



DREDGE FISHERIES IN NORTHERN IRELAND

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for DARD Fisheries and Environment Division

Further information

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Dredge Fisheries in Northern Ireland

Dredge Fisheries

Scallop Fishery

Due to a rapid growth rate and high market value, the scallop fishery is of high economic importance. Most of the UK and Irish scallops are exported elsewhere, mainly to France as high quality fresh, roe on scallops (Coquille St Jacques).

King scallops are fished using dredges with metal teeth set vertically along the front edge of the dredge. The teeth rake up the scallops which are caught by the mesh bag positioned behind the tooth bar. Groups of dredges are hung from a tow bar which has wheels on either end so it can move over the seabed.

In the UK queen scallops tend to be targeted during the summer months when the King scallop beds are closed. In the warmer months queen scallops have been shown to become more active (Jenkins *et al.* 2003). Fishermen can make use of this by using nets instead of dredges which have reduced impacts on the seabed. However, during colder periods queen scallops are fished using dredges.

Scallops may be hand collected by divers and although this requires much more effort, scallops are landed in pristine condition so are more valuable. However, as divers can get to areas where vessels cannot, there are concerns that unregulated dive fishing has impacts on the stock by hand collecting from areas which have been untouched by dredges and therefore have mature scallops which may be acting as a broodstock. Harvesting scallops from a potential source of spawning undermines the sustainability of a population.

In general a higher price is paid for scallops with roe. In the Isle of Man, as a general rule of thumb, a fisherman will not fish if there is less than 30% roe. Therefore the fishery is discriminately removing some of the reproductive stock from the population. In addition fishing has secondary effects on the fecundity. Dredging for scallops' chips the scallop shells so the animal then has to put more energy into repairing the shell and therefore less energy is available for reproduction.

Whilst at a limited scale in Northern Ireland, scallop cultivation has been successful across the world. In Japan cultivation is based on collecting naturally produced larvae on spat collectors. The spat is transferred to pearl nets and then, at 5-6 months, to lantern nets both of which are hung in the water column. Once the scallops reach the age of 2 they can then be placed on the seabed for on-growing or suspended from a pole by placing a hook through

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the ear of the shell. Mulroy Bay in Ireland has been designated as a Class A area, with the Bay having the largest natural scallop spat fall in Western Europe. Scallop seed has been transferred from the Bay for aquaculture purposes since the 1970's (Beaumont, 2000). In areas where collection of naturally produced spat is not possible, hatchery reared spat has been used.

Northern Ireland Scallop Fishery

Fishing for King scallops has been established in Northern Ireland since 1935 (Briggs, 1992) with Queen scallop fishing not becoming commercial until the 1970's and not becoming significant until 2009. In 2011 over 830 tonnes of King scallops was landed into Northern Ireland ports with a first sale value of £1.48 million. The landings of Queen Scallops in 2011 were just over 3300 tonnes, with a first sale value of £1.39 million. This shows the much greater price available for King Scallops. Figure 1 shows the landings of scallops into Northern Ireland between 2009 and 2011 (no queen scallops were landed into Northern Ireland in 2008 but a collapse in American stocks led to huge market demand from 2009 onwards). In the 1970's there was a queen scallop fishery in Northern Ireland, however, the short life span of queenies make the fishery much more boom and bust. In total, in 2010 43,000 tonnes of scallops (king and queen) were landed into the UK by UK vessels. Northern Ireland contributed 9% of this.

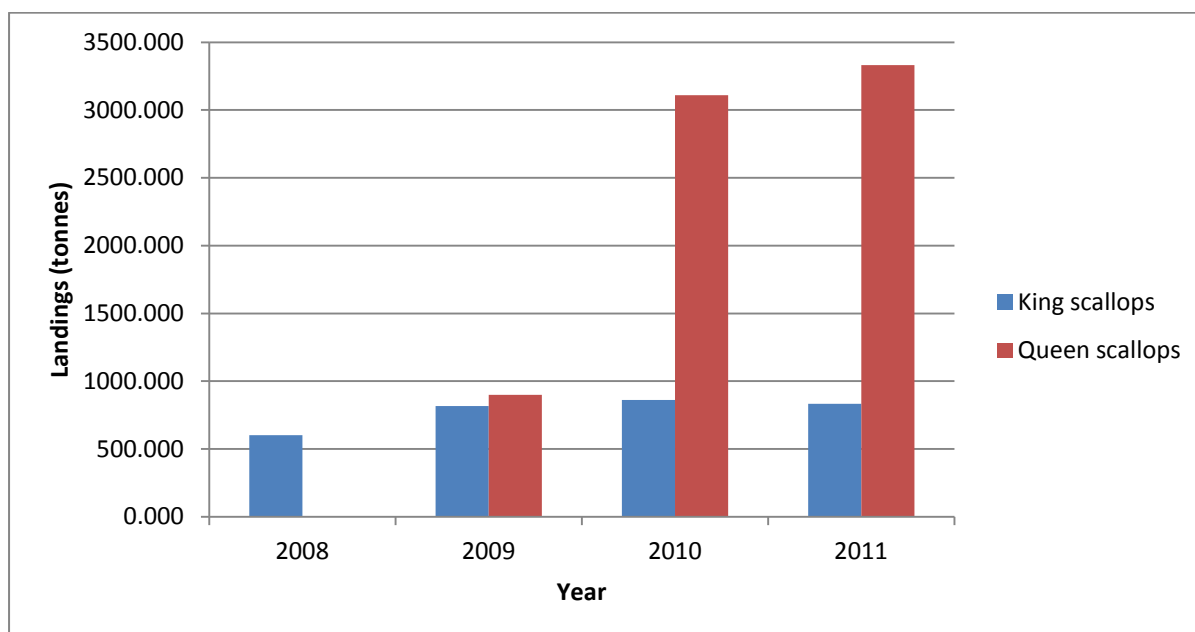


Figure 1 Landings (tonnes) of King and Queen Scallops into Northern Ireland (DARD landings data)

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From 2007-2009 Portavogie had the largest landings of scallops into any port in Northern Ireland peaking in 2009 with over 282 tonnes landed with a first sale value of just under £0.4 million (Figure 2). However, in 2010 whilst there was a decrease in landings to Portavogie, landings of scallops in Kilkeel almost trebled, going from 121 tonnes in 2009 to 345 tonnes in 2011.

The peak in King Scallop fishing occurs annually in November (Figure 3). Fishing continues at moderate levels between December and May. The Irish Sea is closed to scallop fishing from the 1st June to the end of October. Landings taken during the summer months are therefore from the North coast which has no closed season.

In 2011 38 vessels reported landings of King scallops into Northern Ireland. Of these vessels 32% were less than 10m in length with the same percentage of vessels being between 10 and 15m in length (Figure 4). This is in comparison to the vessels which landed scallops into Northern Ireland in 2007 when only 15% of vessels were less than 10m and the majority (55%) were greater than 15m. This reflects changes throughout the inshore fishing fleet in Northern Ireland.

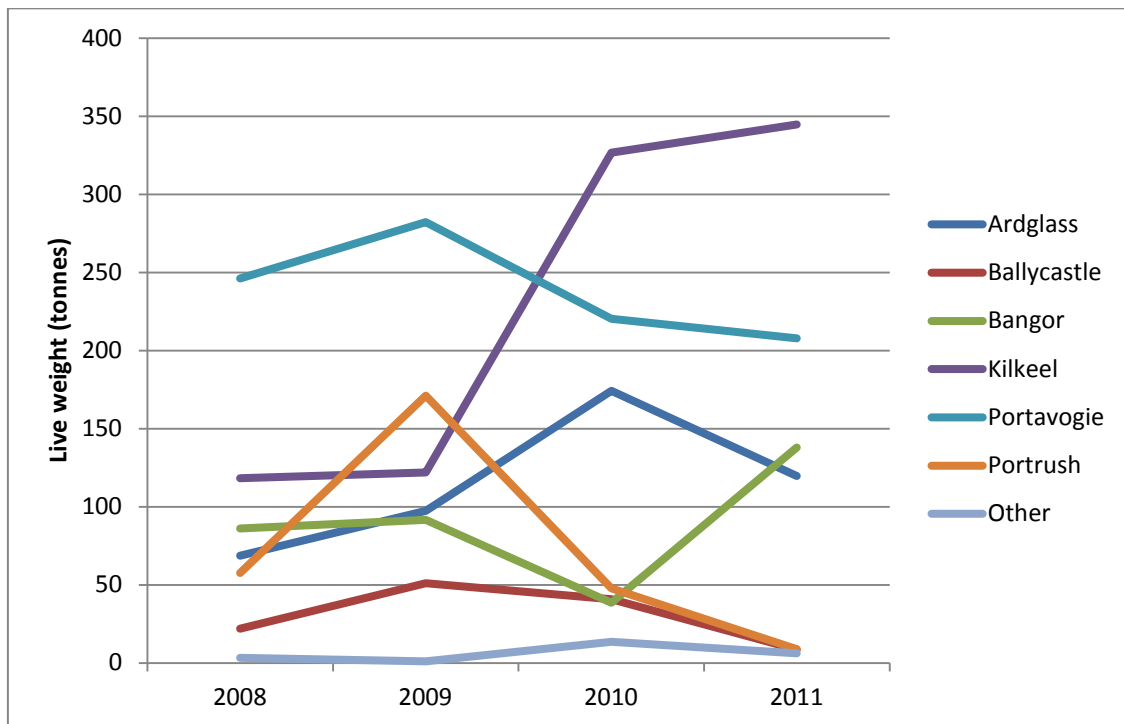


Figure 2 Landings of King scallops into all Northern Ireland ports from 2008-2011

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The Northern Ireland Queen scallop fishery is located on the North coast. This is shown in terms of landings, with Ballycastle representing the largest port for Queen scallop landings (Figure 5).

In 2009 6 vessels prosecuted the Northern Ireland queen scallops grounds on the North coast. Of these vessels only 1 was less than 15m in length. In 2010 23 vessels landed Queen Scallops into Northern Ireland. Only 4 of these vessels were less than 10m with a further 4 being between 10-15m. 65% of the vessels landing queen scallops were greater than 15m in length with 2 of these vessels being larger than 20m. In 2011, of the 14 vessels which reported landings of Queen scallops into Northern Ireland, 13 were greater than 15m in length.

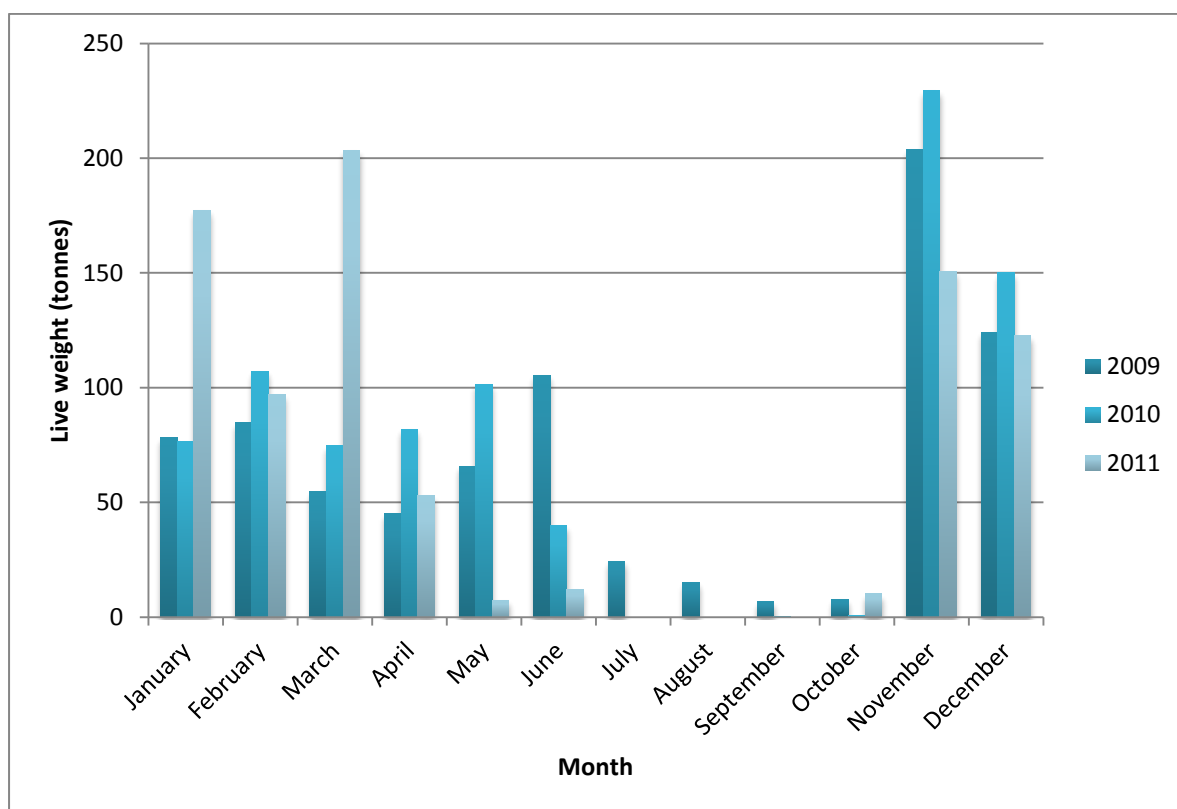


Figure 3 Landings of King scallops into Northern Ireland. From June to October the Irish Sea scallop fishery is closed and therefore all landings recorded during this period are from the North Coast.

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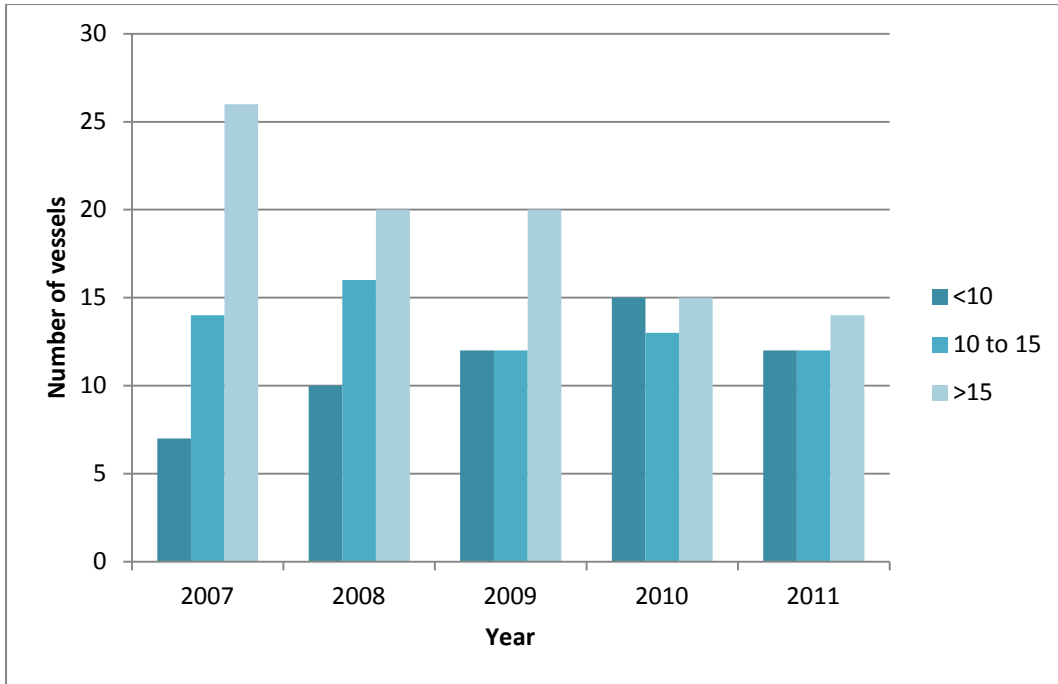


Figure 4 Number of vessels by length which reported landings of King scallops into Northern Ireland between 2007 and 2010

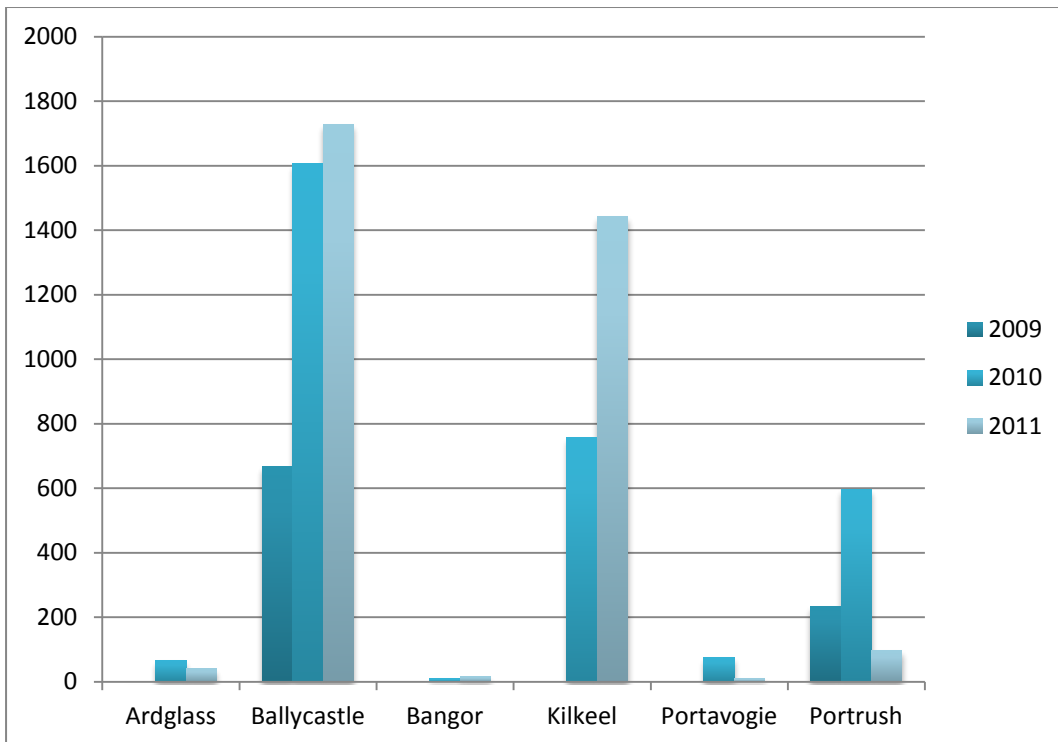


Figure 5 Landings (tonnes) of queen scallops by port

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Prior to 2003 there was an important scallop fishery in Strangford Lough. However, in response to concerns over *Modiolus modiolus* beds in the Lough, The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Amendment) Regulations (Northern Ireland) 2003 prohibited the use of all mobile fishing gear within Strangford Lough put an end to all dredging and trawling. Now only diving for scallops is permitted within the Lough.

Scallop Management throughout the UK and Ireland

At a European level the UK scallop fishery is controlled by the Western Waters effort regime which was developed in 1995 to avoid an increase in fishing effort when Spain and Portugal entered the CFP. The Western Waters effort regime Council Regulation (EC) No 1415/2004 sets out the maximum levels of annual fishing based on kW days. In Area VII the United Kingdom have been allocated a total of 3,315,619 kW days whilst Ireland have been allocated 525,012 kW days, and in Area VI, the UK have been allocated 1,974,425 kW days. Effort allocation is fixed and does not change year to year. Only vessels greater than 15m in length are curtailed by the western waters regime (apart from in the Irish Biologically Sensitive Area). Effort (days at sea) may be traded between countries if a member state has exhausted theirs. An example of this occurred in 2011 when there was a possibility that the UK would exceed their limit. For this reason the fishery had to be closed (to vessels greater than 15m only) for a month until the UK could arrange a trade of quota for effort. In the UK Queen Scallops are also included in the Western Waters; however, in Ireland and France they are not included in the effort regime.

Throughout the United Kingdom there are no restrictions set on the total catch of scallop, with the fisheries being controlled primarily by the use of a minimum landing size which is set by Council Regulations (EC) 850/98 (as amended). ICES areas VIIa and VIId have a minimum landing size of 110mm. Under the European Regulations ICES area VIa has a MLS of 100mm.

Throughout the UK different gear controls have been set out. The Scallop Fishing Order 2004 states that a dredge to be used for scalloping must

- have a frame not exceeding 85cm in width,
- include a fully operational spring loaded tooth bar and belly bar,
- not contain any attachments to the dredge,
- not contain a diving plate or similar device
- have a total weight not exceeding 150kg.

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In addition, if the dredge measures 80cm or more in breadth it should not have more than 8 rows of belly rings hanging from the belly bar or more than 9 teeth. If the dredge is less than 80cm in length it should have no more than 6 rows of belly rings hanging from the belly bar or more than 6 teeth on the tooth bar.

The dredges used must meet a number of specifications: internal belly ring diameter (\geq 75mm); top net mesh size (\geq 100mm); tooth spacing (\geq 75mm). A number of the English IFCA's have set a limit on the number of dredges allowed to be towed (a summary of the English Inshore Fisheries and Conservation Authorities byelaws used to manage scallop fishing is shown in Table 1). In the North West the maximum number of dredges which may be towed is 12 and all these dredges must be fitted with a spring loaded tooth bar. No more than 2 tow bars may be used at any time and the maximum length of any tow bar cannot exceed 5.18 metres including attachments

Common management measures in the UK include the use of closed seasons which are designed to protect scallops during breeding and settlement. Under The Scallops (Irish Sea) (Prohibition of Fishing) Order 1984 the Irish Sea is closed to scallop dredging between the 1st of June and the 31st October. In Sussex during the closed season it is also an offense to remove more than 200 scallops per 24 hour period by use of a trawl.

A curfew system is in operation in the North West where fishing can only take place between 0700 and 1900. In the Isle of Man fishing is prohibited within the 3-12 mile limit between 2000 hours and 0600 hours by any means, including diving. In addition, in the Isle of Man under the Sea Fisheries (Scallop Fishing) Bye-laws 2010:

- vessels with an engine power exceeding 221kw are prohibited from fishing for scallops within the whole of the Territorial Sea, unless they have been granted grandfather rights
- Satellite tracking devices are required for all vessels, regardless of length, fishing for scallops throughout the whole of the Territorial Sea
- Maximum tow bar diameter of 185mm
- Maximum of 7 dredges aside permitted within the 3-12 mile limit
- Recreational fishing for scallops is restricted to a maximum allowance of 18 scallops per day.

The Welsh Government established The Scallop Fishing (Wales) Order 2005 to restrict effort placed on the fishery. Under this Act the number of permitted dredges was restricted to 4 on each side of the vessel within 3nm of the shore and 8 on each side of the vessel beyond

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3nm zone. In addition, no scallops can be taken during 1 June and 31 October, including by diving. In 2010, amendments to the order increased the closed season to 1 May to 31 October and banned all scallop dredging within 1nm of the shore. Vessel size restrictions were also introduced. No vessel can fish for scallops in Welsh waters if the boat's engine has a power output exceeding 221kW. Within the 1-3nm zone no boat can exceed 10 meters in length. Also the number of dredges allowed in the 3-12nm zone was reduced to a total of 14. Six closed areas, including Cardigan Bay were set out.

In Scotland in 1999 a restricted scallop licensing scheme was introduced to limit the expansion of the sector. In 2003 additional gear restrictions were introduced including a limit of 8 dredges per side within the Scottish 6nm limit and a maximum of 10 dredges per side in UK waters out to 12nm which are adjacent to Scotland.

Other than the EU MLS of 40mm, there are much fewer regulations for the exploitation of queen scallops. Unlike Ireland and France, the UK include queen scallops in the Western Waters effort regime. In addition, as queen scallops can be fished using a net, they are also restricted by the cod recovery plan (Council Regulation (EC) 1342/2008). Under the cod recovery plan the number of days at sea is limited.

Isle of Man Queen scallops

In 2010, the Isle of Man set up the Sea-fisheries (Queen Scallop fishing) Bye-laws 2010 and has now become a text book example of how a failing fishery can turn around and become an accredited sustainable one. Under these bye-laws no person may take queen scallops using a dredge which has a rigid mouth and teeth. No fishing for queen scallops is allowed within the 12 miles from the 1 April to 31 May. In addition, no fishing is allowed during the spawning and settlement period which is between 1 June and 31 August (thus stopping all fishing for queen scallops from 1 April to 31 August). Fishing is also limited between the hours set out for King Scallop fishing. The Isle of Man have set up "queenie conservation zones" which encompass the whole of the 3 mile area closest to shore plus 2 other no take zones which extend to the 12 mile inshore limit. They have also set a bye-law which gives them the power to implement a total allowable catch if the stock is deemed at risk.

To gain accreditation, government, fishermen, and processors worked together to get stocks back to a commercially exploitable level. Only the best quality animals were landed with the rest of the stock retained to increase the population. By 2010 the queen scallop stock had recovered to levels higher than had previously been seen (Winterbottom, 2011). In 2011 the

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Isle of Man trawl caught queen scallop fishery was awarded the Marine Stewardship Council (MSC), accreditation. This classifies the fishery as a well managed, sustainable fishery.

Proposed English Scallop Order

As with the Northern Ireland inshore sector, the English inshore has seen an increase in the number of fishermen moving from the offshore to fish non-quota species in the inshore. Within the English scallop fishery there are large vessels capable of pulling 42 dredges as well as small inshore vessels whose size restricts them by area and weather. In 2011 a proposed English scallop order was put out to consultation to replace the English Scallop order 2004. The aim of the order is to provide protection for smaller vessels, safeguard scallop stocks, have better enforcement of the fishery and reduce the impact of displacement of fishing between areas.

It has listed a number of measures which could be introduced:

- extending the limit of 8 dredges per side to the 12nm limit.
- applying the larger MLS to all scallops caught in a trip which covers the two regions
- providing clarity of the term 'attachments' to a dredge to allow those solely for safety purposes

Current Scallop Management in Northern Ireland

The Conservation of Scallops Regulations (Northern Ireland) 1997 set out a number of gear restrictions for the Northern Ireland fishery. These included

- a limit of 8 dredges to be allowed on each side of the vessel;
- a maximum of 9 teeth per dredge;
- minimum tooth spacing of 75mm;
- a scallop dredge or system of scallop dredges with a width, or in the case of a system of scallop dredges, an aggregate width, not exceeding 1219cm;
- a minimum diameter of belly ring of 75mm
- a minimum mesh size of 100mm in the netting cover
- The prohibition of French dredges

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Table 1 Summary of byelaws used by the English Inshore Fisheries and Conservation Authorities to manage scallop dredging

Byelaw	North Western	Northumber-land	Eastern	Southern	Devon and Severn	Kent and Essex	Cornwall	Sussex
Effort control								
Size of vessel			14m	12m within 6nm	15.24m within 3 miles	Yes	16.46m	14m
Engine power						221kW		
Dredge number		10	10	12	12		12	
Curfew				1900-0700	1900-0700		1900 - 0700	
Closed season	June-Dec		July-Sept		July-Sept			Jun-Oct
Technical Measures								
Bed may be closed			Yes		Yes	Yes	Yes	
Towing bar				≤5.18m	≤5.18m		≤5.18m	
Gear limitations		Mouth≤75cm	Spring loaded tooth bar and mouth ≤85cm	Spring loaded tooth bar and mouth ≤85cm	Spring loaded tooth bar and mouth ≤85cm		Spring loaded tooth bar and mouth ≤85cm	
Gear limitations			Rings ≥75mm		Rings ≥75mm		Rings ≥75mm	
Conservation Measures								
Closed area			Any area within 3 miles limit					

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The Inshore Fishing (Daily Close Time for Scallops) Regulations (Northern Ireland) 2000 set a curfew with fishing only permitted from 0500-2100, Monday through to Friday. No fishing, including by diving, was allowed during the weekend.

In 2008 these restrictions were tightened in the Conservation of Scallops Regulations (Northern Ireland) 2008 which further reduced the number of dredges allowed to a maximum of 6 per side and increased the curfew with fishing for scallops (including that by diving) only allowed to take place from Monday to Friday and between the hours of 0600-2000. In addition, the MLS for scallops was set at 110mm, including from areas on the north coast (VIa) where under EU regulations the MLS is set at 100mm.

There are also a number of gear restrictions applicable in Northern Ireland:

It is prohibited to

- Use a scallop dredge or system of scallop dredges with a width, or in the case of a system of scallop dredges, an aggregate width, of more than 915 cm;
- Use a tow bar which exceeds 5.5m in length
- Dive for scallops between 1st June and 31st October (except in Strangford Lough)

Through the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Amendment) Regulations (Northern Ireland) 2003 scallop dredging is prohibited in Strangford Lough in an attempt to conserve the *Modiolus* in the lough.

Potential Regulatory Measures for Scallop Fishing

The Northern Ireland scallop fishery is already tightly regulated. Table 2 shows the potential additional measures which could be used to sustainably manage the Northern Ireland scallop fishery. In addition to these measures a number of other management tools were examined but through discussion with stakeholders, were deemed as not necessary/unsuitable for the Northern Ireland fishery. These included:

1. **Quotas** which although would limit the effort placed on scallop fishing, they would not be well accepted across the sector
2. **An increase in the curfew system.** The curfew in place in Northern Ireland under the Conservation of Scallops Regulations (Northern Ireland) 2008 is deemed to be an acceptable curfew for the fishery and should not be extended
3. **An increase in the MLS.** *Northern* Ireland currently operates the EU MLS as does the rest of the UK and Ireland. An increase in MLS would prove tricky due to the nature of

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the fishery. If the MLS in Northern Ireland was changed it would be hard to enforce as a fishermen may end up fishing in areas with different MLS.

4. **Number of dredges allowed.** Northern Ireland has one of the smallest numbers of dredges allowed throughout the UK. Currently the limit of 6 dredges per side is seen as sufficient controls over the sector.
5. **Limit to vessel size.** The limit of 6 dredges per side provides protection from larger vessels. Whilst there is nothing preventing these larger vessels to enter the Northern Ireland scallop grounds, they will be limited to 6 dredges per side and therefore their size is not an advantage.

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Table 2 Possible actions for the management of the Northern Ireland inshore scallop fishery

Challenge	Resolution	Possible Action	Reasoning
Sustainability	Reduce latent capacity of fleet	Permit system	Unlike vessels over 10m which require a scallop entitlement, under 10m vessels do not require a scallop entitlement and can fish using just their licence. If expansion continues, the fishery may not be sustainable. A permit system would cap the number of vessels allowed to fish within the inshore. A permit system should also be introduced for commercial divers.
	Reduction in effort	Ban on Dredging for Queen Scallops	This is of major priority to the scallop fishermen in Northern Ireland. Queen scallops can be fished by dredge or by trawl with the trawl being the more environmentally acceptable form of fishing having a lesser impact on seabed integrity. By putting a ban on dredging for Queen Scallops it will reduce damage to the seabed. Also, as trawling is most effective during the warmer months when queen scallops are more active, it will make the fishery seasonal, putting less pressure on the bed and giving it time to recover between fishing periods.
		Limits to Recreational Diving	Currently divers are only restricted by the curfew and closed seasons, yet recreational divers can have a significant impact on stocks by accessing areas where dredges cannot, therefore potentially damaging mature brood-stocks. A daily catch limit would limit the impact of recreational diving.
	Protection of juveniles/broodstock	Nursery grounds	Resources should be put in to determining the best location for nursery grounds and for the reseedling of these areas. By keeping these areas closed to all scallop fishing, including diving, these areas have the potential to boost surrounding populations of the stock thus making fishing more sustainable. In 1999 trials carried out by the Scallop Fishermen's Co-operation and the Centre for Marine Resources and Mariculture (C-Mar) showed that survival of relaid seed varied from 0% to 100% at Strangford Lough. Growth of the scallops averaged around 2mm per month but was higher at one site averaged 4.21mm per month. This shows the importance of providing sufficient resources for the locating of reseedling sites.

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		Closed season for protection of Queen scallop spawning stock	Implementing a closed season during the spawning period will protect the spawning stock and can lead to increased settlement of spat as the settlement substrate is not being damaged by fishing. Also, after dredging, the number of scavengers in an area can increase. If dredging is eliminated during times of settlement, the number of predators in the area may be reduced thus giving newly settled scallops a greater chance of survival.
	Improved fishing effort allowance	Removal of Northern Ireland from UK western waters effort regime	This is a major priority of scallop fishermen in Northern Ireland which receives 100% support. Currently Northern Ireland shares the UK's western waters effort allowance. English vessels have fewer restrictions than Northern Ireland vessels, and there are much larger vessels in the English fleet which can fish all weather conditions and therefore use up a disproportionate amount of the kW days allowance set for the UK thus negatively affecting the time smaller vessels can fish. Northern Ireland fishermen are heavily penalised under the present days at sea regime, particularly as any time they spend travelling to the fishing ground counts towards their days at sea allowance. Currently Ireland has its own effort allowance. By having a separate Northern Ireland effort then the smaller Northern Ireland fleet will get a fairer opportunity to fish under the western waters.
Lack of data	Increased fishing data	Activity reports for commercial divers	Scallop fishermen who use dredge/trawl are required to provide activity reports. This requirement should also be placed on commercial divers.
	Increased knowledge of stocks	Scientific surveys	Work should be carried out to study the scallop populations around Northern Ireland including examination of the different fisheries areas in terms of growth, spawning season and age classes of both king and queen scallops.
Obligations to Marine Environment	Protection of marine habitat	Resources put into trialling new environmentally more acceptable dredges	Due to the detrimental impacts of dredging, a lot of work has been carried out to examine the use of more environmentally friendly scallop dredges. One such eco-dredge is the N-Viro which has skids which bear the weight of the dredge. The teeth of the traditional dredge have also been replaced by spring bound tines which move individually and are less resistant meaning they will not dig up rocks etc which not only means that tow length can be increased, but also that there will be less damage done to the scallops. As it is less resistant it also

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means it is easier to tow and therefore is more fuel efficient. The N-Viro dredge has already been trialled in Northern Ireland with little success due to the nature of the seabed. Whilst there are no current alternatives, if new gear is developed resources should be provided for the trialling of this gear.

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Cockle Fishery

Cockles are generally fished using a hydraulic dredge. Hydraulic dredges generate jets of water which fluidise the sediment in front of the dredge and displace the cockles. There are two types of hydraulic dredges, suction dredges which pumps the cockles onto the deck where they can be sorted and graded, or non-suction dredges which grade the catch in situ in the dredge (Clarke and Tully, 2011).

As all forms of cockle fishing remove the cockles from the substrate, those which are discarded, even if not damaged, may be lost to the fishery. Coffen-Smout and Rees (1999) found that, after physical shock brought about by fishing, cockles are slow to reburrow and can be rolled away by the tides as well as being at increased vulnerability to scavenging birds. They found that reburrowing is more successful at high tide.

Irregular recruitment is something which affects most cockle beds. For example, in 2004 in the Wash it was noted that recruitment large enough to increase the stock only occurred every 6 to 7 years, whilst other cockle fisheries have experienced similar shortages in cockle stocks.

Northern Ireland Cockle Fishery

A pilot cockle fishery was initiated by DARD in Belfast Lough in 2008 to establish the feasibility of a larger commercial fishery. The licensed fishery was situated between the main Dredged Channel within Belfast Lough and the SPA to the East of the Kinnegar outfall pipe. This fishery was operated by two small 12 meter and under vessels one of which operated a suction dredge and the other a standard cockle dredge. Between them the two boats removed 128 tonnes of cockles. In 2009 this site was closed and a second site to the West of the Kinnegar outfall pipe was proposed (Figure 6). The 2009 fishery was operated by thirteen small 12 meter and under vessels which operated either suction dredges, hydraulic dredges or dry dredges. Each boat was allocated a quota of 8 tonnes of cockles for the season and designated two specific tides between the 5th and the 23rd of October, over which this could be fished. This ensured that only two vessels were fishing at any given time. A total of 66 tonnes of cockles was landed throughout the duration of the 2009 fishing season. In 2010-2012 no cockle took place in inner Belfast Lough due to a lack of recruitment to the area.

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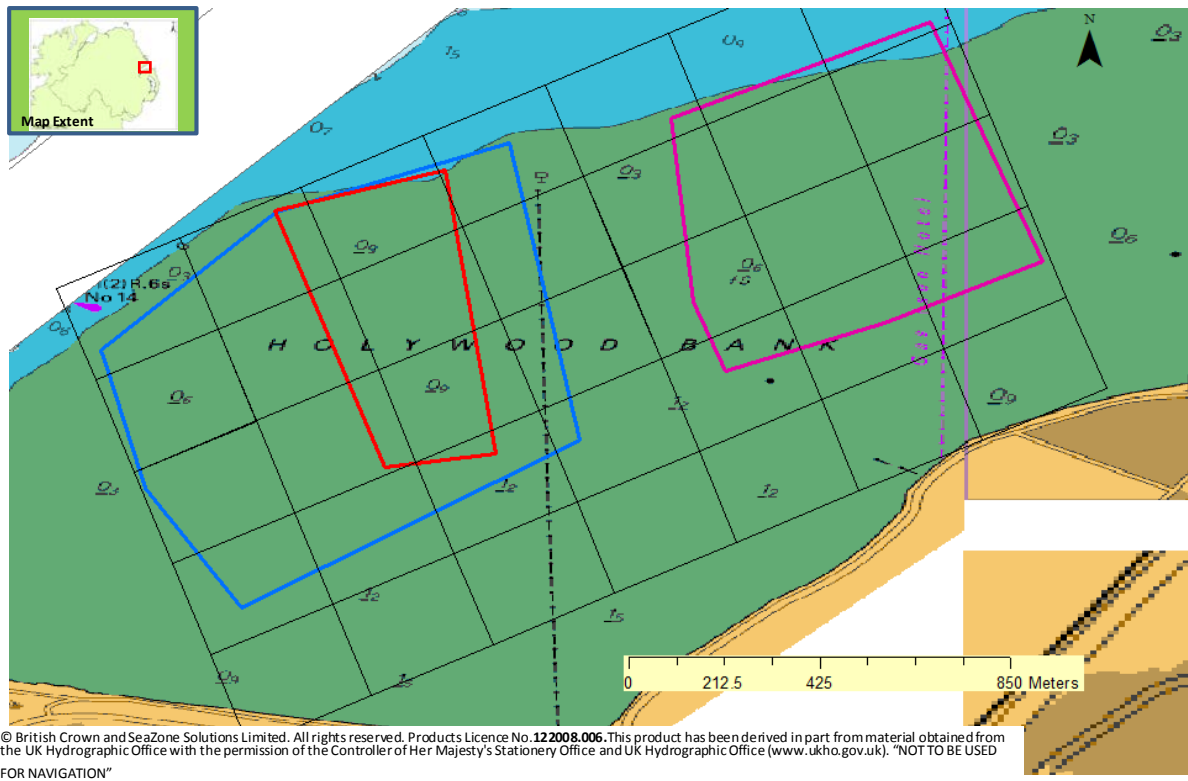


Figure 6 Hollywood Bank cockle bed. The area to the East of the outfall pipe (represented by the pink box) was fished in 2008. The area to the West of the outfall pipe (represented by the red box) was fished in 2009.

Cockle Management in the UK and Ireland

There is no national legislation for cockle fishing across the UK. Management is implemented through local regulations. The two main fisheries for cockles within the UK are the Thames Estuary and The Wash. The Thames Estuary Cockle Fishery Order 1994 was established after the fishery came under heavy pressure in the early 1990's. The Order set up a license scheme whereby anyone who had fished the area for cockles a year prior to the Order would be issued a license at the cost of £1,000 per annum. The Thames fishery is also controlled by a maximum vessel size, engine power, and dredge size, MLS, maximum smash rate, seasonal closures, curfews and catch limits. A summary of the management principles used throughout the UK and Ireland cockle fisheries can be found in table 3.

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In the Wash the maximum number of licenses has been capped at 68. Another method of reducing effort placed on the fishery is a curfew which only allows fishing for cockles from a vessel to occur four days per week. Under the Wash Fishery Order 1992 a number of gear restrictions are placed on the Wash fishery. The inside opening of any hydraulic suction dredge head must not exceed 76cm and only one dredge may be deployed per vessel. In addition a Certificate of Approval must be issued prior to fishing. This certificate is only issued once the vessel has shown a smash rate of less than 10%. Within the Wash there has also been set a maximum daily limit of 4 tonnes for the dredge fishery and 2 tonnes for the hand worked fishery. As the Wash also has a lucrative mussel fishery, 100m buffer zones have been implemented between the two fisheries.

In 2007 the Dee Estuary was closed to fishing due to a decline in cockle stocks. In 2008 The Dee Estuary Cockle Fishery Order 2008 was introduced to regulate fishing within the estuary. The order sets out a number of management tools:

- A license is needed to fish commercially within the estuary
- Licenses last for 1 year and cost £992
- A recreational limit is set at 5kg of cockles per day
- Cultch cannot be removed from the area
- The Environment Agency may set terms to a license including the area where the license is valid; the size/description of dredge used; the size/description of vessel used; when a person may fish; the size of cockles allowed to be taken from the fishery; the amount of cockles allowed to be taken from the fishery.

These measures have been successful in creating a full season of harvesting within the estuary. The area has also been put forward for MSC accreditation in 2011.

Dundalk Bay, on the East coast of Ireland supports a commercial cockle fishery which started in 2001. The Dundalk cockle fishery is within a site which has been designated as a Special Area of Conservation (SAC) and a Special Protection Area (SPA). In 2006 and early 2007 the cockle bed was closed to fishing to allow Bord Iascaigh Mhara, the Irish Sea Fisheries Board who are responsible for the cockle fishery, to set up a management plan to ensure the sustainability of the stock. The management plan included (all information gathered from Hervas *et. al.* 2008):

- A maximum dredge blade width allowed of 0.75m for suction dredges and 1.0m for non-suction dredges
- Fishing activity only allowed in areas where cockle density is, on average, greater than 4 per metre squared

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- The fishery area was 35% of the area over which cockles were distributed
- Minimum landing size 17mm
- A total allowable catch (TAC) of 52% of the biomass of commercial sized cockles in the fishable area was implemented. If the daily catch averaged over all vessels fell to 250kg the bed would be closed.
- Commercial fishing can only take place Monday to Friday and between 07:00 and 19:00.
- A maximum allowable catch per vessel per day of 1 tonne.

However, a number of weaknesses were highlighted with the management plan. Firstly, whilst the MLS was set at 17mm, due to marketability, the fishermen had their graders set at 22mm which meant that even legal sized cockles were being discarded. Therefore to reach their TAC, vessels were fishing areas over and over which could lead to cumulative increases in discard mortality.

Secondly, there was no control over the number of vessels who could fish for cockles and this put pressure on the TAC but also put at risk the economic viability of the cockle bed. If more people fish the site then each vessel gets a reduced TAC and thus less income from the site. This was similar to the situation in Belfast Lough in 2009 when 14 vessels fished the site at Holywood Bank after 2 fishermen had a successful year in 2008. The TAC per vessel was reduced to 8 tonnes per vessel (in 2008 the 2 vessels lifted 128 tonnes between them). This meant that, for some fishers who had taken time out of their regular fishing to modify their vessels for cockle fishing, it was economically unviable.

In 2009 BIM looked to resolve these issues by introducing a permit based on track record. Therefore, only those who had fished for cockles in Dundalk between 2004-2007 were issued with a permit. In addition, anyone hand gathering cockles required a permit and had to submit activity reports. From this, for the period from 2011-2016 BIM have limited the number of permits available to fish cockles in Dundalk Bay to 33.

Whilst as a general rule of thumb in cockle management the TAC is set at 33% (the one third rule which allows one third for the fishery, one third for the birds and one third for the environment), BIM have set limits which will be used to determine the TAC. If the annual survey reports a biomass of less than 750 tonnes of cockles the fishery will remain closed. If 750-3000 tonnes are reported then a TAC equivalent to one third of the biomass will be set. In instances where a total abundance of >3000 tonnes of cockles is reported a TAC of 50% will be set.

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Table 3 Summary of byelaws used by the English IFCA's to manage the cockle fisheries

Byelaw	North Western	Eastern	Southern	Devon and Severn	Kent and Essex	Cornwall
Effort control						
Permit required	40 permits per year	Yes			Yes	
Engine power					221kW	
Size of vessel		14m	12m within 6nm		14m	
Daily limit		500kg per day			Limit 13.6 m ³ per day	Yes
Gear Limitations						
		Head width ≤305mm with spacing ≥20mm	Dredge not exceeding 460mm		ALL parallel bars used for taking, riddling, sorting, grading must have spacing of no less than 16mm; Riddle must be minimum length of 1.75m; Certificate of approval must be issued before gear used. Need to be less than 10% smash rate; One dredge only; Dredge head aperture ≤76cm; Blade ≤76cm	
Technical Measures						
MLS	Any cockle which will pass through 20mm space cannot be landed	Any cockle which will pass through 20mm space cannot be landed	Any cockle which will pass through 23.8mm space cannot be landed	Any cockle which will pass through 19mm space cannot be landed		Any cockle which will pass through 20mm space cannot be landed
Conservation						
Closed season	May-Aug	May-Aug	Feb-April			

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Cockle Management in Northern Ireland

In 2008 permits for a pilot cockle fishery were granted to two fishermen. In 2009 13 permits were granted to those fishermen who raised interest in the 2009 pilot fishery and who had a suction dredge. Conditions of these permits included:

- A MLS of 14mm
- The vessel must have a VMS on board
- Fishing only permitted Monday to Friday
- Smash rate must be less than 20%
- No more than 2 vessels allowed in designated fishing area at any one time. Each vessel was given an allotted time to fish
- Fishing will cease on 15 October 2009
- Log sheets must be completed

In 2009, each vessel was given a fixed quota of 8 tonnes of cockles. No other regulations were implemented with regards gear used, for example dredge size and riddle spacing.

Potential regulatory measures for cockle fishing in Northern Ireland

Whilst there has been no commercial cockle fishery within Northern Ireland since 2009, it is vital that if the Holywood Bank cockle bed becomes viable, or an alternative area is sourced for cockle fishing, there are regulations available for the immediate management of the fishery. Possible actions for the management of a sustainable Northern Ireland cockle fishery are outlined in Table 4.

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Table 4 Possible actions for the management of the Northern Ireland cockle fishery

Challenge	Resolution	Possible Action	Reasoning
Obligations to Protect Marine Environment	Protection of sea bed	Gear restrictions	Gear restrictions could limit the impact of dredging. These could include limitations to the dredge head width and the minimum size of riddle used for sorting. In addition, the gear must be able to fish with minimum damage to the cockles. Currently the smash rate is set at 20%. This could be reduced to encouraging fishermen to purchase the correct equipment for cockle fishing and thus reduce the impact of fishing on the stock.
Lack of Data	Increased knowledge on stock	Scientific surveys	<p>To investigate the potential for a sustainable cockle fishery studies should be carried out to determine if the adult cockles on the bed are reaching sexual maturity and releasing gametes. This can be determined through histological gametogenic investigations. If gametogenic studies indicate that adult cockles are actively releasing gametes then hydrodynamic modelling can be undertaken to identify areas of potential settlement.</p> <p>In order to determine if a cockle fishery should be opened a survey must be carried out beforehand to estimate the tonnage of cockles available to the fishery. The survey should examine the length/age frequency of cockles from each area and the estimated biomass of cockles. This information is then used to determine the total fishable stock and suitable fishing areas.</p>
Sustainability	Protection of stock	Curfew	Limiting cockle fishing to certain tides has a potentially significant effect on cockle stocks. It has been shown that re-burrowing of cockles is more efficient during high tides; therefore by limiting all fishing to high tides, there will be a smaller proportion of cockles lost to the environment.
		Daily catch limits	Daily catch limits would prevent 'the race for fish' - competition amongst fishermen to see who can catch the most when a bed is opened - which can cause devastation to a bed. Also overfishing at the beginning of the season can lead to oversupply to the market and therefore more competitive i.e. lower pricing.
		Minimum Biomass	There is no fixed value in Northern Ireland by which Government and fishermen

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			alike know that if the biomass is greater than this value the bed will be opened. Such a minimum level should be determined so that fishermen do not become suspicious when a bed is not opened. From the biomass present on the bed, a total allowable catch should be set at one third of the total biomass.
		Closed area	A closed area provides protection for a proportion of the stock, most significantly for broodstock. By maintaining a closed area the surrounding area should benefit from increased recruitment. In addition, a closed area provides an undisturbed food source for feeding birds.
	Reduce latent capacity of fleet	Permit system	A permit system would cap the number of vessels allowed to fish within the inshore.
	Effective use of resources	New fisheries	Resources should be provided for locating new cockle beds. Whilst Belfast Lough provided a cockle fishery for two years, poor recruitment has seen the bed remain closed since the 2009 fishery. Through working with fishermen and using historical data other areas around Northern Ireland should be surveyed as potential sites for a commercial fishery.

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Appendix 1 Species Biology

Pecten maximus/Aequipecten opercularis

The King scallop (*Pecten maximus*) is a large, long lived bivalve which can commonly grow to 150mm or more (Ansell *et al.*, 1991). The shell is unequivalve with the right valve being convex whilst the left is flat. Both shells are externally ridged with up to 17 thick rounded ribs. The umbones on the midline are flanked on either side by similar sized large and flat ears. The King scallop is entirely sublittoral living on fine sand and gravel. If disturbed the King scallop can jump or swim, but these movements are localised with no great distance being travelled. This lack of significant movement is apparent by looking at the shell of the scallop which generally matches the colour of the environment it is living. Scallops recess into the substrate with the upper flat valve level with the seabed. This can prove a catchability issue within the fishery. In some cases a ground may appear barren in one month yet prove good fishing the next month. This is not due to movement of scallops from one area to another, but rather due to the recessing of the scallops deeper into the substrate. Through underwater video footage it is estimated that the normal density of King scallops is 0.2/m² (Franklin *et al.* 1980).

The Queen scallop (*Aequipecten opercularis*) is smaller than the King Scallop, growing up to 90mm in length. It also has a much shorter life span. Both shells of the Queen scallop are convex, although the left valve is more curved. The colour of the shell varies, but tends to be shades of yellow, orange or red which are sometimes mottled. Both shells are marked with about 20 radiating ridges and corrugated concentric groves which leave the margins of the shell crenulated. The shell hinge has ears with the anterior ear more pronounced than the posterior ear. The Queen scallop occurs on substrates similar to that of the King scallop but as it does not recess into the seabed it can also live on harder substrates. Queen scallops can swim much more actively than King scallops. Both species of scallop can live to depths of 180m but are more abundant in depths of 18-46m.

Whilst King scallops become sexually mature at 2-3 years of age, Queen scallops mature earlier at around 1-2 years. Scallops display partial spawning in April/May with further spawning in late August. When one individual spawns, some of the eggs which are released are filter fed out by its neighbour. The pheromones contained in the eggs then cause the neighbour to release its eggs and so on. Therefore in low density populations it is possible that there is a spawning stock but no reproduction due to a phenomenon known as the Allee effect i.e. there are too few individuals around to come in to contact for fertilisation. Scallops

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are hermaphrodite having both female (orange or red part) and male (creamy white part) which together form the roe. As they are hermaphrodite they have the potential to self-fertilise. However, if this occurs the progeny may be less viable than if the eggs had been fertilised by a different scallop. Fertilisation produces veliger larvae which live in the plankton. It is estimated that the survival rate of scallops during the larval stage is only 0.1%. After 3-4 weeks the larvae settle onto other sessile organisms such as bryozoans using byssus threads before developing into a small scallop. After a while the byssus threads break down and the scallop can join the adult scallop population (Briggs, 2000). In colder years, the growth of the larvae is much slower and so they remain in the plankton for longer. The longer the larvae remain in the plankton the further they are carried away from the broodstock and suitable attachment substrates. This may mean that after colder periods recruitment is reduced as the larvae are lost out of the system.

Cerastoderma edule

Cerastoderma edule also known as the common cockle is a bivalve with a thick oval equivalve shell reaching lengths of up to 5cm. The shell, which is off-white, yellow or brown, has 22-28 radiating ribs crossed by concentric ridges. Also, due to reduced growth throughout the winter, prominent growth lines on the shell can be used for aging. The inner shell is dull white with a brown or purple stain about the posterior adductor muscle scar. This species is abundant around the British and Irish coasts and lives in clean sand, muddy sand, mud or muddy gravel from the middle intertidal to lower intertidal and sometimes subtidal. Although they burrow into the substrate (to about 5cm) cockles are easily dislodged by storms and can be washed away during gales thus leading to high winter mortalities.

Cockles display rapid growth during the first 2 years, with both males and females reaching maturity at around 18 months, when they are 15-20mm. Gametogenesis is initiated in the winter and increases rapidly throughout the spring. From March-August cockles spawn in a short peak (some may have more protracted spawning) leading to a peak in spatfall from May to September. Recruitment is extremely sporadic, however, it is much higher after a severe winter when the adult population has declined and there is a lesser chance of being inhaled by the adults as well as less competition for food and space.