 2006. Despite being well publicised in advance (newspaper, local radio and trade press), these were poorly attended.

The draft Aquaculture Strategy was submitted for public consultation in late March 2007, where it was published on the Solway Fish website for public download for approximately eight weeks. Once this review period has been completed, the Strategy was be finalised and will be launched in October 2007.

2.4 OWNERSHIP OF THE FORESHORE IN THE SOLWAY

2.4.1 The Crown Estate

The Crown Estate owns virtually the entire seabed out to the 12 nautical mile territorial limit, including the rights to explore and utilise the natural resources of the UK continental shelf (excluding oil, gas and coal). The Crown Estate also owns around 55% of the foreshore, the area between the mean high and low water (spring tides in Scotland) and approximately half of the beds of estuaries and tidal rivers in the United Kingdom but not the water column, nor do they govern public rights such as navigation and fishery over tidal waters.

As with any landowner, The Crown Estate issues leases and licences for activities on their land but they are not a regulator. The Crown Estate has a statutory duty to obtain a return for the use of land within their ownership and so rental is due for areas of seabed used for commercial purposes including aquaculture. For salmon farming, the rental is calculated using a formula based on production, whilst shellfish rents are formula-based linked to the amount of equipment on site. The majority of farms pay a relatively small amount which reflects the nature of the industry, largely comprised of small-scale farms.

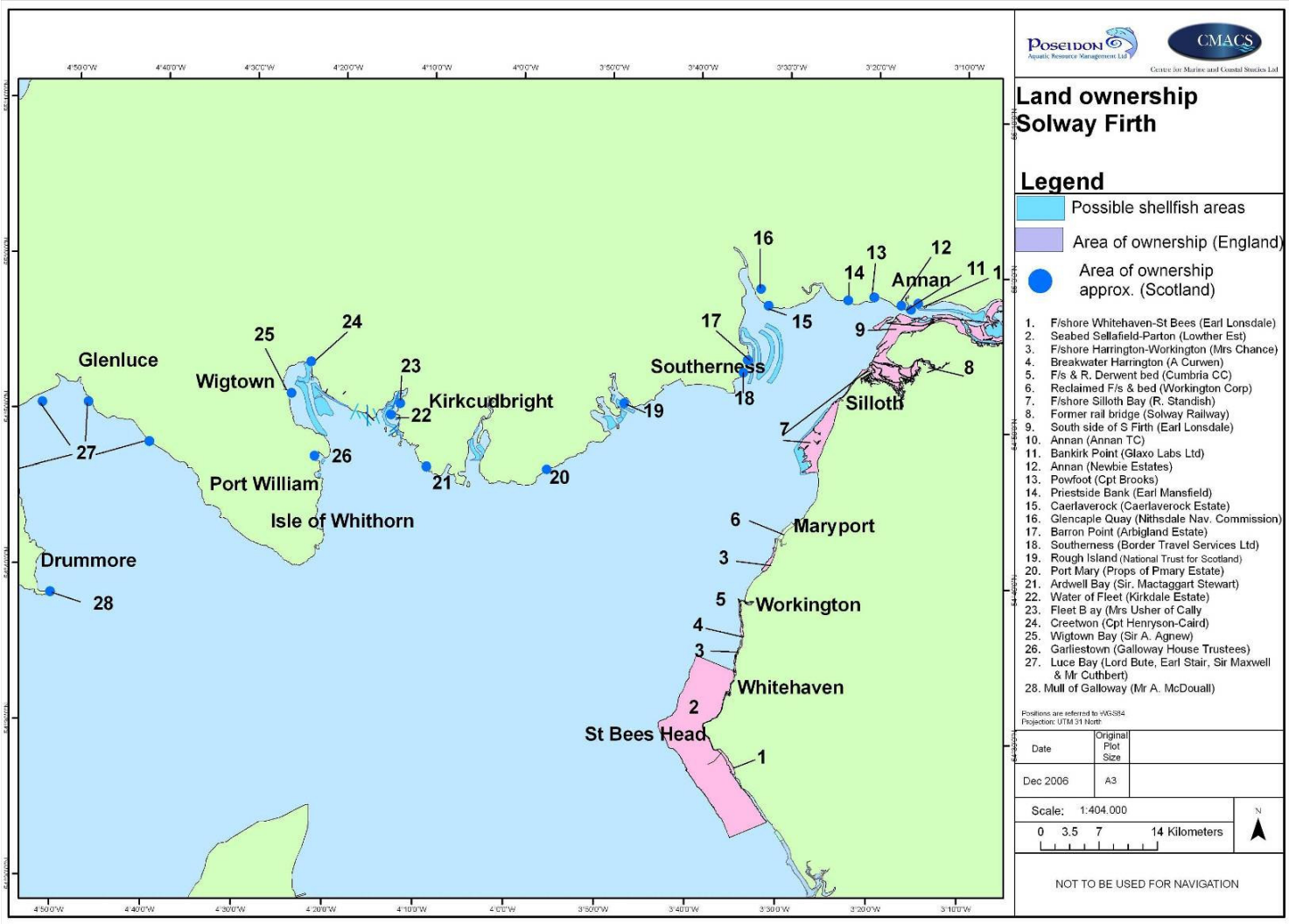
In Scotland, naturally occurring oysters and mussels are the property of the Crown. In some cases these rights have been transferred to other parties but it is important to note that they are not a public fishery and consent is required for their collection (Paul Bancks, pers. comm.).

Generally, The Crown Estate does not sell the freehold of the foreshore, except in a few exceptional circumstances. Instead, The Crown Estate grants leases or licences, of which there are over 2,000 all around the coast. The largest leaseholders are local authorities, ports and harbours and conservation bodies such as Natural England, the National Trust and the Royal Society for the Protection of Birds. Leases for control of conservation or amenity, which do not permit development of land, are granted normally to conservation bodies or local authorities. Through such Regulating Leases, these bodies may control day to day activity and use of undeveloped tidal land. Some 570 kilometres (21%) foreshore is leased specifically for conservation purposes and it is intended to extend this in consultation with Natural England. A great deal more of the coastline is under protective ownership by way of leases to local authorities.

2.4.2 Private Ownership

A considerable proportion of the Solway is under private ownership (see Map 3 overleaf). This includes much of the bay areas that might be attractive to aquaculture, such as Wigtown Bay, parts of Kirkcudbright Bay, the (Rough Isles), Carse Sands, Moricambe Bay and Silloth Bay. Many of the land owners have expressed interest in aquaculture development in order to both diversify their estate incomes as well as to provide a basis for several rights for shellfish harvesting.

Map 3: Private Ownership of the Foreshore in the Solway



3 REVIEW OF AQUACULTURE SYSTEMS SUITABLE FOR THE SOLWAY

3.1 CONTEXT

The northern and western Scottish coasts are the location of a considerable aquaculture industry; it is the largest in volume and value terms of any in Europe apart from Norway. This has created significant impacts; creation of jobs and incomes in peripheral areas, potentially some negative impacts in terms of waste production, visual impacts on seascapes and genetic and disease impacts to wild fish stocks. Much of this production relies on sheltered or semi-sheltered deep water areas suitable for siting fish cages and floating longlines for shellfish cultivation.

The Solway coast and estuary systems are generally shallow and less saline compared to aquaculture areas on the west coast. In addition, the tidal range of up to 7.5 m and current speeds of 3-5 m per second (see Map 4 overleaf), when combined with the shallow and estuarine nature of the Solway means that it is unlikely to see a similar expansion in production, particularly of caged fish. However there are various techniques for growing shellfish in environments such as the Solway and those considered to have potential are discussed below.

It must be emphasised that commercial shellfish production is dependent upon a range of environmental, regulatory and economic variables, many of which can change unpredictably and are generally outside the control of the farmer. It is inherently a high risk activity and many producers in the UK have experienced many years of variable incomes. These notes describe production techniques that have been generally successful in situations around the UK coast and for which some of the variables are either better known or controllable. However, any entrepreneur considering entering production in the Solway, an almost unproven area, should be aware of the risks and develop projects cautiously, preferably on a trial basis to assess potential and identify problems as inexpensively as possible.

3.2 MUSSEL CULTIVATION

Species: *Mytilus edulis* (common or blue mussel). This is the only commercially exploited mussel in the UK.

Life cycle: Mussels are sessile bivalve shellfish that can occur in great densities between mid-tide level and several tens of metres below low water. They cling to the substrate using byssus, a system of threads which have a small adhesive pad at the end of each one. Mussels are non-selective filter feeders and collect feed particles (plant plankton and small zooplankton) on their gills. Unwanted particles such as silt or other organic detritus are expelled as lumps known as pseudofaeces.

Much of the soft tissue is composed of gonad and mussels spawn in spring/summer, triggered by temperature rise. Eggs and sperm mix in the plankton and fertilised eggs develop into larvae, which then drift around in the plankton for a number of weeks. Larvae settle onto any surface where they can gain sufficient grip and metamorphose into the adult body shape, known as spat. Losses in the plankton are probably high, through predation and settling out on unsuitable substrates. The period after settlement is also critical as when the spat mussels are young they have limited adherence. Thus, depending upon density of settlement, weather and wave conditions at the site in the weeks and months afterwards, mussel settlement can be very variable in time and space.

Map 4: Tidal Characteristics of the Solway

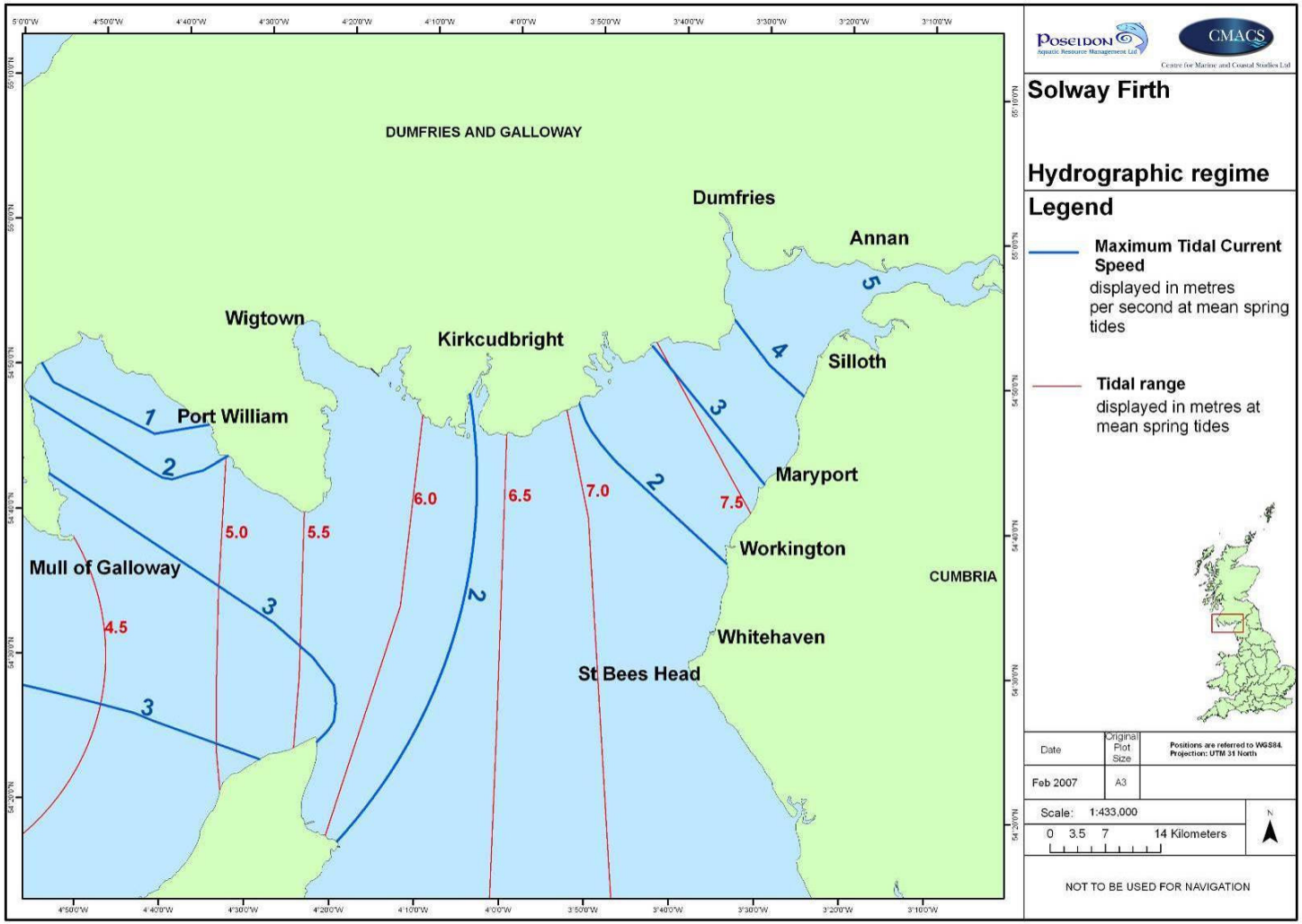


Table 5: Potential Shellfish Production Techniques for Use in the Solway

Species grown	Culture Type	Yield, growth period to final weight	Siting requirements	Support requirements	Pros and cons of system
Mussel	On bottom	30-50 tonnes /ha/year, more in "hot spots" 2 years (45-50 mm)	Substrate type: Stable mudbanks /sandy mud Exposure: Low intertidal Current speed: 1-2 knots Salinity range: 20-35‰ Temp range: 0-27°	Depending on size of operation: Large scale: Specialist dredging vessels, landing quay, handling gear, depuration plant (depending on market). Small scale: Tractor trailer/small boat, landing facilities, depuration plant (depending on market).	✓ Large scale: highly profitable in good years ✓ Good markets in Holland and France, moderate in UK ✓ Small scale-less seed requirement ✓ Low capital input × Large scale: capital intensive × Success closely linked to variable seed supply × Small scale: low profitability × Seed supply
	Bouchot	~30 tonnes/km poles, relatively untried in UK	Substrate type: Firm deep sand Exposure: Low intertidal Current speed: 1-2 knots Salinity range: 20-35‰ Temp range: 0-27°	Vessel or tractor/trailer, Water jetting/ piling gear, landing facilities, depuration plant (depending on market).	✓ Good quality mussels ✓ Relatively exposed locations ✓ Limited environment impact × Relatively untried in UK × May be visually intrusive
Oysters	Trestles	3-4 years to 80g, 15 tonnes/hectare/year, depending upon size of seed used.	Substrate type: Firm sand or mud Exposure: Low intertidal Current speed: 1-2 knots Salinity range: 25-35‰ Temp range: 5-30°	Vessel or tractor/trailer, grading and landing facilities (depend on scale)	✓ Hatchery seed supply × Poor environmental performance from high degree of shading × Labour intensive × Limited markets
	Hanging baskets	Growth rates: as above, yields: too new to UK to provide generic guidance	Substrate type: Firm sand or mud Exposure: Low intertidal Current speed: 1-2 knots Salinity range: 25-35‰ Temp range: 5-30°	Vessel or tractor/trailer, grading and landing facilities, pulling gear	✓ Less labour input ✓ Ability to vary exposure / height for conditioning ✓ Low environmental impact × Limited markets
Clams	In-bottom under mesh	20-40 tonnes/hectare/year	Substrate type: Sandy mud Exposure: Low intertidal Current speed: 1-2 knots Salinity range: 25-35‰ Temp range: 5-26°	Vessel or tractor/trailer, grading and landing facilities, mesh laying gear	✓ Hatchery seed supply × Specialist markets × Yields variable

* As discussed in the text, siting is often a compromise between the various elements desirable for commercial rearing of shellfish. Requirements generic to all sites are avoidance of excessive wave action, turbidity, industrial and agricultural pollutants. Avoidance of sewage related pollution is desirable but may be impossible in many coastal areas, but harvesting areas should be grade B or better, requiring depuration but not relaying prior to sale, (grade A areas require no treatment prior to sale).

In some locations which offer favourable conditions, the settlement of young mussels can be somewhat predictable and very dense. They often settle on other adults, or shells of dead ones, combining with pseudofaeces to form mussel banks or "scalps" which can build up to a metre or more above the level of the surrounding substrate. Mussels grow to a commercial size of around 45 mm shell length in 1-3 years, depending upon level of exposure, food availability and temperature. On some of the higher inter-tidal locations, mussels become thick-shelled and stunted and never reach a harvestable size.

Production in aquaculture: Two main approaches are used to grow mussels in aquaculture – suspended and on-bottom culture. Both rely to a large extent on natural processes. Mussels are too low value to warrant hatchery production, though some attempts at this have been made in Canada. In both systems mussels are harvested at times of year when their gonad are full: this improves eating quality considerably, thus generally harvesting is avoided during the summer.

In suspended culture, ropes are hung vertically in the water at a time when there are known to be densities of pre-settlement larvae in the water column. Mussels settle on the ropes, adhere in clumps and grow onwards for 2-3 years. Some "thinning" may take place part way through the cycle, often when new spat have settled onto part grown stock and caused overcrowding and too much competition for food. Mussels are stripped off at harvest using specialised machinery mounted on harvesting vessels and graded before being sold. Ropes can be suspended from rafts (common in Spain), fixed to poles (common in France) or from tensioned long-lines (common in Scotland).

On-bottom culture involves simple but labour or capital-intensive interventions in the life cycle. Naturally occurring beds of young mussels are simply gathered a few months after settlement from areas where their growth is sub-optimal or there is risk of them being lost to excessive wave and/or tide movement and/or predation. They are transferred to growing areas, selected as being of less risk to the mussels, where they grow for 2-3 years prior to harvesting. Harvesting is then either by hand or through the use of dredges towed by specialist harvesting vessels. Again the stock is graded prior to sale and small mussels can be returned to the beds.

Siting needs: As the areas around the Solway coast are both shallow and quite exposed, rope or raft technology, which requires depth and shelter, will not be considered. Therefore, the most appropriate form of mussel culture will be using on-bottom growing sites. These will have to be selected to have acceptable combinations of:

- shelter from wave action
- stable substrate
- risk of predation
- submersion time
- exchange of productive, plankton-rich water

Generally, large flat mud-banks around mean low-water level and around 1-2 knot tidal current are considered the most desirable. Selecting drying beds means there is some sacrifice of growth but less impact from starfish, one of the principle predators of mussels, which can aggregate in great numbers on commercial beds.

Successful bottom-growing of mussel depends on a wide interplay of a number of natural, economic and regulatory factors which are site and business specific.

Mussel cultivation in England and Wales is generally carried out through Several Orders. These sever the rights to public fishery, allowing the management and protection of stocks owned by individuals, companies or groups of fishermen. The management of a several order ground is a matter for the holders, within regulatory limits. Some producers rely on natural spat-fall and undertake relatively little intervention, some seed the areas heavily, while others both seed and remove predators to the extent possible.

Capital available and aspirations of the producers, will determine whether there is a need for large areas of seabed for growing and correspondingly large quantities of seed.

Large-scale mussel production is capital intensive and success depends upon sites with the basic minimum characteristics described above that can be accessed by large vessels for seeding and harvest. There also needs to be a significant shore-based infrastructure for handling the crop, with berthing, lifting gear, grading gear, large vehicle access etc. Depuration may or may not be carried out at the shore base, depending on water quality conditions and market demands, if so, significant plant is needed with ability to draw and discharge large quantities of sea-water. Activities on the ground are thus often a compromise between localised factors, for example a larger Several Order area may offset a longer distance from the shore-base, as might a site with better growth characteristics. Superimposed on these practical considerations is the extent to which operations might interfere with other uses of the marine environment, not least conservation and the need to constrain scale of farm operations to acceptable levels of impact. Indeed, the thrust of developing this Strategy is to find an acceptable combination of economic freedom and environmental protection.

The most significant variable factor in bottom mussel production is the supply of seed. Spatfall can vary from year to year in intensity and location and considerable resources can be dedicated to locating seed (sonar surveys, dredge surveys, inter-tidal surveys). Banks of seed can disappear in a short time-frame. One key factor to success is the use of fast, efficient dredgers which can catch seed before this happens. The northern end of Menai Straits is the largest single example of bottom mussel growing in the UK. Production there has varied between 2,000 and 9,000 tonnes in recent years, the variation largely being attributable to seed availability. Similarly, in the Wash, the other main production area which also encompasses a wild fishery element, harvests have fluctuated between almost zero and 5,000 tonnes over the last decade. For planning, a seed : harvest weight ratio of 1:1 is a safe average. From time to time this has been exceeded, equally there have been near total failures of seeding on some occasions and locations.

The conservation value of seed is a complex and highly debated point. Conservation of intertidal seed, particularly for bird use, is seen as critical in some areas. The picture is less clear in sub-tidal areas as the main predators are green crab or starfish, both very common. However it should be noted that seed mussel beds that form biogenic reefs qualify as an Annex II habitat.

Yields from on-bottom cultivation are obviously very variable for the reasons cited. A good crop (plentiful seed, good growth conditions) in the Menai Straits provides a yield of some 35 tonnes per hectare overall in the usable parts of the several orders. Within these, "hot-spots" have been known to yield as much as 300 tonnes per hectare where seed has been laid very thickly. Experience suggests that seed placed at higher densities does better than that spread thinly: losses to predators outweigh any loss of productivity through over-crowding.

Farming on-bottom can be at two possible levels. Basic hand-working of seed can be carried out with hand tools and tractor and trailer (or small vessels) to move seed from various inter-tidal locations to areas of greater stability and growing conditions. About 50 tonnes/person per year is feasible. Above this level more and more equipment is needed, in particular, purpose built dredgers which can collect, relay and harvest large quantities of mussels. These have to be licensed for open water activity if seed is to be gathered anywhere but the immediate vicinity of the culture area.

Pole grown: Mussels grown on poles, or *bouchots*, are highly valued in the French market. Mussels settle on ropes hung out horizontally in the water for a short period when spat are settling. Once seeded, these are then strung in a spiral fashion around a vertical pole. Because they are grown off-bottom they grow extremely fast and have thin shells and a high meat yield. These are features common to rope-grown suspended mussels, but unlike these, *bouchot* mussels are 'trained' by tidal exposure to close tightly when out of water. They therefore have a much longer shelf-life than rope-grown mussels.

The conditions where it is practical to grow mussels in this way exist in very few places. The prime requirements are a large tidal range, so that long poles can be used, which preferably do not expose on neap tides. The bottom must be sandy for a thickness of several feet, so that the poles can be inserted with a water jet and be held in place firmly enough not to be washed out by storms or strong tidal streams. The poles must not be a hazard to navigation.

One great advantage of bouchot farming of mussels is that it makes use of seed which can be collected on ropes very easily. If used, the poles would need to be about 2 m clear height above the sand. In France, poles of 3-5 m length are used, set in the sand to about half of their length. The poles are set in double rows, with a spacing of about 0.5 m between poles and about 0.75 m between the two rows. Thus a double row of poles, 100 m long would be made up of 400 poles.

In France, reported yields vary between 25 kg and 100 kg per pole. In a trial carried out by SEAFISH in South Wales in 1987-89, an average yield of about 10 kg per metre of exposed pole was achieved.

One significant benefit of *bouchot* cultivation is that it makes use of seed settled on rope collectors. Even in areas which suffer years of low spatfall on the ground, seed is usually seen to set on suitable floating surfaces, such as mooring lines. It is probable that seed would be caught in all years, making the operation much less at risk of failure from seed shortage.

In France, the minimum spacing of *bouchots* allowed by law is 25m between adjacent lines (though a bouchot can be a double line). France produces about 50,000 tonnes of mussels on 1,538 km of bouchots, or 32.5 tonnes per km.

Bag culture: One of the applications to establish a shellfish farm in the Scottish side of the Solway involved rearing mussels in BST longline systems (as described for oysters, please see below). This type of cultivation is new to the UK and as such no guidance can be provided as to its likely success.

3.3 OYSTER CULTURE

Species: The majority of true farming of oysters in the UK is of the non-native Pacific oyster, *Crassostrea gigas*. There is some limited cultivation of the slower growing native oyster, *Ostrea edulis*. In some situations this involves little more than interventions to encourage growth and survival of the very depleted wild stocks, through laying cultch to increase settlement (for example several orders in the Solent) or the relaying of part grown oysters, (for example in the Helford estuary, Cornwall). However it can also be grown on conventional trestle systems, described below, in the same way as *C. gigas*, though with a longer grow-out time of 4 years or so. Native oysters are also susceptible to infections of *Bonamia,* a notifiable and serious parasite. *C. gigas* is the basis of a very large (*c.* 100,000 tonnes) cultivation industry in France, also massive cultivation in China and other Asian countries.

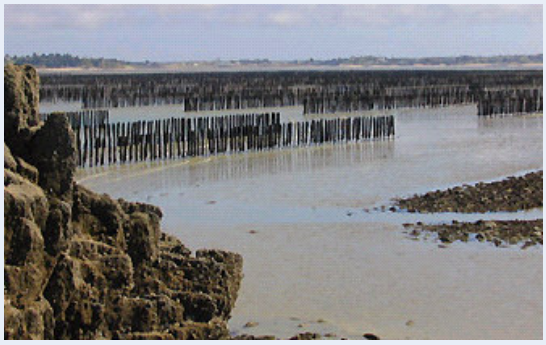
Figure 4: Illustrations of Different Forms of Aquaculture

Bottom culture of oysters on the inter-tidal zone

Trestle culture of oysters in the inter-tidal zone

BST Long-line culture of oysters

Bouchet (pole) culture of oysters



Life cycle: The life cycle of oysters is broadly similar to that described for mussels. However *C. gigas* do not normally spawn in UK waters as it is too cold (spawning is becoming more frequent in farmed populations in southern UK). Growth from seed to market weight of about 80g is around three years, again depending upon conditions and, like mussels, differential growth between individuals can be significant. In the wild, oysters tend to settle on something hard (shells, rocks, stones), to which the shell adheres. They can become clumped through their shells adhering to each other if densities are high.

Production in aquaculture: Because there is minimal spawning in the UK, *C. gigas* have to be grown under artificial conditions in a hatchery. This is a complex and capital intensive process and there is only one large scale commercial producer of oysters in the UK. The hatchery process uses techniques to induce spawning and provides conditions suitable for hatching followed growth of larvae in high densities, (correct water quality and cultured micro-algae). Hatcheries provide artificial settlement media and the animals are allowed to adhere to this and are raised for a few weeks until they are hard enough to be handled and can be transferred to upwelling systems. Hatchery production is then extended to the nursery phase, using shore-based tanks or ponds and this can be quite long, growing juveniles to a size dictated by the on-grower customer. Size for transfer to an inter-tidal farming system is a strategic choice for the farmer, depending on his site conditions. Obviously the larger and more expensive the seed, the shorter the grow out time to market size and the greater the survival rate.

The on-growing process is centred around providing the best conditions possible in terms of exposure to food-laden water and exclusion of predators, principally crabs. This is achieved through holding the oysters in a mesh bag clear of the substrate in the low inter-tidal.

Siting needs: the main method of ongrowing oysters in France and the UK is the use of *poches*, flat bags made of plastic mesh which are strapped onto trestles in the low inter-tidal. The process is quite simple with trestles often made of steel reinforcing rod to hold the oyster *poches* about 0.5m clear of the substrate. The trestles are individually about 6m long (the length of a single rod) and are arranged in long rows with orientation to allow tidal flow across rather than along rows. Rows are often set out in pairs with sufficient gap between pairs for a vehicle or flat-bottomed vessel to pass, allowing servicing.

Sites thus need to be quite flat and firm and provide a maximum of about 4 hours aerial exposure per cycle. This allows both access for servicing and a degree of shell-hardening for the stock. Soft substrates may be acceptable if access is predominantly by boat. However, silty areas are best avoided as silt can quickly build up around and under trestles making them un-workable. Water flows need to be 1-2 knots and salinity around 25% or more.

The juveniles can be introduced as small as 4 mm shell length. The bags have to have fine meshes to start with and as the stock grow then they can be sorted and divided into more, larger mesh bags, progressively until about 15 kg of market size stock can be held in a bag with up to 25 mm mesh.

One of the main inputs is labour, to turn the bags each fortnight in summer (monthly in winter). This de-clumps the oysters and kills off algae that can grow on the upper surface, suffocating the stock. Grading the oysters by size is also a significant undertaking.

In a typical farm in the UK, about two-thirds of the trestle space is taken up with near-market sized stock. Yields of around 15 tonnes per hectare per year can be expected but are again very site specific and trials should be undertaken at any site before full commercial production commences.

The trestle and *poche* system is well tried and tested in the UK and has been used mainly because it is cheap. An alternative technique, using an Australian-developed 'BST' long-line system for mussels and oysters (also known as the Boddington system after the UK importers), is now being trialled on a small scale at two locations on the English Solway coast. This consists of a more rigid bag of triangular or oval cross section. These are suspended from highly tensioned lines strung between a row of poles. The height of the lines can be adjusted to alter exposure time, allowing the control of shell growth and condition. The advantage of this system is that the bags are hung by one edge and allowed to "swing" with wave action thus allowing culture in dynamic, high sediment conditions. This moves the oysters and prevents clumping and possibly reduces weed growth, so reducing the labour input needed considerably. Against this the system is more expensive and the poles more visible. Whatever the system, a farm will need a shore-base with facilities to maintain equipment, possibly grade stock mechanically, handle seed intakes and crop harvests, also possibly packing and depuration, depending on the market outlet used. This should ideally be close to the growing area, though perhaps 1-2 miles distant is acceptable for both vessel and tractor/trailer access.

3.4 CLAM CULTIVATION

Clams are a relatively minor species for cultivation in the UK with only a few tonnes being produced, mostly in the shallow waters of Poole Harbour on the south coast. However, they may be suitable to certain areas in the Solway and could form part of a multi-species approach, so are discussed briefly here.

Species and life cycle: The species of clam most likely to be able to survive the spates of low salinity in the estuaries of the Solway would be the Manila clam *Tapes semidecussatus*. This grows faster than the native palourde and is less sensitive to the nature of the substrate. Seed is available from the hatcheries, with larger sizes ex-nursery. It normally takes around three years for clams to reach market size of about 40 mm.

Production and siting needs: Production is normally carried out under protective nets, to exclude crabs, but small scale operations use oyster *poches* simply laid on the ground. Steel pegs may be used to stop the bags moving, or a small quantity of gravel put in each bag with the clam seed, to weight them. The bags sink partly into the bed and accrete silt and the resulting substrate within the bag can be very favourable to clam growth. Once established in suitable growing conditions, stocks need very little attention, and so labour input, until harvest.

Site selection is the most important factor for successful clam farming, with a firm mud/sand mixture being the preferred substrate. The site must not be close to mobile banks, which can slump and smother the nets or bags. When nets are used, damage by boat propellers can be a serious problem, as any opening which can allow crabs to enter will lead to high mortalities.

As with oysters, clam seed can be purchased at a variety of sizes, typically from 4 to 30mm shell width. Little work is needed during grow-out apart from changing the net covering when it is fouled and increasing the mesh size. Yields of about 20-40 tonnes per hectare could be expected.

3.5 COCKLE RE-LAYING

This process involves minor inputs and is essentially management of wild stocks when they are abundant.

There is a traditional cockle fishery in the Solway and all stakeholders will be familiar with the biology of the animal and the background to the fishery, which are adequately described in Solway Firth Regulating Order Management Plan. The fishery has been re-opened in recent years under strict exploitation conditions. However it is not impossible that occasionally heavy spatfalls will be encountered and their commercial use can be better secured through re-laying.

Re-seeding of cockles from beds with heavy spatfall has been successfully carried out in Poole Harbour. The re-laid seed are maintained at a lower stock density and they grow fast under these conditions. They are then used to supply the live in-shell trade, mainly in France, but with some home sales.

4 ENVIRONMENTAL IMPACT OF SHELLFISH AQUACULTURE

A recent study for the EC (Huntington *et al*, 2006) evaluated the impact of different forms of aquaculture on sensitive coastal environments. The following section summarises the findings for the two main shellfish culture systems envisaged for the Solway. It should be noted that these matrices are generic assessments and may not reflect the specific conditions and sensitivities of individual sites that would need to be investigated on a case by case basis.

4.1 INTER-TIDAL SHELLFISH CULTURE

Inter-tidal shellfish culture is practised extensively in west Europe and is one of the older forms of aquaculture in the EU. It takes place within the inter-tidal area, it benefits from accessible land-based support, as well as the dynamic environment of the land/water interface.

Table 6: Habitat Risk Matrix - Inter-tidal Shellfish Culture

Pressure Category		System-related Pressure Level	Habitats, Communities and Species Sensitivity													
			Reefs: mussel beds	Reefs: polychaete	Sea grass beds	Sand/mudflats	Maerl beds	Kelps & seaweeds	Saltmarshes	Sand dunes	Shingle	Cetaceans	Pinnepeds	Otters	Fish	Birds
1. Sedimentation	*Smothering*	Low														
	Turbidity	Low														
2. Change in bio-geochemistry	*Dissolved O_2*	Negligible														
	Nutrients	Negligible														
3. Change in coastal processes		Negligible														
4. Infrastructure impacts		Low														
5. Visual land & seascape modification*		Medium														
6. Disturbance		Medium														
7. Predator control		Medium														
8. Chemical use		Negligible														
9. Pathogen transmission		Low		?					?		?					
10. Inter-breeding with wild organisms		Negligible														
11. Introduction of alien species		Medium														
12. Indirect pressures on the ecosystem		Negligible														

Sensitivity Key

High **Moderate** **Low** **Negligible** **? Uncertain**

***** *Note that the visual land and seascape modification could be locally high and may need to be broken down into impact on landscape character, impact on visual amenity (views and people), and impact on the integrity of areas designated for their landscape value..*

System-related Pressures: inter-tidal shellfish systems are generally fairly extensive, although they can be concentrated in extensive, shallow shelving estuaries. As such, the physical and bio-geochemical pressures exerted by these systems are fairly low, but their presence in important bird feeding and fish nursery areas, and need for active management, means that they may impact on the integrity of sensitive coastal sites. There is also the risk of introducing alien organisms, either directly through culturing exotic species or indirectly through the accidental, such as the introduction of the slipper limpet (*Crepidula fornicata*) in association with imported American oysters (*Crassostrea virginica).*

Ecosystem Risk: the smothering of nearby inter-tidal and sub-littoral habitats with faecal and pseudofaecal material, as well as other detritus generated by the culture process, is the main concern, with reef, sea grass, sand flats and maerl bed areas all at risk. The introduction of alien species such as *Crepidula* is known to impact maerl beds, whilst the introduction of exotic kelps such as *Undaria pinnatifida* or *Macrocystis pyrifera* may result in competition with endemic seaweed or kelp communities.

The extensive use of trestles or racks may impact upon the hydrology and sediment transport processes of inter-tidal areas, with resultant impacts upon both inter-tidal and sub-littoral habitats. They may also have an unsightly appearance, although this depends upon the density and types of equipment used as well as their past historical use and their acceptability by human residents and visitors. Similarly, the relatively high level of maintenance required by inter-tidal facilities may lead to high levels of disturbance, especially in important bird foraging and over-wintering areas.

Scale Issues: *Zone A*[7] may be extensive in these cases, depending on the lateral extent of cultivation and the area between high and low tide levels. The subtidal extent of Zone A needs investigation, especially in highly energetic waters in which faeces and pseudofaeces may be spread over some distance. *Zone B* and *Zone C* effects will be the same as those for suspended cultivation of shellfish.

4.2 BOTTOM SHELLFISH CULTURE

An extensive form of shellfish culture is where juvenile animals are placed or 'relayed' on a suitable substrate for on-growing. The substrate selected will depend upon the shellfish species being used – mussels and oysters prefer a hard or firm substrate whilst infaunal species such as clams or scallops prefer a softer substrate into which they can burrow. Despite the low level of impact of bottom culture, this form of aquaculture is often practised in shallow coastal or estuarine areas where there are often conservation areas for their sand / mud flat or seagrass communities, and thus there may be conflicts over use and management of the area.

A habitat risk matrix for bottom shellfish culture is provided overleaf.

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[7] **Zone A**: dissolved substances and free buoyant particles remain in this zone for only a few hours, and most sinking particles (including food, faeces and dead fish) reach the seabed here

Zone B: dissolved nutrients (and other dissolved substances produced by farms) spread through and remain in this zone for a few days, giving rise to long-term increases in mean concentration, and the residence time allows phytoplankton biomass to increase significantly if light is adequate.

Zone C: the regional scale, with water residence times of weeks to months, often spatially heterogeneous (e.g. with mixed, frontal and stratified waters), and only impacted by the aggregate output of large sources of pollutants; also important because it provides the 'farfield' conditions against which zone B changes should be considered.

Table 7: Habitat Risk Matrix - Bottom Shellfish Culture

Pressure Category		System-related Pressure Level	Habitats, Communities and Species Sensitivity												
			Reefs: mussel beds	Reefs: polychaete	Sea grass beds	Sand/mudflats	Maerl beds	Kelps & seaweeds	Saltmarshes	Sand dunes	Shingle	Cetaceans	Pinnepeds	Otters	Fish	Birds
1. Sedimentation	*Smothering*	Low														
	Turbidity	Low														
2. Change in bio-geochemistry	*Dissolved O_2*	Negligible														
	Nutrients	Negligible														
3. Change in coastal processes		Negligible														
4. Infrastructure impacts		Low														
5. Visual land & seascape modification*		Medium														
6. Disturbance		Low														
7. Predator control		Low														
8. Chemical use		Negligible														
9. Pathogen transmission		Low		?					?		?					
10. Inter-breeding with wild organisms		Negligible														
11. Introduction of alien species		Medium														
12. Indirect pressures on the ecosystem		Negligible														

Sensitivity Key

High **Moderate** **Low** **Negligible** **? Uncertain**

***** *Note that the visual land and seascape modification could be locally high and may need to be broken down into impact on landscape character, impact on visual amenity (views and people), and impact on the integrity of areas designated for their landscape value..*

System-related Pressures: this form of aquaculture is essentially an extensive, low impact approach. The main pressures emanating from bottom culture is a degree of sedimentation from both animal excretion, as well as the dredging process used for harvesting and a degree of physical disturbance. The only medium category of pressure exerted by bottom culture is the introduction of alien species, as fast growing non-endemic species (such as *Crassostrea gigas*) are often used rather than local shellfish.

Ecosystem Risk: sublittoral benthic habitats such as mussel and polychaete reefs, sea grass beds, sand/mud flats/banks, maerl banks and seaweed/kelp beds may be impacted by smothering from sediments generated from excretory products or following harvesting, especially if hydraulic or physical dredges are used. If smothering occurs periodically then the level of recoverability is usually reasonable, especially if beds are scoured by currents. The impact from increased turbidity is usually low, and may even be beneficial for wild mussel beds if a small degree of water column enrichment occurs. However continuous turbidity, which is unlikely from such culture techniques, may impair seagrass and seaweed growth. There is also the chance of pathogen transmission from cultured to wild mussel populations, and significant infestations may result in loss of a portion of the wild mussel population. However, tolerance levels and recoverability are reasonable, and high pathogen loads from bottom culture are unlikely.

The introduction of alien species can be a particular issue with these extensive systems which, as stated earlier, often overlap with SAC designations for their sand or mudflat communities and other features. Therefore, the use of alien species such as *C. gigas* can be a sensitive issue in these areas, even if the species is already established in the area. In addition, the non-intentional introduction of alien species such as *Crepidula* is known to impact maerl beds.

Scale Issues: *Zone A* may be extensive in these cases, depending on the lateral extent of cultivation and the area between high and low tide levels. The subtidal extent of zone A needs investigation, especially in highly energetic waters in which faeces and pseudofaeces may be spread over some distance. *Zone B* and *zone C* effects will be the same as those for suspended cultivation of shellfish.

It is important to note that the scale of development is crucial to determining the final impact of any aquaculture development project and this is not taken into account with the environmental matrix tables used above. This again demonstrates the need to assess the possible impact of individual farms, based on their own scale and nature of development and their particular siting conditions.

5 STRATEGIC FRAMEWORK

5.1 VISION OF AQUACULTURE DEVELOPMENT IN THE SOLWAY

The overarching vision for aquaculture in the Solway is as follows:

Aquaculture working in harmony with the Solway's natural character and heritage that provides sustainable social and economic benefits to local communities

The **Solway Aquaculture Strategy** seeks to guide the management and development of aquaculture over the coming two decades. The vision statement communicates a simple structure to the Strategy and incorporates the key guiding principles involved. *However, it will not replace the detailed investigations required into siting individual developments. and the required planning consent.*

5.2 GUIDING PRINCIPLES FOR SUSTAINABLE AQUACULTURE DEVELOPMENT IN THE SOLWAY

In order to achieve this vision, a number of guiding principles have been developed that provide a framework for aquaculture development in the Solway.

General

- The Strategy is a long-term framework that is adaptive to changing circumstances and external circumstances through review at appropriate intervals.
- The Strategy should strengthen cross-border political, economic and cultural relationships.

Sustainability

- Any aquaculture development should be sustainable in environmental, landscape, social and economic terms.
- Aquaculture development must be within the local and cumulative carrying capacity of the Solway and its ecological components.
- The pattern of aquaculture development is planned according to the particular sensitivities of the different parts of the Solway.
- The scale of aquaculture production should safeguard and enhance the natural heritage and cultural dimension of the Solway.
- Aquaculture development will, where possible, enhance the character of the Solway through the use of sustainable culture techniques that are appropriate to the distinct nature of the Solway's habitats and communities.
- Aquaculture developments should respect the character and diversity of their landscape setting and help sustain the quality of the Solway's coastal landscapes.
- The industry should be proactive in promoting sustainable use through adopting best environmental practices and active monitoring programmes.

Aquaculture as a one of many users of the Solway

- Aquaculture development operates within existing and future regional guidance and planning, including integrated coastal zoning and multiple-use management.
- Aquaculture development should work closely with wild fisheries harvesting and where possible, encourage joint local and regional processing and marketing opportunities.
- Aquaculture development should be responsive to the needs of other Firth Users – it should also ensure its own concerns are heard.

- The benefits and opportunities of sustainable aquaculture in the Solway should be advocated in a balanced and transparent manner.

Benefits from Strategic Aquaculture Development

- A Strategy will provide a first-level of guidance for development of a sustainable aquaculture industry. Further scrutiny at individual aquaculture site level is still required.
- Primary job creation will be aimed at the Solway's communities with the additional creation of downstream employment within the wider region.
- The development of high quality aquaculture products from the Solway will contribute to the overall food and drink branding from the region
- The development of a sustainable shellfish farming industry will increase public awareness of the quality of the Solway's waters.

5.3 STRATEGIC ELEMENTS

Five elements to this Strategy have been prepared:

Strategy Element 1: Siting Issues and Guidelines. This element examines the main issues that might affect the siting of aquaculture in the Solway, covering nature conservation issues and designations, landscape issues, other competing users such as capture fisheries, tourism and recreational users, cultural heritage, access and foreshore transit as well as water quality issues. After examining the relevance of each of these to the Solway, it presents a series of guidance notes for developers and regulators. The various maps shown in this section also include the possible shellfish culture areas developed in the outline zoning plan (see next section).

Strategy Element 2: Outline Zoning Plan. This element provides an outline aquaculture zoning plan for the Solway based upon the conflicts identified in Strategy Element 1 as well as the physical area suitable for shellfish development. For each bay area, the Strategy identified the scale of development possible, the inter-tidal area that might be suitable for aquaculture and the resulting area recommended for development.

Strategy Element 3: Management Issues and Approaches. Whilst Strategy Element 1 deals with siting issues, this third element looks at on-going management issues associated with the disturbance and predator control resulting from husbandry and harvesting activities and recommends mitigatory approaches where appropriate.

Strategy Element 4: Business Development. This fourth Strategy Element examines the cumulative production potential of the Solway and provides an assessment of the market potential for different culture products, the different business strategies that might be employed, and then examines the possible socio-economic benefits of potential aquaculture development.

Strategy Element 5: Strategy Implementation. This final Strategy Element provides a time-bound, six component action plan for progressing this Strategy.

6 STRATEGY ELEMENT 1: SITING ISSUES AND GUIDELINES

The Solway is widely recognised for its combination of rich ecological habitats, bird populations, attractive landscape and past heritage. Aquaculture planning must recognise differing sensitivities to new forms of coastal development and ensure that both new applications and existing facilities are appropriate in scale and form.

This first element of the Strategy examines the *main planning issues* and acts as a precursor to the second Strategy element that provides an *outline zoning plan for aquaculture development in the Firth and guidelines for siting*. Useful guidance for locational planning for shellfish aquaculture can also be found in the ASSG's Code of Good Practice.

6.1 NATURE CONSERVATION

As described earlier, the Solway has a number of important nature conservation designations including SACs (Map 5), SPAs and Ramsar sites (Map 6), SSSI's (Map 7) and both national and local nature reserves (Map 8)[8].

Shore based facilities will be required for any aquaculture method. While these would have the potential if poorly planned to cause damage to conservation interests - including to upper shore habitats such as saltmarshes and sand dunes - the shore-based requirements for aquaculture are usually relatively modest. It is, therefore, considered unlikely that this would cause any constraints significant enough to preclude whole areas at this stage, although clearly potential issues relating to shore based facilities should be taken into account at the planning stage of any individual development.

One other important potential conflict, which might be regarded as indirect, is access. It is possible that important upper shore or coastal "terrestrial" habitats, including, for example, saltmarsh, might be impacted by vehicles and people accessing shores where they previously didn't, as a result of the development of aquaculture. *Zostera* beds and, to a much lesser degree, *Sabellaria* reefs could be degraded by regular passage, while, clearly, feeding or roosting birds could be disturbed by the passage of people or machines such as tractors or quad bikes. In the latter case it is likely that many areas would be most sensitive over winter and less so at other times, but this is by no means clear cut, since there can be important numbers of birds present at any time of year, although the species will vary. For example, populations of several species of wading birds peak in spring and autumn, while a number breed on marshes and other habitats in the summer. It is not possible at this stage to predict the likelihood, or likely scale and importance of impacts due to access, and it is, therefore, important that these aspects are assessed properly during any proposals for aquaculture development. Access is discussed in detail in Section 6.6. Aspects of the ecology of the area of relevance to this and other considerations are discussed in more detail after the review of the Appropriate Assessment process below.

6.1.1 Appropriate Assessment

The designation of any European Marine Site, (SPA or SAC) produces a requirement for an appropriate assessment of the likely impacts of any development on the integrity of the site as detailed in the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Appropriate assessment can also be required for plans outwith Natura sites if the proposal could affect the Natura site.

[8] Ramsar sites operate at global level, SACs/SPAs at European, NNRs and SSSI's at national and LNRs at local level

Thus any proposal for aquaculture developments within any EMS, or likely to affect any EMS, is likely to require an appropriate assessment. It is important to note that developments that take place outside a site, but are perceived as being capable of affecting features within a site, require an appropriate assessment. The relevant competent authority for the EMS must carry out the appropriate assessment, but the developer is required to provide the information required to reach a decision. In the event of doubt about possible impacts the precautionary approach must be adopted – i.e. the competent authority must assume negative impacts until there is evidence to the contrary and may on that basis refuse an application.

As an example, proposals to develop a cockle fishery at Beckfoot Flats in 2003 were the subject of an appropriate assessment, which in this case concluded that interactions with birds would be minimal. More recently, proposals in 2005/06 for the development of a subtidal cockle dredging fishery in the upper Solway Firth were approved, subject to a variety of management measures.

Also in 2005-06, proposals for hand gathering of an ephemeral mussel bed at Beckfoot were approved subject to a series of management measures following appropriate assessment. This case demonstrates the complexity that an appropriate assessment may require.

Detailed information was required on the fishery, including:

- **Hand-gathering methods**, including the use of quad bikes and trailers and the size-sorting and cleaning process;
- **Yields and effort**.
- **Aspects of the fishery** including the selectivity of hand raking, ease of enforcement, employment potential of the work
- **Information on the management of the fishery**, including monitoring and assessment programme, controls on mussel harvesting, including the need for fishery permits and the option to close mussel beds when required; and
- **The biology of mussels** in the Solway Firth.

The following possible impacts needed to be considered:

- **Intertidal mudflats/sandflats and slightly covered sandbanks**: Physical loss through removal; biological disturbance through translocation; biological disturbance through the selective extraction of species
- **Reefs:** damage to *Sabellaria*, found nearby
- **Birds**: Visual/noise disturbance; biological disturbance through the selective extraction of species

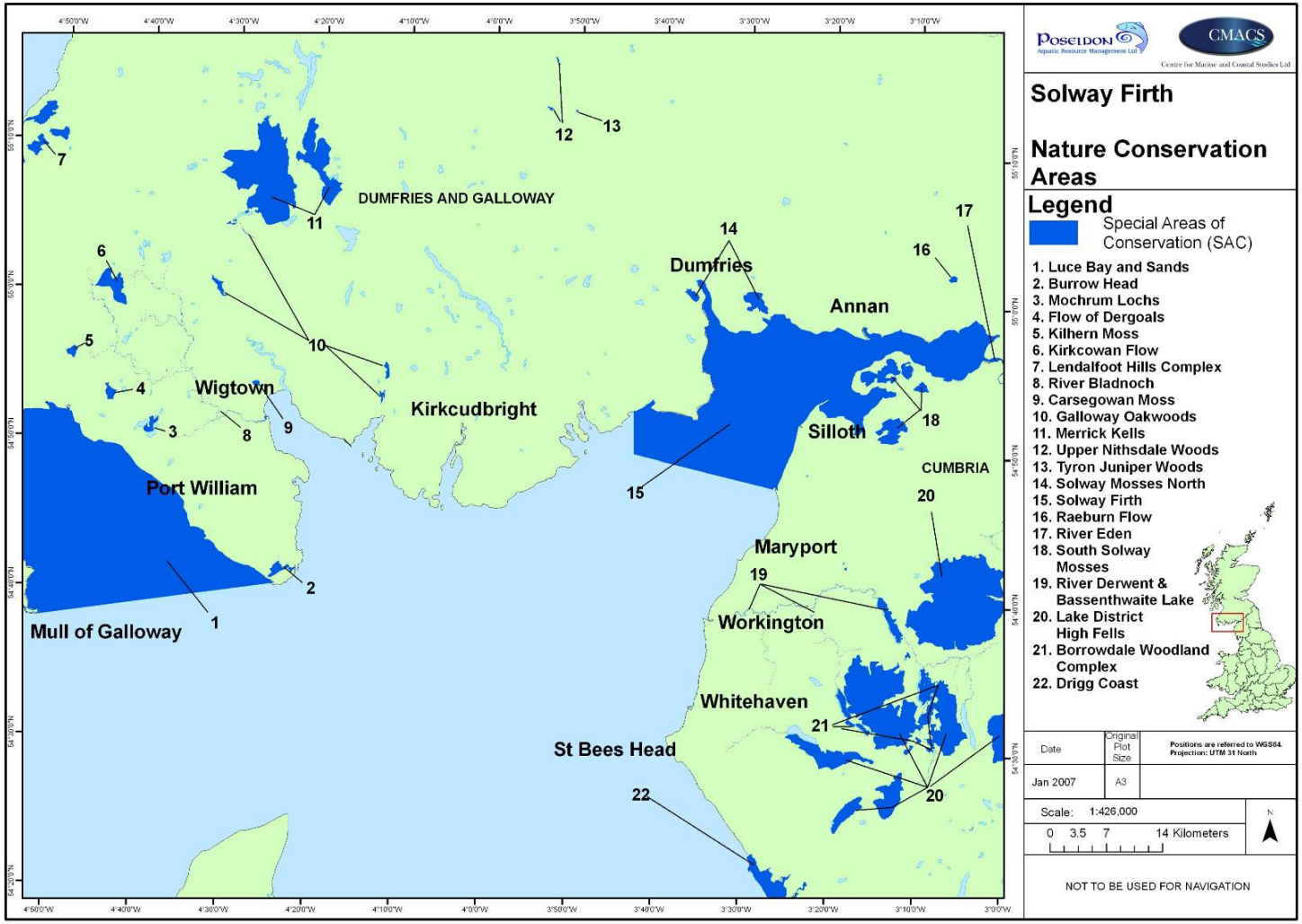
There is presently some uncertainty with regard to the degree to which relatively modest or "routine" changes in management practices need to be accompanied by an appropriate assessment on each occasion.

6.1.2 European Protected Species

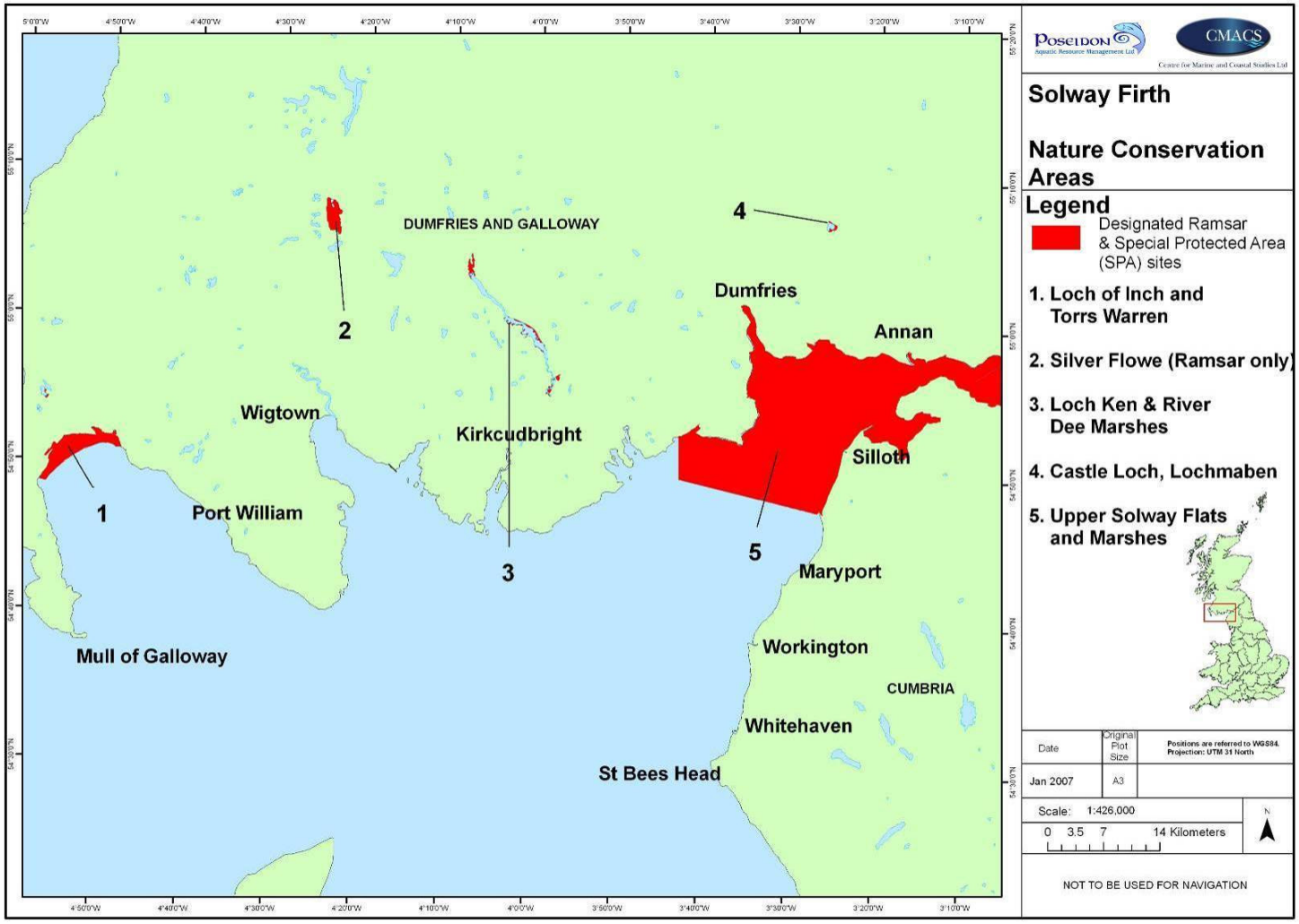
Three European Protected Species are known from coastal areas of the Solway; the European otter (*Lutra lutra*), the natterjack toad (*Bufo calamita*), and the great crested newt (*Triturus cristatus*).

The otter is listed on Appendix 1 of CITES, Appendix II of the Bern Convention and Annexes II and IV of the Habitats Directive and Schedule 2 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (Habitats Regulations). Under Schedule 5 of the WCA 1981 (as amended in England and Wales) it is an offence to kill, injure or take an otter or to intentionally (or in England recklessly) damage, destroy or obstruct a holt; or to disturb an otter in its resting place.

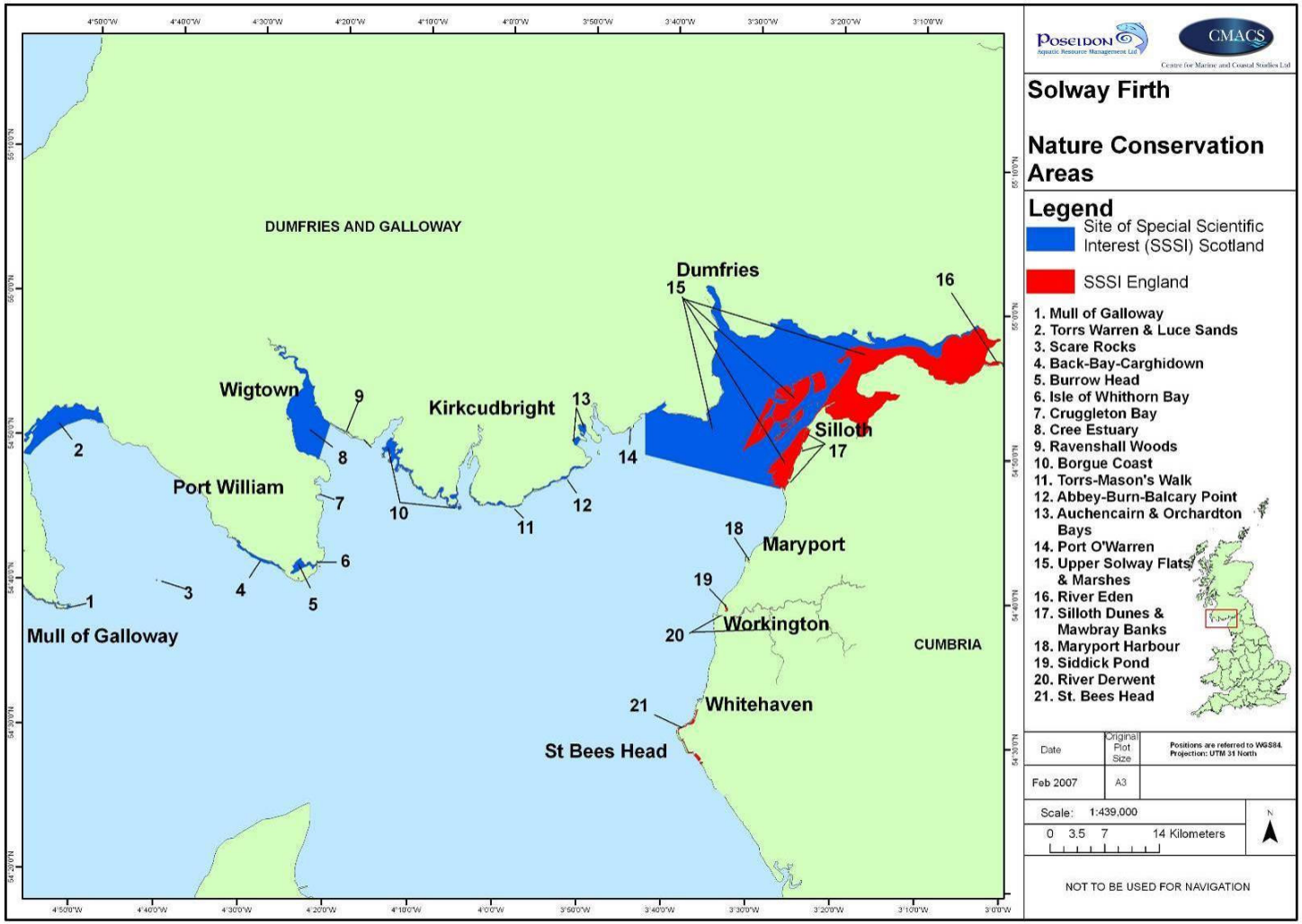
Map 5: Nature Conservation Designations (Special Areas of Conservation)



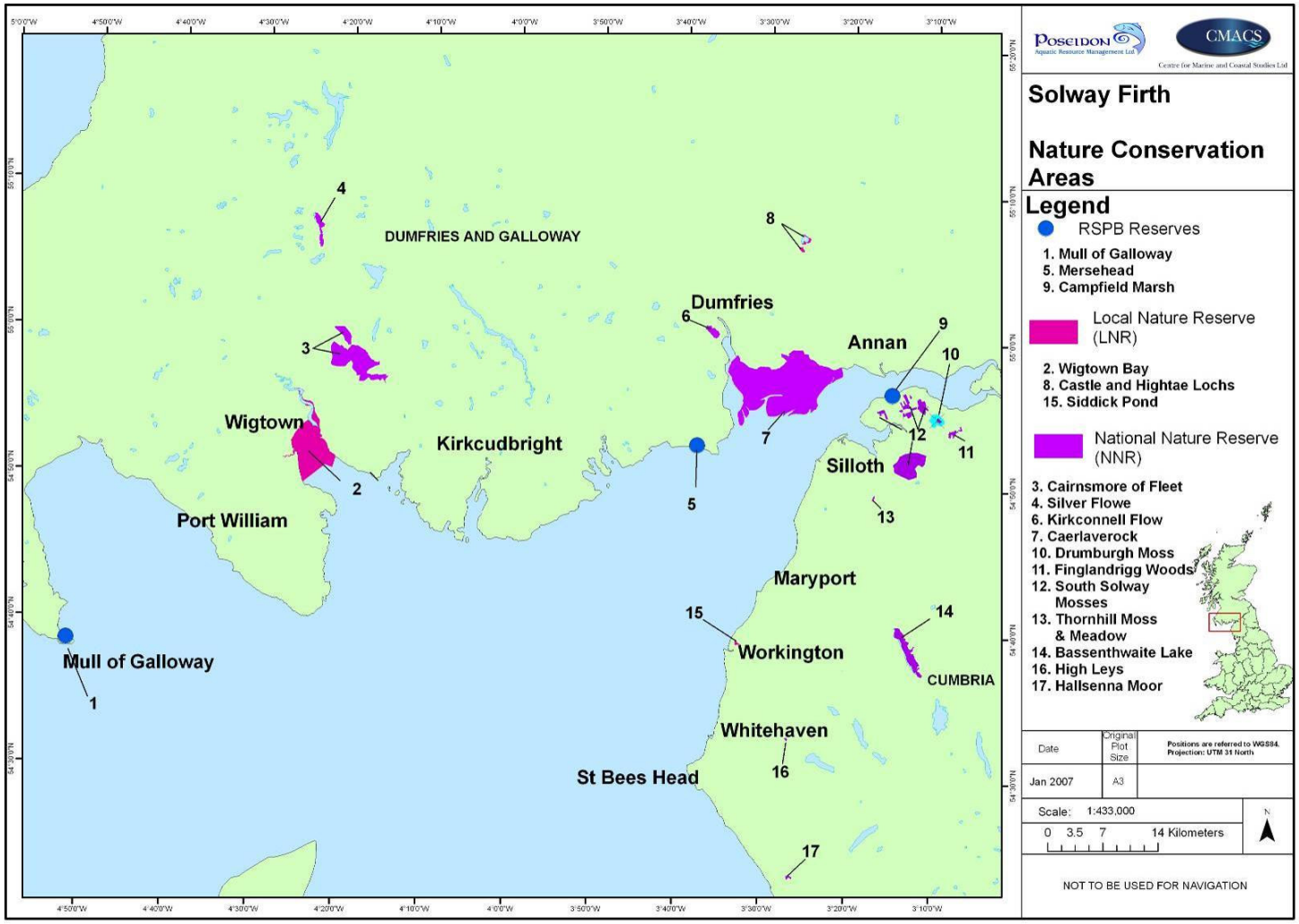
Map 6: Nature Conservation Designations (Special Protection Areas / Ramsar Sites)



Map 7: Nature Conservation Designations (Sites of Special Scientific Interest)



Map 8: Nature Conservation Designations (National and Local Nature Reserves)



The European otter present in the UK is also listed as globally threatened on the IUCN/WCMC Red Data List and the otter is a priority species for conservation in the UK BAP.

The otter is a semi-aquatic mammal. In coastal areas, animals may use shallow inshore areas and the intertidal for feeding on prey such as fish, shellfish and crabs, but they do require access to freshwater for bathing and terrestrial/riparian areas for resting and breeding. Coastal otters in the Solway may be considered partly marine and are known to range widely and hunt around rocky shores, especially where kelp beds are present (Cumbria Wildlife Trust, 2007). It should be considered that otter could occur anywhere in the Solway, especially along the Scottish coast, and any proposals for aquaculture developments will need to consider the potential for disturbance of this species.

The natterjack toad is listed on Appendix II of the Bern Convention and Annex IVa of the EC Habitats Directive. It is listed on Schedule 2 of the Conservation (Natural Habitats, etc.) Regulations, 1994, and Schedule 5 of the WCA 1981 (as amended), and is a BAP species. The species is afforded protection from intentional (and in England reckless): killing, injuring or taking (capture etc.); possession; disturbance whilst occupying a 'place used for shelter or protection' and destruction of these places.

Typical habitat of natterjack toad is loose, sandy soil, such as sand dunes and lowland heaths, although it is sometimes found in brackish water in upper saltmarsh. During the day, it tends to rest under stones and in crevices and burrows. It is known from Caerlaverock on the Scottish Solway coast and is probably relatively widespread on the Cumbrian coast, which is the prime location for this species in the UK. According to EN & SNH (2000) around 10% of the UK breeding population is thought to occur on the Solway, where saltmarsh pools form important breeding and feeding resources. Individual applications will have to consider potential impacts, particularly in the case of on-land facilities or access in the areas mentioned above. The Lake District National Park Authority considers that any developments affecting, or within 500m of, sand dunes, saltmarsh, ponds and wetlands on the west coast may require a survey, for example.

The great crested newt is listed on Annexes II and IV of the EC Habitats Directive and Appendix II of the Bern Convention. It is protected under Schedule 2 of the Conservation (Natural Habitats, etc.) Regulations, 1994, (Regulation 38) and Schedule 5 of the WCA 1981, and is a BAP species. It is afforded equivalent protection to the natterjack toad. Great crested newts are widespread in Britain, but extremely localised. They spend most of the year around weedy ponds and small lakes with structurally diverse terrestrial habitat, generally where fish are absent, although they can also be found in dew-ponds, quite far away from other bodies of water. They tend to be nocturnal, hiding under stones, logs etc during the day, and may hibernate in winter. This species is known from Burrow Head on the Scottish Solway coast (SNH pers comm.) and has been recorded at a number of other coastal locations around the Solway including Silloth, Kirkbride and Bowness Common (NBN Gateway). Some records are from sites less than 1 km from the coast and it should, therefore, be considered that a specialist amphibian survey may be required if a water body potentially offering great crested newt breeding habitat is present within 500m of a proposed development.

A number of marine species are also to be found in the Solway area (see table overleaf). As aquaculture potential in the Solway is essentially limited to the inter-tidal area, little interaction with any of these species is considered likely. Any interactions with fixed equipment e.g. trestles, BST long lines should be recorded and reported to the relevant statutory authority (SNH in Scotland and Natural England in England) so that appropriate mitigatory approaches might be discussed and developed. Appropriate mechanisms to reduce impacts such as nocturnal activity or excessive underwater acoustic noise might be included in a code of practice (see Action Plan 6) in Section 10.6.

Table 8: European Protected Species (Marine) Recorded in the Solway Area

Common name	Scientific name	Found in Scotland	Recorded for Solway area
Cetaceans (all species)	All species	Y	Y Harbour porpoise – a breeding population present in the Solway Estuary. Bottle-nose dolphin occasional sightings. Other species – possible.
Leatherback turtle	*Dermochelys coriacea*	Y	Y Evidence indicates this is a rare but regular member of the British marine fauna. Several sightings in the Solway.
Loggerhead turtle	*Caretta caretta*	Y	Y
Green turtle	*Chelonia midas*	Y	Unknown
Kemp's ridley turtle	*Lepidochelys kempii*	Y	Unknown
Hawksbill turtle	*Eretmochelys imbricata*	Possible	Unknown
Sturgeon	*Acipenser sturio*	Y	Single record

Source: SNH, pers. comm.

Note that otters also inhabit marine environments (shoreline habitats).

The Habitat Regulations were amended in Scotland and came into force on 15th February 2007. European Protected Species are covered under Regulation 39 (note in England/Wales it is Regulation 38). In Scotland, the amended legislation under 39 (1), states that it is an offence to:

(a) deliberately or recklessly to capture, injure of kill a wild animal of a European Protected Species;

(b) deliberately or recklessly:

- (i) to harass a wild animal or group of wild animals of a European protected species;
- (ii) to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
- (iii) to disturb such an animal while it is rearing or otherwise caring for its young;
- (iv) to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;
- (v) to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs; or
- (vi) to disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young;

(c) deliberately or recklessly to take or destroy the eggs of such an animal; or

(d) to damage or destroy a breeding site or resting place of such an animal.

Under 39 (2), subject to certain provisions, it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean).

The bottlenose dolphin and harbour porpoise are listed on Annex II of the Bern Convention and Annex II and IVa of the EC Habitats Directive and in Schedule 2 of the Habitats Regulations as European Protected Species. Turtles and Sturgeon are also protected under Annex IVa of the EC Habitats Directive and under Schedule 2 of the Habitats Regulations. These are also all UK BAP species.

Of both economic and conservation importance are salmon (*Salmo salar*) and sea trout (*Salmo trutta*). Other important fish species covered by various national and international legislation that also enter and leave the region's rivers to spend at least part of their life cycle in the Solway include the sea lamprey, river lamprey, Allis shad, Twaite shad and sparling. Shad and sparling in particular utilise the River Cree estuary.

6.1.3 Biogenic Reefs

The majority of the habitat within the Solway area is composed of intertidal sands and muds, with varying amounts of "scar" ground, the latter consisting largely of cobble and boulders. Truly rocky intertidal habitat is limited mainly to the more exposed headlands (more notably on the Scottish side of the Firth) and these are, in general, well away from the areas proposed here for aquaculture.

Some of the scar grounds are of importance for the reef-forming tubeworm *Sabellaria alveolata* (which in the Solway area can also extend into the subtidal to at least a few metres below LAT). Dense aggregations of this worm form honeycomb-like patches, hummocks or sheets which may coalesce to form more extensive areas. Such *Sabellaria alveolata* aggregations may be regarded as a "biogenic reef" i.e. a reef habitat that is created by the animals themselves; Holt *et al*, 1998) as a result of which they are regarded as an Annex II habitat under the EU Habitats directive. For this reason they are often cited as a qualifying feature of SACs. Although it does not have its own species Biodiversity Action Plan (BAP), there is a BAP for the reef form. Some *Sabellaria* reefs occur within the Solway Firth SAC but they are not considered a primary reason for its designation (JNCC website; UK SAC site list); however, the Cumbrian Coast is widely recognised as having many excellent, well developed and extensive examples of this habitat, both north and south of St Bees Head, that have long been considered to be of National Importance (e.g. Holt *et al*, 1998; Cunningham *et al*, 1984; EN 1994). Scar grounds in general, including those colonised by mussels or *Sabellaria*, are considered as qualifying sub-features for the Solway SAC.

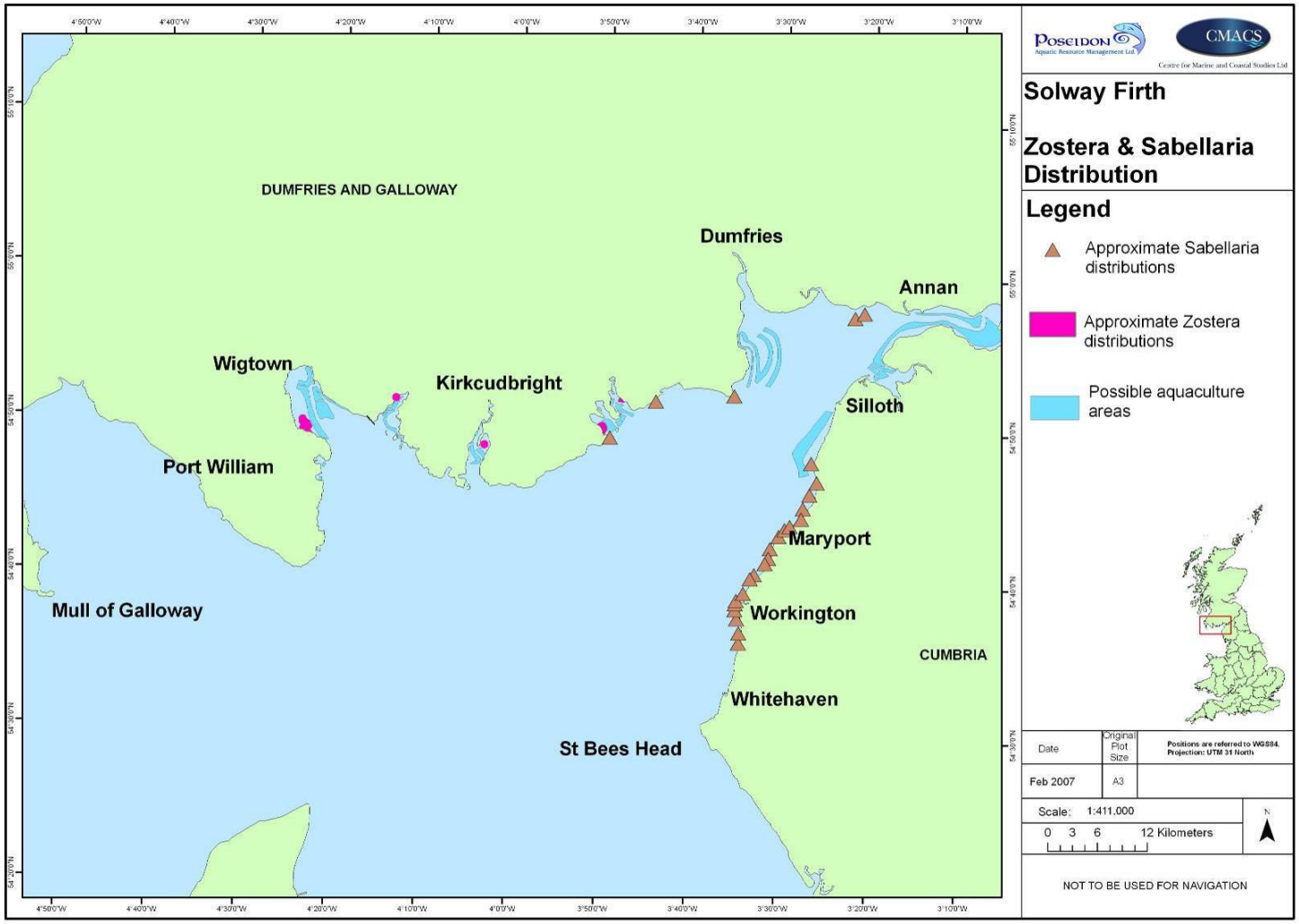
The majority of the extensive areas of this habitat within the north-eastern Irish Sea are found on the Cumbrian Coastline, both north and south of St Bees Head (see Map 9), which uses information adapted from Hartnoll *et al* (1998) (who in turn summarised data from a wide variety of sources) as well as *Sabellaria* dominated scars on the Scottish coast mapped by Cutts and Hemingway (1996). The Dumfries and Galloway coast represents the northern limit of this community in the UK (and probably in Europe) but *S. alveolata* reefs on the Scottish side of the Solway tend to be fewer and less well developed or less extensive. *Sabellaria alveolata* reefs tend to occur on cobbles, boulders and rocks where there is a good supply of suspended sediments with which they can form their tubes. It is well recognised that, within the Solway, scar grounds can be periodically buried/exposed due to the shifting nature of the sands, and the potential for this needs to be recognised when making assessments. The common mussel *Mytilus edulis* can also dominate scars, and appears to compete with *Sabellaria* in at least some cases, with dominance shifting between the two species over time, notably between Silloth and Dubmill Point. Even where *Sabellaria* consistently dominates a scar, the "quality" of the reef may undergo cycles over periods of a few years, with older reefs gradually becoming more eroded until such time as a good recruitment of juveniles occurs (e.g. Holt *et al*, 1998; Cunningham *et al*, 1984). Areas of dense, relatively new *Sabellaria* reef are often relatively low in diversity, with the worms smothering existing habitat and creating a fairly homogeneous habitat, although in some cases

they may create pools in areas where there were previously none. As the reefs age and become more eroded, however, associated diversity tends to increase, with a variety of algae and animals able to exploit the increasing variety of niches available. Mussels can also occasionally develop sufficiently dense cover to be regarded as biogenic reefs, and there is some suggestion that parts of those scars between Silloth and Dubmill Point could be regarded as reefs in this sense (Holt *et al*, 1998). Although *Sabellaria* reefs are a relatively unusual and interesting habitat, little is known of their importance as bird feeding habitat. It is generally believed that mussel beds/reefs are probably much more important as a feeding resource for birds than would be an equal area of *Sabellaria*, but the latter do nevertheless act as bird feeding areas, and probably support different species than do areas of mussels.

It is essential that there is a presumption against siting of aquaculture developments directly on, or immediately adjacent to, important areas of *Sabellaria* or mussel scar ground. Given this proviso, the potential for significant effects of aquaculture developments in *Sabellaria* (or indeed mussel) reefs are limited, however. There is clearly potential for physical damage by large numbers of people (trampling) or vehicles such as quad bikes. However, this would be relatively easily avoidable by careful siting of developments and by setting sensible access routes. Of the known areas of *Sabellaria*, those in the region of Dubmill Point on the Cumbrian coast would be the most potentially vulnerable in this regard, given their importance and the possible sitings of aquaculture developments suggested here, and these considerations should be noted during any aquaculture proposals. The possible aquaculture areas as presently outlined for this area lie very close to known areas of extensive *Sabellaria* dominated scar ground (totalling over 90 ha.) on the low and mid shore in the region of Dubmill Point, most of which tend to be mixed with mussels. Although very extensive, overall coverage of *Sabellaria* was not particularly high at 15-20% cover particularly at the higher levels (Allen *et al*, 2002). Based on presently available information there is probably little or no direct overlap between these scars and the "possible aquaculture area" that stretches from Dubmill Point northwards, but in order to safeguard the scars a buffer zone will be required, the size of which will probably depend upon how important they are for birds. However, given the suggestion here that only 10% of each "possible aquaculture area" would be actually used there is likely to be scope for such buffers where appropriate without unduly affecting the overall Strategy (see Section 7- Strategy Element 2: Outline Zoning Plan).

Due to the dependence of *S. alveolata* on suspended sand grains with which to build its tubes, developments that significantly alter wave action and/or sediment characteristics in the long term could have impacts on *Sabellaria* reefs, but the levels and nature of developments proposed here would be very unlikely to have any significant detrimental effects (this, of course, presupposes that no aquaculture development would take place directly on scars); again, however, it would be necessary to consider these possible impacts in detail for all individual proposals, using resources such as the MARLIN website and the SAC's project publication (Holt *et al*, 1998) which provide guidance on possible sensitivities and effects.

Map 9: Location of *Zostera* and *Sabellaria* Beds



6.1.4 Infauna

Intertidal sands and muds in the Solway Firth and estuary grade from relatively mobile exposed sands on much of the open coast or sandbanks, where the fauna may be sparse and dominated by small numbers of small amphipod crustacea, through more muddy or fine sands in more sheltered areas, particularly bays, where the fauna is much richer and may include high densities of bivalves and worms, and in some places cockle *Cerastoderma edulis* are sufficiently abundant to form exploitable beds. The ragworm *Nereis diversicolor* and the lugworm *Arenicola marina*, are widespread and often very abundant in these habitats. The small amphipod crustacean *Corophium volutator* appears to be almost ubiquitous in the muddiest areas, and at the head of the Solway Firth the small gastropod *Hydrobia ulvae* and the bivalve *Macoma balthica* are also often abundant, again especially in muddier habitats. Their richness, together with their great extent, means that the intertidal sands and muds of the Solway make good feeding grounds for birds, especially wintering waders and wildfowl, and also for fish, particularly flatfish such as plaice, dab, flounder and sole.

The JNCC, in summarising the interesting features of the Solway SAC, note that "the Solway is an unusually dynamic estuarine system, with mobile channels and banks. Fine sandy sediments occur in the inner estuary, and more stable and diverse conditions in the outer reaches. Salinity ranges from fully marine to estuarine in character, and these gradients in physical conditions add to the ecological diversity within the site. The presence of intertidal sediment flats of fine sands, rather than muds, in conditions of estuarine salinity is a notable feature."

These habitats may be subject to smothering, and associated changes in sediment and water chemistry such as reduced dissolved oxygen levels and increased turbidity and nutrient levels (see Section 4) as a result of aquaculture activities. Such impacts can be expected to be significant in the immediate locality of intensive suspended raft culture, but in intertidal and on-bottom-shellfish culture smothering (as envisaged here for the Solway) by accumulated shell and detrital material (faeces and pseudofaeces) is thought likely to be of medium severity at most, with effects generally not extending far outside the aquaculture area, and having only very limited detectable effects on water quality (mainly the possibility of slight changes in turbidity). Thus, although some changes to the nature of the infauna are likely to occur, these are likely to be very localised and not very significant. Epifauna may also be significantly influenced, with predators such as crabs and starfish sometimes exhibiting greatly increased localised populations in shellfish relaying areas, for example, although this can be reduced by appropriate management such as choice of site (including shore level) timing and size of relaid shellfish.

Sand and mudflats will, of course, also be locally susceptible to disturbance during access, especially by vehicles but also by passage of people. Intertidal sand and mudflats are reported to be inherently adapted to change (Elliott *et al*, 1998), but more exposed sandy areas can be expected to have a higher tolerance to physical disturbance and to recover relatively quickly whereas more muddy areas will be more impacted and may take longer to recover. In all cases it is expected that, given care in selecting access routes, impacts will be very localised.

6.1.5 Birds

The upper Solway area is one of the largest continuous areas of intertidal habitat in Britain, and the whole estuary complex is a vital link in a chain of west coast estuaries used by migrating birds. Numerous wintering waterfowl occur in nationally or internationally important numbers, particularly in the Upper Solway Flats and Marshes SPA and Ramsar site, (which is a site of international importance by virtue of holding >20,000 waterfowl), but also in Wigtown Bay and Luce Bay (nationally and internationally important species are listed in Table 9), while significant numbers of waterfowl can also occur in Auchencairn Bay and Rough Firth, Kirkcudbright Bay, and Fleet Bay. The upper Solway is also noted for populations of breeding birds.

It is beyond the scope of this work to attempt to accurately map important bird feeding, roosting or breeding areas, but some interpretation of low tide count data provided by WEBS data for the upper Solway is provided in Appendix E), which concentrates on the internationally important species, as a very broad indication of main feeding areas. However, it is important to note that even within this area WEBS counts are not carried out everywhere, with important gaps particularly to the west of the study area, whilst the fact that not all counts are carried out every year also complicates interpretation. For example, Natural England consider that the Silloth-Dubmill area is one of the key areas for bar-tailed godwit and turnstone (both internationally important species) on the English side of the Solway, but this area has very limited WEBS coverage. These maps serve to indicate that some areas of the upper Solway have a greater density and larger number of bird species than others. Such areas include the upper part of Cardurnock Flats (directly south of Annan) and the southern part of Cardurnock Flats towards Moricambe.

Table 9: Wintering waterfowl species of national or international importance

Site	Species of national importance		Species of international importance
Solway estuary SPA and Ramsar site (Upper Solway Flats and Marshes)	Wigeon Ringed plover Golden plover Goldeneye Shoveler Cormorant Grey plover Black-tailed godwit	Great crested grebe Teal Scaup Red-breasted merganser Sanderling Ruff Greenshank Lesser black-backed gull	Barnacle goose Pink-footed goose Whooper swan Dunlin Shelduck Knot Bar-tailed godwit Curlew Turnstone Oystercatcher Redshank Pintail
Wigtown Bay	Whooper swan Pintail duck	Curlew Oystercatcher	Pink-footed goose
Luce Bay			Greenland white-fronted goose

The intertidal sands and muds are often rich in bivalves, crustaceans and worms, and thus may make good feeding grounds for wintering waders and wildfowl. Some birds also make use of the scar grounds at low tide where mussels may be abundant; oystercatchers, eider, scaup, scoters, sandpipers, knot, turnstones, bar-tailed godwit, herring gulls and even crows may use mussels as an important food resource, and many of these birds are found in important numbers in the study area. For many other species of waders the intertidal sands and muds form vital feeding grounds, with the most important areas being the Mersehead Sands, Blackshaw and Priestside Banks, Cardurnock Flats and the mouth of Moricambe Bay. The inner, sheltered parts of the estuary support species preferring muddy substrates. According to summary information for the Upper Solway Flats and Marshes SSSI presented on the SNH Portal (SNH, undated) oystercatchers are the only species to make significant use of the harder outer sandflats for feeding. Dabbling ducks, of which the scaup is arguably the most notable in the Solway, are concentrated in the Caerlaverock area; in the channels of the Nith and Eden, and at the mouth of Moricambe Bay. Unlike waders, scaup and eider (for which mussels are an important food source) other dabbling or diving ducks are likely to be prone to disturbance by boat operations such as would occur with shellfish relaying operations. Wading species, however, would be more prone to disturbance during aquaculture operations carried out at low tide.

The more extensive and least disturbed marshes, notably Rockcliffe and Caerlaverock, support important breeding bird populations. These include lesser black-backed and herring gulls with good numbers of common and arctic terns, black-headed gulls, redshank, lapwing and oystercatcher, together with a number of other species which breed in smaller numbers or sporadically.

The intertidal areas of the estuary are of value to geese, including barnacle, greylag and pink footed geese, primarily as a safe nocturnal roosting area, with most of the feeding activity on the marshes or inland. The main roosting sites for geese, are Blackshaw and Priestside Banks, Mersehead Sands, Rockcliffe and Moricambe Bay. Similarly, whooper swans and golden plover also roost intertidally but feed on saltmarsh areas.

The Svalbard (Spitzbergen) population of the barnacle goose is of particular importance in the Solway, since virtually all of the population winter there (Collier *et al*, 2005). The peak count was over 28,000 for 2003/2004 (Collier *et al*, 2005). This included birds in Wigtown, Auchencairn and Orchardton Bays, although, as in previous years, Caerlaverock and Mersehead were consistently favoured areas, whereas other areas were used more sporadically. Auchencairn Bay was used by up to 32,100 birds between October and January but at Wigtown Bay they were not found until late in the winter, peaking at 690 in March.

Conflicts between birds and shellfish exploitation have been contentious in recent years (as summarised, for example, in a letter from SNH to SEERAD: Scottish Fisheries Division; Crofts, 2001). Disturbance to, and displacement of, birds in feeding, roosting and breeding areas are obvious areas of potential conflict with aquaculture. Careful consideration of the siting of aquaculture developments on the foreshore, together with careful selection of access routes, will be required to minimise this. Consideration of the seasonality and timing of aquaculture activities in relation to those of the birds will also be required. All species would, of course, potentially be sensitive to loss of important feeding resources, but it is the suggestion of this Strategy that important bird feeding areas are avoided; and that relatively modest total areas of intertidal are used. It is intended that significant loss of important feeding areas should, therefore, be avoided.

The interactions between feeding birds and food resources such as mussels and cockles have been intensively studied in recent years, and in some cases these interactions have been the subject of increasingly sophisticated models (see e.g. Caldow *et al*, 2004 oystercatchers and mussels and West *et al*; 2003 oystercatchers and cockles). If potential areas of significant conflict occur, it may be worthwhile considering such a modelling approach.

Where mussel laying is proposed, interactions with birds are, arguably, potentially fairly complex, since mussel lays have the potential to act as a positive source of food for birds, notably oystercatchers, but clearly the preference of the lay managers would be to minimise the losses to birds. Clearly the removal of mussel seed locally may also have conservation implications, although it is by no means certain that this would be likely or necessary, and it is not possible to assess this at this stage. Recent publications suggest that careful management of the mussel laying (essentially the management of the upshore-downshore position and density of mussels at different sizes) can help in this regard without significant negative effects on the birds; this will be dependent upon local site –specific conditions, however, including whether or not the lays are developed upon important bird feeding areas and the availability of alternative prey sources (Caldow *et al*, 2004). Oystercatchers are capable of feeding on a variety of marine invertebrates and some populations rely heavily on cockles and other bivalves. They are capable of altering their preferred prey items, for example in response to changes in abundance, so that it cannot be assumed that a species that is presently unimportant as a food resource will always be so.

A further possible source of conflict lies with eider, for which mussels are an important food source, and have in some cases been regarded as problematical for mussel culture and relaying. It is worth noting that Natural England recently refused consent to 14 fishermen who wished to use electronic bird scaring devices to deter eider ducks from feeding on their mussel lays in the Wash SSSI, a decision that was upheld at public enquiry following appeals by the fishermen.

6.1.6 Zostera

Three *Zostera* species occur in British waters, although *Zostera marina* is usually very low shore or subtidal, and it is not clear if any significant beds presently exist in the Solway Firth, although it has been recorded in the past. The two intertidal species, narrow-leaved seagrass *Zostera angustifolia* and dwarf seagrass *Zostera noltii* are, however, found in quite extensive beds in a number of places on the Scottish side of the firth. The known distribution is shown in Map 9 above. This information is taken from a number of sources, including Hawker, 1994, Dumfries and Galloway local BAP undated; GIS files supplied by SNH; Crofts, 2001), and while the extent in Auchencairn Bay and Rough Firths is taken from recent data and likely to be reasonably accurate, in many other cases the extent is not well mapped or based on old data. In many, if not all, of these areas both *Z. noltii* and *Z. angustifolia* occur either intermixed or in adjacent patches, although there is a tendency for *Z. noltii* to occur slightly higher on the shore than *Z. angustifolia.*

There are also suggestions that *Zostera* beds occur in "the inner Solway" (Crofts, 2001) but no specific locations were given. The Inner Solway in this case does not refer to Auchencairn Bay and Rough Firth as these were mentioned separately; however, we have so far come across no other references to beds higher up the estuary than Auchencairn Bay/Rough Firth.

In a Draft Management Plan for the Solway Firth Regulating Order (SSMA, 2004), the distribution of intertidal species of *Zostera* was said to be "confined to sheltered areas on the north side of the Solway, namely Auchencairn Bay, Rough Firth and Wigtown Bay". Natural England also report that *Zostera* occurs only on the Scottish side of the Solway (EN, 1997), and there appear to be no confirmed reports of *Zostera* anywhere on the English side of the Solway.

Zostera beds are regarded as being important for a variety of reasons (e.g. Holt *et al*, 1997; Davison & Hughes, 1998); they are nationally scarce, particularly having suffered a severe decline in the early twentieth century, from which they have only partly recovered; they can be highly productive, supplying shelter and food for a variety of plants and animals, including a number of wildfowl such as wigeon and Brent geese, and are thought to act as nursery grounds for some commercially important species of fish; and the roots and rhizomes can act to stabilise the substratum, so that seagrass beds may reduce coastal erosion. However, seagrasses are not physically robust, and are vulnerable to destruction or damage by trampling, digging, dredging, bivalve harvesting or other forms of physical disturbance. According to Davison and Hughes, human disturbance may also cause wildfowl to spend longer on *Zostera* beds, thus increasing the grazing pressure on them. According to the SSMA, areas of fine sediments and *Zostera* beds "such as Auchencairn Bay and Rough Firth", should be "closed to cockle fishing by mechanical methods, except under the special circumstances as described in the Environmentally Sensitive Areas. All fishing is restricted/prevented on and across *Zostera* beds." (SSMA, undated).

SEPA in their Dee-Ken catchment management plan mention that the beds in Manxman's lake were surveyed (extent and quality) by SNH as part of a national survey in 2002 (data not seen), and that developments in this area should take the conservation of these beds into consideration.

This Strategy has attempted to avoid disturbance to seagrass beds by providing a minimum of around 250 m buffer zone between the areas suggested for possible aquaculture development and known extent of seagrass beds, and in most cases far more; however, these locations must be taken as indicative only, and care must be taken to ensure avoidance of damage to seagrasses, including careful consideration of access, during preparation of detailed proposals. Note SNH should be consulted about access near known Zostera locations.

6.1.7 Introduction of Non-Endemic Species

Aquaculture can lead to the deliberate and accidental introduction of non-endemic species. A number of exotic shellfish species, in particular the Pacific oyster (*Crassostrea gigas*), are cultivated in both England and Scotland. It was previously thought that thermal intolerance would limit the natural establishment of *C. gigas* in UK waters, its ability to grow in waters as cool as 6°C has raised concern over its possible establishment as a result of climate change. Wild populations of *C. gigas* have established themselves on inter-tidal mussel beds in the Wadden Sea and are now known to spawn in the southern and south-west coasts of England (Couzens, 2006). As yet they have not been known to spawn in the waters off northern England or Scotland – however this is an eventual possibility and one that needs following over the medium-term. The Scottish Executive is currently finalising a consultation exercise to examine whether new species need to be added to Schedule 9 and the use of an order made under Section 14A of the Wildlife & Countryside Act 1981. The species proposed include *C. gigas*, as well as American hard-shelled Clam (*Mercenaria mercenaria*) and the Zebra Mussel (*Dreissena polymorpha*)[9].

The accidental introduction of pathogens such as the epizootic parasite *Bonamia ostreae* have impacted native oyster populations (but not *C. gigas*), and other pests such as *Crepidula fornicata* (originally imported with the American oyster *C. virginica*), the oyster drill *Urosalpinx cinerea* (also introduced with *C. virginica*), as well as invasive seaweeds such as *Sargassum muticum* (can clog oyster beds, and has been identified in the Clyde (Brown *et al*, 2006) and Loch Ryan (SNH, pers. comm.)), *Undaria pinnatifida* (imported with *C. gigas* shipments from Japan), *Heterosiphonia japonica* may give rise to concern. There are also other potentially serious pests such as the colonial sea squirt *Didemnum* sp. And the Japanese oyster drill *Ocinebrellus inoratus*. In the view of SNH, an estimated 10% of introduced species will escape to the wild; of these, 10% will become established and 10% of them will go on to become pests (this means that 0.1% of all introductions will become pests).

There is now considerable legislation to regulate and control imports of shellfish into UK waters, including the 'Shellfish and Specified Fish (Third Country Imports) Order 1992 (No 3301). International legislation and conventions include the Convention on Biodiversity (Rio), the Bonn and Bern conventions and the EU Habitats Directive. National legislation includes the Nature Conservation (Scotland) Act and the Shellfish Order (1965). Current EC legislation considers the introduction and transmission of mollusc diseases via the movement of live shellfish, under EC91/67, as amended, and EC95/70. EC91/67 lists notifiable diseases and those shellfish species proven susceptible to them. Under Commission Decision 2003/390 EC the Pacific Oyster (*Crassostrea gigas*) is listed as non-susceptible to, and not responsible for, transmission of *Bonamia* and *Marteilia*. It is important to note that consignments of *C. gigas* must not include hitch hiker non-indigenous species which are susceptible to disease. However it is important not to import shellfish from zones infected with the diseases *Bonamia* and/or *Marteilia*. As noted above, the exception to this is *C. gigas*, which therefore can be imported, for example, from France.

Discussions with SNH regarding the acceptability of using *C. gigas* indicated that as this species is already used in Scottish waters, its further use was considered acceptable (Chris Miles and Fiona Manson, pers. comm.). A recent Defra publication (Brown *et al*, 2006) emphasises the role of shellfish farmers as the "first line of defence" against the establishment of pest species, both in terms of preventing possible introductions in the first place and both detecting and controlling infestations should they occur.

[9] See http://www.scotland.gov.uk/Resource/Doc/921/0042657.doc

The ASSG Code of Good Practice suggests a number of guidelines to reduce the impacts from introductions:

1. Comply with existing legislation regarding the introduction of new species or disease.
2. Ensure that appropriate relay permits and certification are obtained prior to moving shellfish or shell.
3. Endeavour to use native species for cultivation where possible.
4. Endeavour to use locally obtained stock whenever possible, thereby avoiding translocation of stock from one area to another.
5. Dry off and clean cultch shell obtained from an area distant to the farm locale before relaying so that any passenger species are killed off.
6. Notify FRS of any sudden abnormal mortalities in stock (>15%).
7. Notify of impending imports using form DoF14 from EU member states.
8. Apply for a licence to import shellfish from any other, or 'third' country.
9. Arrange for inspection of shellfish sites, consignments for import/export by FRS, SEERAD.
10. Contact the Fish Health Inspectorate regarding shellfish health queries or site inspection.

Box 1: Strategic Guidance Summary – Nature Conservation

- Develop the dialogue between ASSG, SAGB, Natural England and Scottish Natural Heritage in order to pursue a memorandum of understanding regarding nature conservation and shellfish production objectives at a national level. The SAGB seeks parity between the use of sites for cultivation and nature conservation. However, at a local level this may not always be possible due to potential conflicts with National and European Legislation. However this dialogue should also be further developed at a local level (perhaps by the SFP/Solway Fish and the ASSG) and should of course include SNH as well as NE.
- The shellfish industry must engage in the dialogue on marine spatial planning to ensure areas for cultivation can be identified and developed whilst recognising and acting on the importance of the natural marine environment.
- Individual applications must take account of biogenic reefs, *Zostera* beds, important scar ground and bird feeding / roosting areas when considering sites for possible development.
- Individual applications must take account of potential disturbance to birds and habitats when considering access routes. Sensitivity may change according to time of year.
- Where shellfish farms are located adjacent to sensitive bird populations, the scale and footprint of the farm should be such that it will not have a negative impact on conservation status.
- That proposed aquaculture developments should avoid important areas for feeding and/or roosting birds, thereby minimising the risk of directly or indirectly adversely affecting them.
- The demarcation of buffer zones around known important feeding / roosting areas should be identified.
- An understanding of the seasonality, diurnal timing and other visiting patterns needs to be developed to ensure that construction, operation and maintenance activities are designed to mitigate the farm's impact.
- Careful consideration of a shellfish farm's location on the foreshore, and access to and from it, is vital to assist in reducing negative bird / aquaculture interactions, which will vary according to the species being cultured and the bird species present.
- There should be a presumption against deliberate disturbance or lethal control of birds predating aquaculture initiatives.
- Adhere to the ASSG 'operational good practice' guidelines (see above) to prevent the introduction of unwanted new species and diseases.

6.2 LANDSCAPE AND VISUAL AMENITY

The Solway provides some of the most impressive landscapes in the UK. On the Scottish side there are three National Scenic Areas (NSAs) - the Nith Estuary, the East Stewartry Coast and the Fleet Valley – and much of the Cumbria coast down to Maryport is classed as an Area of Outstanding National Beauty (AONB, see Map 10). In addition, various Regional Scenic Areas (RSAs) have been designated and given protection by the DGC Structure Plan[10] - the coastal RSAs are designated for their various features, including the peninsulas, esp. with gorsey knolls and the coastal flats that include coastal plain areas, estuarine flats, intimate coastal parkland, coastal moss and merse.

It is evident from both stakeholder feedback during the preparation of this Strategy, as well as records from previous aquaculture development planning applications, that the potential impact of aquaculture upon the land and seascapes and their scenic value is a key issue in the acceptability of new farms. As a result, aquaculture development within these areas needs to be considered carefully to ensure that it does not detract from the designation features.

The following sensitivity analysis evaluates the differing sensitivity of the different 'coastal character areas' (Scott, K.E., 2004) around the Solway, working from Luce Bay in the north-west around to the Cumbrian coast in the south. This analysis focuses on the main areas where aquaculture is technically feasible to develop and, therefore, is not an exhaustive assessment of the whole coast. The main sources of information are from stakeholder feedback during the field visit as well as published literature sources. Of the latter, key sources were the NSA and AONB management plans[11] and a report by Alison Grant and Carol Anderson entitled "Landscape/ Seascape Capacity for Aquaculture' that included the Scottish coast from Luce Bay to Fleet Bay. In addition the Dumfries and Galloway 'Landscape Character Assessment' (Land Use Consultants) 1998 is another important publication.

Luce Bay: Lucy Bay is an extensive inter-tidal area (Luce Sands) contained either side by the long undulating peninsulas of the Rhins and the Machars. The shallowness of the bay, together with the extensive Ministry of Defence (MoD) use of the bay are likely to be technical constraints to aquaculture development. Furthermore, aquaculture development would impact the open expansiveness of the bay. However small-scale aquaculture might be located on the more sheltered edges at their transition with rockier headlands either side of the bay, although it is probably too exposed (see Section 7.2.1). Whilst the remote, inaccessible Sinniness Bluff is unlikely to have much potential, the more developed and regular east coast of the bay from Auchenmalg to the Point of Lag shows more potential, so long as it relates to the linearity of the coastline and is kept as close as possible to shore and away from the elevated views from the A747 (Grant and Anderson, 2004).

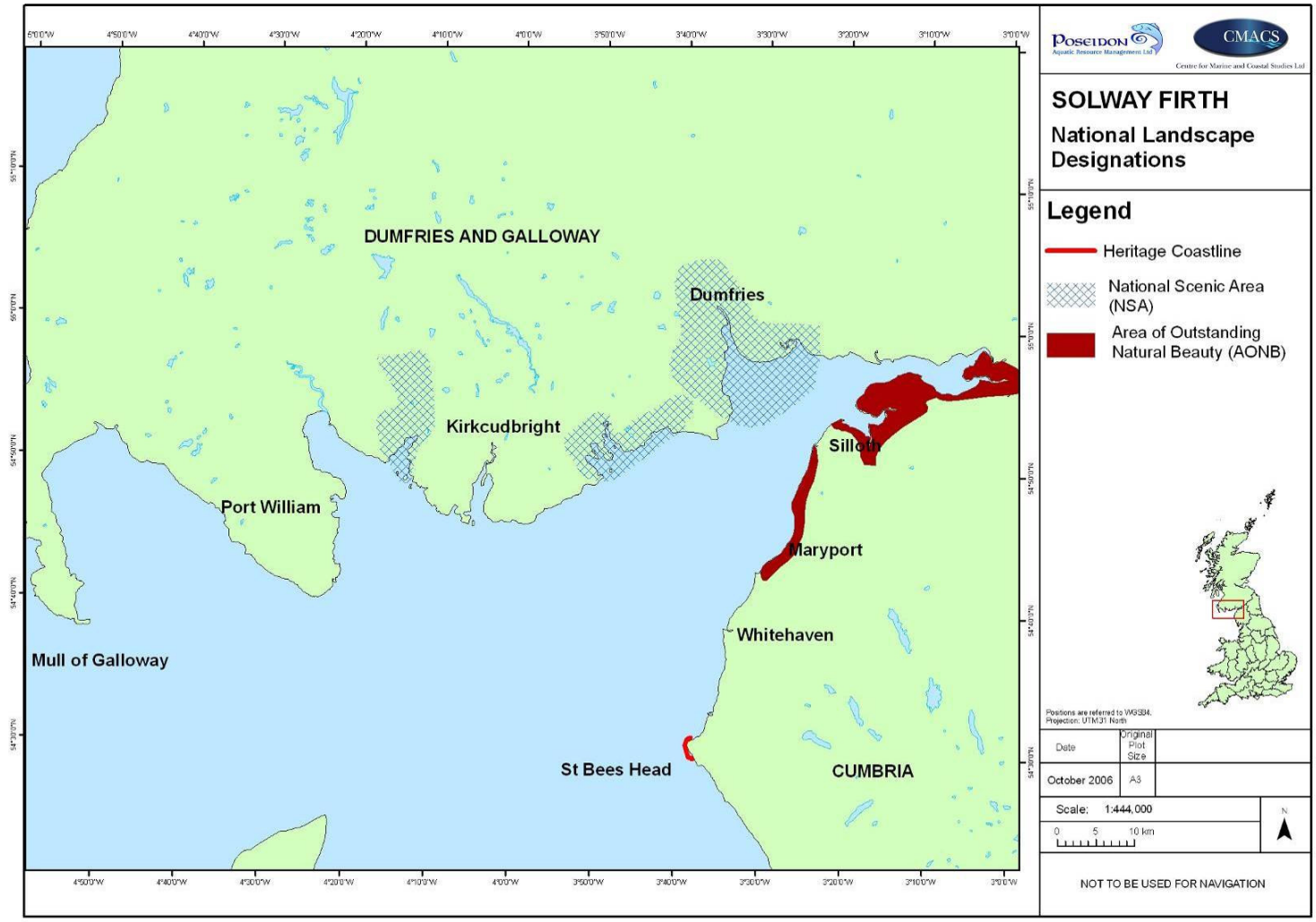
Burrow Head: this exposed headland of the Machars peninsula is rugged in character with a stepped profile of rocky raised coastal platform with long beaches of rounded pebbles and shingle exposed at low tide. This is a remote area with distant views of Ireland and the Isle of Man. For both the west and east side of Burrow Head there is a presumption against aquaculture as it would be technically challenging and contrast with the wild, elemental nature of this coast. The Machars coast RSA is mainly characterised by its peninsular nature and gorsey knolls.

West Wigtown Bay: this indented coastline forms the outside arm of Wigtown Bay. It consists of the rocky foreshore and domed cliffs that run from the Isle of Whithorn to Cruggleton which then transform to sheltered sandy bays and the harbour at Garlieston. Further north, to Innerwell, the rocky shorelines becomes more exposed with a dark coloured shingly beach.

[10] See Structure Plan Technical Paper 6 https://www.dgcommunity.net/dgcommunity/xdocuments/2364.pdf

[11] See http://www.dumgal.gov.uk/dumgal/miniweb.aspx?id=254%20 for the NSA Management Plans

Map 10: Landscape (National Landscape Designations)



Compared to many other parts of the Scottish Solway, its convoluted nature allows some scope for limited aquaculture development, although the more open Cruggleton to Eggerness Point is more sensitive to development. Furthermore, for visual acceptability they would have to stay close to shore where they can be associated with the coastal edge (Grant and Anderson, 2004) – however, this would make them unusable as they would be exposed for too long for adequate growth. Key views, notably Cruggleton Castle and the setting of Innerwell beach, would have to be avoided.

Inner Wigtown Bay and Fleet Bay: the Fleet Valley National Scenic Area (NSA) values this area's core qualities of a "diverse landscape, rising gently from coast, through valleys and hills within a very small area and valued for its harmony and timelessness". Compared to the other two NSAs, this is a compact and diverse area. The Galloway Hills RSA notes its strong and distinctive estuarine character that provides a dramatic contrast to the Galloway Hills. In particular, the Islands of Fleet that fringe the seaward edge of the NSA characterise the extensive intertidal area, which links the islands to the mainland at low tide. The narrowness of the valley, its recognised touristic and recreational value, leads to a presumption against foreshore development unless on a very small and artisanal level. The scenic quality – especially the dynamic intertidal area- and the degree to which the area is overlooked add to this conclusion. Grant and Anderson (2004) concur with this and consider that only limited potential for aquaculture development in Fleet Bay exists. In particular, the sense of space of the Martyrs' Stone at Wigtown could be degraded by aquaculture in close proximity, particularly the noise and movement associated with active management rather than the sight of shellfish aquaculture at low tide.

East Stewartry: the more dramatic East Stewartry NSA consists of shallow intertidal sand areas and rocky shorelines surrounded by dramatic coastal granite uplands. The core scenic qualities are the "sheltered, enclosed coastal landscape, valued for its peacefulness, intimacy and sea views across the Solway". The East Stewartry NSA has similar issues and aims as Nith, although does "support ongoing moves to achieve sustainable fisheries and promote acceptable working practices". It also seeks to reduce "inappropriate" vehicular access to the foreshore. The Solway Coast RSA exhibits a diverse and attractive mixture of coastal landscape types. In the west the peninsulas (with and without gorsey knolls) create rocky coastlines of cliffs, raised beaches and isolated coves, backed by smooth undulating open landscapes of improved pastures interspersed with knolly, gorsey areas. These coastlines show similarities to the northern Rhins and the Machars RSAs, but are dissected by the major inlets of Kirkcudbright Bay, Auchencairn Bay and Rough Firth.

Nith Estuary: the Nith Estuary NSA is characterised by the coastal flats of Carse Sands bordered by the estuarine flats to the west and the merse (grazed saltmarsh) to the north. The scenic qualities are summarised as "bold elemental landscape valued for its tranquillity, sense of remoteness and harmony". In addition, it is seen as a "living, working landscape imprinted with the evidence of man through its farmland to its numerous landmarks" (Nith Estuary NSA Management Strategy). Aquaculture development is not specifically mentioned in the NSA Management Plan, although concern is raised over the physical disturbance, noise and visual disturbance from tractors and lorries involved in cockle harvesting. The plan does advocate the reinstatement of maritime features such as jetties and quays, especially if they "reinforce the character" of this landscape. Therefore, appropriate scale aquaculture development would be acceptable if carefully sited.

Solway Coast AONB: stretching along the Cumbrian shore of the Solway Firth. This is a low, open and windswept AONB with wide views across to the hills of Galloway. The Solway Coast AONB has been relatively unchanged since becoming a designated area in 1964. The area covers most of the English Solway Firth coastline from Rockcliffe to Maryport, with the exception of the town of Silloth on Solway.

Physically part of the Solway Plain, the coast's characteristic feature is its continuous 7.6m raised beach. Silting along the estuary has left extensive marine deposits and the open foreshore strip now consists either of marine terrace with low, scrub-covered sandstone cliffs or undulating dunes. The falling tides expose wide sand stretches, intertidal mud-flats and, higher upstream, salt-marsh and peat moss, in a landscape with a sense of remoteness that is the essence of its value and character. With varied habitats and rich feeding grounds, the estuary is of significant wildlife importance. An over-wintering ground for huge numbers of wildfowl, the Upper Solway's flats and marshes are a Ramsar site and seals, dolphins and porpoises have been sighted offshore. Much of the foreshore has been bought, for its protection, by Cumbria County Council and conservation bodies. The area has a rich historical and cultural heritage associated with its position on the Scottish border.

The AONB Management Plan recognises the cultural importance of traditional fishing techniques such as the haaf net fishery and hand-gathering of mussels, which are being promoted as 'heritage fisheries'. However, it applies the precautionary approach whereby any new development needs to preview its acceptability before being permitted. Discussions with the AONB Management Unit (Brian Irving, pers. comm.) raised two main issues regarding potential aquaculture development, (i) the visual impact of the culture units and (ii) deterioration of coastal access points due to excessive inappropriate use (this second point is considered more fully in Section 5.6). The scale and placement of aquaculture development is critical. For instance, the existing oyster farm at Dubmill Point (three 25 m double strings of oyster baskets on a long line system) can hardly be seen against the boulder-strewn scar area some 200 m away from the high tide mark (see picture below).

Figure 5: Longline oyster farm at Dubmill Point, Cumbria

Box 2: Strategic Guidance Summary – Landscapes and Visual Amenity

- Trestles or longlines should be aligned parallel to each other to reduce visual intrusion at low tide.
- Well-ordered, consistent layout, design and materials tend to work best – new structure should use dark, subdued colours and non-reflective materials where possible.
- Inter-tidal areas with 'scar' or rocky banding will allow parallel, linear arrays of shellfish systems (e.g. long line systems) to blend into the landscape.
- Extensive dark-coloured ground may be suited to trestle-type systems.
- Low level viewpoints emphasis the horizontal dimension and foreshortened views may absorb low-lying structures; conversely high set viewpoints may be particularly sensitive to any form of development.
- Shellfish farm development may be suited to areas with some form of existing development, but must be sensitive in particular to visitor interests e.g. caravan and camp sites.
- The visual integrity of wide open areas of light coloured sand may compromised by extensive shellfish farming facilities
- Equally, small, convoluted areas with tidally-connected islands such as the Isle of Fleet may also be sensitive to development, although small-scale and appropriate development may blend in with less remote islands close to the shoreline.
- When preparing shellfish farming applications, the proponent should assess how the landscape and visual environment will change (see Appendix F). This analysis will help reduce impacts at the design stage and reassure regulators that these issues have been actively considered.
- Where trials are undertaken there should be a presumption that the materials are removed unless the trial is enlarged and still active.
- Assessments should include onshore infrastructure as well as the farms themselves.

A standard methodology used at Public Local Inquiries, would be the *Guidelines for Landscape and Visual Impact Assessment* (Landscape Institute with the Institute of Environmental Management and Assessment, 2002).

Another useful report is the *Landscape Capacity Study for Marine Aquaculture Developments in the Orkney Islands* (David Tyldesley and Associates, 2001). This includes guidelines for the siting and design of finfish and shellfish aquaculture developments, both general and specific to the Orkney coastline, with a four point scale as follows:

VHS Very High Sensitivity, aquaculture development would not be appropriate.

HS High Sensitivity, aquaculture development would not normally be appropriate in these areas.

MS Moderate Sensitivity, a single aquaculture development would normally be appropriate if carefully sited and designed.

LS Low Sensitivity, one or more aquaculture developments would normally be appropriate if carefully sited and designed but cumulative effects need to be considered.

6.3 INSHORE FISHERIES AND SEA ANGLING

6.3.1 Marine fisheries

There are a number of inshore fisheries within the Solway that might interact with aquaculture:

Brown shrimp: there are around nine English vessels currently operating in the Solway, mainly based in Silloth and Maryport. These vessels mainly fish the inner Solway and the Silloth Channel, but would not fish over the drying areas, operating mainly in water depths of 3-10 m, although this is highly variable. If aquaculture gear was placed low in the intertidal area, such as in the Bowness area, there is the potential for gear conflicts should they be placed in traditional trawl lines or insufficiently marked at high tide. Many of these shrimp boats will work cockles and mussels as well.

Cockle fishing: much of the Scottish part of the Solway[12] is covered by a Shellfisheries Regulating Order for cockle fishing (see Map 11), which is managed through the Solway Shellfish Management Association (SSMA). After a short season of fishing in early 2006 the SSMA, following a number of scientific assessments, reopened the fishery to licence holders on 13th November 2006. The commercial biomass is located on the larger grounds (see Map 12) with over 63% on the North Bank, 23% on Barnhourie, 11% on Wigtown, and about 3% shared between the smaller grounds (Davis *et al*, 2004). However, much of the presently closed area has yet to be surveyed and the current zoning plan is subject to change (Stephen Alexander, pers. comm.). The English cockle fishery is smaller – there is a TAC for around 400 tonnes which is not usually completed and gathering is limited to mobile gears as the densities are loo low for hand-gathering (Dave Dobson, CSFC, pers. comm.).

Mussel gathering: in contrast to the cockle fishery, mussels are mainly gathered on the English side of the Solway. They are mainly found in the more saline waters to the west of Port Carlisle. They are captured through a combination of hand-gathering and dredging of seed, especially in the Silloth Channel.

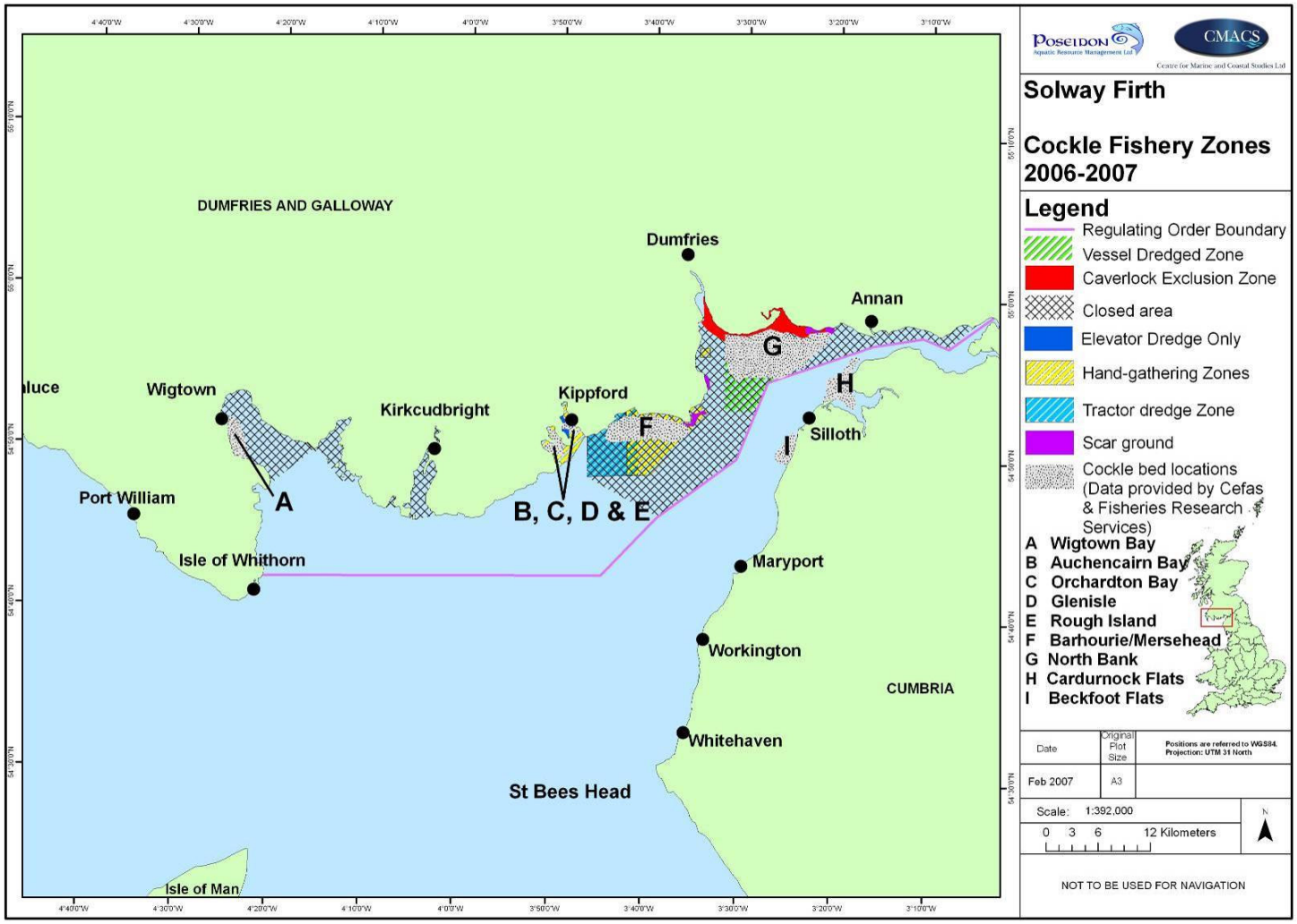
It is important that the Strategy recognises the needs and sensitivities of the wild fishery[13] and that guidance is consistent with the sustainable management approach of SSMA. This includes the current spatial zoning plan that includes closed areas (mainly *Zostera* beds and scar/reef areas), gear-restricted areas (hand-gathering, tractors and vessels) and an exclusion zone that is based on the high level of ecological sensitivity of the inner Solway from the Caerlaverock NNR eastwards. In general, hand-gathering areas need higher cockle densities than tractor raking, which in turn require appropriate access points.

To date, given the limited development of both cockle gathering and shellfish aquaculture, there has been limited interaction between the two industries. However, discussions with stakeholders indicated that there are a number of potential conflict areas, as well as development synergies (see Table 10).

[12] Isle of Whithorn to the medial line between Scotland and England at the confluence with the River Esk

[13] Wild fisheries presume that there are no human intervention or husbandry efforts in developing the stock; aquaculture infers that the stock is re-laid or reared with human assistance and that ownership of the stock is conferred through a Several Order or other legal mechanism.

Map 11: Cockle Fishery Zones 2006 – 2007



Map 12: Cockle Bed Locations in the Solway

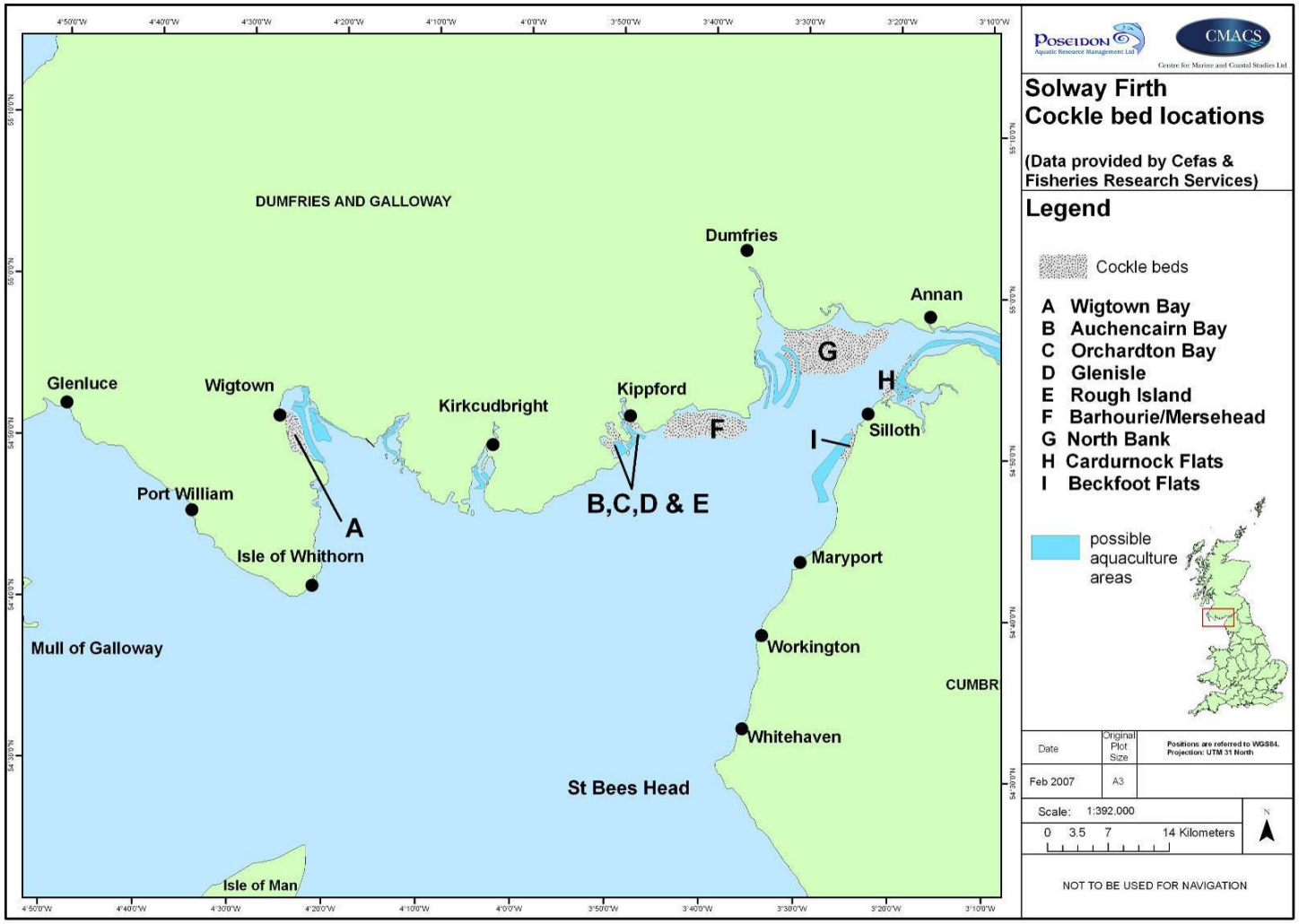


Table 10: Potential conflicts and synergies with wild shellfish gathering

Potential conflicts	• Ownership of cockle stocks on privately owned land, especially where the land owner is developing a combined wild harvesting and aquaculture Strategy • Theft of stock, especially by illegal or unlicensed cockle gatherers • Disagreement over the maintenance of access points by shellfish gatherers and aquaculturists
Potential synergies	• Coherent spatial zoning at both strategic and local levels • Agreeing and maintaining joint shore access agreements, inc. maintenance and environmental impact assessment (EIA) • Sharing of port infrastructure, particularly at Kirkcudbright • Contribute to value adding through joint processing and marketing initiatives, including a regional seafood brand

Static gear: there is a creel fishery in Luce and Wigtown Bays targeting lobster, whelks, crabs and nephrops. This is a year round fishery (with the exception of whelks), with most of the boats based in Garlieston, Isle of Whithorn and Port William. There are around 30 full-time creel fishermen in the Scottish side of the Solway, although there may be many more part-time fishermen joining in during the summer months. Most creels are laid in 2-35 m water depth (below the low water mark) and are thus unlikely to conflict with aquaculture, although gear conflicts with super crabbers is known (Static Gear Fishermen's Association, pers. comm.).

Other marine commercial fisheries: Kirkcudbright is home to a fleet of 18 scallop boats employing around 100 crewmembers and a processing plant which employs 200 full and part time workers. In a community with a total population of approximately 3,500 inhabitants, the scallop fishing industry makes a major contribution to the local economy. Interaction with aquaculture is unlikely – Scottish byelaws prevent vessels >12 m from entering in the bay areas whilst English bylaws prevent vessels >15 m from fishing within 3 nautical miles of the shore. Again, there are reports of vessels infringing these rules and fishing close to the shore, so both the charting and clear marking of vulnerable aquaculture structures would be required.

Recreational sea angling: Boat sea angling in the Solway provides the highest spend of around £1,350 per person per year, sailing second and shore-based sea angling third at £861 (Land Use Consultants, 2006). The Solway has, for many years, been noted for its variety of species on offer. Marks such as the Isle of Whithorn, Abbeyhead and Borness produce dogfish whilst Balcary Rocks is renowned for its large cod. The river estuaries can produce flounder along with the occasional bass. The majority of the angling activity in conducted in Luce Bay and to the west of the Mull of Galloway, with declining levels as one moves further east to the Inner Solway.

The potential for conflict with anglers stems mainly from competition for the foreshore. This is particularly acute for traditional angling competition marks that might extend a considerable way along a beach. For instance, a 200 m corridor has been used for a winter league shore competition down the west side of Kirkcudbright Bay (see Figure 6 overleaf) and was an important reason for a shellfish farming application for the same location being refused.

Figure 6: Sea angling competition mark at Kirkeoch, west side of Kirkcudbright Bay

Box 3: Strategic Guidance Summary – Marine Capture Fisheries and Recreational Fishing

Marine fisheries

- There is potential for resource access conflicts between aquaculture and wild cockle gathering, esp. hand-gatherers – it is important that liaison with SSMA licensee, SSMA management and SFPA staff[14] reduces the potential and causes for such conflict.
- Options for conflict resolution should be explored with the emerging Inshore Fisheries Group (Scotland).
- Where possible and especially when competing for the same species, wild fisheries and aquaculture should be spatially separated.
- Spatial zoning for aquaculture and the Regulating Order management plan be agreed at both strategic and local levels.
- Joint shore access agreements via public and private access points need to be developed together with the participation of both the relevant authorities and landowners. These agreements should cover the level of traffic allowed, restrictions (e.g. time, vehicle type and specification, etc), maintenance sharing where necessary and the preparation of environmental impact assessments (EIA).
- There is scope for managed wild shellfisheries and aquaculture to jointly contribute to value adding through shared processing and marketing initiatives, including a regional seafood brand.

Recreational angling

- Narrow estuaries with a short foreshore and ready access to roads should be considered as potential recreational fishing areas. Discussions with local angling clubs should be conducted to ensure these are not regular match fishing marks and to determine whether any compromise can be reached. That some shellfish farm designs might attract angling species should be considered in this process.
- Sub-tidal or inter-tidal aquaculture structures should be well marked to ensure they do not pose a navigation risk to boat angling.
- Reference should be made to the new SFP Recreational Sea Angling booklet.

[14] Other law enforcement agencies include the Police, the Gangmasters Licensing Authority and HM Revenue and Customs.

6.4 TOURISM AND RECREATIONAL USE

The Solway coast is seen as a key asset in the draft Area Tourism Partnership Plan. The Solway has around about an 8% share in the Scottish coastal recreational sector (Land Use Consultants, 2006). This recent report showed that the most popular form of recreation was walking along the Scottish Coast with around 17% of all specialist recreation activities comprising walks of more than five miles. Sea angling (11%) and shoreline angling (10%) were the next most popular activities, between them accounting for over 21% of all recreation activities recorded in the survey. Sailing accounted for almost 10% of activities, kayaking and canoeing for 8%, and bird watching and wildlife watching for 8%. Cycling, sub-aqua/snorkelling and climbing/bouldering each accounted for between 5 and 7%. Other activities including bird-watching, surfing, speed boating (including the use of personal watercraft), fossil hunting, windsurfing, kite surfing, horse riding, land yachting, metal detecting and motorbike scrambling/4x4 off roading each accounted for less than 3% of all recorded activities.

The Destination Management Plan for Cumbria 2007/08 (DMP), which can be viewed at http://www.cumbriatourism.org/destination, provides the strategic basis for tourism development activity in Cumbria and has been agreed by a wide range of public and private sector partners.

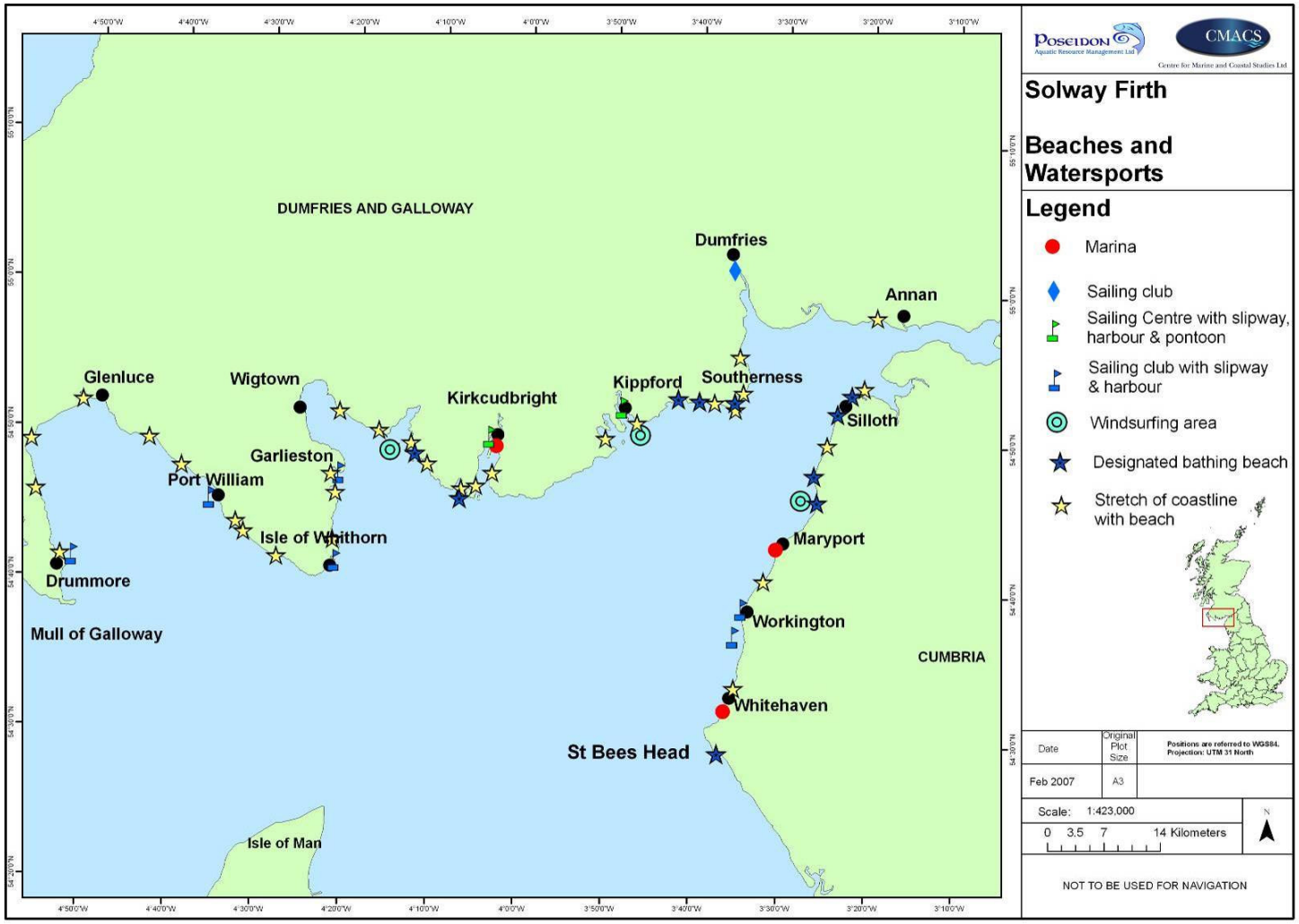
Map 13 shows the distribution of beaches and water sports centres around the Solway. Sailing – mainly dinghies in the Scottish bays and estuaries – is particularly focused in areas of interest to aquaculture. The current Clyde Cruising Club 'Sailing Directions' for the Solway and the Clyde do not include warnings for aquaculture installations, unlike other volumes in this series, with the exception of Loch Fyne, they are not common in these areas. Discussions with various sailing clubs indicated that most sailing takes place in deeper waters, with dinghy sailing most active at the top of the tide. The Solway offers only a few secure deep water anchorages but many well sheltered drying ones, thus presenting the potential for conflict between shoal draft boats (the majority of Solway-based boats are either centreboard or bilge keelers) and shellfish farms. It is therefore possible that there may be navigational issues over aquaculture structures placed low on the foreshore. This was particularly important for narrow estuaries and bays such as the Fleet, the Dee and the Urr that provide safe refuge from the prevailing S to W winds for shoal draft boats. However, with good quality buoy marking and appropriate consents regarding navigation as discussed in Section 2.1.2, they considered this was a manageable issue (John Wilson, Commodore Solway Yacht Club, pers. comm.). The Clyde Cruising Club have stated that they would be happy to publish information concerning the location of farms and reserved areas for anchoring etc, in their Sailing Directions. They also mentioned that their biggest problem on the west coast is in keeping the information up to date as aquaculture units are frequently moved and emphasise that satisfactory marking and buoyage is vital (pers. comm., Edward Mason, editor of the CCC's Sailing Directions).

Other forms of recreation are less likely to directly conflict with inter-tidal aquaculture. However, it is important to recognise that beach users and recreation associated with the inter-tidal area will need to be consulted on the visual and possible infrastructural conflicts with aquaculture development.

Box 4: Strategic Guidance Summary – Tourism and Recreation Use

- Consultation with local sailing and boating interests will identify frequent boat passage, anchoring, regatta marks or shore access points. These will indicate the sensitivity to sailing interests and the degree of site marking necessary e.g. buoys, lights, etc.
- Information on aquaculture installation location is forwarded to the Clyde Cruising Club for inclusion in their 'Sailing Directions' and updated as necessary.
- In general, aquaculture should avoid sites which are frequently used for recreational or competitive sailing courses which may be submerged during the upper half of the tide.
- Other foreshore recreational uses, such as bird watchers, walkers, sun bathers and other user groups should also be consulted. This should cover infrastructural development, access and operational use.

Map 13: Beaches and Water Sports



6.5 CULTURAL HERITAGE

The area's cultural heritage reflects a long and complex pattern of settlement and communication, particularly sea borne transport. More recent history has given us the traditions associated with the turbulent history of the National Border and the Debatable Lands. The Solway coast is dotted with scheduled ancient monuments, castles and coastal gardens that both enhance the life of the residents and provide a focus for the region's tourism industry. In addition, the haafnet, stakenet and the hand-gathered mussel fisheries are all considered 'heritage' activities both sides of the border.

The aquaculture development needs to be receptive to this existing heritage and ensure that it does not unduly compromise its integrity. Some areas, such as the foreshore around Caerlaverock as well as the Isles of Fleet (owned by the National Trust for Scotland) are particularly sensitive to foreshore development (Karl Mundy, NTS Senior Ranger, pers. comm.). Furthermore, if planned in an appropriate fashion, aquaculture can add to the sense of purpose and heritage as demonstrated by oyster culture in rural France, which is now 'part of the landscape' and an attraction in its own right.

Box 5: Strategic Guidance Summary – Cultural Heritage

- If aquaculture development might affect scheduled heritage sties – either directly or in terms of visual impact – proactive measures to mitigate these impacts are the responsibly of the developer. Approaches to assess and reduce landscape impacts are provided in Appendix F).
- In particular, aquaculture development should limit disturbance to traditional fishing such as haaf netting, if necessary through spatial zoning.
- The scale and design of the farm should be appropriate to the setting (see also Section 6.2 above).
- Proposals must take full account of local and national planning policies in regard to avoiding direct, indirect and cumulative impacts on cultural heritage assets. The planning authority may assess any proposals against these policies.

6.6 ACCESS AND SUPPORT INFRASTRUCTURE

Together with nature conservation and landscape issues, foreshore access and other infrastructure requirements of aquaculture are of most concern to planners. Foreshore access can be sub-divided into two separate issues, (i) the point of entry or ramp onto the foreshore and (ii) the passageway across the foreshore itself.

Point of entry: access to the foreshore is restricted by the limited number of entry points due to terrain obstruction, restrictions to private land and reduced access across environmentally sensitive areas such as SSSIs. European sites are also limited in terms of the numbers of usable access points. As a result, access points are often heavily used by a variety of different users, including farmers, wildfowlers, walkers, water sports participants as well as wild cockle gatherers, resulting in high levels of traffic, noise and wear of what is usually an unmetalled surface. In terms of aquaculture, as culture sites are usually located with the agreement of the landlord, access permissions are rarely an issue. However, conflicts might arise when (i) the nearest access point may be unusable if it results in passage across environmentally sensitive foreshore areas and (ii) in agreeing a fair contribution to access point road maintenance (see box overleaf).

Box 6: Access Agreements with the Regulated Wild Cockle Fishery

"Tractor dredge fishermen and hand-gatherers will be encouraged to negotiate their own access points for their vehicles (hand-gatherers' vehicles and tractors) privately with the relevant landowners. Information on these access points must then be passed on to the Regulating Body. The Regulating Body will investigate whether the use of the access points is likely to cause any problems for residents, wildlife or public amenity in the area. The Regulating Body may then attach special conditions to the use of a designated access point, such as rotational access points or daily time restrictions (Sections 5.1.7 and 5.1.9.iii). Assistance and guidance on these measures will be sought from relevant bodies such as the Scottish Fisheries Protection Agency."

Source: Draft SSMA Regulating Order Management Plan

Passage across the foreshore: passage across the foreshore usually requires an all terrain vehicle, mainly tractors, quad bikes or 4x4 vehicles. This might have implications in terms of bird disturbance and damage to the substrate as well as disturbing the 'wilderness' element of the inter-tidal zone. Aquaculture has the advantage, when compared to many other users, of permitting an orderly and manageable visit schedule to farm sites, and thus has the potential to mitigate its activities.

Support infrastructure: compared to finfish farms, there is relatively little immediate infrastructure support needed for shellfish farming e.g. feed storage and delivery. Product depuration and post-harvest sorting can be conducted off-site. Stock grading and equipment cleaning may be conducted on site but requires little specialist equipment or power.

Box 7: Strategic Guidance Summary – Access and Support Infrastructure

- In selecting sites, the location of the foreshore access point and potential sensitivity of the subsequent route to the farm should be assessed. Where possible, designated nature conservation and other protected areas should be avoided.
- The development of aquaculture that will share access points with other users will need to consider how conflicts might be reduced through sharing agreements and conflict mitigation approaches e.g. designating different times for usage, avoiding sensitive areas such as scar grounds.
- Where possible, avoid sensitive areas such as *Zostera*, *Sabellaria* and scar grounds.
- In order to reduce disturbance to wildlife, transit routes should avoid recognised bird feeding or roosting habitats.
- Options for conflict resolution should be explored with the emerging Inshore Fisheries Groups (Scotland).

6.7 WATER QUALITY

6.7.1 Radioactivity

The Solway has two nuclear power stations located both within, and adjacent to, the Strategy area – *Sellafield*[15] (fuel reprocessing at the Magnox Reprocessing Plant and the Thermal Oxide Reprocessing Plant, THORP) to the south and *Chapel Cross* (Magnox Nuclear power station) at Annan.

- Sellafield: The 'Sellafield Coastal Area' extends 15 km to the north and to the south of Sellafield, from St Bees Head (the southern limit of the Strategy area) to Selker, and 11 km offshore. Following the agreement of Ministers, the Environment Agency issued a new Sellafield authorisation, which came into force on 1 October 2004 which reduced the limits on atmospheric and liquid discharges for most radionuclides. Concentrations of caesium-137 in 2005 were generally similar to those in 2004 and generally reflect progressive dilution with increasing distance from Sellafield.
- Chapelcross: Electricity generation ceased in June 2004 and the station has been preparing for decommissioning. Gaseous wastes from the site are discharged to the local environment and liquid waste is discharged to the Solway under authorisation from the Scottish Environment Protection Agency. Concentrations of artificial radionuclides in marine materials in the Chapelcross vicinity are mostly due to the effects of Sellafield discharges and are consistent with values expected at this distance from Sellafield (see table below). Concentrations of most radionuclides and gamma dose rates in intertidal areas remained at similar levels to those detected in recent years. Since 1992, a number of particles have been found at the end of the discharge outfall. Most of these particles are limescale and originate from deposits within the pipeline – a planned filter system has yet to be installed.

Table 11: Concentrations of transuranic radionuclides in shellfish and fish from the Solway, 2005

Location	Material	No. of ob's	Mean radioactivity concentration (wet) Bq kg^{-1}						
			^{237}Np	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Pu	^{241}Am	^{242}Cm	^{234}Cm+ ^{244}Cm
Whitehaven	Cockles	1	-	0.00072	0.0052	-	0.0041	-	0.0001
Whitehaven	Mussels	1	-	0.00033	0.0029	0.086	0.0029	-	0.00001
Maryport	Plaice	4	-	-	-	-	<0.22	-	-
Silloth	Mussels	1	-	0.70	3.8	-	7.0	-	-
Silloth	Shrimps	1	-	0.0056	0.030	0.23	0.0059	-	0.00005
Inner Solway	Shrimps	1	-	0.0022	0.011	-	0.024	-	-
Inner Solway	Plaice	1	-	-	-	-	<0.17	-	-
North Solway	Winkles	2	-	0.28	1.4	14.0	3.3	0.0064	0.0058
North Solway	Cockles	2	-	0.76	4.2	30.0	10.0	-	0.015
North Solway	Mussels	2	-	0.56	3.0	29.0	7.0	0.0083	0.0058
Southerness	Winkles	4	-	0.18	1.4	-	2.5	-	-
Kirkcudbright	Scallops	2	-	0.037	0.21	-	0.11	-	0.00006
Kirkcudbright	Queens	2	-	0.0012	0.060	0.11	-	-	0.00017

Source: CEFAS, 2006

[15] The Calderhall nuclear power plant ceased generating in 2003

In general, exposure in the UK is generally well below the limits. There has been a lot of research on shellfish consumption from the Solway, which probably accounts for the highest risk and most studied region (for dietary sources), due to Sellafield and plumes from other industrial processes. Natural radionuclides are the most important source of exposure in the average diet of consumers. Man-made radionuclides contributed less than 5% of the dose.

Habits surveys have been used to investigate aquatic and terrestrial exposure pathways. A habits survey was conducted during July 2005. This survey confirmed the existence of local fishermen who eat large quantities of local seafood and are also exposed to external radiation whilst tending stake nets. The dose to the critical group of fishermen who consume seafood and are exposed to external radiation over intertidal areas was 0.018 mSv in 2005, which was less than 2% of the dose limit for members of the public of 1 mSv[16].

Box 8: Strategic Guidance Summary – Radioactivity

- Although local discharges have ceased, given that the Solway may act as a deposition area for radionuclides originating from Sellafield, it is suggested that new sites should investigate local radionuclide levels in the foreshore substrates as part of the site selection process (Paul Dale, SEPA, pers. comm.).

6.7.2 Pathogens

The *Shellfish Harvesting Waters Directive* (EC 91/492) aims to classify waters in order to prevent viral contamination from human sources. Water classification uses the indicator *E coli*, which can also originate from livestock that are not contaminated by virus. Shellfish can be marketed directly from Class A waters, but can only be marketed from Class B waters after depuration in an approved plant. Therefore, such facilities need to be accessible to developers. Shellfish from Class C waters can only be marketed after relaying in Class B waters, followed by depuration, which all adds to costs. Shellfish must, in any case, meet end-product standards for microbiological quality. Sites are tested periodically by Environmental Health Departments of local authorities, passed to CEFAS (in England) and FRS (in Scotland) for interpretation and then Food Standards Agency reviewed classification annually. The current classification of sites in England is 3% Class A, 85 % Class B (of which 60% are based on a long term series of results), and 9% Class C sites. In Scotland, over 30% of designated shellfish harvesting waters currently provide Class A products, with 50-60% Class A for much of the year.

Under the *Designated Shellfish Growing Waters Directive* (EC 79/923), shellfish waters can be designated to ensure their long term quality status. The EU standard for designation is directed to achieve the equivalent of Class A, but the England and Wales target has been set at Class B. It is difficult to maintain even this standard, because periodic bursts of diffuse pollution that are difficult to trace and manage (e.g. from storm water overflows) produce high *E. coli* counts that lead to downgrading. Such seasonal classification changes complicates commercial decision-making (Doug McLeod, ASSG, pers. comm.).

The *Water Framework Directive* (EC 60/2000) aims to establish *River Basin Management Plans* by 2012 to achieve 'ecological status', or where that is not feasible, 'pristine status'. This would have considerable benefit for the shellfish industry. The Growing Waters Directive will then be subsumed. The Directive also has provision to create protected areas for economically important aquatic animals.

[16] The prescribed EU annual dose limit is 1 millisievert (mSv) per year for members of the public from non-medical sources of radioactivity. For naturally-sourced radioactivity there are no legal dose limits.

The industry is concerned that (CEFAS, 2006):

- major retailers already have a policy to buy shellfish from Class A waters only,
- sites downgraded on the basis of individual rogue results take a long time to be upgraded,
- testing standards may differ in other EU countries, where sites are mainly graded as Class A (some UK shellfish from Class B waters are reported to have been exported to the continent, and then imported back to the English market as originating from Class A waters).

The main emphasis on shellfish waters classification on the Solway has been in respect of cockles. Various sites from Wigtown Bay eastwards are classified as B grade. There is also a B grading for mussels at Rockcliffe in Rough Firth. On the English side there are various B gradings for mussels related to the natural beds near the Silloth Channel (see http://www.food.gov.uk/multimedia/pdfs/classshellscot0806.pdf for the Scottish designations, http://www.food.gov.uk/multimedia/pdfs/shellprodenglandwales0607.pdf for the English ones).

Box 9: Strategic Guidance Summary – Pathogens

- In consultation with the SSMA, develop a Solway 'Local Action Group' to engage with water classification issues with SEPA and Defra.
- Continue the dialogue between ASSG, SAGB, the testing laboratories, and FSA and FSA Scotland.
- Pursue investigation of whether there are significant differences in the standards that are applied to testing and classifying waters in UK and Europe.
- Explore what further research is needed/possible on the difference between *E. coli* from human and agricultural sources.
- Develop a longer term Strategy for this issue.
- The shellfish industry must engage in the dialogue on long term water classification through their Local Action Groups.
- Develop integration plans for generic management of pollution incidents.
- Develop a longer-term approach to integrating the aquaculture Strategy with River Basin Management Plans under the forthcoming Water Framework Directive.

6.7.3 Naturally Occurring Biotoxins

Shellfish harvesting is prohibited when the biotoxins responsible for PSP (Paralytic Shellfish Poisoning), DSP (Diarrheic Shellfish Poisoning) and ASP (Amnesic Shellfish Poisoning) exceed set thresholds during algal blooms. This has caused the closure of scallop fisheries in Scotland, and periodic stoppage of sales in England due to DSP in cockles, oysters and mussels. Cultivators accept the need to protect the public, but have been seriously affected by the financial losses occasioned by false positive results. These appear to have been caused by putrefaction products in samples sent by post, and by technical weakness in the testing methodology, which have required considerable effort by the SAGB to investigate.

Box 10: Strategic Guidance Summary – Naturally Occurring Biotoxins

- The industry must continue to insist on the adoption of best-practice in testing and incident-management.
- The dialogue between SAGB, FSA, FSA Scotland and CEFAS must be developed.

7 STRATEGY ELEMENT 2: OUTLINE ZONING PLAN

7.1 DEVELOPMENT OF A ZONING PLAN

Section 3 of this Strategy document described the various cultivation systems that might be applicable to the Solway coast and their physical needs in terms of degree of shelter, position on the foreshore, substrate type, tidal current and exposure, water quality and salinity regimes and so on. Section 6 assessed the various existing uses and issues along the coast and how they might interact with aquaculture. This current section brings these two themes together to define the locations for possible aquaculture development.

The zoning plan has consisted of two steps:

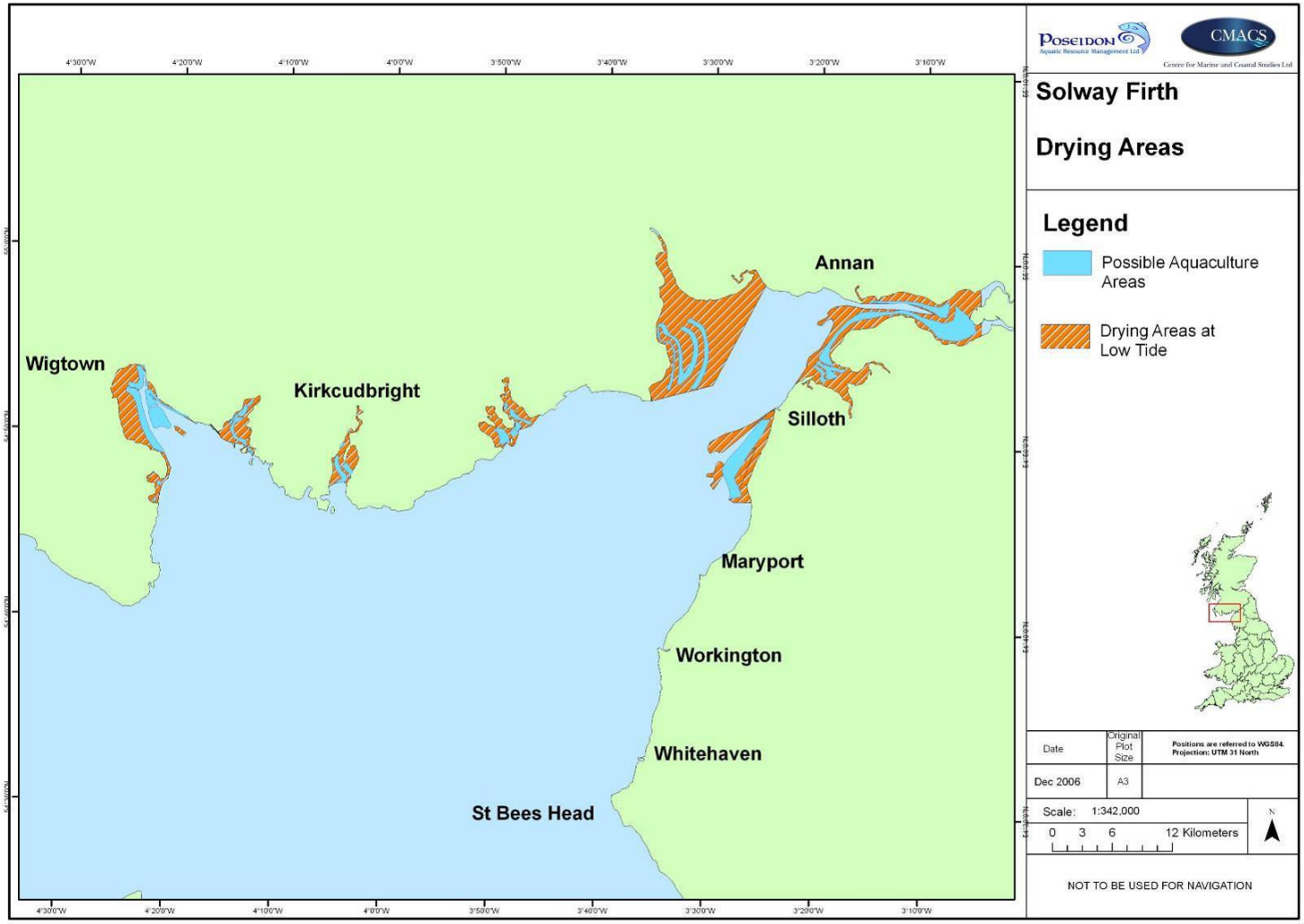
1. Firstly, in each main bay system the total area that has physical potential for aquaculture has been defined. These areas are predominantly *the lower third of the intertidal zone* and the areas have been estimated from interpretation of the somewhat limited information on drying heights on the Admiralty charts (see Map 14 overleaf). This has been supported by site inspections in the majority of cases, though the limited time resource for fieldwork limited this to inspections from the shoreline in some areas. It was only possible to conduct better "walk-over" inspections at the time of low water at three locations. Therefore, the areas defined as having physical potential should be treated as indicative only and any production project under consideration should obviously make their own, more detailed survey of sites, exposure, elevation etc. before going ahead.
2. Secondly, an assessment of the extent of aquaculture development that would be appropriate in each bay system has been defined. This has followed the logical system of gauging impact of area occupied by aquaculture as a proportion of the total drying area in a bay as set out in the report on visual amenity (Grant and Anderson 2004). That system defined scale of aquaculture development relative to its surroundings as follows:

    - **Small scale**: oyster trestles which occupy up to one tenth (10%) of a bay when the intertidal is revealed at low tide
    - **Modest scale**: oyster trestles or similar which occupy up to one quarter (<25%) of a bay when the intertidal is revealed at low tide
    - **Large scale**: oyster trestles or similar which occupy more than one quarter (>25%) of a bay when the intertidal is revealed at low tide.

This system of scaling is felt to be the most appropriate as it allows any development to be considered in proportion to its setting. The cut off points between small, modest and large are logical and in line with what might be considered as small, modest or large development elsewhere in the UK, although this system has not been used to scale or limit development elsewhere to the consultant's knowledge.

It should be noted that the Grant and Anderson study considered only (i) oyster trestles and (ii) visual amenity. This Strategy considerers other culture systems as well as interaction with a wide range of uses. It is true to say that potential developments may well include oyster trestles, though other systems using on-bottom culture (mussels, possibly clams) have much lower visual impact as the stock is simply placed on the bottom and left to grow. Sowing and harvesting can be either by hand and vehicle for low volumes or by dredging vessel for higher volumes. Arguably, bottom growing should not be scaled by this system. It is reasonable to assume that BST long-lines have roughly equivalent visual impact as oyster trestles. However, given the approximations involved in defining areas with physical potential for production, for simplicity, this study follows this system of scaling for all species and production systems.

Map 14: Drying Areas in the Solway



It should also be noted that this Strategy does not simply follow the recommendations of the Grant and Anderson study with respect to acceptable scales of development in each bay. As mentioned above, this study considers other impacts apart from merely visual and the study cited only covered Luce Bay to Fleet Bay, a relatively small part of the Solway. Given the relatively small number of bays under consideration, and the individual nature of each, the team have allocated acceptable scales of development on an individual basis rather than against strict criteria. However, there is an automatic presumption for "small" scale where a bay system includes a SSSI or is within a National Scenic Area. Given the sensitivity of the whole of the Solway coast from many perspectives, no area has been deemed suitable for "large" scale development, i.e.>25% of a bay area potentially taken up with production facilities.

The proportion of drying area acceptable for production is then compared, both the total drying area and that part of it judged to have physical potential. If the area with physical potential is larger than the area of "acceptable" impact as defined above, then it can be assumed that the development could take place at one or more locations within the potential area. If the area with physical potential is smaller than the area of "acceptable" impact, then clearly any development will be limited to that location alone.

This is discussed bay by bay below.

7.2 ZONING PLAN

7.2.1 Luce Bay

This Bay is wide, very open and exposed and is considered unsuitable in physical terms for any form of aquaculture.

7.2.2 Wigtown Bay

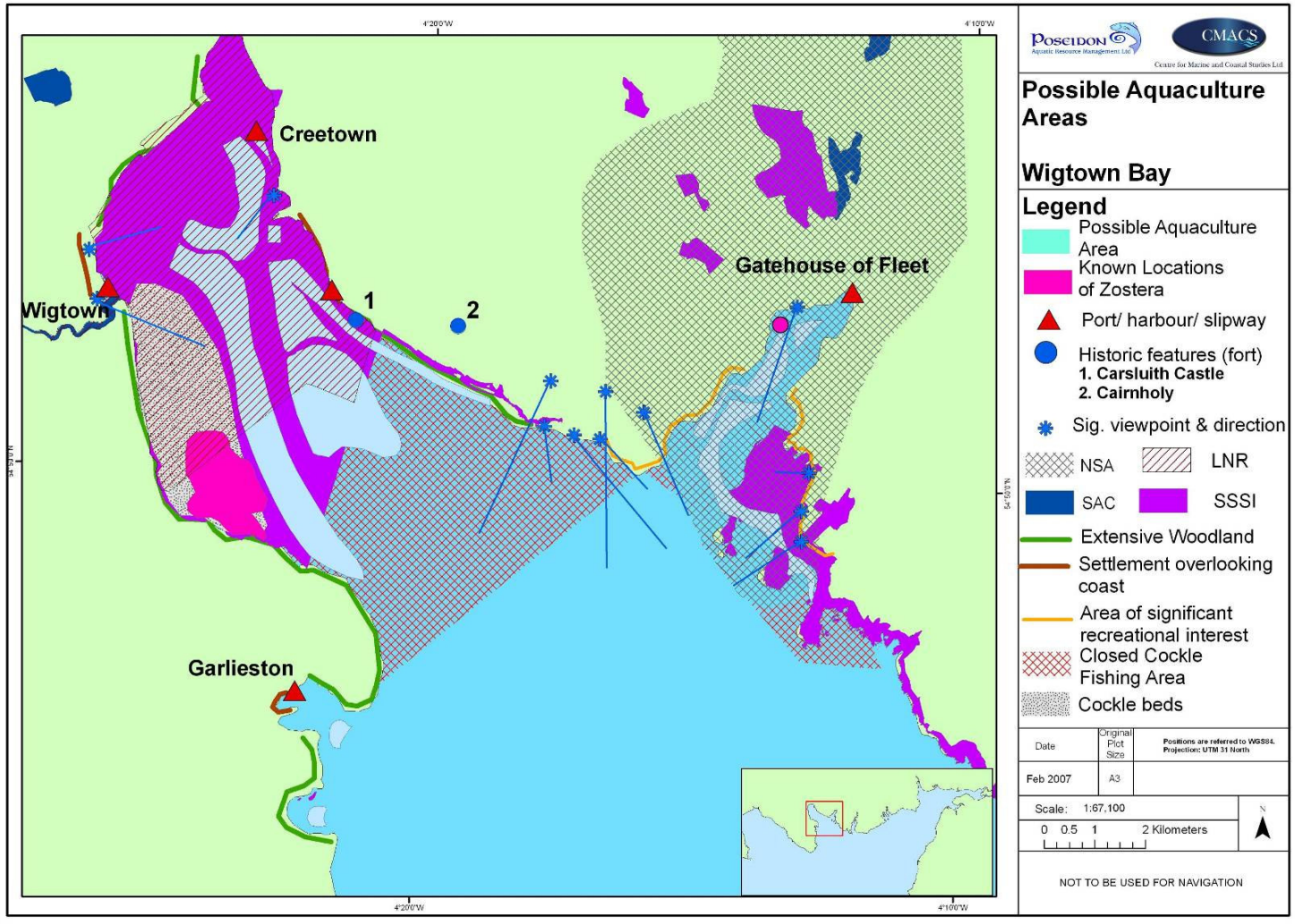
Physical potential

This bay is less open than Luce Bay with large drying areas that are sheltered from prevailing westerly winds and waves.

The demands of the species involved mean that the growing sites are roughly on the lower one third of the beach. The western side of the bay is considered to have quite large physical potential. The extensive flat areas with gentle gradients (as far as can be determined from the charts) suggest that there could be an extensive area suitable for cultivation running parallel to the main channel of the River Cree. There are small pockets with potential in the lower parts of Garlieston and Rigg/Cruggleton Bays. There are also banks in the centre of the Wigtown Bay where the Cree channel divides, though this is perhaps more exposed than the sides of the channel further into the Bay. Access to the banks would have to be by boat or amphibious vehicle because of the channel.

The eastern side is more restricted due to the sharper gradient. Nevertheless, there are some limited areas on the lower intertidal, predominantly to the south-east of the large jetty at Kirkmabreck, as far as Ravenshall Point. There is a small trial production site working with mussels on trestles just south of Creetown.

Map 15: Possible Aquaculture Areas: Wigtown Bay



Scale of development

Overall this area is judged as suitable for **small scale** development.

Wigtown Bay has a number of designations (see Map 15 on previous page), mainly for its saltmarsh habitat, winter assemblages of non-breeding birds, mudflats and sparling. Much of the inner part of the bay which contains significant areas with physical potential is a SSSI, the main designation feature being over-wintering geese. There are two valued viewpoints out of the Wigtown area. The area is also a Local Nature Reserve which essentially gives the Dumfries and Galloway Council powers to limit activities in the LNR through a permit system, underpinned by byelaws. This was established mainly to regularise the wildfowling situation. Nevertheless aquaculture probably could co-exist with these designations and uses, given careful planning and management. The Bay is an extensive area, around 4 km or more wide for the most part and small scale-development on the lower intertidal will not be visually intrusive, although care should be taken so that it avoids unnecessary impacts and disturbance on foraging areas for waders and wildfowl in winter. As the table below shows, small scale development would allow up to some 2.9 km^2 of production. The actual location of such production should be determined on a case by case basis on individual merits. Any production is recommended on a trial scale in the first instance and so this offers scope to resolve detailed locational issues and any issues over access and management. The area viewed as acceptable is only around one quarter of the total area with physical potential and so there should be scope for determining a location that is acceptable in terms of its physical characteristics and to other stakeholders.

Table 12: Wigtown Bay: Summary of Development Potential

Estimated drying area (km^2)	28.7
Potential aquaculture area (km^2)	12.1
Potential aquaculture area as a proportion of the total drying area (%)	42
Allocated limit (% for small-scale)	10
Acceptable for development (km^2)	2.9

7.2.3 Fleet Bay

Physical potential

Fleet Bay is small and south-west facing, but the land mass on the opposite side of Wigtown Bay down to Burrow Head means it enjoys a reasonable degree of shelter from approximately west-south-west clockwise.

The Islands of Fleet also provide shelter to the drying areas behind them. The drying area is understood to be sand or firm muddy sand and appears to be generally suited to trestle culture or bottom culture. The Admiralty charts give almost no indication of drying heights so the areas marked as having physical potential are estimates and are assumed to be the lower shore following the Water of Fleet.

Scale of development

Fleet Bay is protected under several designations. It is a National Scenic Area and views from many vantage points and the caravan parks on both sides are highly valued. The caravan sites give rise to significant tourism use of the bay in summer. Significant facilities such as trestles and people working them would detract from enjoyment of the area at low tide. Presence of holiday makers may even give rise to stock interference or theft.

Much of the eastern side of the Bay is a SSSI. The Islands of Fleet are owned by the National Trust for Scotland and as such are viewed as particularly sensitive to any development in the intertidal area.

As discussed in section 5, the Grant and Anderson (2004) report suggests that there could be some very limited aquaculture development in association with the shoreline and the rocky outcrops on the north-west corner of Fleet Bay. This is dismissed here, as the areas would be very small and have to be at a high level on the beach to have the minimal impact described. This is unlikely to be suitable for proper economic activities and given there are much more suitable areas in the wider Wigtown Bay adjacent, it is difficult to see justification for development here. A previous application for shellfish culture sites in the Isle of Fleet and Milton Sands was rejected on the basis of its impact on tourism and that it would have prevented use of the area as a safe anchorage point in bad weather.

Therefore, in spite of the physical potential, for the purposes of this Strategy it is recommended that Fleet Bay is considered as **unsuitable for development** of aquaculture.

Table 13: Fleet Bay: Summary of Development Potential

Estimated drying area (km^2)	8.8
Potential aquaculture area (km^2)	2.4
Potential aquaculture area as a proportion of the total drying area (%)	27%
Allocated limit (%)	0%
Acceptable for development (km^2)	0

7.2.4 Kirkcudbright Bay

Physical potential

This bay is orientated approximately north-south and the inner two thirds of the bay dry, apart from the meandering channel of the River Dee.

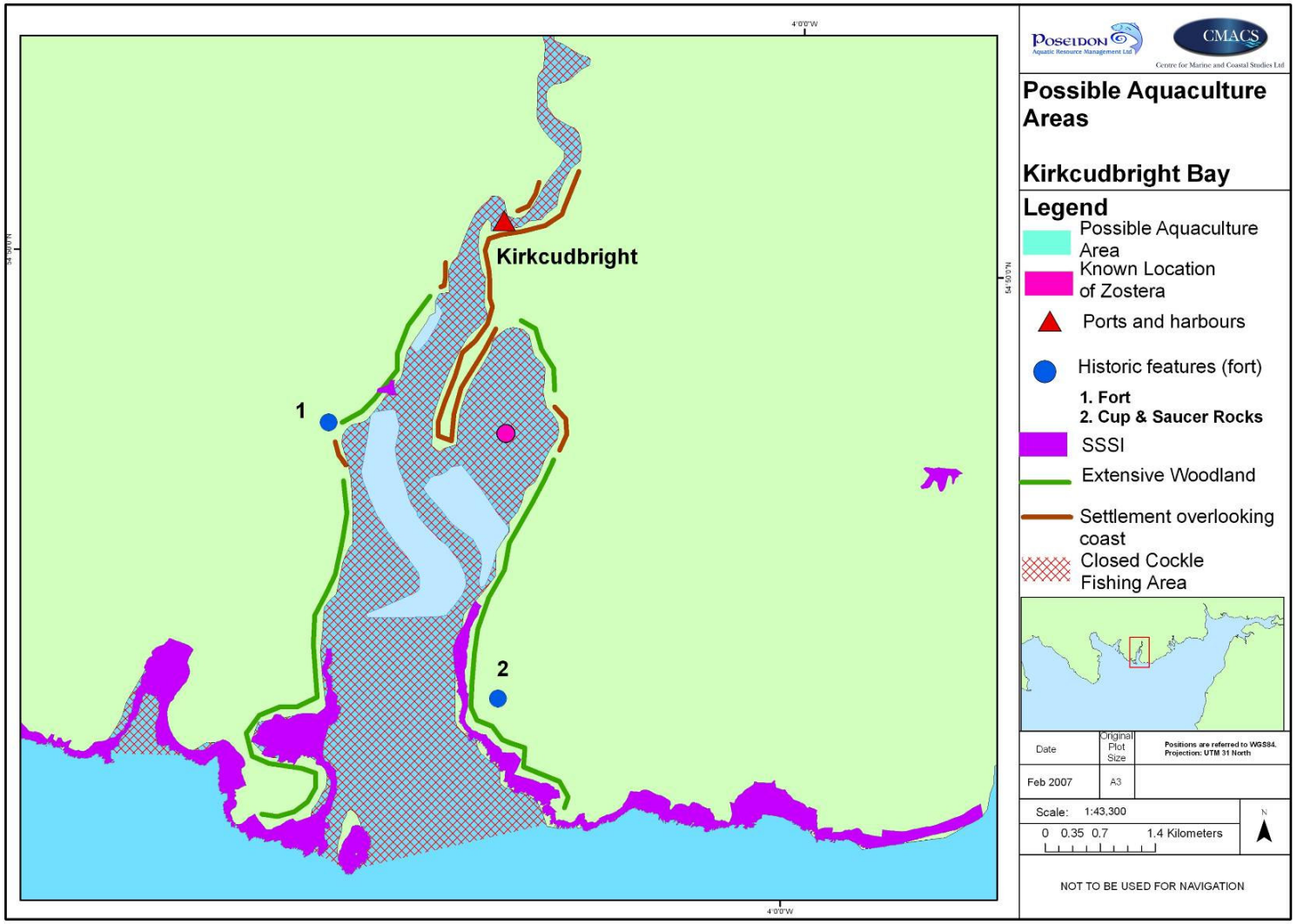
There appears to be reasonable potential either side of the channel of the Dee in approximately the central third of the bay. The inner part of the bay is probably too elevated and the sediment may be too muddy and has been excluded from area calculations, although this could be explored further locally. There may also be some problems with lowered salinity after heavy run off in the higher part of the bay. The middle third is wider and so seawater volumes each tide are probably large enough to prevent any problems. Also, Ross Bay in the south-west corner may offer some possibilities for production. It is small in size but sheltered.

Scale of development

This bay is considered suitable for **medium scale development.** The main reasons for this are the relative lack of conservation designations, there only being an SSSI on the outer fringes of the bay and in Ross Bay (which may preclude the latter from development) and a geological SSSI at Shoulder O'Craig. The coast is mostly undeveloped and generally not overlooked. The 'B' road on the western side runs through trees for much of the route adjacent to the bay and so views are few and far between. The west side has been used for match angling and so any development would have to be discussed and agreed with local angling concerns, as mentioned in Section 6. There is also a beach development, including toilet facilities, at Nun Mill. A site has been permitted for aquaculture development to the south-east of the bay.

Kirkcudbright is the base for an active commercial fishing fleet targeting mostly scallops. There is potential for navigational conflict with trestles or a BST system involving posts. The depths of the bay mean that most vessels will transit at half tide or higher. Trestles typically are around 60 cm in height and so should not be at risk when not visible unless the vessels are taking particular risk by leaving only this much water under their keels. However BST posts can be as high as 200 cm (though c 130 cm is more typical), and so may be more at risk when not visible. Any farming area should thus be clearly marked with lit buoys and charted.

Map 16: Possible Aquaculture Areas: Kirkcudbright Bay



One advantage of this bay is that a farm could be serviced by vessels working out of Kirkcudbright. There are several companies involved in the shellfish industry who have some of the infrastructure and skills needed to handle and sell farmed shellfish. It would be a logical location for a depuration plant.

Table 14: Kirkcudbright Bay: Summary of Development Potential

Estimated drying area (km^2)	7.9
Potential aquaculture area (km^2)	2.2
Potential aquaculture area as a proportion of the total drying area (%)	28%
Allocated limit (% for medium-scale)	25%
Acceptable for development (km^2)	2.0

In this bay, therefore, the upper acceptable limit for development would almost fill the area judged to have physical potential. As with other areas, individual projects should be judged on their merits and it seems unlikely that this area would be developed at one time or by one developer.

7.2.5 Auchencairn Bay and Rough Firth

Physical potential

This bay complex is quite small and exposed to the south-east. However Rough Firth in particular has a high potential recreational value. Any development should be on a trial basis to examine what kind of system would withstand local conditions. It would seem likely that BST longlines involving posts, being more robust than trestles, would be better in the outer areas with trestles or possibly bottom-grown mussel on the inner areas in Rough Firth.

Scale of development

This bay is considered suitable for **small scale development.**

There are several reasons for restricting recommendations in this area to small scale.

Firstly, that the bays form part of a National Scenic Area and so <10% of the drying area used for aquaculture seems appropriate and should minimise impact. These bays are designated as hand-gathering areas in the SSMA exploitation plan and so some degree of activity on the foreshore will already be taking place at periods when the fishery is open.

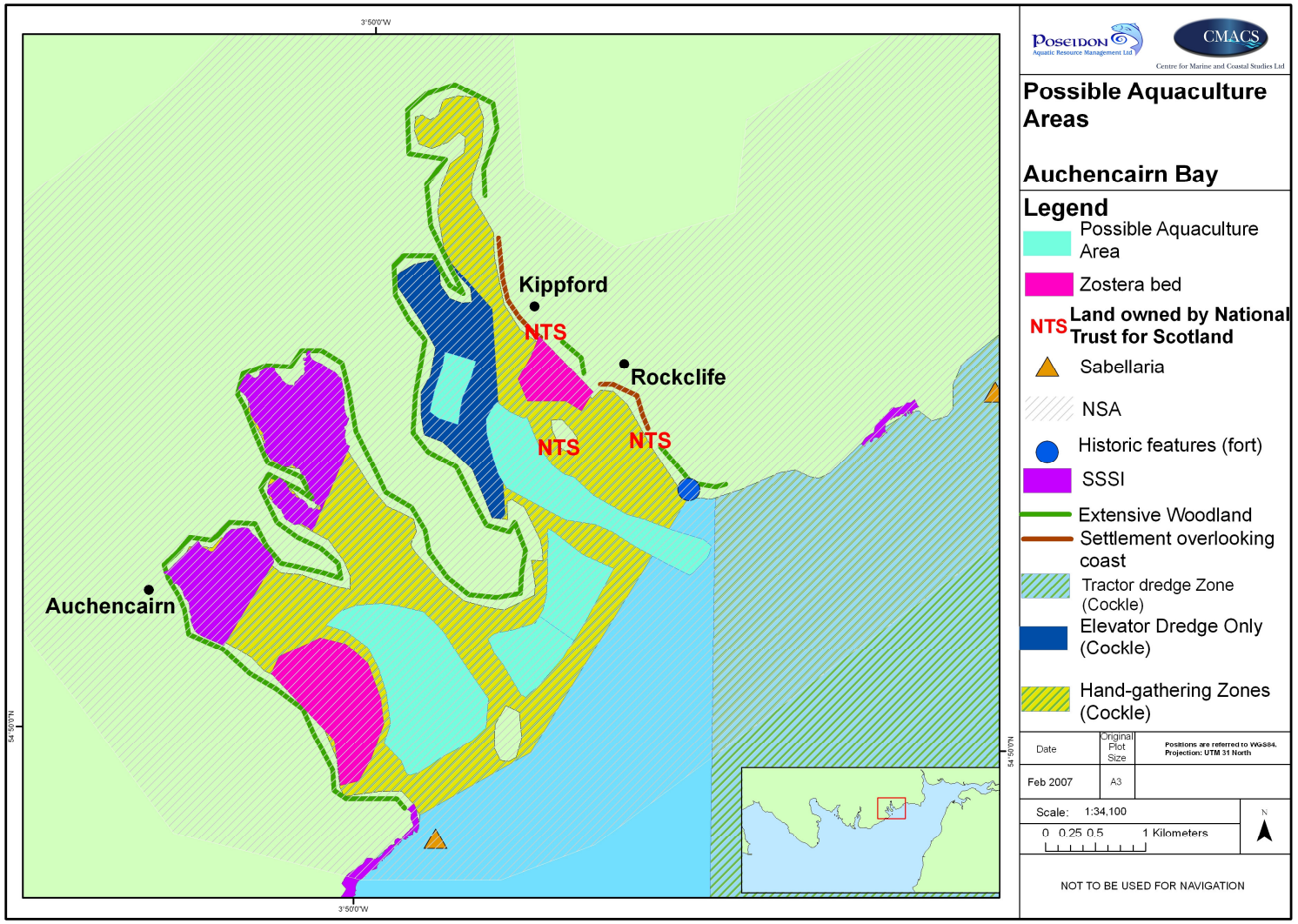
The cockle fishery itself is another reason for minimising space uptake. Space taken up by trestles, longline systems etc would mean that it is lost to cockle gathering. However there should not be major conflict between the two activities as the highest cockle densities occur at around mid tide while the aquaculture facilities would be lower on the beach around low-water neaps. Cockles need to be relatively dense to make hand-gathering viable. This is also discussed at the generic level in Section 5.

The upper parts of the Auchencairn Bay are SSSI's and while there is no overlap with potential shellfish farming areas, small scale development lower on the shore should ensure there is no impact on those sites nor the goose feeding areas on the supralittoral.

Small scale development will also give ample scope for siting any developments well away from the pockets of *Zostera* beds in these bays.

Caution should be taken over ensuring that there are no conflicts with others users – such as cockle collection – over the limited number of access points onto the inter-tidal zone of this area.

Map 17: Possible Aquaculture Areas: Auchencairn Bay



There is a sailing club at Kippford and small scale developments would seem appropriate to reducing possible spatial conflict with leisure boating. Larger yachts most probably stay within the main channel of Urr Water, but dinghies are likely to use the whole bay. Again adequate charting and buoying of small areas should mean both activities can co-exist without problems.

Table 15: Auchencairn Bay and Rough Firth: Summary of Development Potential

Estimated drying area (km^2)	13.276
Potential aquaculture area (km^2)	3.375
Potential aquaculture area as a proportion of the total drying area (%)	25%
Allocated limit (% for small-scale)	10%
Acceptable for development (km^2)	1.33

7.2.6 Carse Sands and the Nith Estuary

Physical potential

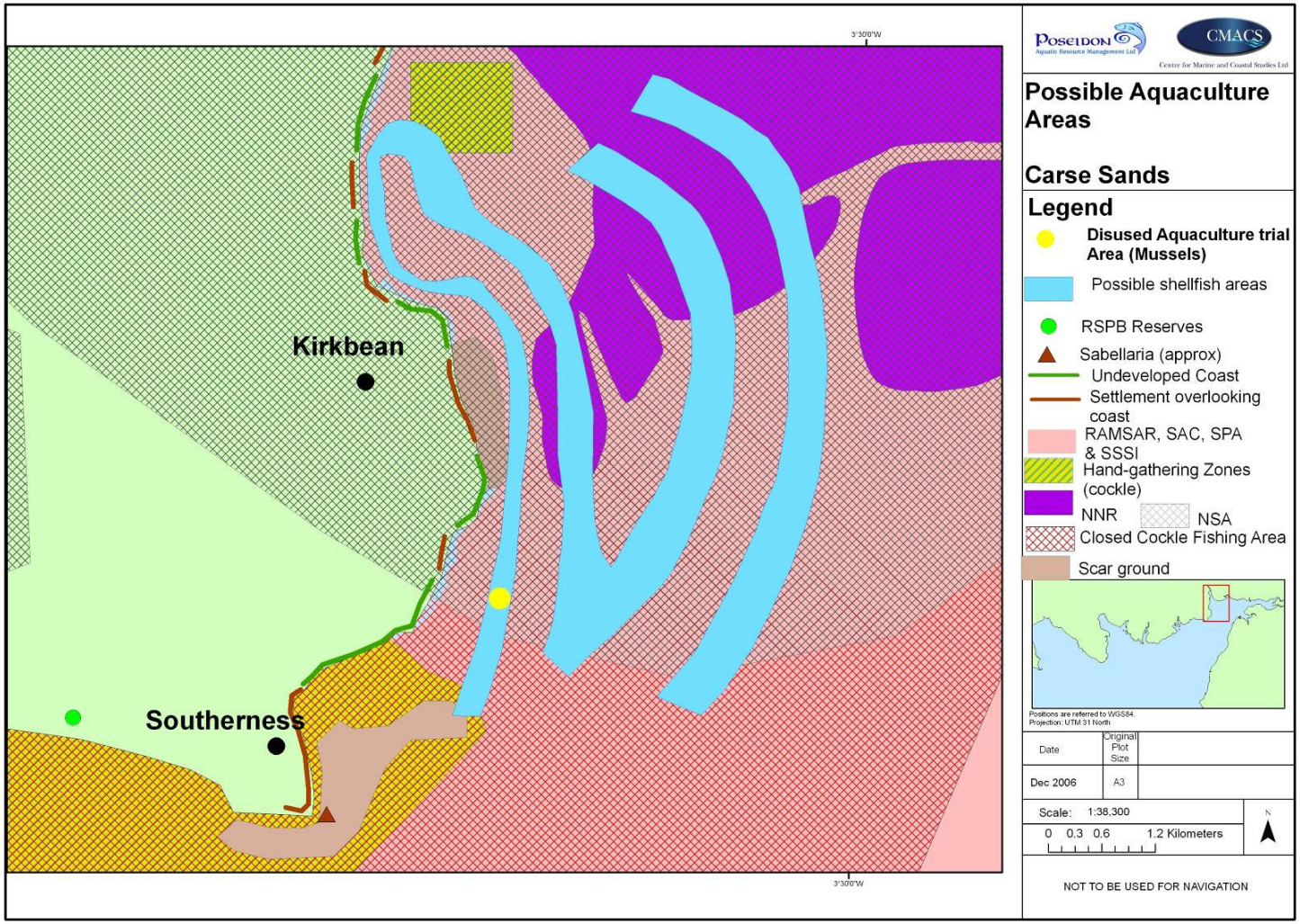
This extensive area of sands is viewed as having quite a large area that may be physically suitable. It is sheltered from prevailing westerlies, from the north and round to the east. The exposure between east and south is, however, significant (particularly due south, about 35 km), so the rare gales experienced from that direction could be damaging to stock and equipment and facilities would have to be robust.

The drying areas and elevations of the sands are not given on the Admiralty charts as the area is deemed to be subject to change. The areas viewed as having physical potential are thus indicative only. Broadly, most of Carse sands appears to be at around mid-tide elevation and indeed periodically holds significant cockle stocks, which are densest at around this level. The areas for aquaculture production are thus seen as those where the elevation tapers downwards either side of the Nith channel. There is also a back-channel or "gut" of the Nith that extends northwards from Arbigland, quite close to the shore and drains the minor waterways of Carse gut and Drum Burn. The lower areas of beach sloping into this back-channel are also considered suitable in principle. It is worth noting that these potential areas exclude the Gillfoot Bay area and its extensive recreational use. The sheltered bays at Arbigland, South Carse and the Carse Gut are all potentially suitable for aquaculture production, possibly with rafts in the latter.

The exposure at this site and the changeable sands means that any growing system would have to be robust. It is highly recommended that trials for one, if not two, winters are undertaken before large scale commercial investment is undertaken. It seems likely that conventional trestles would be too light for the conditions and BST longlines or similar are probably the only solution. The exposure and changeable nature of the sand levels means that it is likely to be unsuitable for bottom grown mussels over most of the area. They would either not hold, or risk being buried, and so bottom-mussel production is ruled out of the strategic production estimates.

The more elevated extensive section of Carse sands could be suitable for relaying cockle. This practice is sometimes undertaken if cockles are becoming over-dense in natural beds and/or are at risk of becoming banked. Broadcasting over a wider area gives more space for burrowing, feeding and growth. If investment in such an exercise is to be undertaken it is important that the re-laid stocks are legally protected and ownership established. As this is only likely to be an occasional opportunity on these grounds, the area is not marked and is not included in the strategic production estimates.

Map 18: Possible Aquaculture Areas: Carse Sands



Scale of development

This area is considered suitable for **small scale development.** The drying area with this site is extensive and it is difficult to scale the impact in terms of a "bay" as with most of the other sites. For the purposes of establishing relative impact in the local area the "drying area" is assumed to run from Southerness Point, around the mouth of the Nith and to a point just east of where Lochar Water drains to the shore near Ruthwell. This is some 74 km^2. The actual drying area, of which Carse Sands forms a part, is of course considerably larger.

The selection of small scale development follows similar designation principles. The site is in a SSSI, SPA, SAC and also in a National Scenic Area. Part of Carse Sands are covered by Caerlaverock National Nature Reserve. As noted in Section 6, there has been concern over noise etc associated with vehicles and people engaged in hand gathering of cockles. However, this is a traditional cockle area and some degree of precedent is set for human activity on the beach. The scale of the area and distance from the foreshore of aquaculture facilities, also the intermittent attention needed to farm areas (see Section 6, management issues), mean that impact from aquaculture on visual and other amenity should be minimal.

There may be some degree of conflict with cockle areas. There are currently two hand-gathering sites with very minor overlap with potentially suitable aquaculture areas. It is possible that the hand gathering areas will change in future, subject to variations in cockle settlement. However, as already discussed in the case of Kippford, the aquaculture areas are likely to be lower on the beach than the prime densities of cockles and so there will be natural segregation of the two activities. There may also be some conflict for dredging for cockles from boats. The areas of potential production on either side of the Nith Channel are within the western edge of the area currently designated for cockle dredging using vessels. Aquaculture equipment such as posts and longlines would be a nuisance and possibly a hazard to cockle vessels who want to fish the area at their convenience during high tide, when facilities may be submerged. On the other hand, the area allocated for vessel fishing is not permanent, it is only open for relatively short seasons and may be closed or moved elsewhere, depending upon distribution of cockle stocks over time.

Aquaculture development here needs to recognise the extensive recreational use of the Gilfoot Bay area and the use of the area for wildfowling. It should also recognise the elevated views of the estuary from just north of Kirkbean.

In summary, this area is difficult to define in terms of quantitative opportunity. The multiple conservation designations suggest that "small scale" is the only acceptable development category. On the other hand, the large scale of this area means that even up to the 10% threshold of the fairly restrictive definition of drying area used, Table 16 below shows there is still significant area that could be used for commercial development. This area represents some two-thirds of the rough estimate of the physically suitable area. However, in practice, the exposure of the site means that development will have to take place by trial and error. The scale of the area also means that conflict with cockling activities is manageable on a project by project basis. Finally, it should be emphasised that this area carries a high degree of nature conservation designation, and any new activity would need to be subject to an Appropriate Assessment, including assessment of cumulative impact with existing activity.

Table 16: Carse Sands: Summary of Development Potential

Estimated drying area (km^2)	73.9
Potential aquaculture area (km^2)	11.19
Potential aquaculture area as a proportion of the total drying area (%)	15%
Allocated limit (% for small-scale)	10%
Acceptable for development (km^2)	7.39

7.2.7 Upper Solway

Physical potential

This section considers the area from approximately Powfoot to Silloth.

This inner area is characterised by high tidal range and streams, firm but changeable sediment and outflow of two major rivers, whose courses are subject to change. The area is relatively exposed to the southwest, though the inner area (east of Bowness) will gain some shelter from the shape of the coast and wave energy dissipation over the shallow waters to the west.

This area is considered marginal for aquaculture development. The mobility of the sands and river channels in particular make it a relatively high risk to operate here.

There was an experiment site set up for oysters some five years ago in the approximate area of Cardurnock Flats (north of the entrance to Moricambe Bay). The trestles evidently washed out and were lost as a result of changing sediments. There are some other trials currently underway in an area further east, roughly south of Barnkirk Point. These trials have been using BST longline systems. These systems too, have been subject to difficulties through sediment movement, however the latest trial site had, at the time of the site visit (early September 2006), shown some promise in that it remained in good condition for longer than the other trials, but had sustained damage to one end of the longline, almost certainly from a shrimp trawl.

If there is to be any development in this area, it will have to be through careful trial and error to establish those locations that enjoy a combination of relatively stable sediment conditions, sufficient immersion of the stock and safety from fishing conflicts. As with any development involving structures that are potential navigational hazards, trial areas should have approval of Department of Transport, be buoyed and details issued in Notices to Mariners published by the Hydrographic Office. If a permanent site becomes established it should, in time, also be charted.

Scale of development

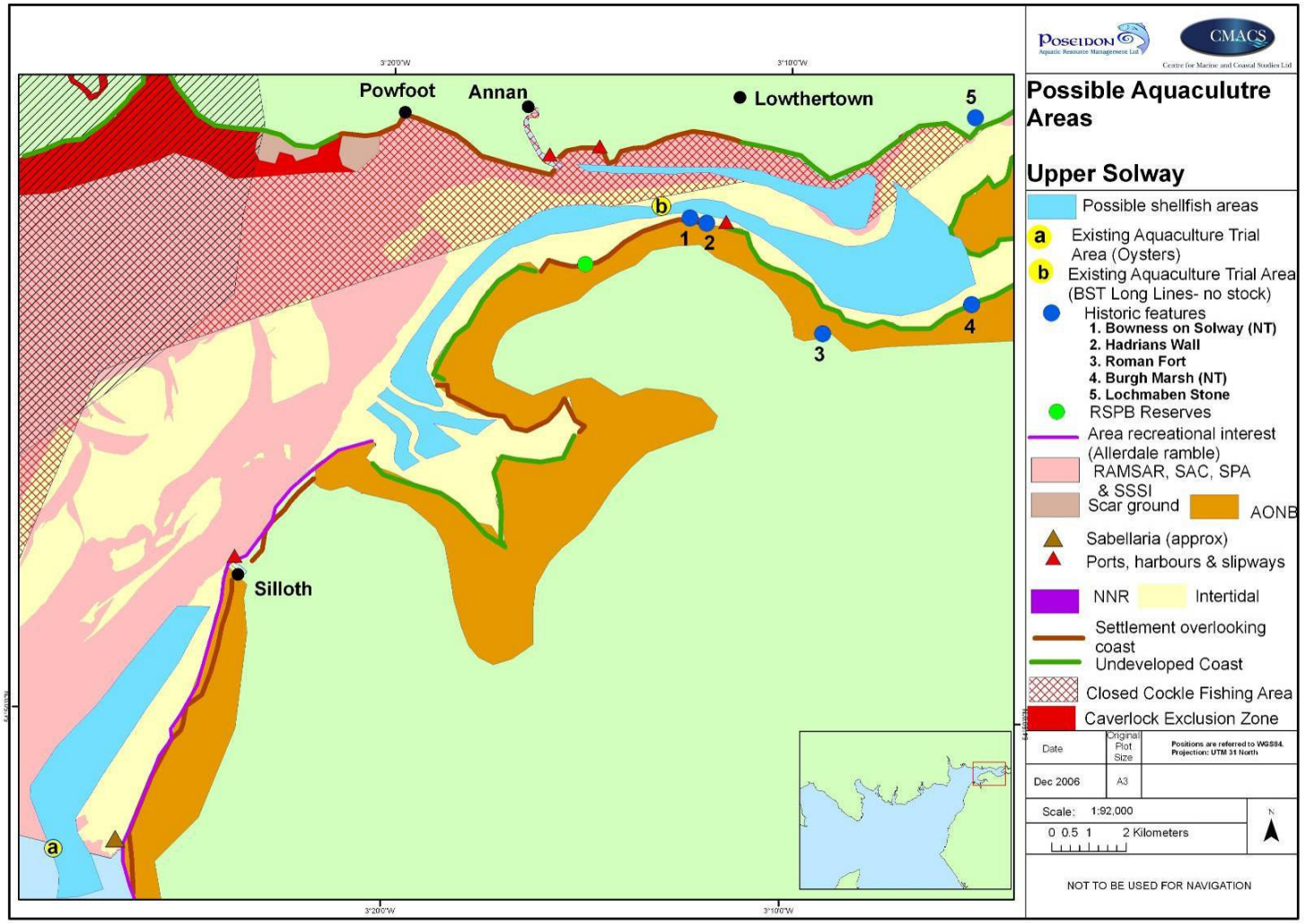
As with the Carse Sands site, this area is similarly heavily designated and so any developments should be **small scale** in relation to their surroundings.

It is understood that the existing trial sites are yet to be granted permission by the Planning Inspector after a long planning process but shows that, if carefully addressed, the issues of concern relating to these designations do not necessarily mean a presumption against all aquaculture development. The area is viewed as highly sensitive and so any scaling up of these trials will have to be done sensitively, and will probably have to accept current limitations in terms of access positions, numbers of trips and minimal servicing from October to April. As with Carse Sands, it should be emphasised that this area carries a high degree of nature conservation designation, and any new activity would need to be subject to an Appropriate Assessment, including assessment of cumulative impact with existing activity.

Table 17: Inner Solway: Summary of Development Potential

Estimated drying area (km^2)	68.9
Potential aquaculture area (km^2)	22.0
Potential aquaculture area as a proportion of the total drying area (%)	32%
Allocated limit (% for small-scale)	10%
Acceptable for development (km^2)	6.89

Map 19: Possible Aquaculture Areas: Upper Solway and Cumbria Coast



The size of the drying area of this area too is somewhat uncertain, due to lack of charting by the Admiralty. An estimate has been made from Ordnance Survey maps. This is a large area and physical potential has been estimated as the lower parts of the intertidal, roughly following the river channels. 10% of the drying area would represent about one third of the area estimated to have potential. However, it should be emphasised that this area is marginal and should not be considered for commercial operations unless significant trial work proves the physical hurdles can be overcome. For this reason, this area is not considered as a strategic contributor to the overall potential production of shellfish later in this report.

7.2.8 South of Silloth

Physical potential

This area is characterised by hard sand interspersed with "scar" ground as far south as Allonby Bay (see Map 19 above). Further south than this, there is almost no suitable beach area, the beach becomes much narrower and it is composed of almost continual scar/stony ground and cliffs towards St Bee's Head.

Unlike the inner Solway, the ground here is generally compacted and stable[17], so equipment should not suffer from changing sediment heights. The site is fully exposed to prevailing westerlies, however the banks on the west side of the Silloth Channel will dissipate some of the wave energy and provide a small degree of shelter, particularly at low water when the banks dry.

Shellfish cultivation has not been attempted in such exposed locations in the UK before, so this area too must be considered as experimental. One developer has been running a trial site at Dubmill point, toward the southern end of the area, for some three years using BST longlines. Of two sets installed, one set has remained intact while another set further to seaward has suffered damage. These are likely to be the only successful growing system here; trestles would be too light and on-bottom stock would almost certainly be banked up or washed away by wave action.

Oysters in the trial systems appeared to have acceptable growth rates and are nearly at commercial size. However, the oysters have become significantly rounded and smoothed as a result of the swinging action of the baskets. Normally, Pacific oyster shells are highly sculptured and crenulated. It is not certain how the market would react to these, though there would almost certainly be a market for finishing these oysters in less energetic conditions where the shells would take on their normal characteristics.

The area with similar conditions to Dubmill extends as far north as Silloth and, while quite extensive, contains significant unsuitable scar ground.

Scale of development

The area between Silloth and Dubmill shares the same designations as the Inner Solway and Carse Sands. Thus, any development should be **small in scale** compared to its surroundings. The smaller area into Allonby Bay is not designated but, given they are experimental and the relatively small area, they are considered as one in this exercise. It was not possible to inspect this stretch of coast in detail. The significant scar ground shown on the Ordnance Survey maps suggest that some of it will be unsuitable, so the estimates here must be seen as highly approximate.

[17] Although there are small areas of soft and mobile sand, esp. to the south of Silloth (Wilf Morgan, pers. comm.)

Table 18: South of Silloth: Summary of Development Potential

Estimated drying area (km^2)	29.3
Potential aquaculture area (km^2)	10.2
Potential aquaculture area as a proportion of the total drying area (%)	35%
Allocated limit (% for small-scale)	10%
Acceptable for development (km^2)	2.93

The acceptable scale of development here is about one third of the area viewed as having physical potential. As mentioned above, scar ground is ignored in these calculations, and so development of up to 10% of the drying area may, in fact, represent around half of the area marked as having physical potential. Although trials have been longer lasting than in the Inner Solway and give some grounds for encouragement, this area is also considered as experimental and again further development will have to take place through carefully conducted pilot scale development so that mistakes are made when not too costly. At this stage, the potential of this area is excluded as a strategic contributor to the overall potential production of shellfish later in this report.

7.3 CARRYING CAPACITY

It is worth noting that the production estimates in this study do not take into account possible carrying capacity limits of inshore areas. Clearly, the amount of natural productivity is vital so that not only farmed biomass can be sustained with adequate growth rates, but also natural populations of filter feeders remain unaffected. Some of the suggested production levels in Section 8 are quite high, particularly where the scale of development in a bay is above small scale (10% of drying area).

For the purposes of this study, it is assumed that carrying capacities are adequate. This draws on experience of the Menai Straits, where there is very high biomass of farmed shellfish (>15,000 tonnes) in a small area. Studies have attempted to identify impact to other biota in the area, but none can be discerned outside the footprint of the farming area. Tidal exchange is almost identical to Kirkcudbright Bay and water productivity is assumed to be similar. For reasons set out later, it seems unlikely that the industry will reach the potential for production identified in this document, but if it does, then some carrying capacity studies may need to be undertaken as a precaution.

8 STRATEGY ELEMENT 3: MANAGEMENT ISSUES AND APPROACHES

Strategic Element 1 in Section 6 covered the main issues involved in siting shellfish farms and ensuring that conflicts are minimised from the beginning, whilst Strategic Element 2 in Section 7 provides an outline zoning plan. This third strategic element examines the management issues relevant to the on-going operation of a shellfish farm in inter-tidal coastal waters.

In comparison with finfish farming, where there is a higher level of husbandry and input use, shellfish culture is a lower management activity. As a result, the potential for conflict with other coastal users and conservation interests is relatively low. The main ongoing management issues for the three different shellfish culture systems is summarised in Table 20 overleaf. Essentially, two main areas of concern can be identified:

1. Disturbance from access and on-site activities
2. Predator control

8.1 DISTURBANCE

The construction and subsequent operation of an aquaculture operation will inevitably result in human activity in and around the farming unit. The typical human activities associated with aquaculture are summarised in the table below.

Table 19: Sources of Disturbance from Shellfish Culture Activities

Activity	Visual intrusion	Noise		Light	Traffic		Dust
		Percussive	*Background*		*Land*	*Water*	
Facility construction	✓	✓	✓	✓	✓	✓	✓
Maintenance	✓	✓	✓	✓	✓	✓	✓
Acoustic deterrents		✓					
Harvesting	✓		✓	✓	✓	✓	

The impact of these activities will depend upon the sensitivity of the species and environments concerned. Visual and background noise impacts might affect nesting and foraging habitats, whilst percussive noise from construction activities as well as acoustic deterrents (e.g. bird scarers) may also affect marine mammals and sensitive fish e.g. those with large swim bladders. Birds tend to habituate to continuous, low-level noises (although they may increase the strength of their calls to compensate) but will vacate areas subject to unexpected and intermittent percussive sounds. Land traffic may be limited to narrow access corridors but may restrict animal migration (e.g. amphibians), as well as cause dust and noise. Whilst bright lighting is unusual in most aquaculture production, it may become a feature during peak activities such as construction, maintenance and harvesting, and may impact roosting and nesting behaviour.

Disturbance: all forms of aquaculture will have some disturbance factor. More intensive farms will have a smaller footprint but a higher level of mechanisation, resulting in higher noise levels and vehicle movement. Less intensive facilities may have lower levels of mechanisation, but more persistent human movement over a wider scale.

Although disturbance is composed of a wide variety of consequences of human activity on or around the farm (see table above for more details), the variable that has the most significance and is most easily measurable is noise. Sound emanates from construction and maintenance activities, as well as active predator control measures, transport (both vehicle and boat), as well as through routine human presence. Therefore, the duration of sounds may be less important to breeding and foraging birds than the frequency and magnitude.

Table 20: Summary of Management Issues by Aquaculture Type

Culture system	Defining characteristics	Management issues	Management options
Trestle systems	• Static system that is reached by land via the foreshore or by boat • Requires reasonably firm and stable substrate • Flat surface area near low water • Requires periodic maintenance to clean bags and trestles	• If accessed via land, requires agreed beach ramp access point and foreshore transit route • If accessed via vessel, requires landing point and safe transit route • Periodic cleaning, grading and harvesting required, usually during spring tides • Occasional removal of build-up sediment from under trestle structures • May obstruct vessels when submerged • Risk of theft of cultured stock	• Landowner access agreements • Establish and maintain "lowest impact" access routes across foreshore in respect of any relevant conservation designations for site • Clear marking with lit buoys, marking on Admiralty charts • Surveillance by operators, evidence gathering, liaison with police and prosecution under theft and criminal damage legislation
Suspended 'BST type' longline culture	• Static system that is usually reached by land via the foreshore or by boat • Requires reasonably stable substrate • Flat surface area near low water • Limited maintenance requirement due to system control and a degree of self-cleaning	• If accessed via land, requires agreed beach ramp access point and foreshore transit route • If accessed via vessel, requires landing point and safe transit route. • Periodic cleaning grading and harvesting required, usually during spring tides • May obstruct vessels when submerged • Risk of theft of cultured stock	• Landowner access agreements • Establish and maintain "lowest impact" access routes across foreshore in respect of any relevant conservation designations for site • Clear marking with lit buoys, marking on Admiralty charts • Surveillance by operators, evidence gathering, liaison with police and prosecution under theft and criminal damage legislation

Culture system	Defining characteristics	Management issues	Management options
Bottom culture	• Stock laid on bottom, or in bottom under nets • Low/no visual impact • Requires stable sheltered areas on the low intertidal	• Minimal management after laying • Predator control in extensive mussel culture is very limited so usually considered a inevitable loss • Clams protected by netting • Oysters and scallops have to be large enough to be predator proof • Risk of theft of cultured stock • No obstruction to navigation, anchoring / drying vessels on beds undesirable	• New approaches involve moving stock from higher to lower elevations on foreshore to avoid major invertebrate or bird predation • Netting requires periodic cleaning/changing to maintain water exchange and exclusion of predators • On-bottom only for finishing stages of scallops and oysters • Several Order legislation protects farmed stocks not in containers • Marking on charts, also buoys as necessary

At present there are no statutory guidelines limiting noise production from terrestrial or marine farming operations and there appears to be very little information on likely thresholds or permissible levels. However, the draft Scottish Code of Practice for Aquaculture (Federation of Scottish Aquaculture Producers, 2005) states that "Farmers should ensure that equipment that creates noise (e.g. air blowers, generators) is suitably muffled so as to prevent unacceptable disturbance to wildlife or humans".

8.2 PREDATOR CONTROL

The shellfish stocks held by aquaculture operations will often attract the attention of wild predators. Farm operators have responded by implementing various site selection, design and management strategies to minimise the level and degree of interactions but these will continue to occur. Predator control is made more challenging when considering many predators are protected by Member State and EU legislation, especially within designated sites of conservation interest. Under Article 9 of Council Directive 79/409/EEC, Member States can take measures to limit the impact of protected bird species in order to prevent serious damage to fisheries and water and for the protection of flora and fauna.

The attractiveness of an aquaculture facility to predators is a function of both the rearing method being used and the predator species present. For example, eider are often identified as a conflict species (Bart Danato, NE, pers. comm.) - however eider are not common in the Solway, and although a conflict species on open mussel lays they are not a conflict for bagged oysters. Furthermore, the presence of eider may be a benefit to some oyster systems as they will feed on encrusting mussel deposits on infrastructure, reducing the risk of smothering (as is the case on the Seasalter oyster farm in Morecambe Bay).

The different forms of predator control are described below. It is worth noting that these are more likely to be adopted by finfish farms, as they are more likely to attract piscivorous birds than shellfish culture:

Frightening devices: discourage birds from feeding, roosting or gathering at a location. Frightening techniques rely on sight and/or sound stimuli to discourage birds from remaining at a site by making the birds believe the site is dangerous for them. Success in frightening birds away depends on the number of devices used, how and where they are administered and if their use precedes the establishment of the birds' feeding habits. In general:

- Frightening techniques are most applicable for short duration problems (1 to 3 days), as birds will quickly lose their initial fear.
- Frightening regimes are often started before the birds establish their regular feeding patterns.
- The locations of frightening devices, especially noise-making ones, are changed frequently.
- Long term results are usually achieved by using a combination of methods and by frequently alternating the devices used.

The use of scarers and other predator deterrents within the SSSI/SAC/SPA/Ramsar areas at least will need to take account of disturbance to non-target species and will need to be compatible with the interest features of the site. In September 2006, the Secretary of State affirmed Natural England's decision to refuse consent to 14 fishermen who wished to use electronic bird scaring devices to deter eider ducks from feeding on their mussel lays in the Wash Site of Special Scientific Interest (SSSI).

Scarecrows and predator models: utilise models or silhouettes of humans and/or predators placed in strategic locations and may be combined with frightening techniques.

Physical barriers: can consist of full enclosure which can only be practised on small, intensive sites and are often used for initial fingerling production facilities where predation pressure is high and the site area is low. Over larger, grow out sites, partially-covered systems that interfere with predator feeding behaviour can be employed, such as overhead wires, lines, nets, screens, perimeter fencing and devices that discourage birds from entering the facility. Whilst many of these systems are reasonably benign, they can impact on birds, piscivorous fish and mammals.

Extermination: in extreme cases, and where predators are not protected by legislation, farm operators might kill persistent predators through shooting, trapping or poisoning.

Novel passive methods: all the above methods are aimed at protecting stock rather than reducing the interaction with birds. Caldow *et al* (2003) used a behaviour-based simulation model to predict the extent to which such losses can be reduced by novel commercial management practices, and to explore the consequences for the oystercatcher population. Simulations of novel lay management practices indicated that the losses of commercially harvestable mussels to oystercatchers can be considerably reduced by altering the shore level and/or extent of the commercial lays. They proposed a novel management Strategy for the bottom cultivation of mussels in intertidal areas. Seed mussels (15–20 mm) should be laid relatively far upshore, where losses to oystercatchers will be minimal. As the mussels grow over the next 2–3 years, they should be moved progressively further down shore such that the largest mussels spend their last season prior to harvest in a relatively small area, lower on the shore than all mussels earlier in the cultivation cycle. Support for the effectiveness of this proposed management Strategy can be found in the reports of commercial operators who have incorporated this management Strategy in new management practices in the last few years. They report an increase in the ratio of the live mass of harvested to seeded mussels from the previous norm of 1:1 to 4:1. By accepting greater losses of mussels earlier in the cultivation cycle, rather than later, the feeding conditions for oystercatchers might even be improved under this system. With appropriate management, the interest of shellfish growers and competing shorebirds need not conflict.

Any predator control measures adopted by the industry should concur with best practice, such as that advocated in Ross and Furness' (Glasgow University) report on 'Minimising the impact of eider ducks on mussel farming', and the ASSG's Code of Practice.

9 STRATEGY ELEMENT 4: BUSINESS DEVELOPMENT

9.1 PRODUCTION POTENTIAL

The areas acceptable for development using the criteria set out in Section 6 above can be translated into potential production via a yield per unit area.

The two main production methods for which there is reasonable experience to draw from in UK conditions are oysters grown in trestles and mussels grown on-bottom.

The yields used for this exercise are those quoted by CEFAS in their general guidance booklet for establishing a shellfish farm (CEFAS 2006). It is worth noting that the yields quoted for oysters are quite conservative compared to generic models developed by the consultants in other situations. For mussels they appear to be somewhat high compared to the overall average position for the Menai Straits, the largest area for growing bottom mussels in the UK, when expressed as total production divided by total Several Order area. However, some of the Several Order areas are simply not used and some of the more productive areas within the Several Orders produce up to 150 tonnes per hectare, or in extreme "hotspots" occasionally as much as 300 tonnes per hectare, according to producers there. For the sake of forecasting, the CEFAS figure is possibly on the high side for considering a wide area and actual potential will need to be established through trial and error at individual sites. Given the wide range of possibilities, it seems reasonable to use the CEFAS yield estimate for mussels, though any indication of production levels here should be seen as highly approximate.

Table 21: Potential Yields for Shellfish Aquaculture in the Solway

Bay	Physical potential for aquaculture (km^2)	Allocated limit (of drying area)	Acceptable for development (km^2)	Working yield oysters (mt / ha / year)	Working yield mussels (mt / ha / year)	Production option	
						Oysters (mt / year)	Mussels (mt / year)
Wigtown	12.15	10%	2.87	15.0	40.00	4,312	11,500
Fleet	2.40	0%	0.00	15.0	40.00	-	-
Kirkcudbright	2.21	25%	1.98	15.0	40.00	2,966	7,909
Auchencairn & Rough Firth	3.38	10%	1.33	7.5	0.00	996	-
Carse Sands	11.19	10%	7.39	7.5	0.00	5,543	-
This table **excludes the Inner and southern Solway** – see text for explanation							
TOTAL	**31.32**		**13.57**			**13,817**	**19,409**

The table shows that the Solway coast has very large potential to grow shellfish commercially. To put this in context, the whole of the rest of Scotland produced 246 tonnes of oysters and 4,315 tonnes of mussels in 2005, mostly in suspended culture rather than on-bottom. The above table also assumes restrictive limits to the proportion of drying area that could be used for development at all sites apart from Kirkcudbright Bay.

It must be stressed that these estimates as well as being highly indicative are mutually exclusive: the indicated levels of production assume that the area defined as acceptable is filled to capacity with either oyster production or mussel production.

This study has not been able to examine the potential production areas in anything other than a cursory way. It may turn out that some areas are too exposed, sediments too mobile and, in spite of the restrictive approach recommended, there may be still be many local constraints and conflicts that the consultants are not aware of. Any project implemented in any of the areas identified should be operated on a trial basis for at least the first year. For oysters, the yields assume "conventional" rearing techniques using flat mesh bags strapped to trestles (see Section 3). It is likely that parts of the areas identified will be too exposed for this fairly light equipment. For the sake of simplicity, the table above assumes that trestle systems are used exclusively in Wigtown and Kirkcudbright Bays, while the more robust BST longlines are used in Auchencairn and Rough Firth and Carse Sands, which are more exposed. In reality it seems likely that a mixture of each will be used in developments at the various sites. There are no precedents for oysters grown in 'BST' longline systems to predict yields. These have only been used on a large scale in Australia. The manufacturers, who are assisting with some of the trials in the Solway were unable to quote likely yields as they are evidently very site specific. They appear to be less space intensive than trestle systems, particularly with baskets hung along the main support wire rather than across two wires, as is likely to be needed in exposed positions (and as appears to be working off Dubmill point, see Section 6). However, faster growth may be a benefit of these systems, pushing yields up. For the purposes of this study, however, half the yield of conventional trestle systems is assumed for safety.

No allowance for mussel production has been included for Auchencairn Bay, the Rough Firth and Carse Sands as they are considered as generally too exposed.

The disparity between production potential and actual production is not restricted to the Solway. The actual area already granted for Several Orders in the UK overall could produce more shellfish than it already does. The production potential is not fulfilled mainly as a result of seed shortage in the case of mussel and market-related constraints in the case of oysters. Mussel seed availability is the major constraint to expanding bottom cultivation in the UK. These issues have been discussed in Section 2. Market issues relating to oysters are discussed below.

It is worth noting that there are other methods of production under consideration in the Solway, where there is almost no precedent from which to estimate possible yields. Some operators are considering "finishing" wild, dredge-caught adult mussels in BST longline systems. This is said to increase shell quality and meat (see marketing discussion below). The cycle is said to be 4-weekly, but with no appreciable weight gain. The stocking rate is assumed to be 15 kg/basket and so with up to 10 throughputs per year, very high yields could be achieved on an annual basis. Scaled up to only a small proportion of the total area available, this approach would easily outstrip possible mussel supply and market capacity.

The strategic estimates above also do not allow anything for the areas on the English Solway that are currently under experimental culture for oysters, using BST longlines. Were these trials to prove successful and production to expand to the limits of acceptability recommended, there could be a further 7,000 tonnes of oysters produced, i.e. about half as much as may be possible on the Scottish Solway. Developers here are also considering mussel culture using the bouchot pole system (see Section 3 for description). Again this is experimental and trials would be needed to establish techniques and yields that are possible under local conditions, so no allowance is made for this in strategic estimates, save to say that any space taken up with development of bouchot culture would be at the expense of potential oyster production discussed above.

In summary therefore it can be concluded that there is very large physical potential to produce shellfish in the Solway area, given reasonable scales of development in harmony with other uses and designations.

9.2 MARKET POTENTIAL

9.2.1 Oysters

The market for farmed oysters in the UK is characterised by low demand. Compared to the populations of southern EU countries the British remain unadventurous towards shellfish generally and oysters in particular. The industry has always been too small and dispersed to secure funds and undertake the sort of generic advertising campaign needed to change engrained consumer attitudes and stimulate demand.

The potential outlets are seen as follows:

- Small scale sales to hotels and restaurants
- Moderate level sales to multiple retailers
- Larger scale wholesale sales onto mainland markets (Manchester, London)
- Wholesale sales abroad (France and Germany)

Sales values of typical 80g oysters are around £0.25 to £0.33 each for direct sales to catering outlets and £0.20 wholesale, probably less to France and Germany after transport costs have been taken into consideration.

Traditionally, oyster farming has been a small scale, part-time occupation for many producers in the UK. The immediate markets of local hotels and restaurants can be very small and once these are saturated there is a need to look further afield. Wholesale markets in the main urban centres can not be expected to take high volumes. They, in turn service the specialist catering trade and some producers sell to these outlets on a direct basis.

Oysters sales in wet fish counters in supermarkets are increasing but from a very low base. These are almost always Highland and Islands or Irish produced from A grade waters. All major retailers have a strict policy of purchasing A grade oysters (and mussels). All classifications on the Solway are for B grade, although these classifications are in respect of cockles and mussels.

Occasionally, UK growers have managed to make sales into France. However, this is only possible at times of low supply in France. Prices are consistently lower in the EU as a whole than those reported for the UK. To be able to sell into France, UK producers have to compete with the low price environment created by mass production with economies of scale and good growing conditions coupled with fairly stagnant demand. Irish producers have reasonable trading relationships with France but often this is through French growers supplying surplus seed and buying back the finished product rather than stand-alone production. Irish oyster growers have also benefited from many years of Objective 1 status for EU Structural Funds with support from BIM as the aquaculture development agency. This had provided capital funds and other technical assistance which has generally not been available to growers in England and Wales and to a lesser extent in Scotland. Waters are also predominantly A grade in Ireland so there is no expense of purification.

9.2.2 Mussels

Mussels are a more widely accepted commodity in the UK and across Europe.

The main markets for UK producers are as follows:

- Fresh consumer packs to multiple retail outlets
- Value added consumer packs to multiple retail outlets
- Bulk wholesale fresh purified to urban markets
- Bulk unpurified wholesale to France, Belgium, Holland
- Value added to local foodservice or export markets

Both multiple retail opportunities insist on stock from Grade A waters and so these opportunities are currently closed to the Solway. They are being met very successfully by the Scottish Shellfish Marketing Group based in Motherwell. This co-operative sells most of the rope-grown production from the Highlands and Islands, either fresh or cooked in various preparations, chilled and vac-packed.

The wholesale markets in urban centres have paid about £600-650 per tonne five years ago increasing toward £1,000 today. This product has to be depurated (immersed in UV treated seawater for 42 hours) so that the animals can purge themselves of sewage related pathogens (see Section 8 for more details). Wholesalers are limited to supplying the restaurant trade and independent fishmongers and market stallholders. The restaurant trade is reasonably stable and somewhat dependent on the economic cycle, while independent fishmongers shops and market stalls have been on a pattern of decline for some years which seems set to continue.

The mainstay for bottom grown mussels in recent years has been bulk markets in France, Belgium and Holland. These markets absorb significant quantities from the Menai Straits and Ireland. They are purified at the destination and either sold on fresh for restaurant or home consumption, or processed into value added product. These merchants tap into large consumer demand across much of northern Europe. This demand has been increased in recent years by a marked reduction of domestic supplies in Holland. Prices have risen in these markets and stand at between €1,100 and €1,500 per tonne (~£750-1,000 per tonne).

There is an alternative opportunity for the bottom grown production in grade B waters to add value and sell to either non-retail multiples or to export, where insistence on Grade A production is not so stringent. The main markets are seen as food service companies who sell into pubs and restaurants, both UK and abroad. This market is already supplied by SSMG and some processors in Ireland. Nevertheless, the increasing popularity of mussels, particularly as everyday 'pub' food gives some opportunity for developing this market.

9.3 BUSINESS STRATEGY

There is clearly potential to produce a large amount of shellfish in the Solway, using proven techniques. This is particularly on the Scottish side but also possibly on the English side too. However, fulfilling that potential is bound by two major constraints:

- limited markets giving rise to low profitability in the case of oysters
- limited supplies of wild seed in the case of mussel.

Neither of these constraints are new and neither are unique to the Solway, so one cannot expect a local solution to emerge from either the project sponsors or individual local operators.

Against this backdrop, however, there is no reason why the Solway cannot compete equally with other UK areas containing similar production conditions.

Both constraints mean that only a small proportion of the area assessed as acceptable for development is likely to be needed in the next few years.

Strategically, it seems sensible to concentrate production efforts where there is competitive advantage to begin with and this appears to be Kirkcudbright Bay. This has the advantages of:

- relatively un-conflicted with conservation designations and other uses
- significant shellfish infrastructure already in the port.

This bay has the potential to produce up to 3,000 tonnes of oysters or up to 8,000 tonnes of mussels using the yield estimates derived from CEFAS. Like all sites, it will be necessary to undertake trials to better assess potential growth and survival and the impact of winter storms on stock and equipment. As noted in Section 6, the visual impact of mussel production using

bottom-growing techniques is minimal and so a wider total amount or range of ground could be used for this process. It may be useful to have the flexibility of working with a larger area so that stock can be moved during the growth cycle to different heights on the beach so as to best manage predation problems (birds, crabs), as discussed in Section 6.

Exact locations of production will need to be established through trial and error and it is recommended that developers are given as large an envelope as is feasible in which to undertake trials. This study has indicated possible areas within the middle one third of the bay (on a north-south axis) and these represent almost 25% of the drying area, (the limit of acceptability), but it may be advisable to consider some of this development in the inner or outer one thirds as well.

Permission has already been given by the Council for two trial plots areas using BST systems in the Bay. The plan with these is to build on earlier tests to add value to wild adult mussels caught in the sub-tidal through conditioning. Partial exposure to the air develops the abductor muscle which keeps the shell shut, minimising water loss in air and so prolonging shelf-life. This is an advantage over rope-grown mussels from the Highlands and Islands which are not exposed to air at all in their growth cycle. This is a novel development in the UK and so it is difficult to forecast likely profitability and so make recommendations as to the best use of the ground in this bay.

Depending on the outcome of these trials, the major opportunity here would appear to be bottom-grown mussels. The location has much in common with the existing production areas in the Wash and the Menai Straits, i.e. a large suitable area of ground close to landing facilities with existing fisheries infrastructure. This business can be highly profitable in years where there is abundant seed supply. At some 2 km^2 the area is somewhat smaller than the Several Orders in the Menai Straits (7.82 km^2) and within that 2 km^2 there are likely to be areas unusable, (as there are within the Menai Straits Several Orders). If the area in Kirkcudbright Bay is insufficient, it may be possible to service plots in Wigtown Bay using the same infrastructure.

The main strategic issues facing development of this business are:

Seed: Large quantities of mussel seed are needed to make this operation successful. At a conservative planning ration of 1:1 (tonnes of seed to tonnes of crop), up to 8,000 tonnes of seed would be needed to fulfil the apparent potential in Kirkcudbright, or some 19,000 if Wigtown Bay were included to its full potential. There may be areas of natural seed off the Scottish Solway coast. In other areas sub-tidal seed location and management has been carried out by farmers themselves, Sea Fisheries Committees and conservation bodies. The fishing industry is probably in the best position to comment on locations and regularity with which seed occurs on the Scottish side off the Solway. It may be possible to contract scallopers or even cockle vessels to catch wild seed, although in the long run dedicated dredging vessels which can both catch seed and harvest the crop are likely to be needed if the operation is to be carried out in a large scale (over a few hundred tonnes). These vessels require a large amount of capital. One option in the early years may be to make a strategic alliance with farmers in the Menai Straits and under some kind of contract or crop sharing agreement, use their dredgers to dredge and lay seed and later to harvest the crop, landing it at Kirkcudbright. Even then, the Menai Straits vessels are interested in sourcing seed for their own culture areas first, and may only be attracted to such an arrangement if their own beds were full (which is rare) or if terms of the agreement were particularly favourable.

The banks in the Silloth area occasionally are subject to significant spatfalls. Both the market size mussel fishery and any seed fishery are opened as and when stocks allow, and are managed by Cumbrian SFC through a permit scheme. Seed cannot be taken off the intertidal for conservation reasons and large intertidal spatfalls are occasionally lost to the weather, as has happened in autumn 2006. Subtidal seed is occasionally permitted to be fished. If there was a request made to remove the seed outside Cumbria SFC's district, this would have to be put to

the Committee, who would put interests of local fishermen first. This study, (and Cumbria SFC), have confirmed that there is no area within the District where seed might be relaid, so it is possible that in heavy spatfalls they would allow some removal. Given the overriding local commercial interest, growers on the Scottish side would probably have to purchase the seed from the Cumbrian fishermen rather than simply helping themselves.

In summary, growers where there are favourable conditions on the Scottish side are in a strategically weak position regarding seed sourcing. This could be remedied by regular surveys undertaken by FRS and/or potential growers.

Markets: The main categories of markets have been discussed in general terms for mussels in Section 9.2.2. If there was a significant production of mussel at Kirkcudbright and/or Wigtown, and assuming the B water grading will remain, the main market opportunities are either:

a) bulk unpurified to export

b) bulk purified to wholesale UK

c) 'approved process' cooking and value adding

Option a) is the simplest. It requires large but simple infrastructure to land and bag the product, palletise the bags and load into refrigerated lorries.

Option b) needs depuration tanks in addition to facilities mentioned in a). If volumes are large the tanks would have to be numerous (typical tanks have approx 1 tonne capacity). There are no depuration facilities anywhere in the Solway, but a new factory being planned in Kirkcudbright to handle a variety of local shellfish, including that produced by farming, will include depuration tanks. There is obvious synergy with farmed production and it would seem at least a portion of the crop could go into this category of market.

Option c) would need a dedicated line in a production plant. As already mentioned, this market is being met by SSMG and Irish producers. Any Solway product would have to be of similar or better quality (meat yield, range of recipes/flavours offered, packaging, delivery frequency etc) and price to break into this market.

Given the uncertainty over seed it would seem advisable to follow the simplest, lowest cost route, i.e. option a) to start with. If the seed situation can be regularised then the other options can be brought on stream. Even then, it is recommended that value adding is carried out at a modest scale, taking perhaps 10 or 20% of peak production, so the plant is not left idle in low years. It is interesting to note that the operators in the Menai Straits have opted to market through route a) only. This is firstly because seed supply is irregular, adding risk to the viability of the value adding route, secondly because the additional cost of depuration was not being reflected in the market price and thirdly because when mussels were in good supply, very adequate profits were made through concentrating on high volume sales of the basic product. This is a largely personal choice of the individuals concerned and is strategically somewhat weak as all sales are made to a very small number of merchants.

There would be more diversification and employment generation if at least part of the crop was sold value-added and this is recommended for the Scottish Solway. There are obvious synergies to link the production possibilities in Kirkcudbright Bay with the existing and planned processing infrastructure and skills base in the town.

Oysters: A Strategy with regard to oysters is more difficult to define. In terms of locations, there is less need for large scale bulk handling involving large vessels compared to mussels. Therefore other locations are likely to be only slightly less convenient than Kirkcudbright Bay. If a depuration plant is built there, stock could easily be transported to it by land on the Scottish

side. For the English side, if oysters are to be sold depurated, then a dedicated set of tanks would be needed. Silloth seems the obvious choice of location for this.

If the BST systems prove successful, it seems as though there could be very large scope for development taking into account the large potential at some of the more exposed sites such as Carse Sands and south of Silloth. On the other hand these systems are relatively expensive in capital terms compared to simple trestles and poches. There is also some question as to whether the market would accept "smooth" oysters in wave- washed BST systems.

In most oyster growing areas in the UK, for example the estuaries of Devon, Cornwall and Essex; sheltered sea lochs in the Highlands, conditions are generally more sheltered than most locations on the Solway coast. The inner parts of Wigtown, Kirkcudbright and Rough Firth bays may be similar, but trials will be needed to establish which areas can safely use trestles as opposed to the more robust BST systems.

Taking these points into consideration, it would seem logical for the industry to develop in two forms:

1. A relatively small scale using conventional trestles and poches in the more sheltered sites, aiming at the local restaurant / pub market and wholesale sales within UK. Product would need depuration.
2. A larger scale production in the more exposed sites, using BST systems, aiming for economy of scale and supplying the wholesale UK or overseas markets, either depurated or not.

There may be scope for the type a) producers to develop a "niche" market based on point of origin and using the values associated with the Solway: fresh, clean, remote, natural, wild etc. However it has to be said that these qualities are not unique and Highland Scottish producers can also sell on such a basis. The Grade B water in Solway will in fact be a disadvantage in terms of trying to sell environmental quality compared with products from further north. The local pub and restaurant trade will also be very small and will only absorb a handful of tonnes per year.

The type b) producers would be more likely to succeed through economy of scale to drive down unit costs of facilities and keep man-power and equipment depreciation costs low. It may be necessary to sell the oysters for relaying, either here or abroad, so that the shells can grow back some of their natural sculpture. The oysters would be large enough to relay on the bottom, as they would be crab proof, but quite sheltered areas. Several Orders would be necessary to protect them from wave damage and human predators respectively. Marketing trials may be necessary to establish the costs and benefits of such a final step.

9.4 EMPLOYMENT POTENTIAL & SOCIO-ECONOMIC IMPACT

Given the many uncertainties outlined in the business Strategy, it would be misleading to predict that the Solway area could be guaranteed a certain level of employment and associated social benefit through the development of local aquaculture industry.

However, as a means of providing general guidance for all stakeholders, employment estimates are made here for a plausible level of development. Actual levels of employment can be scaled up and down pro-rata to production output.

It is assumed for illustration that in five years time the Solway area could produce

- 5,000 tonnes of bottom-grown mussels.
- 200 tonnes of oysters.

For mussels, the estimate is some 25% of the potential production from the area judged as acceptable for development, the limit on potential being seed supply. It is some 30% of production of the Menai Straits in a good year and slightly over the current total Scottish rope-grown production.

For oysters, the total is a small fraction of the potential production from the area judged as acceptable for development, the limit on potential being the markets. It is some 80% of current Scottish production and 20% of UK production.

Employment and value estimates are based on farm surveys undertaken by CEFAS and FRS, to the extent possible, supplemented by industry and the consultant's estimates.

Mussels:

It is assumed that of the 5,000 tonnes, sales would be divided among the different routes set out in the business Strategy as follows:

a) bulk unpurified to export: ..... 3,000 tonnes

b) bulk purified to wholesale UK: ..... 1,000 tonnes

c) 'approved process' cooking and value adding ... 1,000 tonnes

For sales route a) the process is identical to current practices in the Welsh production, predominately Menai Straits, some south Wales. The Welsh industry employs 49.5 FTE[18]'s producing almost entirely mussels, 16,400 tonnes in 2005, or 331 tonnes per person. This very high rate of efficiency is through highly capital intensive mechanisation. Production of 5,000 tonnes in the Solway area might be expected to employ around 200 tonnes per person (tpp), through lower economy of scale.

For sales route b) the additional labour input needed is estimated at 10% less efficiency thatnmethod a), i.e. 180 tpp.

For sales route c) it is estimated from large mussel processors in Ireland that labour needs for value adding are in the area of 50 tpp.

The above production could thus be expected to produce:

Method a) 3,000 tonnes / 200 tpp =	15 FTE's
Method b) 1,000 tonnes / 180 tpp =	6 FTE's
Method c) (1,000 tonnes / 200 tpp) + (1,000 tonnes / 50 tpp) =	25 FTE's
Total	**46 FTE's**

In addition there will be other employment created in construction and/or maintenance of the major capital equipment involved, plus indirect employment form the spending of wages and profits generated by the business. This is impossible to predict reliably, but total value of sales, and so input into the local economy, would be as follows for the above scenario:

Method a) 3,000 tonnes x £875/tonne =	£2,625,000
Method b) 1,000 tonnes x £950/tonne =	£ 950,000
Method c) 1,000 tonnes x £1800/tonne =	£1,800,000
Total	**£5,375,000**

[18] FTE Full time equivalent jobs

Clearly the main employment gain can be derived from value adding and this should be encouraged to the extent that more of this type of employment is needed in Kirkcudbright. It is worth re-iterating that over-rapid expansion could leave a significant work-force, and valuable plant, inactive in periods following low seed supply. The alternative is of course to buy mussel in, which would probably be a viable option, but would reduce overall margins significantly.

Oysters

It is assumed that the 200 tonnes would be divided among outlets as follows:

10 tonnes local pub/restaurant trade

190 tonnes wholesale

Both methods can be expected to have equivalent labour needs and so will not be differentiated. It is not possible to separate employment generated by species from the total shellfish employment estimates given by CEFAS and FRS. The English and Welsh data is not applicable to estimates for oysters as it is distorted by the highly capital intensive situation in mussels. However it is reasonable to assume that Scottish shellfish farming employs people pro-rata to value, as the production is smaller scale and the majority of costs in all species and systems used is labour. The Scottish sector produced ~£6m value of shellfish at first sale in 2005 and employed 261 FTE's in doing so. Therefore turnover per employee was some £23,000.

Predicted turnover for 200 tonnes of oysters is

10 tonnes x 12.5 oysters/kg x £0.33 per oyster =	£ 41,250
190 tonnes x 12.5 oysters/kg x £0.20 per oyster =	£475,000
Total	**£516,250**

Employment generated by this production is therefore estimated as £516,250/£23,000 per employee = 22.5 FTE's.

As with mussels, there is further employment generated from spending of wages and profits locally.

These very rough estimates show that at one plausible level of development, around 70 FTE's could be generated in the Solway area through aquaculture. It is tempting to scale these employment and turnover figures up to the level of production possible from acceptable development of physical resources, i.e. 14,000 tonnes of oysters and 19,000 tonnes of mussels, (Table 21 on page 102). However the reality of the constraints over seed and constraints in the market would make such extrapolations meaningless.

The figures do show the differences in profitability between the two industries. Using the 'all Scotland' average, turnover per employee of just £23,000 shows that the shellfish industry as a whole can be barely profitable. Assuming £23,000 is equivalent to a reasonable manual wage, this suggests that all turnover is absorbed by labour costs, leaving nothing for other operational costs and depreciation. This overall average included rope mussel culture, which is becoming larger, more capital intensive and profitable in recent years, so inferring that oyster culture is more marginal than the average.

Conversely, at >£100,000 per employee, the bottom-grown mussel industry gives much more scope for other running costs and depreciation. Although significant costs are dedicated to interest on capital and depreciation of the capital assets, the bottom-grown mussel industry is much more profitable than oyster production.

Given the relative levels of profitability, it is tempting to simply drop oyster culture from any strategic planning for the Solway and concentrate on mussels. However to do so would be short-sighted. Oyster production, particularly using the BST systems, is likely to be possible in areas that are too exposed to hold mussel seed. There are areas in some of the more exposed locations where significant facilities could be built within the 10% of drying area threshold used in this study for most bays. With both economies of scale and initiatives in the market, it may be possible to improve profitability in oyster culture and develop a business creating significant and sustainable employment. It would be less subject to fluctuation compared to the uncertainties over the mussel seed situation. However a significant level of sustainable production is far removed from the present state of affairs. It is recommended that trials for oyster culture are supported further and assistance given in the development of both niche and wholesale markets.

Regarding the opportunity for mussels, the main thrust should be to try to develop and regularise a seed supply through a combination of:

- survey of the Scottish Solway coast
- liaison with the CSFC and fishermen in Cumbria over supplies from Silloth
- strategic partnerships with Menai Straits farmers

Once this has been achieved, probably over a number of years, benefits can be increased through assisting the developing value adding facilities and penetrating the markets for these products.

10 STRATEGY ELEMENT 5: STRATEGY IMPLEMENTATION

The Strategy sets out the main actions that can be taken at the sector level to promote the development of a sustainable aquaculture sector in the Solway. The Strategy works from an assumption that to some degree growth will be dependent on factors beyond the scope of this Strategy, including:

- Macroeconomic factors that affect competitiveness
- The decisions and actions of those within the sector
- Consumer demand, both domestic and international
- Government policies
- Local and regional planning controls and priorities.

The Strategy focuses on actions that are within the control of the industry acting cooperatively as a sector, or working in partnership with communities, local government, science and training providers, and regional government.

In order to fully implement the Strategy, a six-point action plan is suggested:

1. Develop the capacity of the *Solway Fish* Aquaculture Working Group (AWG) and ensure its long-term ability to guide sustainable aquaculture development in the Solway
2. Secure and promote investment in aquaculture
3. Improve public understanding and support for aquaculture
4. Develop the market for Solway aquaculture products
5. Maximise opportunities to add value through innovation and integration
6. Promote sustainability and environmental management.

10.1 DEVELOP PARTNERSHIP ARRANGEMENTS

The Solway's nascent aquaculture industry needs an over-arching representative group that has the following roles:

- To coordinate the implementation of the Strategy, including any revision as the industry matures
- To clearly articulate the needs of the different partners
- To develop and advocate good and sustainable aquaculture working practises
- To build effective dialogue with the planning and regulatory authorities as well as other stakeholders in the Solway
- To promote sustainable aquaculture production to the public and consumers
- To establish a cumulative water quality and environmental monitoring programme based on farm-level sampling and evaluation.

It is considered that the basis for such a group already exists in the form of *Solway Fish's* Aquaculture Working Group (AWG). The AWG currently consists of a wide cross-section of sectoral interests, including aquaculture operators and proponents, local planners, statutory agencies and other interested parties. The AWG is facilitated through the SFP Solway Fish initiative, although does not currently have any official mandate or terms of reference. The AWG in its present form has a finite life, possibly two years (Jeremy Roberts, pers. comm.) and a long-term structure is therefore required. In addition, the forthcoming Inshore Fisheries Management Group(s) may play a role in aquaculture development.

Three options exist for a long-term body:

1. A stand-alone, cross-sectoral body along the lines of the current AWG that provides a direct forum for aquaculture proponents, planners and statutory consultees to establish policy and guide ongoing development. This arrangement allows planners and statutory consultees to have an immediate input into Strategy and policy development, but may dilute the ability to develop industry-based initiatives for aquaculture development; or
2. An industry-representative organisation that provides a strong lobbying capability and a focal point for engagement with other stakeholders. This would allow aquaculture proponents to develop a strong and cohesive industry alliance, with benefits to developing the industry, ensuring good practice is widely adopted and being able to collectively lobby external interests. The risk of this approach is the increased scope for misunderstanding or disagreement with planners and statutory consultees, resulting in an uncertain investment climate and stymied growth.
3. A third option, and one favoured by the consultants, is a hybrid version consisting of an independent industry association whose governance is linked to Solway Fish (or its successor) where strong linkages with planners and statutory consultees can be maintained, permitting a build in trust and mutual respect. This can only result from regular and informed dialogue, the means for which will need to be built into the institutional structure.

Action Plan 1: Partnership Arrangements

Action	Partners	Timing
Agree mandate and lifetime of current AWG arrangements	Sector participants, SFP, Solway Fish, AWG	Late 2007
Formulate structure for a long-term aquaculture partnership organisation	Sector participants, SFP, Solway Fish, AWG	Late 2007
Develop a Strategy coordination and implementation mechanisms, including appropriate review and revision	Sector participants, SFP, Solway Fish, AWG	Mid 2007
Develop operational partnership with the Solway Inshore Fisheries Management Group when it is established	SFP, Solway Fish, AWG	Mid to late 2007
Build capacity and funding arrangements for long-term aquaculture partnership organisation	Sector participants, SFP, Solway Fish, AWG	2007 onwards

10.2 IMPROVE UNDERSTANDING AND SUPPORT FOR AQUACULTURE IN THE SOLWAY

During the stakeholder consultation, it became evident that an understanding of shellfish aquaculture amongst non-practitioners is extremely limited. In particular, there was little comprehension of either the nature of aquaculture development (i.e. the position on the foreshore, their form and the size of the structures involved) nor the possible scale of development (e.g. what proportion of the foreshore it might occupy, the density of the structures and how this development might impact on the local landscape).

This lack of understanding was not just limited to the public at large, but also professionals both in the planning and environmental conservation agencies as well as other coastal users who might be affected by aquaculture development. It is therefore important that information is provided on the nature, scale and possible impacts of aquaculture, together with the possible benefits in terms of socio-economic gains, improved environmental management through better water quality monitoring.

This promotion needs to be undertaken at an early stage and revisited once a number of farms are established. It is suggested that it takes a dual approach of (i) written articles in local newspapers, magazines and relevant sector media (e.g. sailing, recreational angling, nature conservation, etc) aimed at the general public and (ii) briefing meetings and field trips for planners and other officers involved in the statutory consultation for planning approval. It is important that appropriate pictures, diagrams and where possible site visits are used to provide a real sense of what aquaculture development means and how it might affect people and the surrounding environment.

Action Plan 2: Awareness and Information Dissemination on Shellfish Aquaculture

Action	Partners	Timing
Develop promotion media for distribution in newspapers, magazines and sector-specific press	Sector participants, SFP, Solway Fish, AWG	Late 2007
Prepare briefing package for planning and other officers involved in planning control and regular statutory consultation	Sector participants, SFP, Solway Fish, AWG	Late 2007
Arrange site visits for planning officials and other interested parties to demonstrate actual *in situ* conditions and impacts	Sector participants, SFP, Solway Fish, AWG	Late 2007
Revise and update information packages	Sector participants, AWG	2008 onwards

10.3 SECURE AND PROMOTE INVESTMENT IN AQUACULTURE

At present, there are a number of uncertainties that have limited the development of aquaculture in the Solway. These include:

- Unknown growing conditions in a dynamic, highly variable and high risk environment
- The precautionary approach of the planning agencies and their statutory consultees
- Uncertainly over foreshore fishing rights in estate lands, especially for cockles, that has restricted investment in joint aquaculture/wild cockle harvesting ventures. This is demonstrated by the very slow progress in applying for Several Orders[19].
- Continued uncertainty over the boundary between England and Scotland.
- The lack of sector-specific guidance on what information should be included in planning aquaculture applications in environmentally sensitive areas such as SACs/SPAs/NSAs / AONBs.

It is important that aquaculture proponents are provided a more certain and predictable investment environment if they are to invest in what is traditionally a high risk sector. To a certain extent, the current conditions have resulted from an absence of successful and visible

[19] Jamie Blackett (Arbigland Estate) and Alistair Henryson-Caird (Creetown), pers. comm.)

trials to date that might provide reassurance on the generally benign nature of extensive shellfish culture, and it is hoped that this Strategy will contribute to allowing cautious but positive progress to be made.

Various actions need to be taken in order to reduce uncertainty and promote sustainable investment within the Solway:

Action Plan 3: Secure a Positive Investment Climate for Aquaculture Development

Action	Partners	Timing
Resolve outstanding issues over fishing rights on non-Crown land and clarify eligibility criteria for award of Several rights.	SSMA, SFP, AWG	2007 / 2008
Resolve current uncertainty over the position of the England/Scotland border and related jurisdictional issues.		2007 / 2008
Prepare detailed guidance for aquaculture development in 'sensitive areas'[20]	Sector participants, AWG	2007 / 2008

10.4 DEVELOP THE MARKET FOR SOLWAY AQUACULTURE PRODUCTS

The market opportunities and constraints have been discussed in Section 9. There are various opportunities to market mussels and the size of each market sector is large. The main emphasis for Solway producers is to be able to compete on price. The large continental markets are not particularly interested in origin. Dutch consumers probably think they are consuming Dutch mussels when they are in fact from Wales or Ireland, if anything raising awareness of origin could be negative in this situation. If the main employment opportunity associated with value added is to be pursued, then assistance could be given to brand the product and break into that market, aimed at the catering trade and non-supermarket retail. Improvement of water quality to A grade in the main growing areas could increase the scope of this and fresh markets, as multiple retail would then accept both types of product.

With regard to oysters, efforts will be needed to develop both types of markets. Local fresh sales will need to be supported by local awareness activities and frequent contacts with potential customers. If there are a number of small producers, co-operative efforts are recommended to allow continuity of supply. Large scale sales from BST systems will have to be developed once the end product form and market acceptability is clearer. Local branding may help in UK wholesale markets, probably not overseas. Again, French consumers will assume that they are eating French oysters.

Action Plan 4: Develop the Market for Solway Aquaculture Products

Action	Partners	Timing
Research detail of markets and develop a marketing plan for value-added mussel products	Industry, Seafish, Scottish Enterprise	2008-2010 (assumes production starts 2007)
Assist oyster producers in local branding and local awareness for local fresh markets	Industry, Seafish, Scottish Enterprise	2010 (assumes production starts 2007)
Assist development of wholesale markets, UK and exports	Industry, Seafish, SAGB	2010 (assumes production starts 2007)

[20] The European Commission is understood to be developing such guidelines – for more details, see http://consult-poseidon.com/reports/Final%20FISH-2004-15%20Aquaculture%20Environment%2005-07-06.pdf

10.5 ADD VALUE THROUGH INNOVATION AND INTEGRATION

The Solway's unique and largely unspoiled environment provides opportunities for shellfish culture, just as the Solway's diverse nature presents challenges to its development. As a result, the industry will have to reply upon the dynamism and innovativeness of its proponents in order to overcome these constraints to achieve a sustainable and socio-economically valuable business. This process will largely be independent of the existing, mainly raft-based shellfish culture in the deeper sea lochs of the Scottish west coast, where production is mainly sub-tidal, based on a proven generic model and fairly large in scale. By contrast, Solway shellfish culture is going to be highly site specific, reflecting the diversity of inter-tidal sites, and generally smaller in scale. This presents challenges in terms of achieving a high value product and reasonable economies of scale.

The industry's Strategy should therefore be aimed at niche production that maximises value adding opportunities and integration with the various other unique attributes of the Solway coast, such as its high tourist visitation rates and its position to the main market centres of northern England and southern Scotland.

Action Plan 5: Add Value Through Innovation and Integration

Action	Partners	Timing
Initially though the AWG and recognising individual commercial confidentiality, develop a guidance document of good design and working practices that maximises sustainable productivity in the Solway Environment.	AWG, sector participants	2007 ongoing
Identify researchable constraints to sustainable shellfish culture and seek assistance from suitable organisations for technical and financial assistance to overcome these.	AWG, sector participants	2007 ongoing
Expand and promote new and existing industry/research partnerships that increase the overall innovation in the sector and inform research priorities (see above)	AWG, sector participants	2007 ongoing
Explore options to integrate aquaculture with tourism, through guided tours, 'seafood bars'[21] in strategic locations near farms and local processing such as smoking, marinades, etc.	Sector participants, tourism development agencies	2007 ongoing

[21] Such as the Loch Fyne Oysters model, see http://www.lochfyne.com/pages/content.asp?PageID=48

10.6 PROMOTE SUSTAINABILITY AND ENVIRONMENTAL MANAGEMENT

Underpinning this Strategy for aquaculture development in the Solway is a firm commitment to build the environmental sustainability and integrity of the sector. Aquaculture is one of a handful of nature resource industries that can offer environmentally sustainable economic growth. Not only is it based upon renewable resources, it depends for its existence on pristine waters and therefore has a stewardship role in assisting to conserve the Solway as a whole.

A development that took place during the strategy's creation was the introduction of the European Directive 2001/42/EC (the Strategic Environmental Assessment Directive)[22] "on the assessment of the effects of certain plans and programmes on the environment" requires a formal environmental assessment of certain plans and programmes which are likely to have significant effects on the environment. The Aquaculture working should give serious consideration to taking the strategy a step further and conducting an SEA upon it, as his will add further weight to it and increase its usefulness to planner and developer a like.

Action Plan 6: Promote Sustainability and Environmental Management

Action	Partners	Timing
Develop an advocacy role for the AWG (and its successor) to maintain and improve water quality in the Solway, including control of land-based sources of pollution.	AWG, SFP	2007
Explore potential for collaboration with environmental NGOs.	AWG	2007
Consider developing a phase two strategy which is subject to a SEA.	AWG	2007 - 2008
Develop a Solway environmental code of practice for the sector, based upon the existing ASSC guidelines, that feeds into a possible quality or sourcing 'mark' and promotes good stewardship of the Solway's waters. Develop in partnership with key stakeholders including environmental NGOs.	AWG, ASSG, sector participants	2007 - 2008

[22] The SEA Directive is transposed into UK law by the Environmental Assessment of Plans and Programmes Regulations 2004, and in Scotland by the Environmental Assessment (Scotland) Act 2005.

Appendix A: Terms of Reference

Solway Aquaculture Strategy Project Brief

Purpose

1. The aim of this brief is to commission a consultant to develop an appropriate Strategy for the sustainable development of aquaculture in the Solway. This work forms part of the activity of the Solway Firth Fisheries Forum, shortly to be called Solway Fish, coordinated by the Solway Firth Partnership.

Client

2. The project is being led by the Solway Firth Partnership on behalf of the Aquaculture Working group established as part of the Solway Firth Fisheries Forum (Solway Fish). The Aquaculture Working Group will guide and approve the work throughout the projects duration as appropriate.

Background

3. To date the Solway has not seen the development of an aquaculture industry like that which has become established along more northerly parts of the Scottish coast. However, there is now a developing interest, particularly for growing shellfish.

4. Two applications in 2003/04 for trestle based mussel cultivation on the Scottish Solway coast were eventually refused after inquiries. An alternative technique, using a BST long-line system for mussels and oysters, is now being trialled on a small scale at two locations on the Scottish Solway coast and one location on the English Solway coast. An application on the English Solway coast for further trial sites has recently been the subject of a planning inquiry, the outcome of which is not yet known.

5. At present, the location and management of aquaculture developments around the Solway Firth is an *ad hoc* undertaking, with site selection left to individuals interested in the pursuit. Early applications highlighted concern about insufficient supporting information being provided, particularly in relation to the Solway's nature and landscape designations. Furthermore, public concerns were raised regarding the impacts of developments on visual amenity and the environment.

6. It is now widely recognised that there is an urgent need to develop an appropriate aquaculture Strategy so that sustainable aquaculture development can take place in the Solway, particularly in light of the Solway's natural heritage and landscape value. It is noted that a Solway based aquaculture industry could provide significant local economic benefit and should be integrated with the wider management of the coastal zone.

7. An aquaculture information seminar, co-ordinated by the Solway Firth Partnership with funding from Scottish Enterprise, was attended by a cross section of some 70 stakeholders in October 2005 and further endorsed the need for an aquaculture Strategy.

8. The First meeting of the Solway Fish Aquaculture Working Group took place in January 2006, and a meeting note from this is included in Annex 1 of this document for reference.

Aims and objectives

9. The broad aim for a Solway Aquaculture Strategy is:

'To provide a strategic framework for the sustainable development of aquaculture in the Solway'.

10. The Strategy's objectives are to:

- Promote the operation and development of aquaculture which is sustainable (considers environmental, social and economical aspects) and is not in conflict with other interests;
- Raise public awareness of the resource value of the Solway and guide stakeholders, particularly prospective aquaculture developers and planners, regarding the various interests that should be taken into account when considering development to ensure local benefit;
- Safeguard the seascape/landscape value and key tourism and recreation aspects of the Solway;
- Consider infrastructure requirements to support a Solway aquaculture industry, research aspects and site location carrying capacity.

The proposal

11. The proposal is that an aquaculture Strategy is developed to provide a framework for sustainable aquaculture development in the Solway.

12. It is anticipated that the Strategy will primarily provide guidance for the siting of aquaculture developments in the Solway, allowing for the identification of suitable areas/locations, potentially suitable areas/locations and non-suitable areas/locations for development. This will then lead to the consideration of probable management issues associated with the identified locations.

13. In order to fulfil these requirements it is noted that an assessment of the physical characteristics of the area with regard to aquaculture development will be required e.g. hydrology and that the multiple and conflicting uses of sites will need to be assessed. These may include water quality, landscape and visual amenity, navigation, access, recreation, inshore fishing, biodiversity, archaeology, tourism and others.

14. The Strategy document produced should be a vital tool for all stakeholders including investors, planners and local communities and satisfactory consultation will be required to ensure endorsement by all.

15. It is recognised that a foreshore and seabed ownership audit may be required to assist with the Strategy development in identifying landowners not in favour of development.

16. Geographical Information System (GIS) mapping of the area will be essential, particularly if a framework policy map is to be produced to assist in the interpretation of the Strategy.

17. The Strategy document developed will be a working document subject to revision.

The process and timeframe

18. At this stage a timeframe for the development of the Strategy can only be estimated and is provided in Figure 1, though it is recognised that progress needs to be made quickly. Part of the outline process takes into consideration a period of consultation with wider stakeholders groups. It should also be noted that the contractor will meet with the Aquaculture Working Group on a number of occasions. Additionally, the contractor will also be required to give a presentation when the aquaculture Strategy is launched at an appropriate public event.

Reporting Arrangements

19. The Contractor will be required to prepare and circulate copies of all progress reports and discussion papers to the Solway Firth Partnership for dissemination to the Aquaculture Working Group.

20. Progress reports and other papers to be discussed by the aquaculture working group should be provided at least ten working days before a meeting in paper and electronic format.

21. The Solway Firth Partnership on behalf of the aquaculture working group will require 30 copies of the Final Report, which should be fully proof read. It will include a free standing Executive Summary of not more than 2000 words. An additional master copy will also be made available in the form of a camera-ready copy suitable for direct printing and along with a Microsoft Word 2000 and PDF format on CD-ROM. In addition any map-based data, both baseline data and accompanying maps in the final report, should be made available in digitised GIS on CD-ROM using an appropriate software package, and any statistical tables should also be presented as Microsoft Access 2000 or Microsoft Excel 2000 files.

22. The Solway Firth Partnership will hold the copyright on the Strategy and its publication. The report or the information from it cannot be quoted from or used in any other project work without the written permission of the Solway Firth Partnership.

Supplementary tender points for consideration

The SFP invites contractors to expand on their original tender in relation to the following points:

- Consultation aspects – The involvement of stakeholders with an interest in aquaculture development in the Solway will be an important element in the preparation of a successful Aquaculture Strategy. Submissions should identify the key stages for stakeholder consultation outlining the methods proposed to engage and involve stakeholders in the preparation of the Strategy.
- Socio economic benefits/added value of Strategy – The submissions should identify and take into account the socio economic and other potential benefits which may result from the preparation of an Aquaculture Strategy and provide an indication of their potential impact on the Solway.
- Other aspects – Based upon their knowledge in this area the contactors may wish to suggest other areas of work that would complement the Strategy's development and assist in meeting its aim and objectives, in light of the potentially increased budget.

Appendix B: People Met

Name	Organisation (Position)
David Copeland	Allerdale Borough Council (Environmental Health Officer)
Jamie Blackett	Arbigland Estate
Alistair Henryson-Caird	Castle Cary Oyster Farm
David Dobson	Cumbria Sea Fisheries Committee (Senior Fisheries Officer)
Tommy Clarke	Dee Fish
Peter Knoule	Dumfries & Galloway Council (Biodiversity Officer)
Phillip Harris	Dumfries & Galloway Council (Landscape Architect)
Chris Hopkin	Dumfries & Galloway Council (Principal Officer Planning and Research Group)
Peter Shellard	Dumfries & Galloway Council (Senior Planner)
Sue Hudson	Dumfries & Galloway Council (Senior Planner)
Peter Norman	Dumfries & Galloway Council (Biodiversity Officer)
Andrew Maxwell	Dumfries & Galloway Council
Euan Hutchinson	Dumfries & Galloway Council
Gibby McCoskry	Fishing gear manufacturer
Andrew Lochead	Galloway Static Gear Fishermen's Association
Fraser Scott	Galloway Static Gear Fishermen's Association
John Turner	Lowther Estates
Phil Balls	Marine Fisheries Agency
Judy Baxter	National Trust for Scotland
Karl Mundy	National Trust for Scotland (Senior Ranger)
Wilf Morgan	Oyster farmer
Fiona Manson	Scottish Natural Heritage
Chris Miles	Scottish Natural Heritage (Area manager)
Pam Taylor	Solway Firth Partnership (Assistant Project Officer)
Jeremy Roberts	Solway Firth Partnership (Project Officer)
Alex Watson	Solway Shellfish Management Association (Fishery Officer)
Stephen Alexander	Solway Shellfish Management Association (Fishery Officer)
John Wilson	Solway Yacht Club (Commodore)
Jim Briggs	South West of Scotland Sea Anglers Association
Lord Vaux	Stakeholder (public meeting in Castle Douglas)
Charles Miles	Stakeholder (public meeting in Skinburness)
James Mitchell	Stakeholder (public meeting in Skinburness)
Elizabeth Tindal	Wigtown Bay LNR (Ranger)

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Appendix D: Crown Estate Shellfish Rents

An annual rent will be charged for the lease. The rent is based on the level of authorised equipment regardless of whether the site is developed to its full capacity.

Rents are charged annually in advance on 1 January and an apportionment will be charged for the first year if the lease starts on a date other than 1 January.

The rents for shellfish farms are reviewed every five years in consultation with representatives of the shellfish industry. The current rates are as follows (figures rounded to the nearest pound):

Mussel Cultivation

Band	Longline length (m)	Mainland rent
1	Up to 600	£160
2	601-1,200	£235
3	1,201-1,800	£403
4	1,801-2,400	£560
5	2,401-3,600	£806
6	3,601-4,800	£1,120
7	Over 4,801	23.5 per metre

Scallop Cultivation

Band	Longline length (m)	Mainland rent
1	Up to 1,800	£133
2	1,801-3,600	£196
3	3,601-5,400	£329
4	5,401-7,200	£461
5	7,201-10,800	£663
6	10,801-14,400	£928
7	Over 14,401	7p per metre

Oyster Cultivation

Band	Trestle length (m)	Mainland rent
1	Up to 400	£133
2	401-800	£196
3	801-1,200	£329
4	1,201-1,600	£461
5	1,601-2,400	£663
6	2,401-3,200	£928
7	Over 3,201	29p per metre

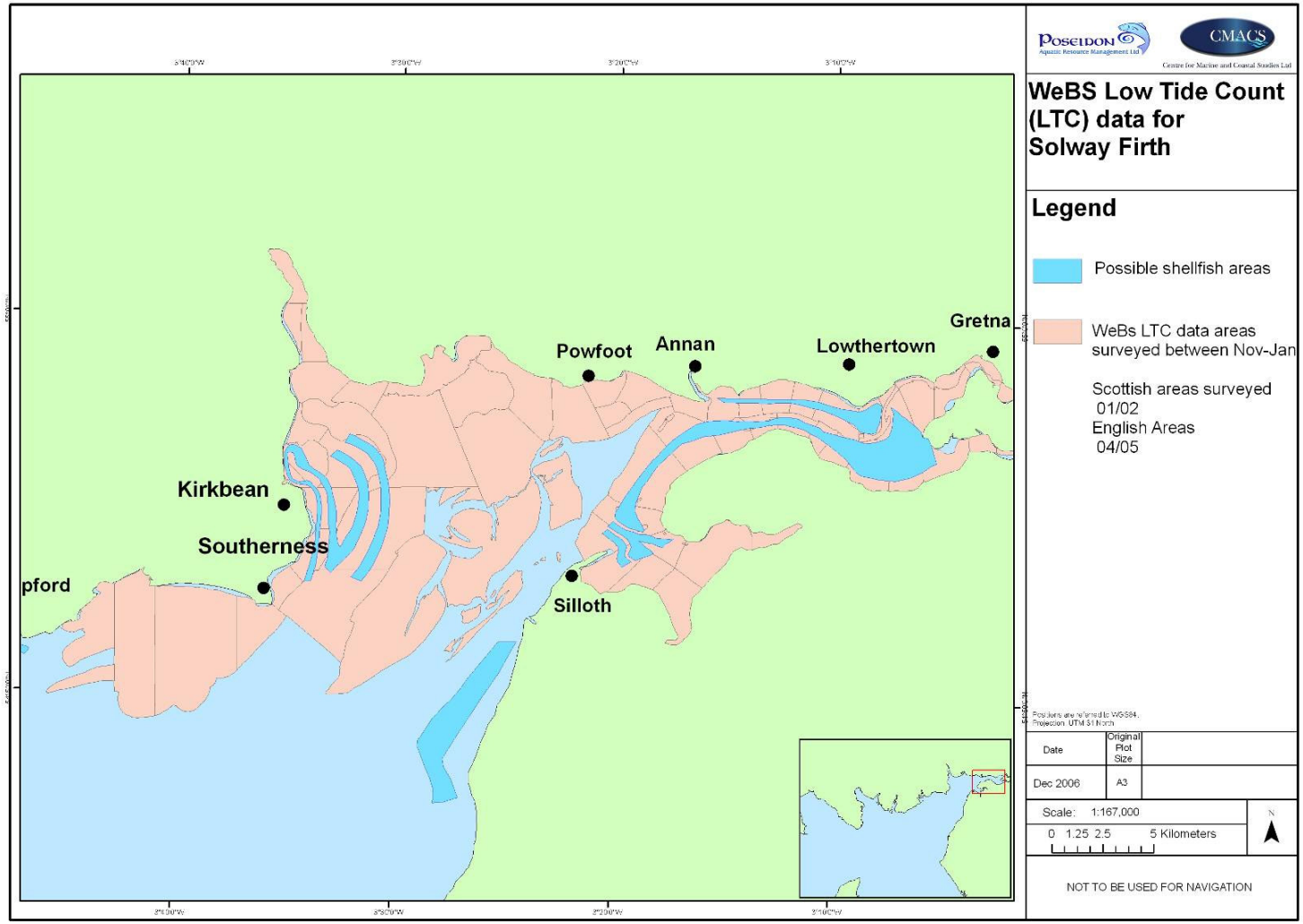
Appendix E: Bird Distribution Maps

The data presented within this appendix displays information relating to bird distribution within the upper Solway taken from The Wetland Birds Survey data Low Tide Count information (WeBSLTC). Distribution maps have been produced based upon raw data supplied by the British Trust for Ornithology (BTO) and the displayed species were selected due to their importance either at the international or national level (Scaup was included at the request of several consultees).

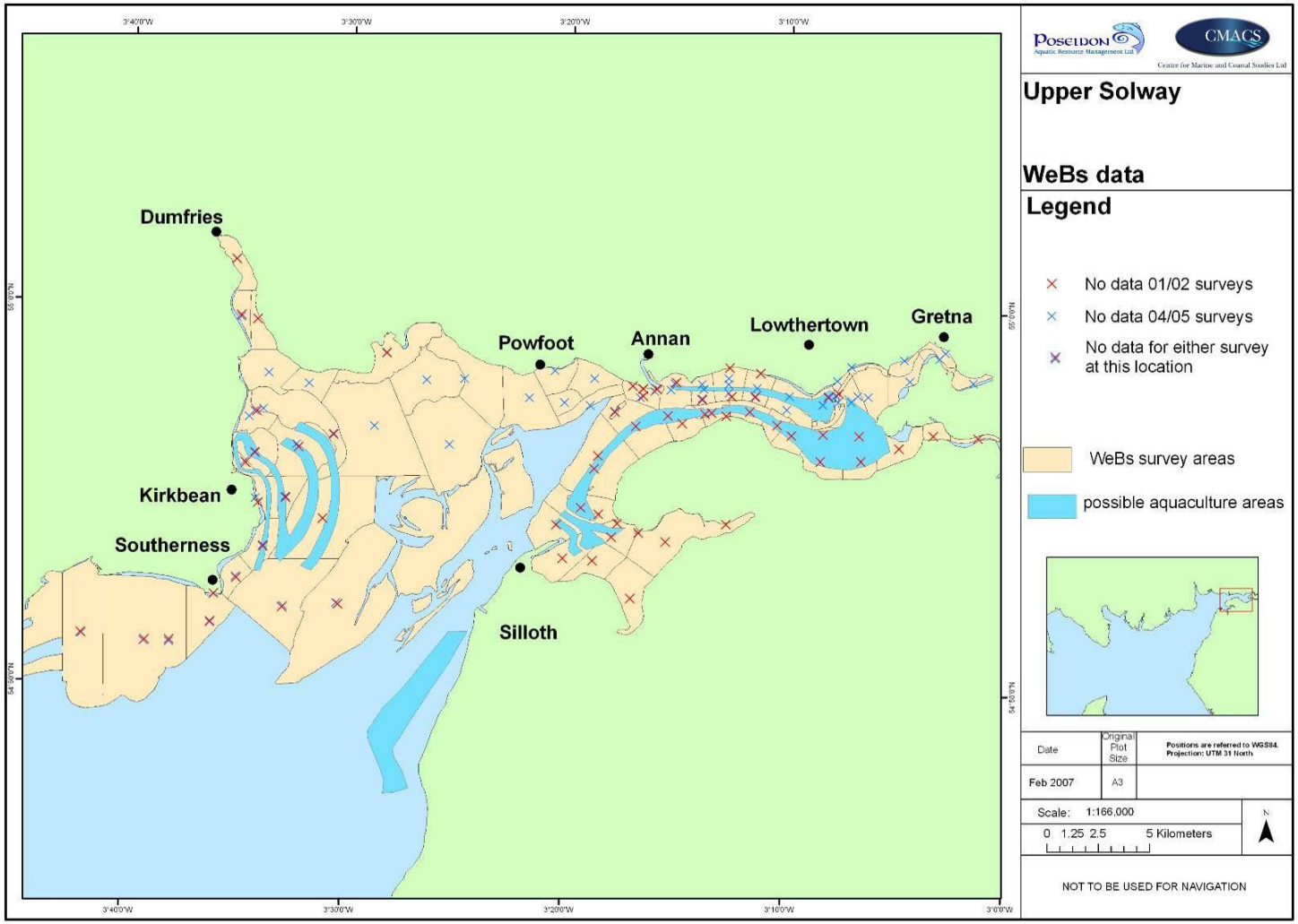
It has been acknowledged by WeBS that the coverage of the upper Solway areas at low water has varied greatly between years, and it has not been possible to provide recent data which covers all of the WeBS survey areas for one particular year. For this reason the maps display data from two separate survey years: winter 2001/02 (when only Scottish areas were surveyed) and winter 2004/05 (when only English areas were covered). The combination of the data from these two surveys has allowed coverage of the whole upper Solway area to be displayed on one map; but it is acknowledged that direct comparisons cannot be made due to the difference in both the year and the survey coverage. In addition to this, certain areas within these survey years do not have any available data for whatever reason e.g. some Scottish sites were not surveyed as part of the 2001/02 survey year and the same for certain English sites in the 2004/05 survey. Areas that do not have any data provided for either 2001/02 or 2004/05 surveys (or indeed both years) have been marked on the first map with a colour coded cross.

The data is displayed as mean density of bird per hectare based upon the average of peak monthly bird count densities. As stated previously, due to the limitations of the data coverage it is acknowledged that these distribution maps are limited in their usefulness as an analytical tool and it is not possible to draw any definitive conclusions from them. However, they are able to provide a broad scale overview of the areas of the upper Solway which are utilised by these important bird species.

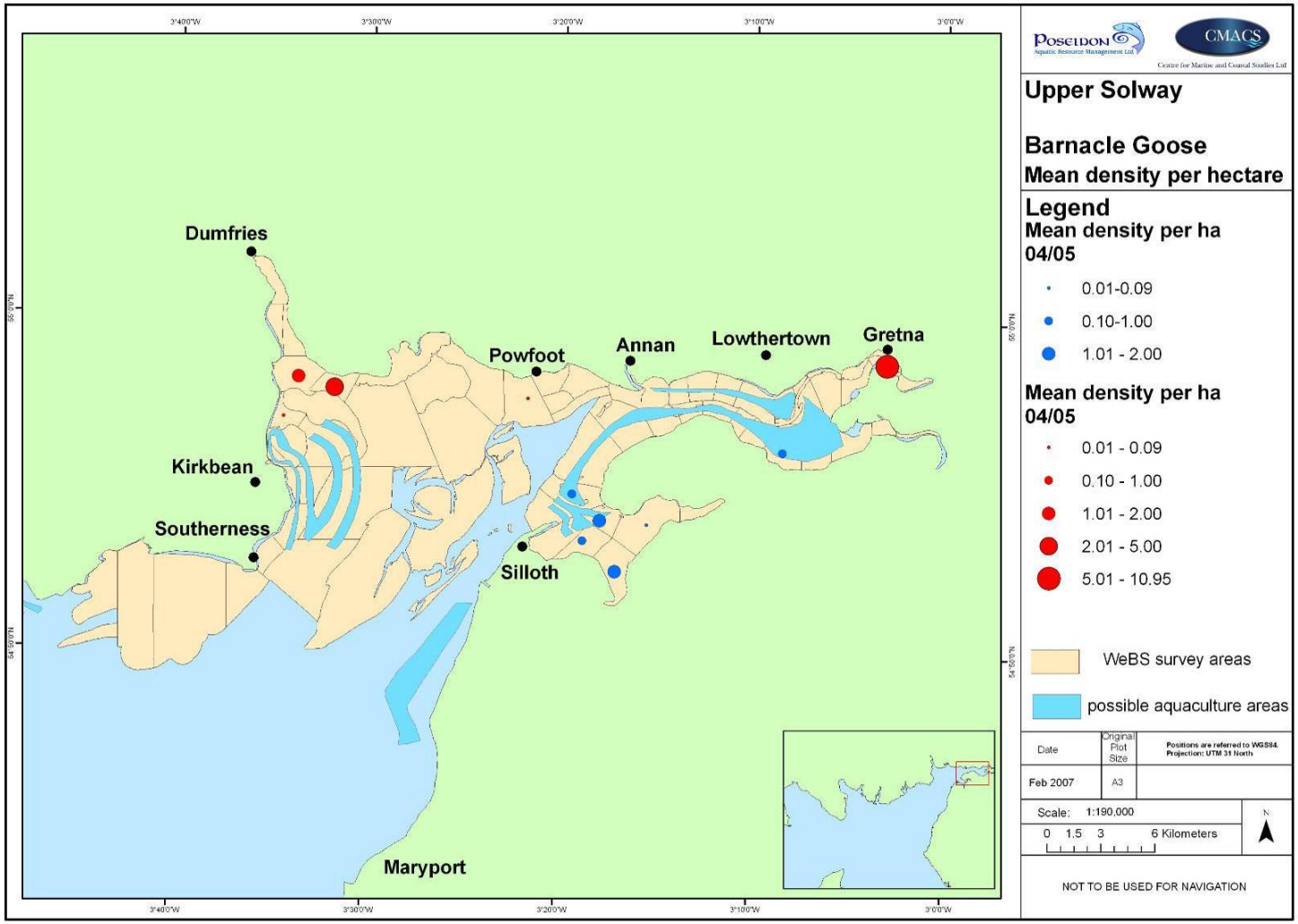
Map 20: WeBS Low Tide Count Data for the Solway



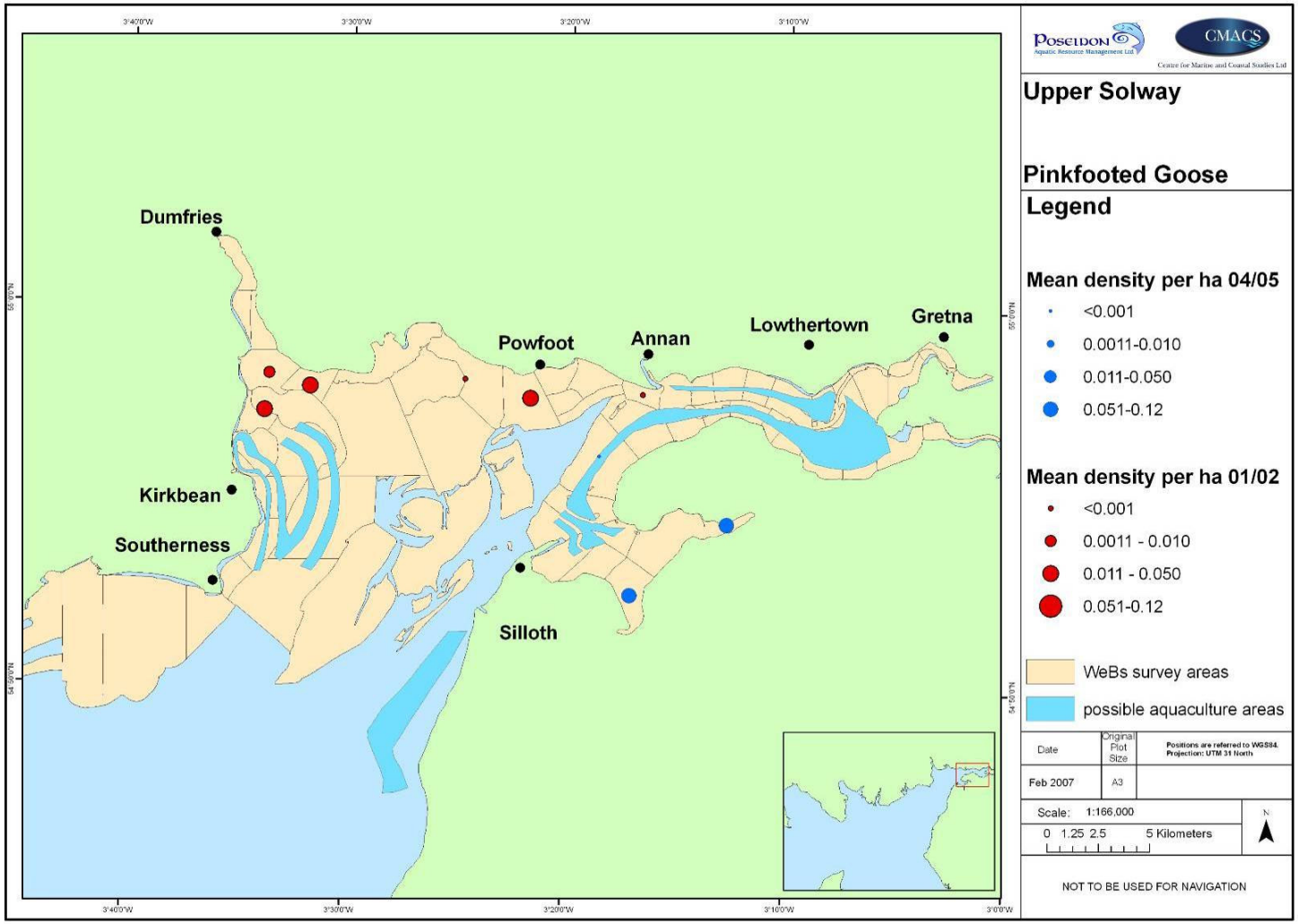
Map 21: WeBs Bird Data Availability



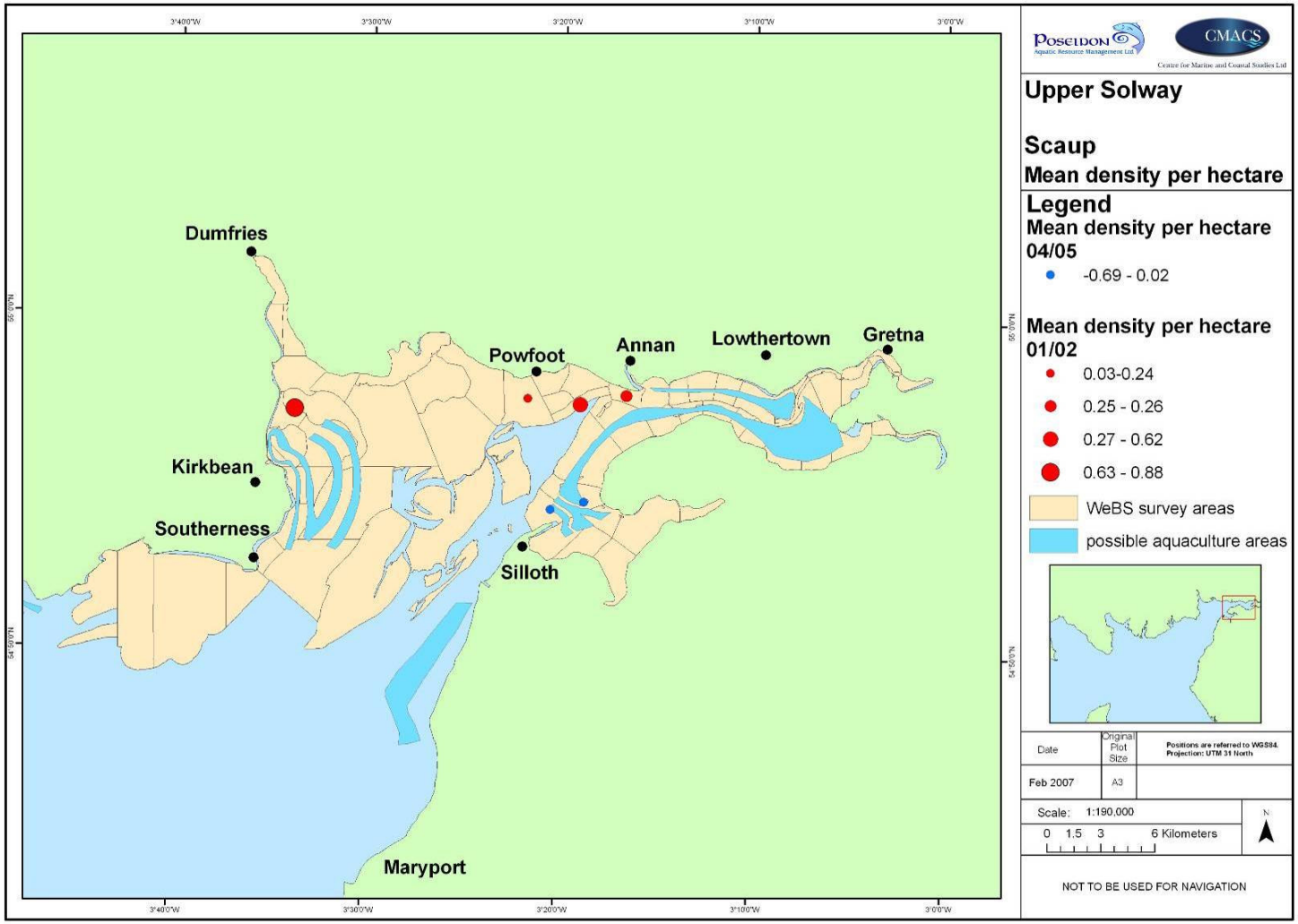
Map 22: Barnacle Goose Distribution



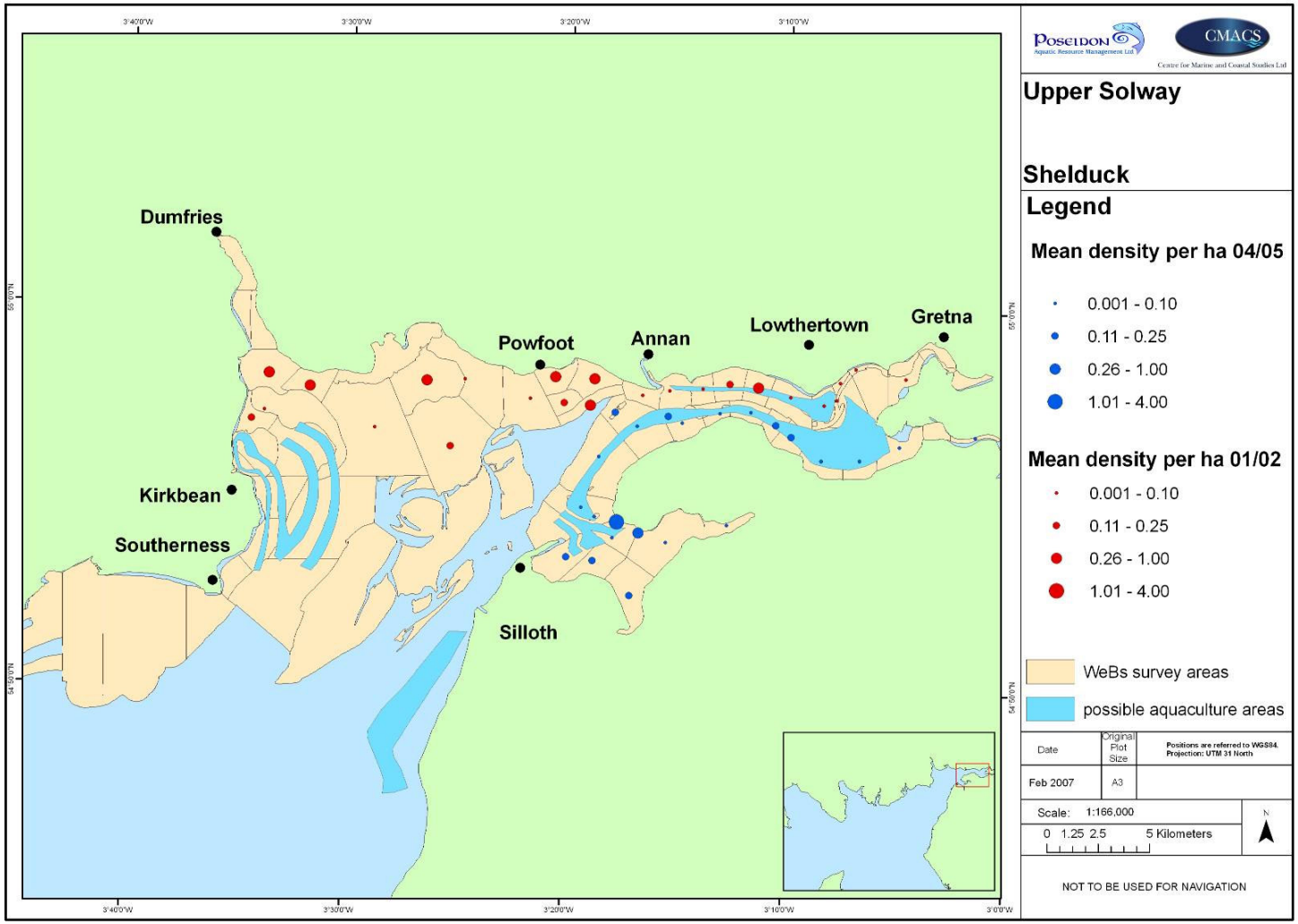
Map 23: Pink-footed Goose Distribution



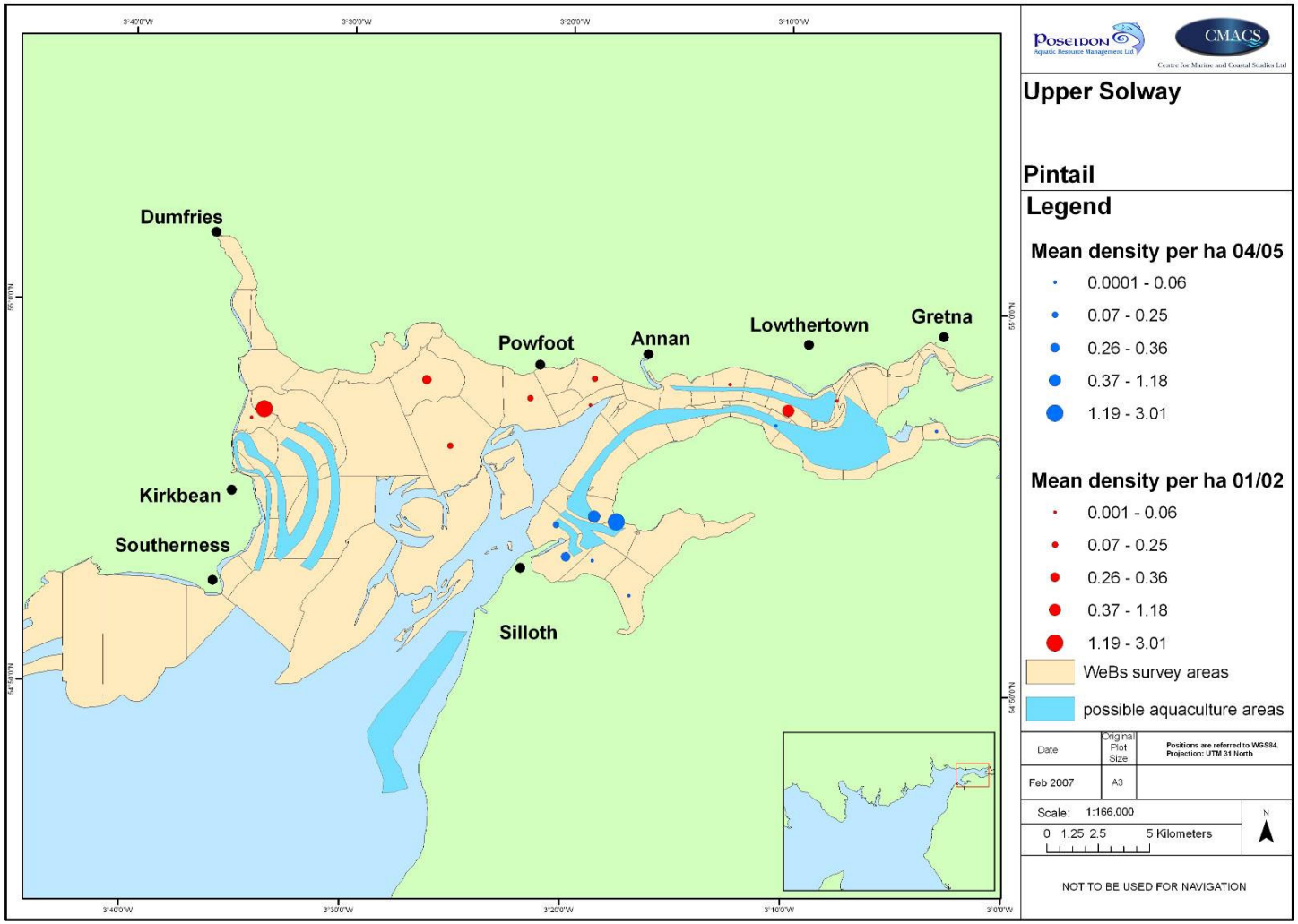
Map 24: Scaup Distribution



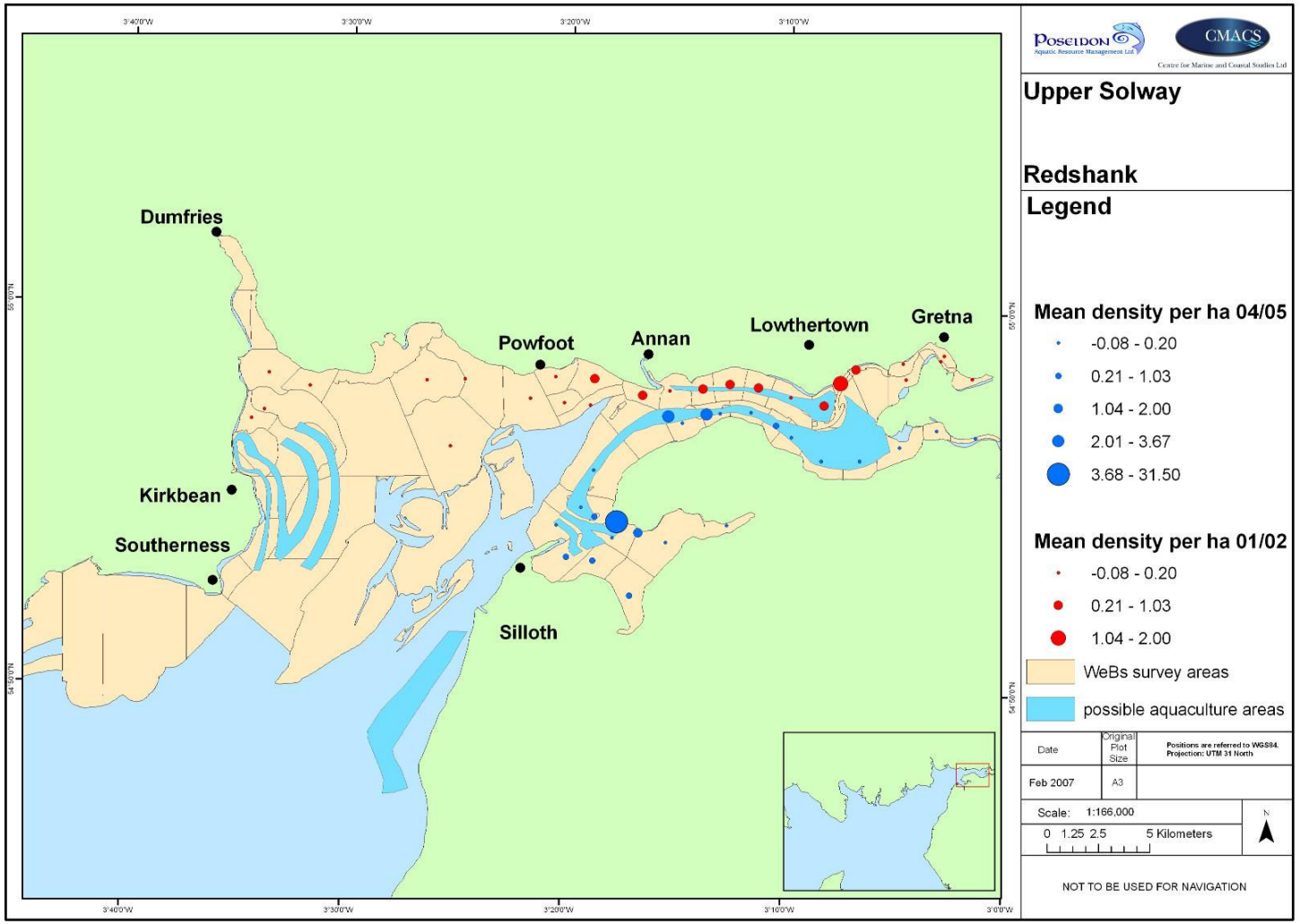
Map 25: Shelduck Counts



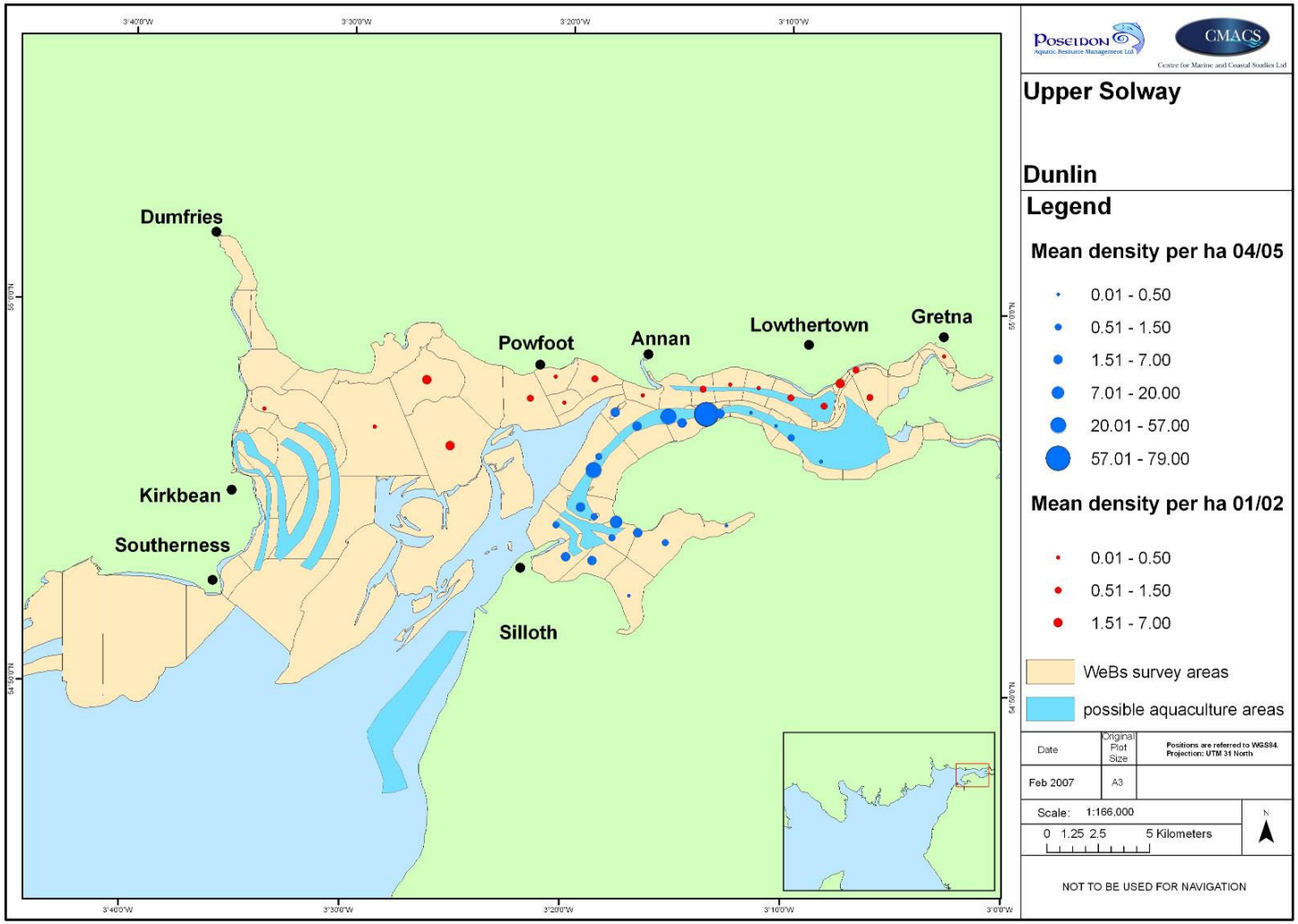
Map 26: Pintail Distribution



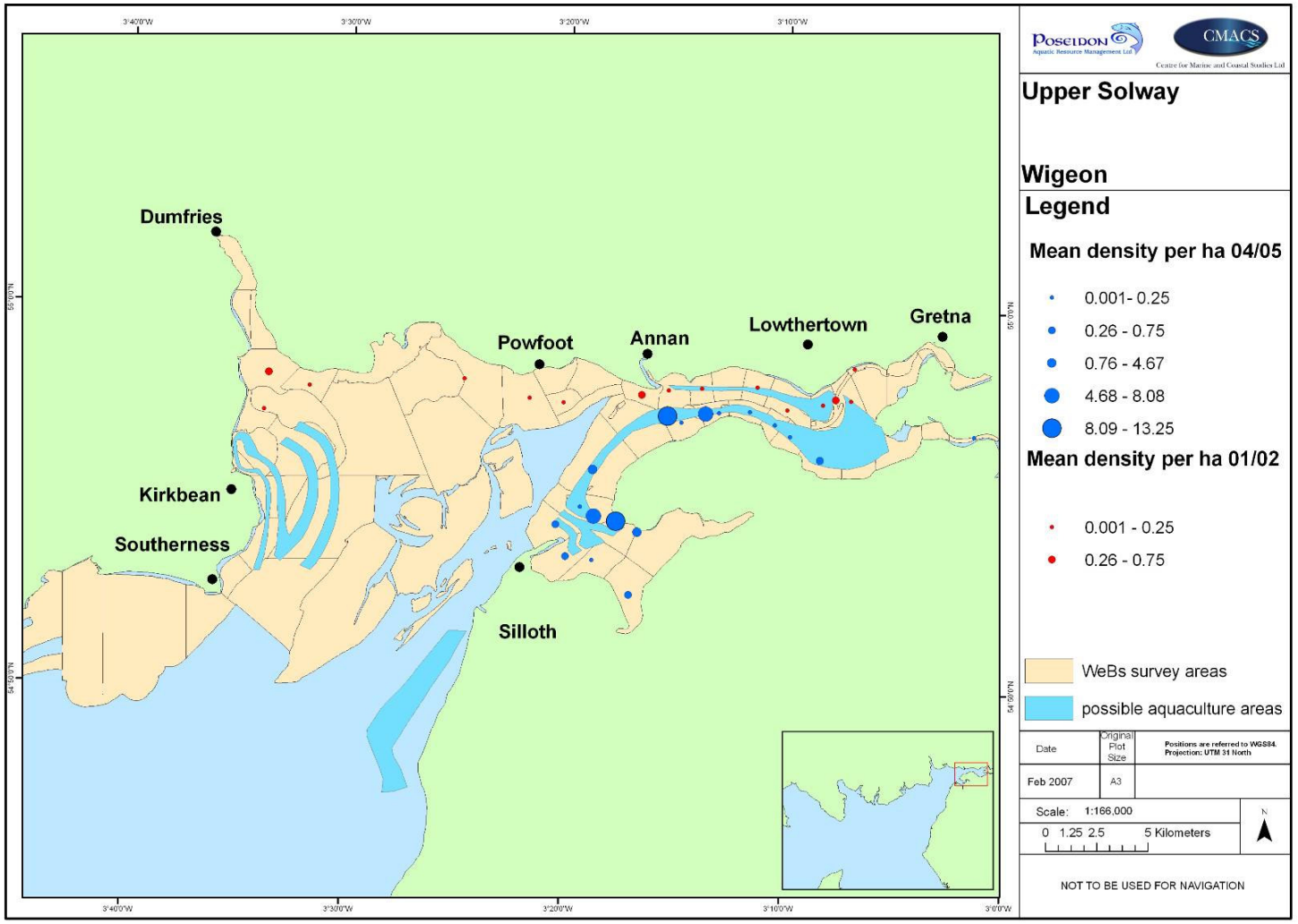
Map 27: Redshank Counts



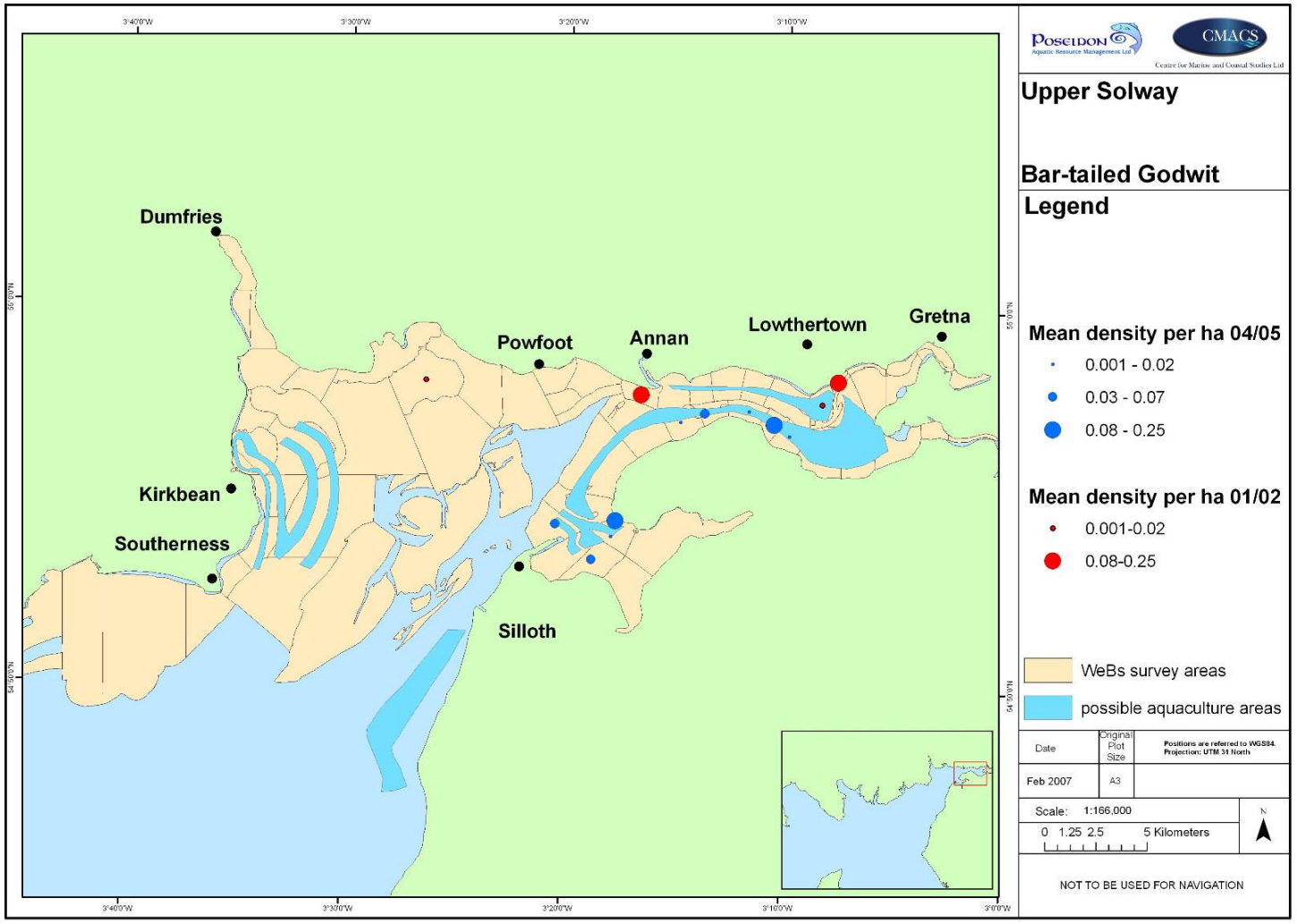
Map 28: Dunlin Counts



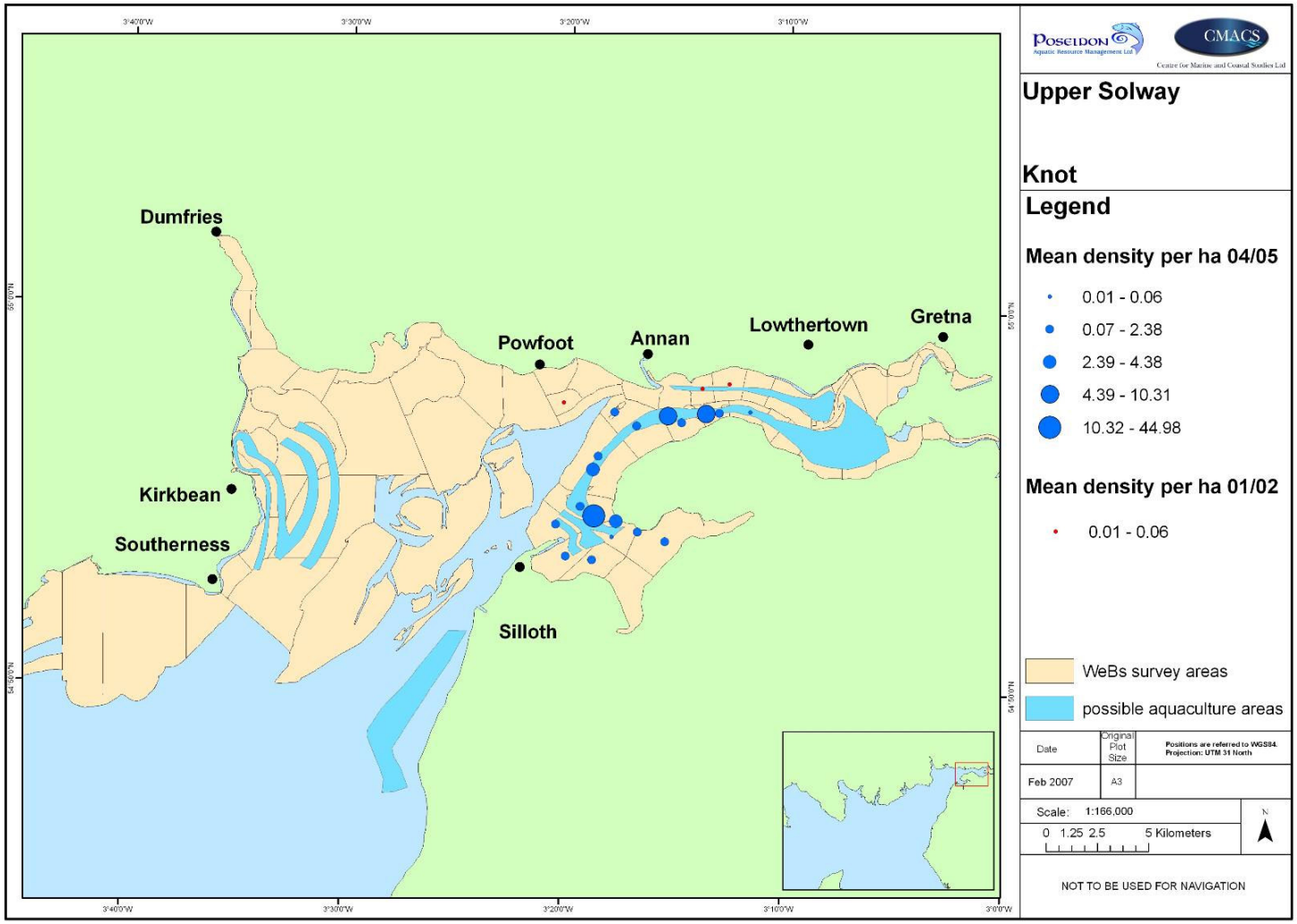
Map 29: Wigeon Counts



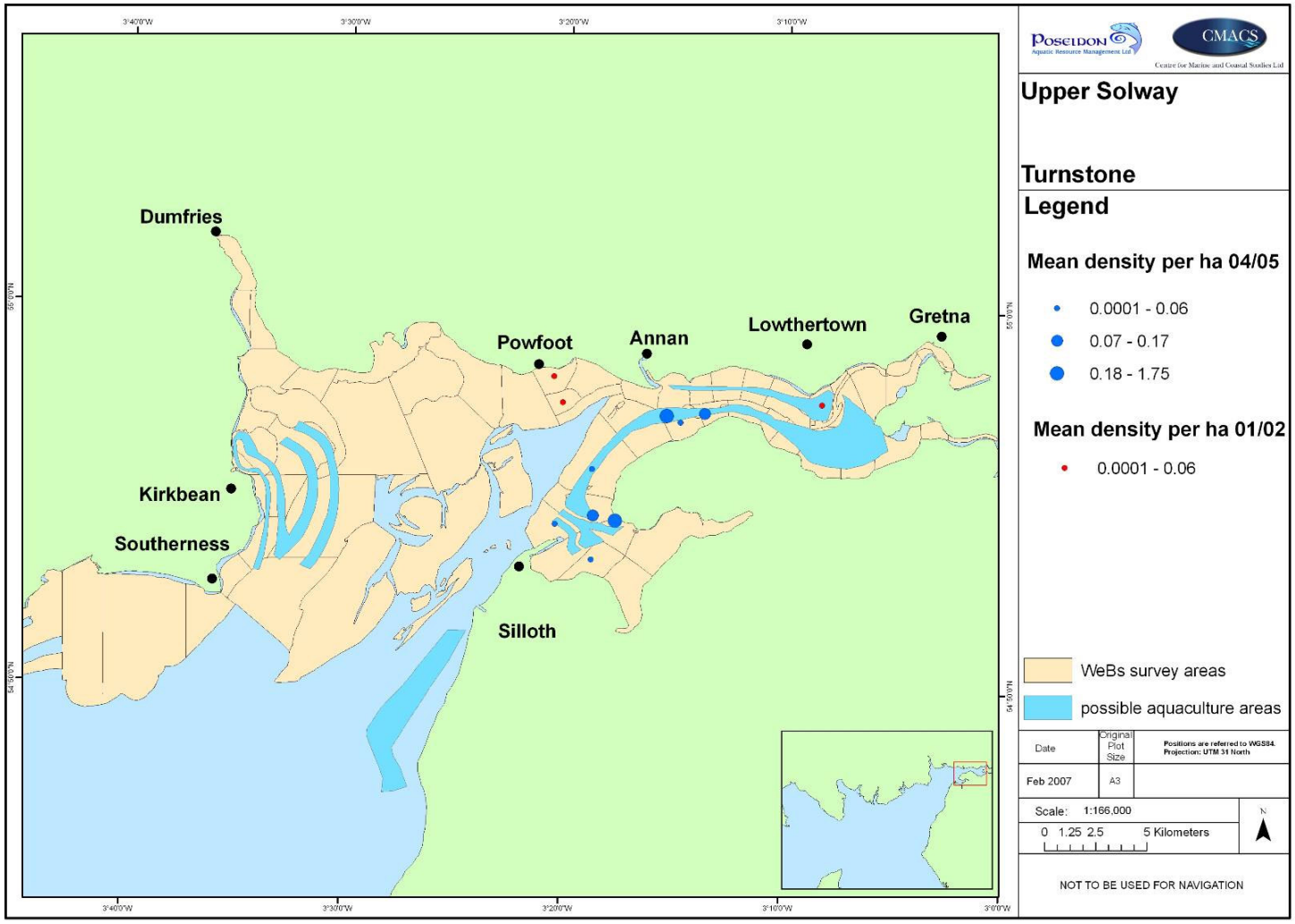
Map 30: Bar-tailed Godwit Distribution



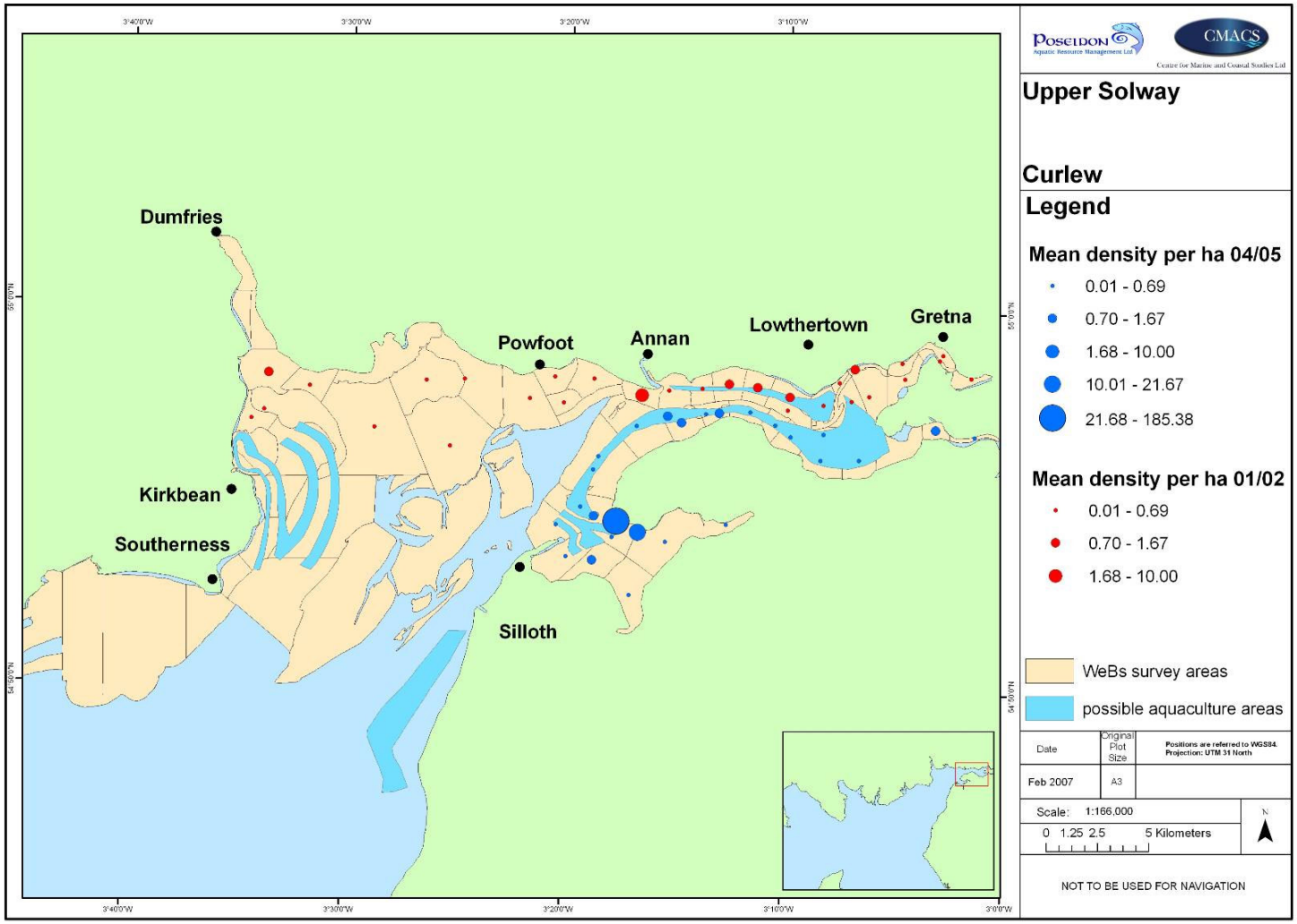
Map 31: Knot Distribution



Map 32: Turnstone Distribution



Map 33: Curlew Distribution



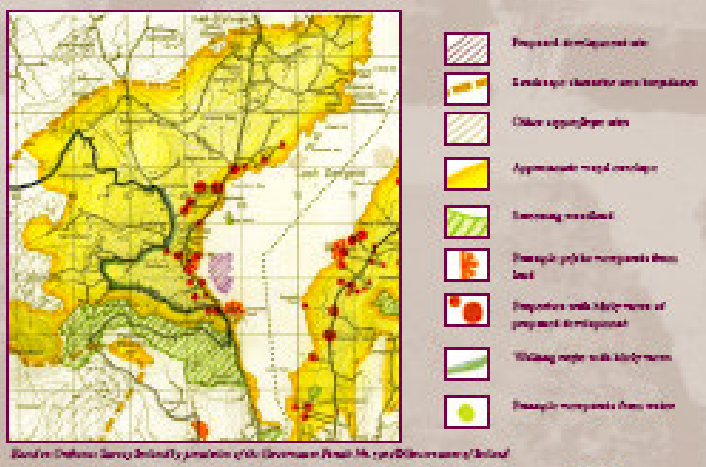
Appendix F: Impact of Landscape and Visual Impact of Marine Shellfish Operations

Assessing Landscape and Visual Impacts

Describe the Existing Landscape and Visual Environment

Consider the main characteristics, qualities and features of the landscape, and the ways in which the landscape is valued. Identify which views contribute to the enjoyment of the area for residents, visitors and others. Find out about any scenic areas or key views that may be shown in the County Development Plan, and identify any existing aquaculture licence areas close by. Is the landscape and visual environment particularly sensitive to change? Go out and look at the landscape and the key views with these issues in mind. Take photos to record what you see.

Sample of a Field Survey Map - this may be a useful way to record the information you collect



Predict How the Landscape and Visual Environment Will Change

Imagine and predict, as accurately as you can, the effects that your site will have. You may find the following two methods helpful.

Draw on a map the visual envelope of your proposed shellfish farm *ie* the area of land from which your farm will be seen. The simplest way to do this is to visit the position of your proposed licence area and mark on a map all areas of land and sea which are visible to you (and which you are visible from).

Take photographs of the area to be covered by your shellfish farm from the most important viewpoints (it is helpful to discuss and agree these with the Department in advance). These photos should be taken using a 50 mm lens as this is closest to what is seen by the naked eye. Overlay a sketch of your farm on these photos to show a 'before and after' image. Be careful to ensure that the overlay is to scale and accurately positioned.

Assess How Significant the Change Is

The Department will use the information you provide to assess how significant the predicted changes will be and this, together with other factors, will inform the Department's decision. In respect of landscape and visual issues, the Department will consider how sensitive the landscape is to change, the types of viewers affected, and how large an impact your proposals will have on the character of the landscape and on the visual amenity of the area as a whole.

Source: Department of Communication, Marine and Natural Resources in Ireland, undated. Can be downloaded from http://www.dcmnr.gov.ie/NR/rdonlyres/601155BC-4C72-43AF-8391-15389DF4C405/0/Shellfish.pdf