MARINE SCOTLAND

A REVIEW OF THE SCOTTISH SCALLOP FISHERY

Final Report

December 2013

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ABSTRACT

A review of the Scottish scallop fishery was undertaken considering the structure and performance of the fleet; the health of stocks; the current management and regulation; and environmental impacts of the fishery. The review informed options aimed at achieving a more productive, efficient and sustainable Scottish scallop sector.

Suggested citation:

Cappell, R., Robinson, M., Gascoigne, J. and Nimmo, F. A review of the Scottish Scallop Fishery. Poseidon report to Marine Scotland, December 2013.

*cover photo credits: bbc.co.uk, Kirkcudbright.com, flickr.com

Acknowledgement

The Poseidon project team sincerely thanks the various stakeholders in the scallop industry and Marine Scotland who gave their time and expertise to inform this review.

EXECUTIVE SUMMARY

The aim of this review is to provide Scottish Ministers with a body of evidence to inform decisions on the future management of king scallop (*Pecten maximus*) fishing. The report is based on a review of existing information and consultation with various stakeholders associated with the Scottish scallop sector, enabling scenarios to be developed which have informed the resulting management recommendations.

The focus of this review is on the management of the wild king scallop fishery, which is mainly targeted by vessels using dredges along with some hand gathering by divers (accounting for around 5% of total scallop landings). The farming of scallop has remained at a very limited scale in Scotland with some ongoing interest in the potential for hatchery/ranching.

The scallop sector

Scallop is the second most valuable shellfish species landed in Scotland after *Nephrops*. Landings into Scotland have fluctuated between 9,000 and 10,000 tonnes of scallops per annum over the last decade, with a value around £25 million.

There are 153 active vessels with licence entitlements to land scallop, but there is a lot of latent capacity as the active scallop fleet is much smaller than this at around 100 vessels. The fleet is characterised by two dredger segments: smaller (generally <15 m in length) vessels that exploit inshore waters and larger vessels (20 m + length) that can operate more nomadically and exploit both inshore and offshore grounds around the UK.

In 2000 the under 15m fleet represented 28% of the engine power of the scallop fleet, but in 2011 the under 15m fleet had grown to nearly half (46%), while the over 15m fleet has declined by 12% in terms of engine power. Recent data indicate that the Scottish under 15m fleet has reduced in number from 42 in 2010 (after an increase from 38 in 2006) to 31 vessels in 2011/12 while the number of Scottish over 15m fleet has remained stable at around 56 vessels.

The average productivity (catch per day) of the offshore fleet doubled from 2006 to 2011, but productivity in the inshore fleet has reduced. With 30% more fishing days at sea (in an attempt to maintain landed volume), static scallop prices and escalating fuel prices, on average the under 15m segment has been loss-making in recent years.

By contrast, the over 15m fleet shows very healthy profits suggesting a sector that has the range to fish productive beds throughout the UK and then move on. This is in stark contrast to fortunes of the inshore fleet, which is dependent on local beds that are at risk of over-exploitation from the growth in inshore fishing capacity and occasional targeting by the nomadic fleet.

Commercial hand-diving involves around 40-50 full time divers that are mainly located in the coastal waters of the west of Scotland and at Orkney, where the method can account for up to 40% of the landings (Dobby et al., 2013). Economic data is not collected for the dive fishery, but with low overheads compared to the fuel-intensive dredge fisheries, divers report good profits from dive-caught product that achieves a premium for its quality and minimum environmental impact.

Approximately 70% of scallops landed into the UK are exported, mainly to France, Spain and Italy, with exports worth £90 million in 2012, suggesting around 30% value added to first hand sales. Scallops are reported to account for ~750 processing jobs in the UK (Mason *et al*, 2011).

Resource status & science

30-40% of Scottish landings are from within the 0-12 Nmile zone, with over 80% of these landings coming from the Clyde and West of Kintyre regions. This geographic variability has defined where Scottish scientific resources have been concentrated and has resulted in eight assessment areas around the Scottish coast. Some areas are subject to formal analyses of stock status, but others are not fully assessed. Also of concern to the Scottish nomadic sector, which is dependent on grounds outside Scottish waters, is the limited assessment of scallop resources elsewhere in the UK.

Based on the most recent data available, it is clear that the 'health' or status of Scottish scallop stocks varies with geographic location. For most areas where relatively robust data collection protocols have permitted analytical assessment, recruitment and spawning stock biomass appear stable, but fishing mortality (F) continues to increase in some areas suggesting a need for management action to reduce F.

The discrepancy between the assessment of 'populations' and the management of 'stocks' is further complicated by the development of dive fisheries. The more traditional dredge fishery targets scallop on softer sediments, and potentially to greater depths than divers operate. Divers often target areas and substrates in which dredge vessels cannot operate. There is a risk that the relatively efficient removal of scallop from smaller areas by divers may reduce the occurrence of what would have represented a 'refuge' in the past, and that these havens from dredge fisheries have contributed significantly to historical SSB. Dived areas are comparatively small (and so the current risk is probably low), but un-managed growth of the dive sector has the potential to create this cumulative impact on scallop stocks.

Total landings and age composition from dive fisheries are included in the scallop assessments. These contribute to better scallop stock information in Scotland than elsewhere in the UK, but critically there is a lack of management resulting from this scientific advice.

Recommendations:

- The appropriate scale for **scallop management units** in Scotland should be informed by science. Management demands should then drive the ongoing provision of scientific advice and the data collected, which should include fishing data (from dredge and dive fisheries).
- **Fishing data** are generally underutilised for management of Scottish scallop fisheries. Scallop management should be informed by spatially referenced catch/landings per effort data of an appropriate resolution. The use of VMS and logbook data for all scales of scallop vessels would provide the necessary fisheries-dependent data to support ongoing survey work.
- A **multi-stakeholder workshop** should be conducted to determine the scientific information needed to manage Scottish scallop fisheries in terms of: the type and spatial resolution of the necessary data; the resources required to deliver appropriate advice; how to improve

the flow of information between science to management; and to establish co-operative links for industry data collection.

Environment

Benthic impact from scallop dredge fisheries is inevitable and could be accepted outside areas identified as sensitive within MPAs. Designation and management of a representative MPA system is a statutory requirement, as is consideration of fisheries impacts in existing and future MPAs. It is reasonable to keep damaging gear such as dredges out of key vulnerable areas, while leaving less sensitive areas open for economic activity.

With sufficient information on the extent of features, the use of buffer zones where necessary to protect relevant interest features and the use of VMS, fishing activity may be able to continue in well-defined areas within MPA boundaries rather than a ban on mobile gear within MPA boundaries, as is the case with the management of European Marine Sites by some English IFCAs.

Inshore MPAs are more likely to be supported when there is a local sense of ownership and some management decisions are taken at a local level. The balance between local management and wider national interests remains to be found in Scotland. Conversely, the marine spatial planning process is highly developed in Scotland relative to the rest of the UK, and potentially provides a forum whereby conflicts between scallop fishing, conservation and other non-fisheries users can be discussed and resolved.

Recommendations:

- **Marine Protected Areas:** Scallop dredging should be excluded from MPAs with interest features sensitive to dredge impact (i.e. biogenic reefs). Detailed mapping of features with adequate buffer zones and compulsory VMS on all mobile gear vessels should enable these specific areas to be closed to fishing and the continuation of fishing elsewhere within MPA boundaries without impacting those interest features. The competent authority should approve written plans describing the alignment with conservation objectives and the measures to ensure full compliance with area-specific terms and conditions.
- **Biogenic reef habitats/priority features:** Areas where significant biogenic reefs or 'beds' are believed to occur (see Shelmerdine et al. 2014 for definition) should be confirmed by a competent authority and mapped then managed as per MPAs above. Where precautionary closure has occurred and a habitat is not subsequently identified, the area can be re-opened.
- **Eco-dredges:** An independent and robust analysis of alternative dredge technologies is required to identify comparative catching efficiency, benthic impact and associated costs and benefits.

Scallop Management

The status of Scottish scallop stocks in some areas of Scotland, the poor economic performance of inshore scallop vessels and many industry stakeholders consulted suggest that current management is not sufficient. Effort restrictions are in place (limited licensing, limits on dredges per side, technical measures), but these have not halted or reduced fishing mortality where and when needed. The proposals to remove entitlements are not expected to fully address the problem of latent capacity.

There is limited data from small vessels as they are not required to submit logbooks or carry VMS and this makes stock assessment and activity monitoring difficult for several areas.

It is difficult to establish a causal relationship between Minimum Landing Size and recruitment and the economic impact of increasing MLS must be considered. From the Isle of Man and subarea VIId

in the Channel, there is evidence that an MLS of 110mm can be effective at maintaining a stable fishery even when fishing effort is relatively high.

The management of European marine sites may well result in permanent closed areas (for dredging or for towed gear), which will displace scallop effort but the impact on the health of scallop stocks is unknown. Seasonal, rotating or permanent closed areas specifically to manage scallop grounds can be effective management tools (as found in some areas such as the Outer Hebrides).

Case study evidence also suggests that local management of inshore scallop fisheries can be effective. Some IFGs have proposed management plans for inshore fisheries in Scotland, including scallops. Regulatory support at a national level, expertise and resources to implement these plans are required for successful implementation of these plans.

Recommendations:

- **Joined-up management:** The dredge fishery and the dive fishery target the same resource and therefore management of each segment should be under an overall management plan of the Scottish scallop fishery (that supports local IFG planning).
- **Cap effort and remove latent capacity:** The total number of scallop entitlements within the fishery should be reduced to include only active scallop vessels (as per license review consultation proposals), with an important additional restriction to prevent upsizing of existing vessels (e.g. total VCU cap). Further management of effort is required and should be applied when there is a better understanding of relationship between nominal effort and F.
- **Increase in Minimum Landing Size (MLS):** An initial increase from 100mm to 105mm is proposed as some stock conservation and market benefits are expected. Compared to an immediate move to 110mm, this will reduce, but not remove the short-term economic impact. Maintaining this increase for four years will provide sufficient time to detect changes in recruitment arising from the increase. The economic impact on the sector should also be assessed throughout this four-year period and the costs and benefits of any further MLS increase should be explored.
- **Spatial reserves:** To protect locally important scallop beds from over-exploitation and support recruitment into the fishery, Marine Scotland should work with IFGs to identify fishery reserves within the 0-6 Nmile zone. These could be permanently closed to all forms of fishing or opened and closed on a rotational basis as informed by monitoring.
- **Bar length:** Bar length restrictions should be implemented within specific zones in Scottish waters to replace the current dredge restrictions. To avoid the need to carry two sets of bars and to partly compensate for other restrictions proposed, the dredge limit outside 12Nmiles could be removed, bring Scottish regulations into line with other UK waters. Additional effort restrictions (i.e. a reduction in permitted bar length) for inshore zones should be considered when the impact of such measures is better understood (i.e. CPUE reduction and displacement of vessels).
- **Inshore Curfew:** A curfew should be introduced prohibiting scallop fishing within 6 Nmiles of shore between agreed hours of the night. The details may vary seasonally and some flexibility could be agreed in the case of tide-limited harbours.
- **Dive fishery:** The dive-caught scallop sector should be considered a full partner in the future management of the Scottish scallop fishery. The Scottish Scallop Divers Association (SSDA) should be assisted by Marine Scotland in its efforts to improve safety and compliance by Scottish scallop divers and to develop Scottish dive caught scallops as a premium brand.
- **VMS and higher resolution data collection:** A VMS system should be mandatory for all vessels engaged in commercial scallop fishing (including dredge and dive methods) to demonstrate compliance with spatial management and provide data to inform science.
- **Quality and marketing initiatives** will be required as management improvements are implemented in order to capitalise on improved governance and industry standards.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 CONTEXT

Scallop is the second most valuable shellfish species landed in Scotland. Landings by UK vessels into Scotland have fluctuated between 9,000 and 10,000 tonnes per annum over the last decade, with a value around £25 million. Traditionally the species has been exploited in Scottish waters via the use of dredges towed across the surface of the seabed, with commercial hand-diving fluctuating at around 5% of total landings. The dredge fleet is characterised by smaller (generally <15 m in length) vessels that exploit inshore waters and less numerous larger vessels (20 m + length) that can operate more nomadically and exploit both inshore and offshore grounds around the UK.

Consultation between Marine Scotland (MS) and industry stakeholders during 2012 highlighted the need for careful consideration of the economic impact of increasing minimum landing size. Although this can be estimated for areas where landings size composition is recorded (e.g. market-based sampling by MS Science), the overall biological benefit is much harder to predict for a species that displays a wide range of spatial variability in both growth rate and size-at-maturity. The EU legislative minimum landing size of 100 mm shell length is intended to afford legal protection from harvesting to at least a proportion of the spawning stock biomass (SSB). In many fisheries areas however, there is insufficient pre-recruit abundance, growth, mortality or size-at-maturity data to adequately 'weigh-up' the potential biological benefit with the economic and business risk.

The Scottish scallop fishery faces significant challenges and opportunities. A number of barriers to effective management of the biological stock(s) exist, but these are not insurmountable nor require large economic commitments to resolve. The Scottish Ministers wish to review associated policy and management, which is timely when the 'Scottish' brand and reputation for quality seafood production is growing internationally. The scallop fishery has the potential to play a part in this continued growth and represent a global exemplar of best practice.

1.2 OBJECTIVES

The aim of this project is to provide Ministers with a body of evidence to inform decisions on the future management of king scallop (*Pecten maximus*) fishing which will meet the Scottish Government's aims of sustainable economic growth through a more productive and efficient fishing sector based on sustainable exploitation which supports solidarity and cohesion in Scottish communities.

Through reviewing available evidence, including expert judgement and stakeholder opinion the project sought to:

- Analyse the challenges and opportunities facing the Scottish Scallop fishery and recommend policy responses;
- Consider the health of scallop stocks and the level of fishing pressure currently applied;
- Assess the impact of scallop fishing on other users of the marine environment e.g. other fishing gears, disturbance of benthic habitats etc;
- Assess the financial health of Scottish businesses prosecuting scallop stocks;
- Assess the current and potential future impact of restrictions on access to scallop grounds (closed areas, MPAs, offshore renewables, aquaculture development, etc.);
- Review the available evidence related to onshore activities such as processing and on the impacts on employment and communities;

- Consider the operation and impact of the current management regime and how things might develop under a number of key scenarios (e.g. different stock projections, changed market environment).

1.3 APPROACH

The overall approach was one of data and information gathering via existing statistics, reports and consultation with industry, scientists and fisheries management authorities. This approach:

1. Efficiently collated and analysed the existing body of work to present the current situation in the fishery (science, management, fishery and post-harvest sector performance);
2. Considered future opportunities and threats via a number of potential scenarios (stock status, restrictions in MPAs, market changes) in terms of impact on key elements of the fishery;
3. Determined the objectives of stakeholders and identified the barriers to achieving the desired fishery objectives.
4. Developed options for the Scottish scallop fishery based on evidence and addressed resulting impacts.

To deliver the above approach the team analysed specific aspects of the fishery before drawing this together in scenario development for consultation and options development via the following sequential tasks:

1. Review and analysis
2. Scenario development & Consultation
3. Options development

Consultation was undertaken with a range of industry stakeholders and managers including:

- Scallop Association;
- Scottish Fishermen's Federation;
- Scottish Whitefish Producers Association;
- Scottish Scallop Divers Association;
- Marine Scotland Science, Compliance and Policy; and
- Scottish Natural Heritage.

A questionnaire was developed to structure discussions with these stakeholders (appendix A)

2 SECTOR STRUCTURE AND PERFORMANCE

2.1 UK OVERVIEW

King scallops (*hereafter referred to as 'scallop'*[1]) are the third most important fishery in the UK, worth £68.8 million to UK vessels landing into UK and foreign ports in 2012 (behind mackerel: £155 million; and Nephrops: £111 million) (MMO, 2013). Scottish vessels landed 17,000 tonnes of scallops into the UK in 2012, with a first sale value of £31.3 million (45% of UK landings).

As indicated in Figure 1 the majority of landings by UK vessels are from the Irish Sea (42% by weight), the Channel (26%) and West of Scotland (22%), as well as smaller quantites taken from Northern and Central North Sea.

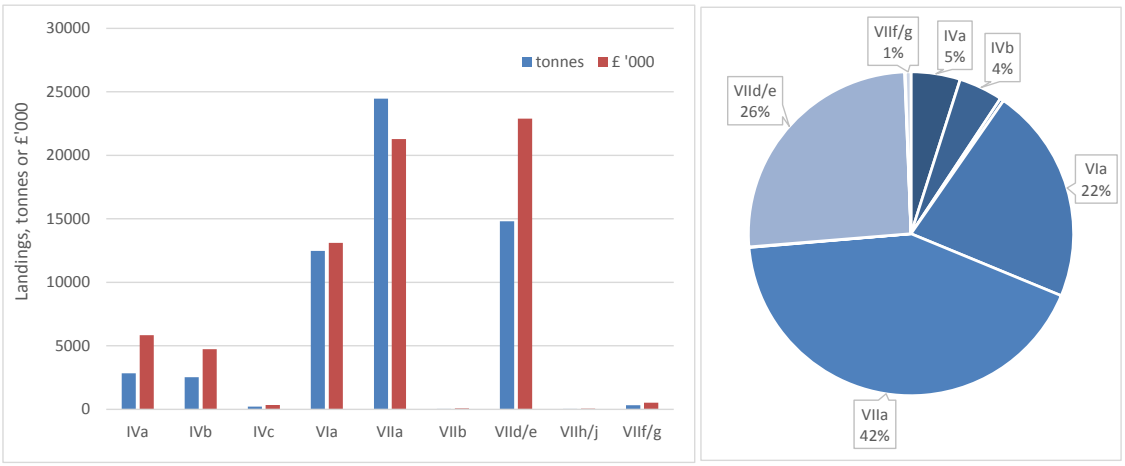


Figure 1: Left: Scallop landings by UK vessels into UK and foreign ports by ICES area, 2012 and; Right: Proportion of scallop landings by weight made by UK vessels into UK and foreign ports by ICES area, 2012 (Source: MMO, 2013)

The amount of scallops landed by UK and foreign vessels has grown steadily from 2008 to 2012 (Figure 2), with overall increases of 93% by weight and 59% by value. Volume plateaued from 2011 to 2012, although slight price increases resulted in a continued rise in the value of scallops landed into the UK.

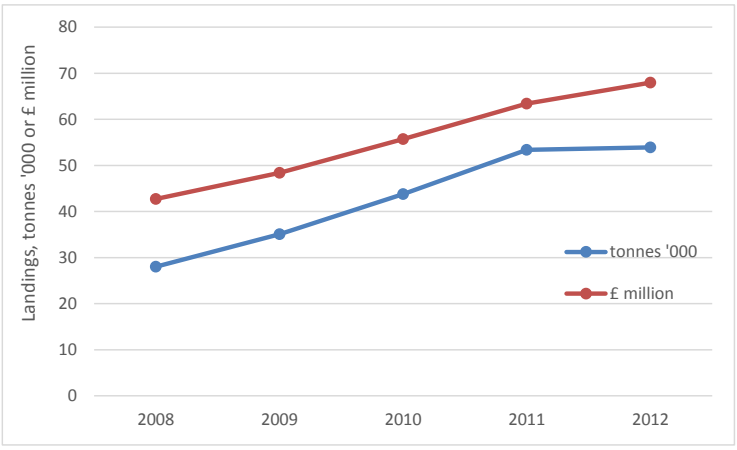


Figure 2: Scallops landed into UK by UK and foreign vessels, 2008-2012 (Source: MMO, 2013)

[1] King scallop (*pecten maximus)* are referred to as 'scallop' in this report, to be distinguished from queen scallop (*Aequipecten opercularis*) commonly referred to as 'queenies'.

The majority of UK scallops are landed into England (42% by weight), followed by Scotland (39%), Wales (12%) and Northern Ireland (7%) (Figure 3). There was growth in scallop landings into all UK countries from 2008 to 2012, although landings into England fell slightly from 2011 to 2012. 2013 has seen significant decreases in the volume and value of scallops landed across the UK (32% and 27% respectively).

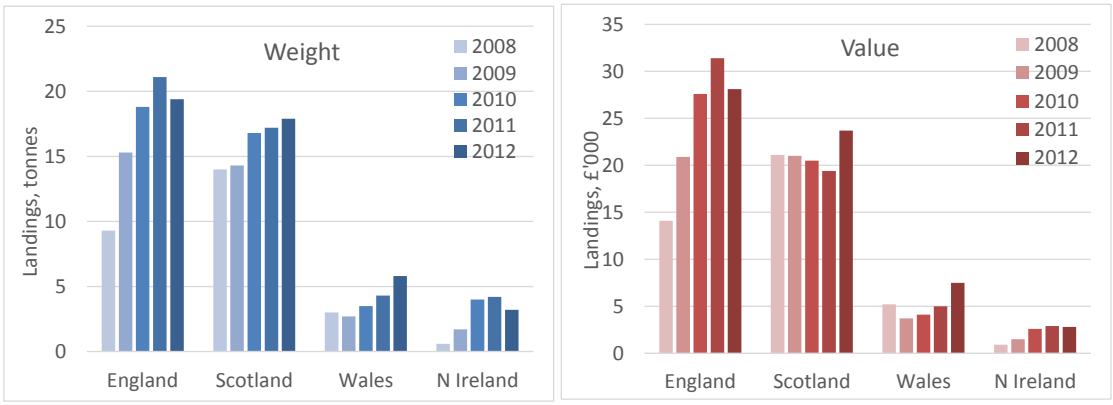


Figure 3: Scallop landings by UK and foreign vessels into UK by country, 2008-2012 (Source: MMO, 2013)

Key UK ports for scallop landings are presented in Figure 4 for all UK vessels.

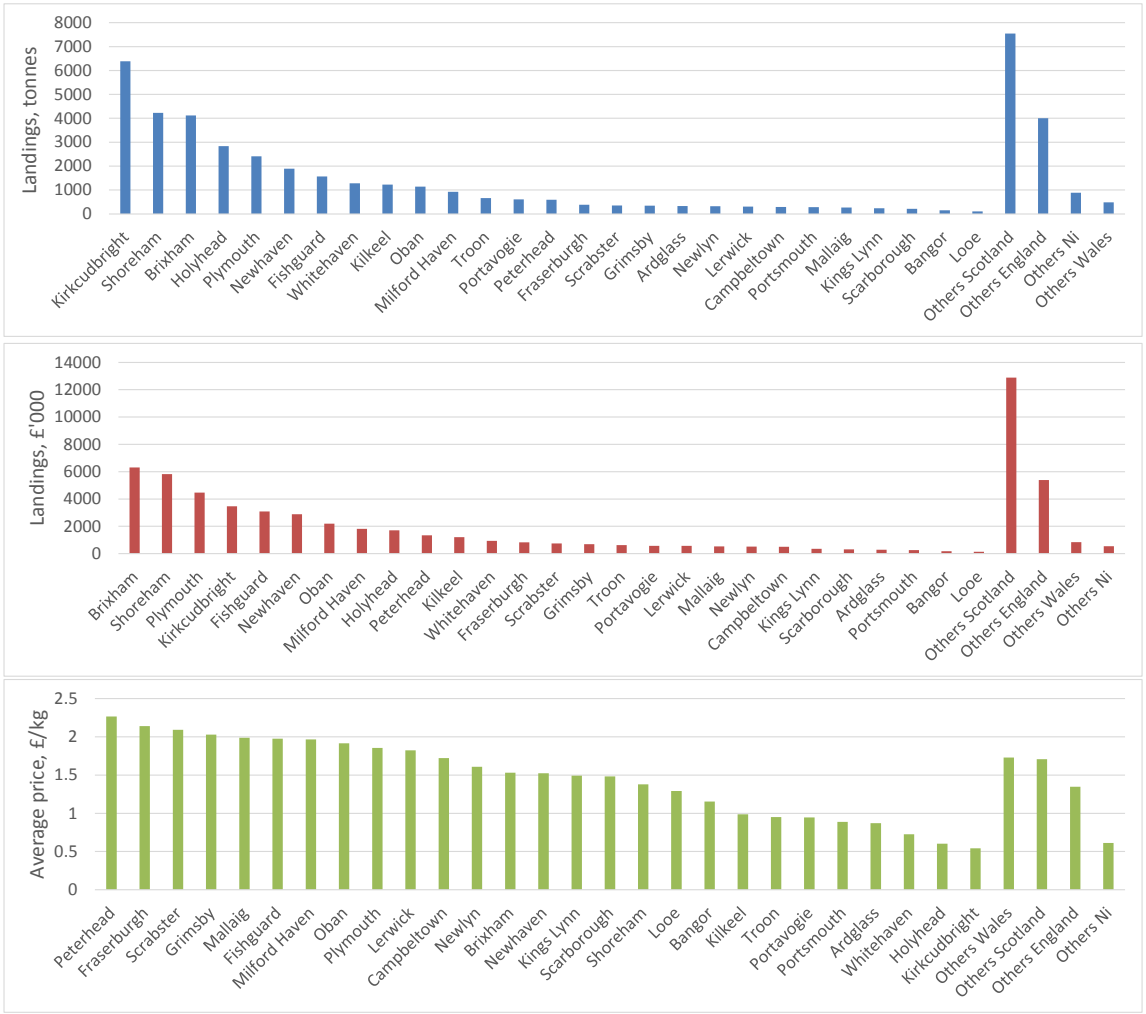


Figure 4: Landings of scallops into UK major ports in 2012 (MMO, 2013)

2.2 SCOTLAND

Scottish vessels landed 17,000 tonnes of scallops into the UK in 2012, with a first sale value of £31.3 million. Over half (57%) of this by weight was landed into Scottish ports, representing 61% of the value, with the remainder (£12.1 million) landed into other UK ports.

Landings into Scotland have grown from 2008 to 2012 by 27% in volume, but only 12% in value, representing a price drop of ~£0.22 per kg over this period. Similar price fluctuations are noted for Wales and Northern Ireland, but not England.

Landings are widely dispersed as is illustrated by the greatest value and volume being 'other Scotland'. Kirkcudbright accounts for the highest volume of landings. It is the homeport for many large nomadic scallop vessels, but is only fourth in value terms behind ports on the South coast of England (where this fleet would also land to).

The Scottish nomadic fleet lands much of its catch into the English Channel ports of Shoreham, Newhaven and Plymouth (Figure 5). Key Scottish ports are Oban, Aberdeen, Peterhead, Port Ellen and Kirkcudbright.

The high volume, but relatively low value landed at Kirkcudbright results in an average price per kg that is significantly lower than at other Scottish ports. However as much of the nomadic fleet has close links with or are owned by key local processors, this estimated price might well be somewhat artificial.

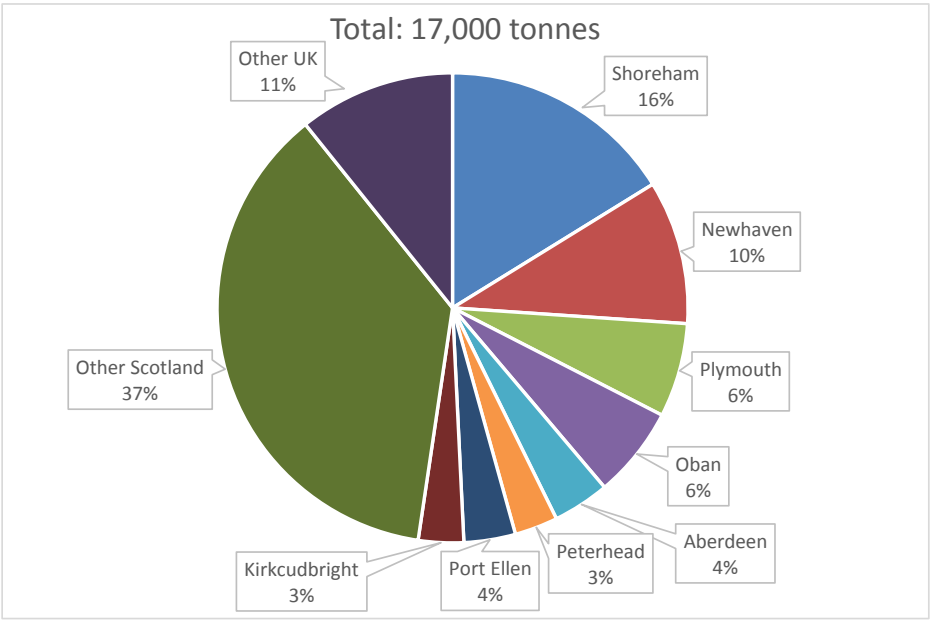


Figure 5: Proportion of scallop landings by Scottish vessels into UK ports by weight, 2012 (Marine Scotland, 2013)

2.3 THE DREDGER FLEET

As of 31st December 2012 there were 153 active vessels with scallop entitlement in the Scottish fleet. This compares to figures from 10 years ago indicating that there were 268 vessels with a scallop licence of which 150 were active (Watson et al, 2004).

Of the 153 current active vessels, 46 have not recorded landings of scallops in any of the years between 2003 and 2012 (Marine Scotland pers comm., 2013), which suggests that significant latent capacity (vessels with the potential to target scallops) remains within the Scottish fleet.

Of the 107 vessel owners that had utilised their scallop entitlement, 97 did so by means of mechanical dredge. Only 44 vessels with scallop entitlement have landed scallops every year during the 10-year period (2003-2012).

Table 1 shows the gears used by Scottish vessels with scallop entitlement that have landed scallops. Over 90% of landings are by dredgers over 10m in length with a scallop entitlement. Landings by otter trawls or pots are small levels of retained bycatch. Some of the 107 vessels landing scallops registered landings with more than one reported gear type ('boat dredge' and 'mechanised dredge'), resulting in more than 107 being recorded. Vessels under 10m in length do not require an entitlement to land scallops. In addition, 28 hand-fishing licences without scallop entitlement are recorded as landing scallops in 2013.

Table 1: Number of Scottish vessels with scallop entitlement with proportion of total 2013 (January-September) scallop landings by weight (Source: Marine Scotland, 2013)

Gear	Vessels with scallop entitlement		Vessels without scallop entitlement	
	Number of vessels	% of landings	Number of vessels	% of landings
Boat dredges	87	66.7%	25*	4.5%
Mechanized dredges	36	23.7%	7	1.8%
Otter trawls	4	0.2%	7	0.0%
Pots	4	0.2%	23	0.5%
Hand fishing	4	0.04%	28	2.1%
Gillnets and entangling nets			1	0.02%
Hand dredges			3	0.1%
Miscellaneous gear			2	0.1%

* Vessels under 10m do not require an entitlement to land scallops.

There are principally two fleets of Scottish mechanical dredgers targeting scallops: the inshore fleet and the offshore nomadic fleet. The inshore fleet are vessels typically under 15m in length, with 3-4 crew and normally focusing effort within inshore waters (within 12 nautical miles) (Watson *et al*. 2004). The nomadic offshore fleet are larger (>15m in length) and travel around the UK predominately targeting offshore grounds, with 5-7 crew and fishing for longer trips.

Marine Scotland provides vessel characteristics for fishing vessels by gear type, with a total of 89 mechanical dredgers recorded in 2012, representing an increase of 2 vessels from 2011. MMO data for the UK fleet gives 89 over 15m vessels and 215 under 15m vessels in 2011[2]. Scottish vessels therefore account for 56% of the UK nomadic fleet and 18% of the UK under 15m dredge fleet by number, although other vessel land scallops (as shown in table 1 above) and many others retain scallop entitlements.

Figure 6 presents the size range of Scottish mechanical dredge vessels, in detail for 2012 and in broader categories for 2008-2012. The majority of the fleet are over 15m in length and this has been consistent since 2008 with vessels 15-24m in length dominating the over 15m segment.

[2] Seafish Costs and Earnings data cite 155 active UK scallop dredgers over 15m and 85 under 15m in length. This is at odds with the MMO data as a different methodology is used to attribute vessels to fishing segments.

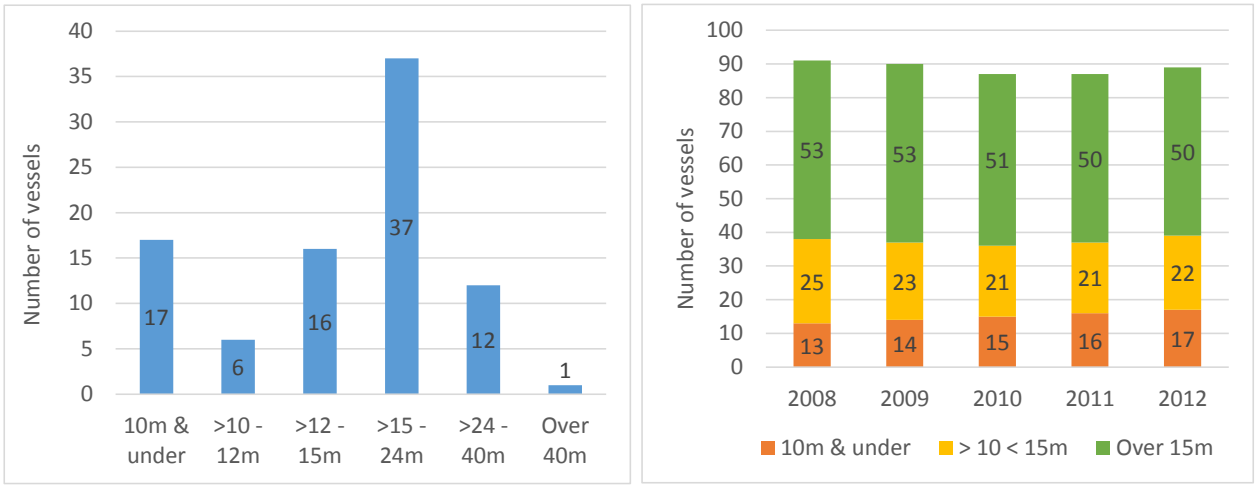


Figure 6: Vessel size range (length, m) of Scottish mechanical dredge vessels in 2012 (left) and from 2008-2012 (right) (Source: Marine Scotland 2009-2013)

There has been a dramatic increase in the fishing capacity of the under 15m (and particularly under 10m) UK fleet in power terms as illustrated in Figure 7. In 2000 the under 15m fleet represented 28% of the engine power of the scallop fleet, but in 2011 the under 15m fleet had grown to nearly half (46%), while the over 15m fleet has declined by 12% in terms of engine power.

The true capacity in the under 15m Scallop segment is difficult to quantify as:

(i) Vessels under 10m do not require a scallop entitlement;
(ii) Those with a scallop entitlement may not be active in the scallop sector; and
(iii) Many operate in other fisheries, fishing for scallop on a seasonal basis and dependent on other fisheries

Recent cost and earnings data from Seafish (where segments are allocated depending on gear and proportion of landings) indicate that the Scottish over 15m fleet has remained stable at around 56 vessels, while the Scottish under 15m fleet has recently reduced in number from 42 in 2010 (after an increase from 38 in 2006) to 31 vessels in 2011/12. The poor financial performance described in section 2.5 explains these exits from the fishery. Vessels are expected to have remained in other fisheries rather than changing gear to target scallops, which remains an option for these vessels.

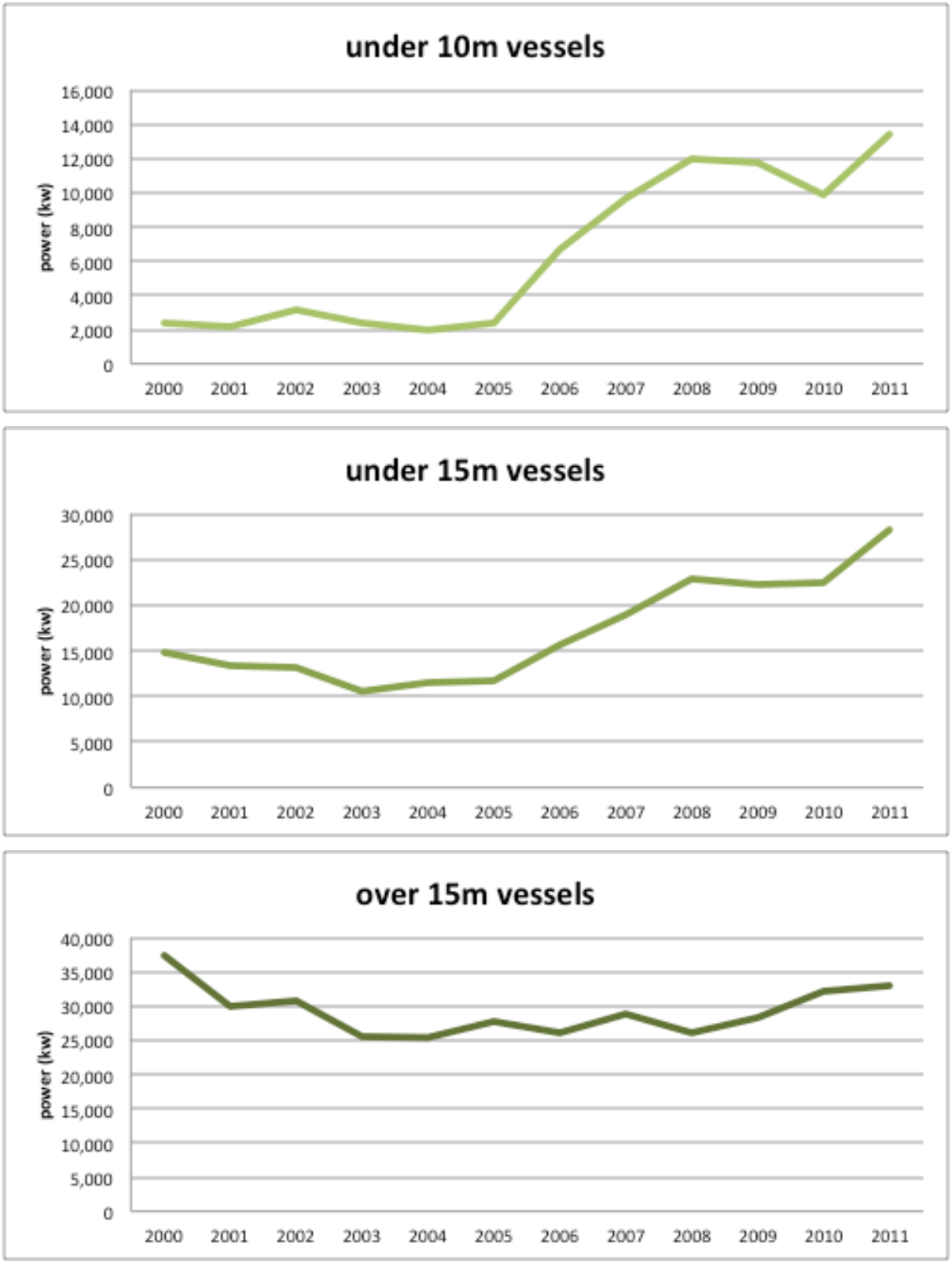


Figure 7 Trends in UK Scallop fleet capacity (by engine power) for under 10m, under 15m and over 15m segments (source: MMO)

2.4 SCOTTISH DREDGE EFFORT

In 2010, the Western Waters Effort Management regime (Council Reg. 1415/2004) has forced Scottish vessels out of Area VII (Irish Sea, Channel), where effort had increased by 47% since 2001, and into Area VI West of Scotland. Effort in 2011 and 2012 in Scottish waters has therefore increased dramatically (see Figure 11). In addition to the growth in inshore fishing effort shown in Figure 7, the problem with Western Waters Effort has further increased the overall effort in the Scottish fishery.

There is significant activity by the Scottish fleet outside Scottish waters, specifically in the Irish Sea, the English Channel, and a small patch off the Holderness Coast. In Scottish waters small levels of effort by other UK vessels targeting scallop are noted in the East Coast and West Kintyre areas.

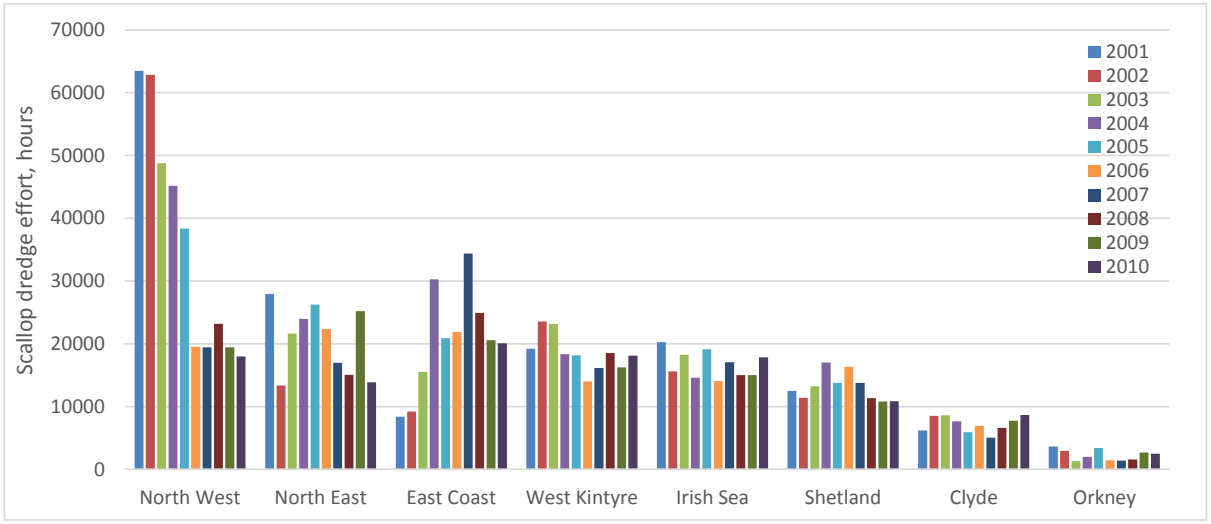


Figure 8: Scallop dredge effort (hours fished) by Scottish area 2001-2010 (Source: Marine Scotland, 2011)

Landings and effort by the Scottish dredge fleet occur throughout the year, with slight increases during spring and early summer. Historically (from 2001-2005) the majority of effort has been in the North West Scotland area (Figure 8), but more recently (2006-2010) effort is more evenly spread throughout East Coast, West Kintyre, North West and the Irish Sea (Figure 9). Vessel Monitoring System (VMS) data for vessels targeting scallops corroborate this geographical spread of effort (Figure 10 for 2012 and Appendix A for 2008-2011).

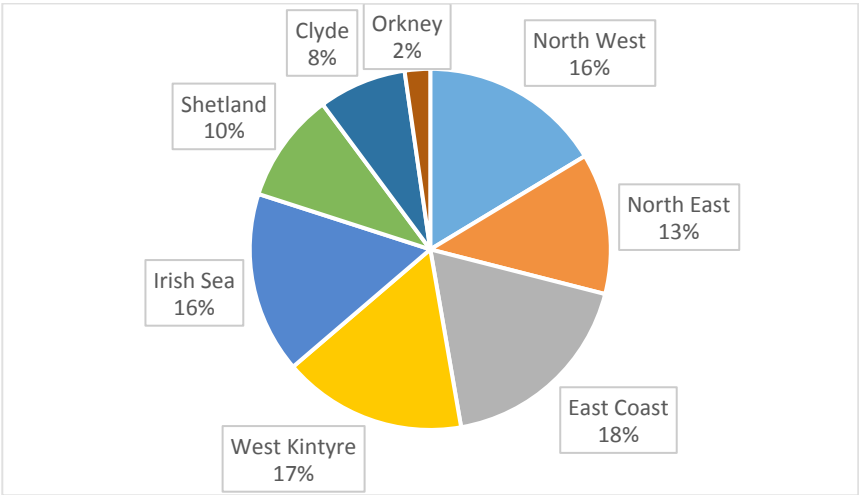


Figure 9: Proportion of scallop dredge effort (hours fished) by Scottish area, 2010 (Source: Marine Scotland, 2011)

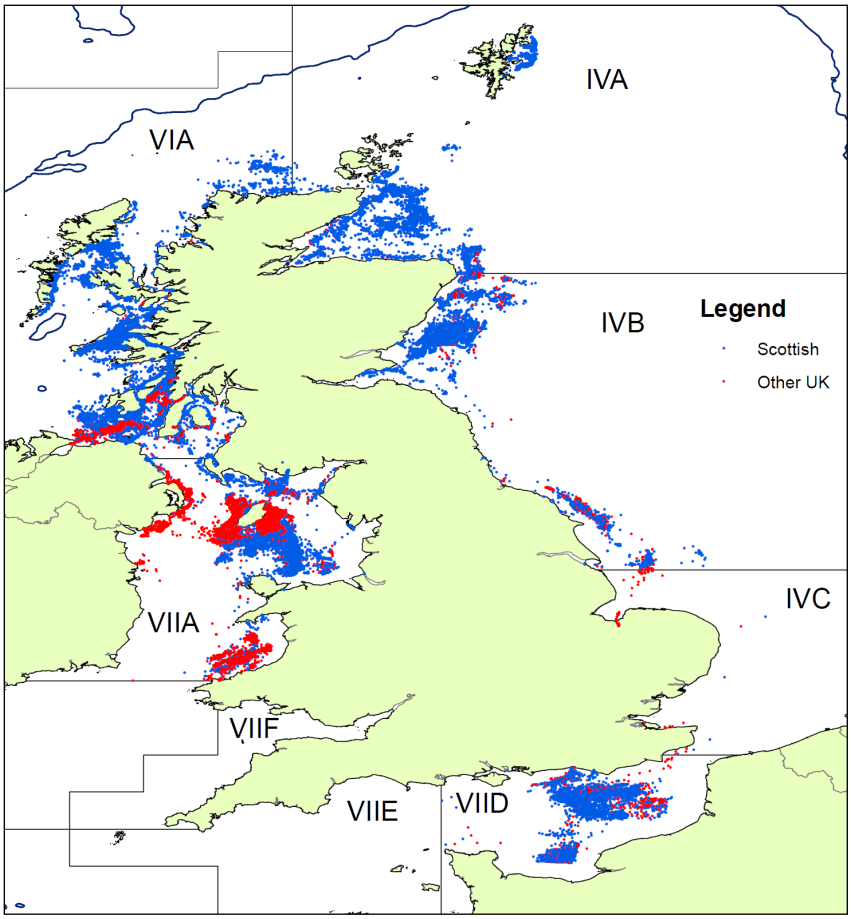
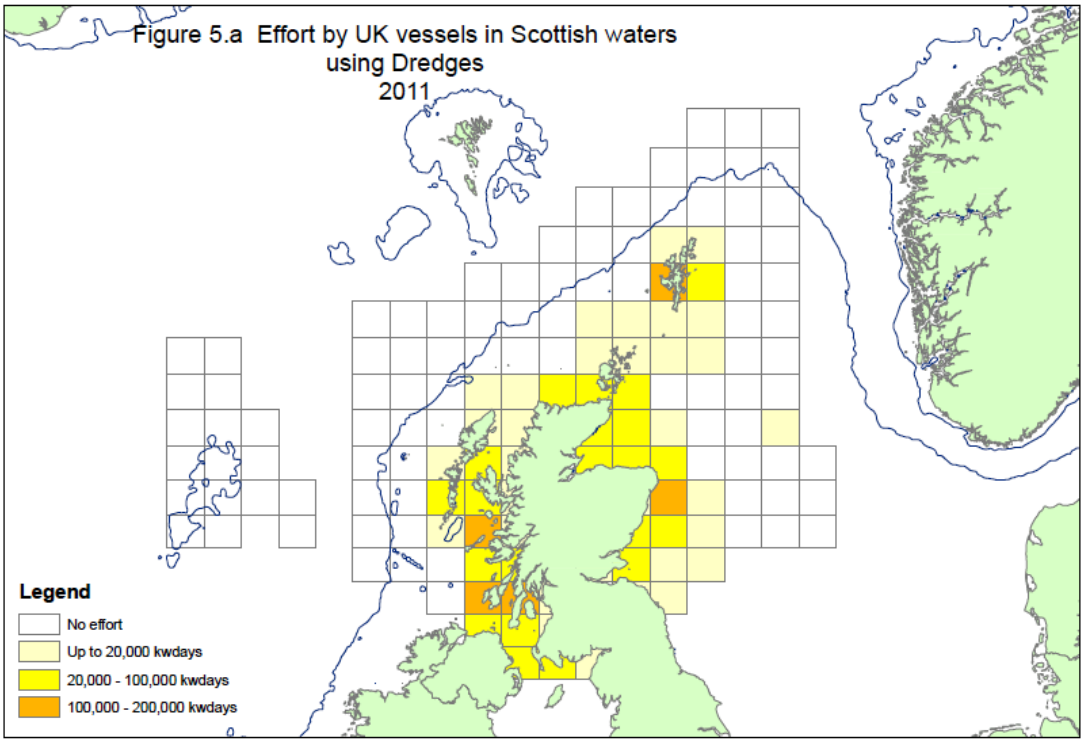


Figure 10: VMS data for Scottish (blue) and other UK (red) vessels targeting scallops 2012 (Source: Marine Scotland, 2013)



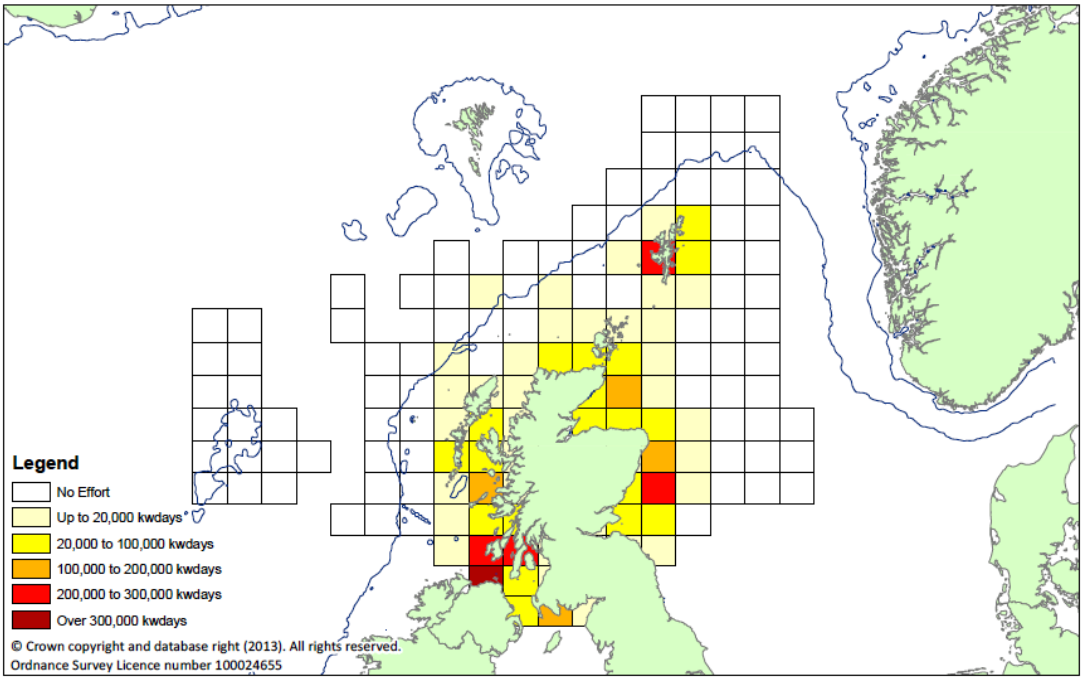


Figure 11 UK fishing effort by dredge in Scottish Waters in 2011 (top) and 2012 (bottom)

2.5 FINANCIAL PERFORMANCE

Financial performance indicators for the Scottish scallop dredge fleets (under and over 15m) are presented in Table 2. Net profit as a % of turnover is given in

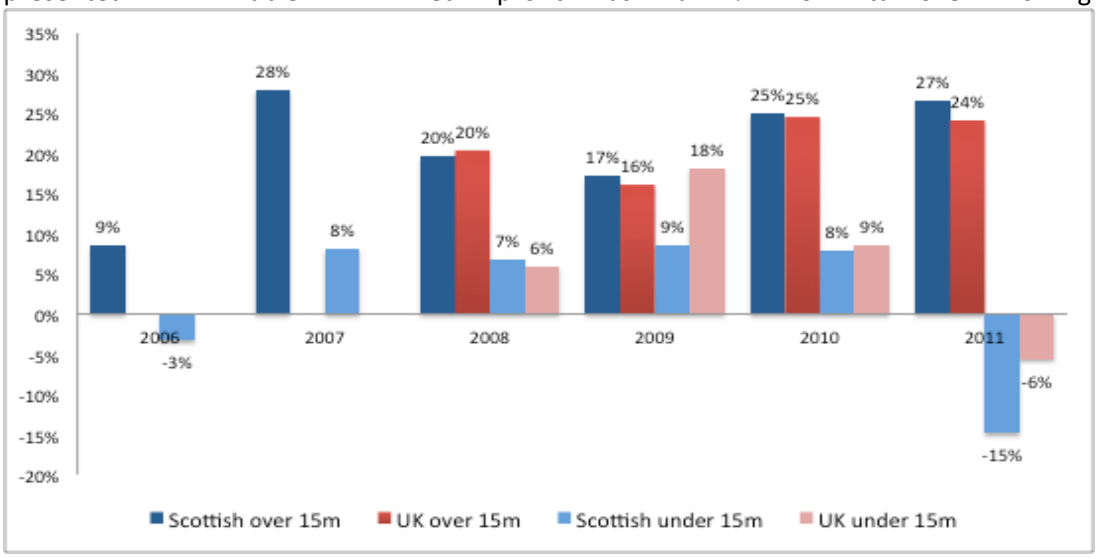


Figure 12 along with these figures for the UK fleet.

The average profitability of the Scottish under 15m fleet has been marginal over the years since 2005 with 2006 and 2011, each year showing an average loss of around -6%. Operating profits in 2012 once more suggest a net loss by this segment of the fleet. Rising fuel costs are predominately responsible for this precarious financial position.

In contrast, the over 15m fleet has seen a rise in profits since 2009, with a net profit representing 27% of turnover in 2011 and preliminary figures suggest this good profit level continued in 2012. Profits dipped to 17% in 2009 due to the fuel crisis and the wider economic crisis in key overseas European markets, but overall a far healthier financial situation is evident for the larger vessels.

The available data suggest that this difference between the over and under 15m dredge segments is even more polarised in Scotland than in the UK as a whole with the larger Scottish vessels generally slightly more profitable than the whole of the UK and the smaller Scottish vessels making even more of a loss than others around the UK. The reasons for these differences are not obvious, but could relate to differences in catch per unit effort (with some Scottish grounds showing signs of decline – see section 3.1.4) and the value of other species landed by inshore scallopers as bycatch and in other seasonal fisheries (most are not full-time scallopers).

This situation reflects that seen in the UK fleet and in the EU dredge fleet, as presented in the STECF Annual Economic Report (AER), The data suggest that the dredge (DRB) segments were the least profitable between 2008-2010, with net profit as a % of income of 1% in 2008 and 2010 and -36% in 2009 (AER, 2012). The main factor is identified as the increased fuel price, but further investigation shows dredger performance varies significantly across fleets. Italian dredgers targeting clams were one of the most profitable Italian segments (21% net profit as % of total income), while Baltic and North Atlantic dredgers showed a net loss (-11% net profit) in 2010. This includes Irish vessels targeting scallops, which also showed significant losses in this period.

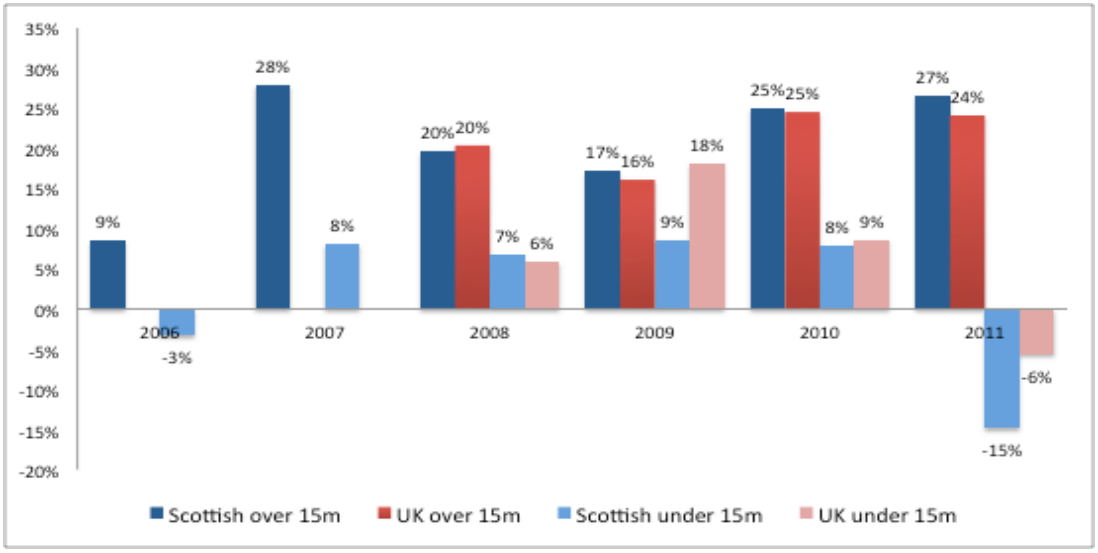


Figure 12: Net profits as % of turnover for an under 15m and an over 15m Scottish and UK scallop dredge vessels (Source: Seafish, 2013)

The difference in profitability is understandable when the trend in average catch per day is considered (Figure 13). The over 15m fleet doubled its productivity from 2006-2012 in terms of tonnes per fishing day, while catches for the under 15m fleet reduced by 13% over that period. The average days at sea for the over 15m fleet fluctuated in that time, but has increased by 30% for the under 15m fleet. Inevitably fishing harder for less reward has impacted profitability for the under 15m fleet and fuel as a proportion of turnover has gone from 18% in 2006 to around 40% in 2011/12. Fuel for the over 15m fleet has stayed around 10-12% of turnover throughout this period.

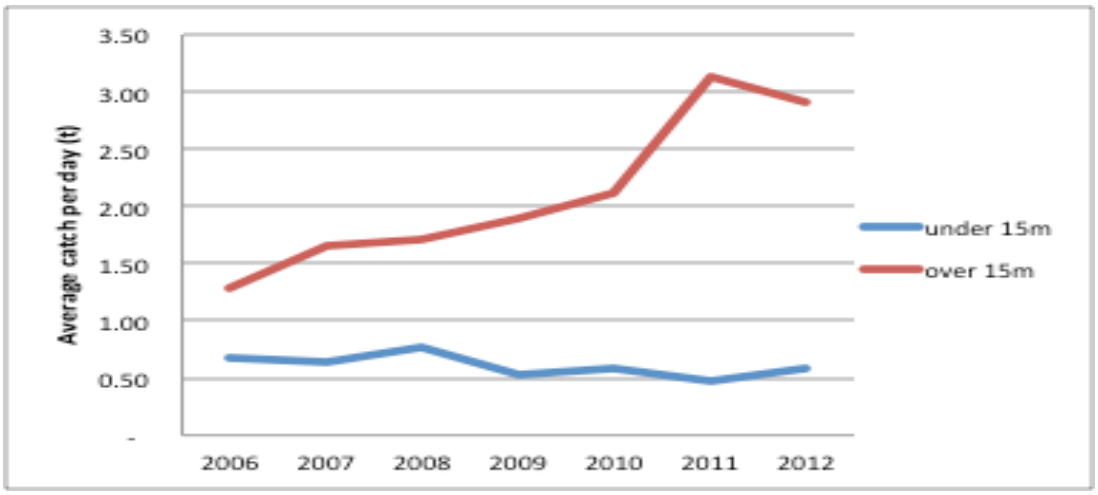


Figure 13 Average catch per day for under & over 15m Scallopers (Source: Seafish, 2013)

The above analysis illustrates a situation where nomadic vessels with greater catching efficiency are able to target productive grounds around the UK coast. The shorter range of the inshore fleet means that they are limited to local grounds that are easily over-exploited with the high levels of effort in the inshore fleet coupled with access to these by larger vessels on occasional visits.

Vessels in the under 15m segment will continue to operate in the short to medium term despite losses in attempts to maintain crew and bank repayments, but a loss-making situation is clearly not sustainable in the long term. Recent data indicate vessels have exited the under 15m scallop segment, which decreased from 42 vessels in 2010 to 31 in 2012 (Seafish, 2013). Over the same period the number of UK under 15m vessels has continued to increase.

Table 2: Average characteristics & performance of Scottish scallop vessels under 15m and over 15m vessels (Source: Seafish, 2013)

Characteristics	Under 15m vessels								Over 15m vessels						
	2006	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*		*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*
Length (m)	11.4	11.2	11.1	11.4	11.6	11.6	*11.8*		20.1	20.9	21.4	21.0	20.8	21.3	*21.9*
Power (kW)	141.3	138.8	134.5	146.1	145.2	142.2	*153.1*		349.4	376.3	392.8	378.7	365.9	384.5	*381.1*
Registered Tonnage	17.8	17.1	17.2	20.5	19.8	20.5	*22.6*		92.6	106.8	112.5	107.6	103.6	111.9	*119.3*
Days at Sea	107	105	112	126	119	131	*138*		168	188	198	200	199	175	*178*
Vessel Age	19.2	19.7	21.8	22.0	22.5	25.8	*21.6*		27.3	26.1	27.1	28.8	30.5	30.8	*31.9*
Income, costs, profit (£)															
	2006	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*		*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*
Landings (Tonnes)	71.7	67.3	86.5	66.4	70.0	61.8	*80.3*		215.3	310.1	340.4	379.0	422.5	547.6	*516.9*
Fishing Income	124,589	94,360	133,798	123,200	166,237	122,734	*147,529*		337,079	434,531	500,846	509,998	513,193	604,936	*579,849*
Non Fishing Income	2,564	1,180	1,302	2,977	2,518	817	*982*		8,478	1,423	10,619	9,593	23,661	6,554	*6,282*
Total Income	**127,153**	**95,540**	**135,100**	**126,177**	**168,755**	**123,551**	***148,511***		**345,557**	**435,954**	**511,464**	**519,591**	**536,854**	**611,490**	***586,131***
Fuel Cost	22,584	21,069	34,415	32,696	34,926	50,945	*58,604*		35,544	43,312	64,994	51,335	53,331	69,228	*71,878*
Total Costs	**116,899**	**82,038**	**117,376**	**103,483**	**144,345**	**131,133**	***159,840***		**276,147**	**300,724**	**372,644**	**398,770**	**375,913**	**421,053**	***404,573***
Operating Profit	**10,254**	**13,502**	**17,724**	**22,694**	**24,410**	**-7,582**	***-11,329***		**69,410**	**135,230**	**138,820**	**120,821**	**160,941**	**190,437**	***181,557***
Depreciation	9,674	5,267	6,945	10,153	7,891	8,224			31,854	9,324	28,475	26,903	22,751	22,440	
Interest	4,769	536	1,756	1,602	2,657	1,112			8,166	4,348	10,280	3,903	2,799	2,836	
Other Finance Costs	0	0	0	28	653	1,448			0	0	0	930	1,376	2,103	
Net Profit	**-4,188**	**7,699**	**9,023**	**10,911**	**13,209**	**-18,367**			**29,391**	**121,558**	**100,065**	**89,086**	**134,016**	**163,057**	
% of turnover	**-3%**	**8%**	**7%**	**9%**	**8%**	**-15%**			**9%**	**28%**	**20%**	**17%**	**25%**	**27%**	

2.6 DIVE-CAUGHT

Landings of dive caught scallops into Scotland from 1982-2010 are presented in Figure 14 by area. Typically dive caught scallops account for 5% of the total Scottish scallop landings by weight, although Figure 14 highlights significant variations throughout this 29-year time series. Large increases in landings are noted from 1994 to 1995, but these fell again in 1999. A significant drop also occurs from 2003 to 2004, however since 2005 landing have remained more consistent.

The number of divers associated with the fishery is more difficult to track; Watson *et al* (2004) reported approximately 350 divers targeting scallops in 2003. However representatives of the Scottish Scallop Divers Association (SSDA), established in February 2013 (with a growing membership of 30), estimate that there are only about 43 'legitimate, full time' scallop divers. Important issues for the association are safety, legitimacy and compliance.

There are occasional reports of gangs of hobby divers fishing in an area without licence and knowledge/care for regulations (MLS, biotoxins etc.). This problem that has been highlighted in Orkney (a recreational diving hotspot) of some divers shucking and selling buckets of meat to buyers on the quayside. SSDA states that most professional divers are accepting of hobby divers taking half a dozen for own consumption.

In contrast to the dredge fisheries, the main dive fisheries in 2010 (Figure 15) were located in the coastal waters of the west of Scotland and at Orkney, where the method accounts for 40% of the landings (Dobby et al., 2013).

Statistics for 2013 indicate that diver caught scallops attain a higher price at £2.68 per kg compared with dredge caught scallops at £1.78 per kg (Marine Scotland, 2013). However prices quoted in interview were substantially higher at £6,500 per tonne of dive caught compared to £3,000 per tonne for dredged. If operated on a professional basis, dive boats can develop are profitable business model with comparatively small overheads (low fuel consumption etc.). Most boats using 2 divers are averaging about 1 tonne per week or up to 1,400kg with 3 in a dive team (SSDA pers. comm.)

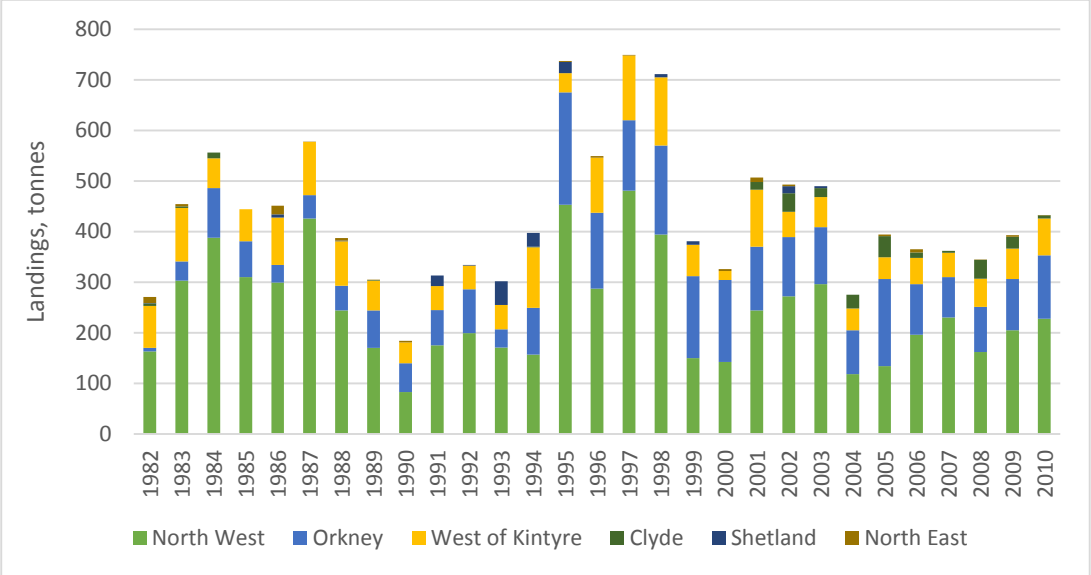


Figure 14: Landings of dive caught scallops into Scotland, 1982-2010 (Source: Dobby *et al.,* 2013)

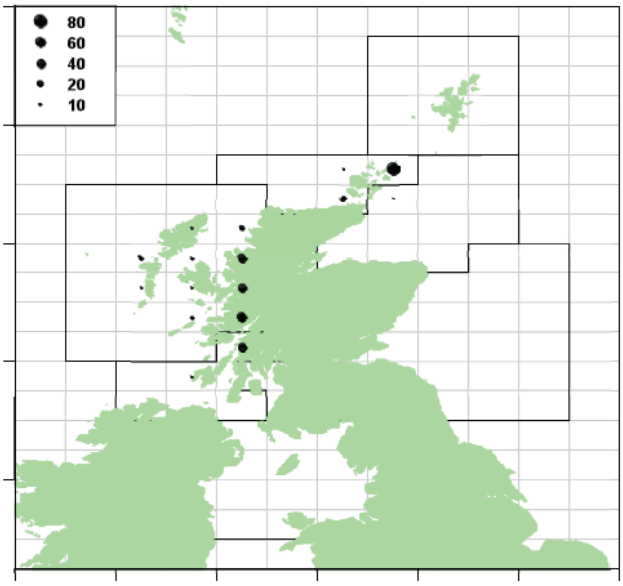


Figure 15: Spatial distribution of dive caught scallops, 2010 (Source: Dobby *et al*, 2013)

2.7 AQUACULTURE

In 2012 the value at first sale for Scottish aquaculture was estimated at £100,000 for scallops and £1,000 for queen scallops. Almost all (95%) of the scallop production was in the Highlands from two businesses, with small quantities from one company in the Strathclyde region.

Production statistics show major reductions in queen scallop aquaculture production for the table from 2003 to 2012. King scallop production for the table and for on-growing fell significantly during 2007-2009, and although has increased from 2010-2012, it remains well below figures recorded in 2003 (Munro *et al.,* 2013).

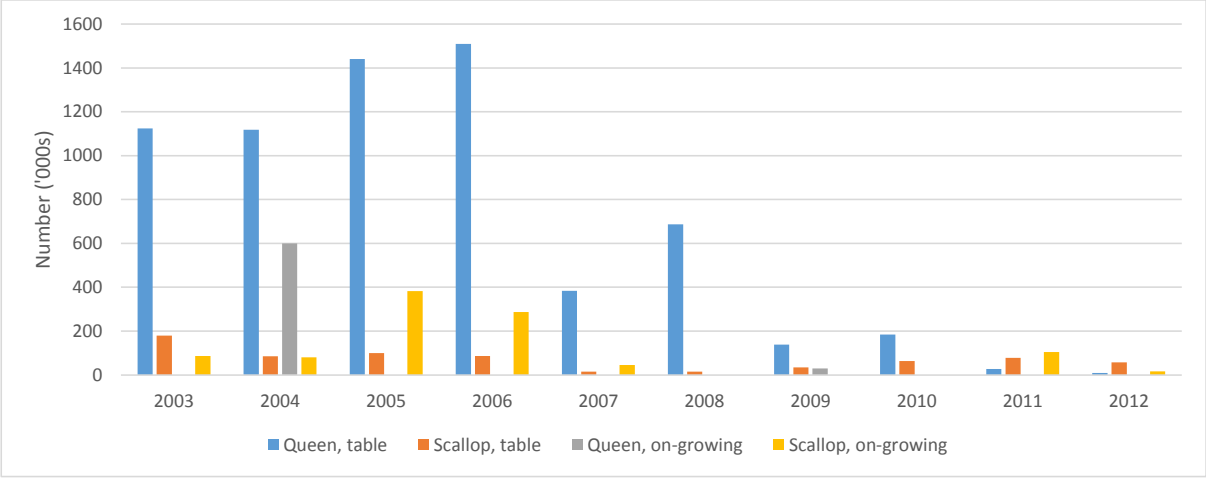


Figure 16: Scottish aquaculture production statistics for scallop and Queen scallop, 2003-2012 (Source: Munro *et al*., 2013)

Over the past few years there has been some renewed interest in scallop ranching, which is similar to bottom-culture of mussel. Seed scallop (40mm) is distributed in an area, with harvesting (by dredge or diver) at 110mm 4 years later. One company has been on-growing Scottish seed hatched in Norwegian hatcheries and is seeking to develop a Scotland-based hatchery (Scot-hatch pers. comm.), which would represent a major expansion in production from the current low levels.

2.8 POST-HARVEST & PROCESSING SECTOR

Approximately 70% of scallops landed into the UK are exported, mainly to France, Spain and Italy, with exports worth £90 million in 2012 (Figure 17). This suggests 30% added value compared to the reported first hand sales value. Scallops are reported to account for ~750 processing jobs in the UK (Mason *et al*, 2011).

Post-harvest and processing data specific to the scallop sector are very limited with the most recent Seafish UK Seafood Processing Industry survey grouping scallops within an overall 'shellfish' category including Nephrops, crab etc. Further detail will be sought as part of on-going consultation with the Scallop Association and the Scottish Fishermen's Federation Scallop Group to inform this section of the report.

It is noted that Watson *et al.* (2004) cites 62 processors in the UK that deal with scallops; 25 of which are based in Scotland; but it is expected that these figures are out-dated.

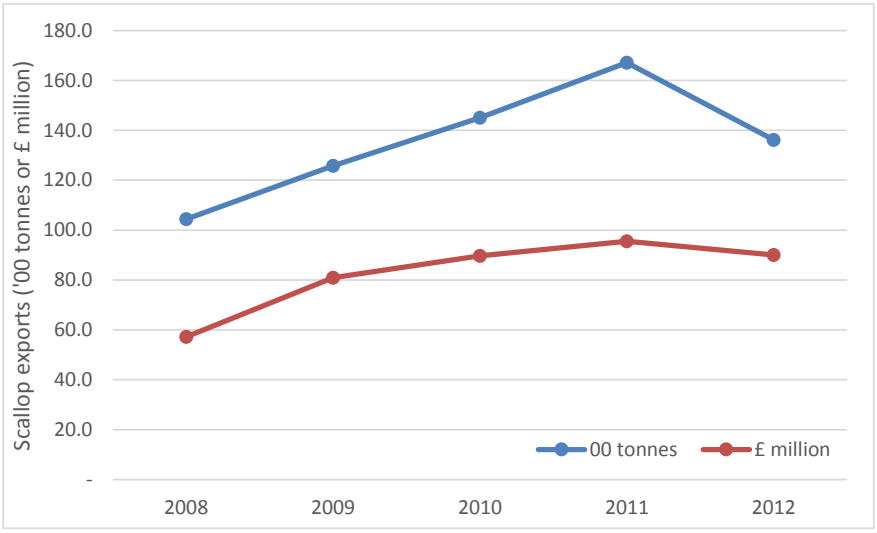


Figure 17: Exports of scallops from UK, 2008-2010 (Source: MMO, 2013)

2.9 SUMMARY

Scottish vessels landed 17,000 tonnes of scallops into the UK in 2012, with a first sale value of £31.3 million, representing 45% of UK landings by value.

2008 to 2012 saw landings into the UK by UK and foreign vessels increase by 93% by weight and 59% by value of scallops. However 2013 has seen significant decreases in the volume and value of scallops landed (32% and 27% respectively).

As of 31st December 2012 there were 153 active vessels with scallop entitlement in the Scottish fleet with 89 categorised as mechanical dredges operating in 2012. In terms of vessel numbers, Scotland accounts for 56% of the UK over 15m scallop dredge fleet (typically nomadic, targeting offshore waters around the UK) and 18% of the UK inshore fleet (typically targeting local waters within 12 nautical miles).

The number of scallop vessels under 15m has more than doubled in the last 10 years, while the number of over 15m vessels has remained relatively stable, but the segment shows a steady increase in power. The lack of sufficient effort allocations in the Western Waters effort regime has created additional pressure in the Scottish scallop fishery.

Significant latent capacity (vessels with the potential to target scallops) remains within the Scottish fleet, with 30% of Scottish vessels with scallop entitlement having not reported scallop landings in any of the years between 2003 and 2012.

The latest costs and earnings figures indicate marginal profitability in recent years and an overall net loss (-15%) for the Scottish under 15m scallop dredge fleet in 2011. This is primarily due to increased fuel costs. The over 15m scallop fleet have, however, maintained relatively healthy profit levels of over 25%.

Dive caught scallops typically account for 5% of total Scottish scallop landings, although trends fluctuate greatly. Dive caught scallops attain significantly higher prices than dredge caught scallops and are harvested in a manner less damaging to the environment.

There is very little aquaculture production of scallops in Scotland, following a large drop in queen scallop production (for table) in 2006 and a further drop in 2008. In total aquaculture production of scallops and queen scallops was estimated at £101,000 in 2012. There are attempts by some individuals to develop production via scallop ranching.

70% of UK scallops are exported with the key markets being France, Spain and Italy. There is limited information on the post-harvest sector for scallops, but it is evident that prices have not changed for many years (equating to a price reduction in real terms), which can only partly be attributable to the recent economic crisis.

3 HEALTH OF SCOTTISH SCALLOP STOCKS

3.1 REVIEW OF EXISTING EVIDENCE

3.1.1 Introduction

Marine Scotland Science (MSS) provides the Scottish Government with data and scientific advice relating to scallop stocks. It is important to distinguish this responsibility from the development and implementation of policy, the act of management, which rests with other units within Marine Scotland.

In other UK waters provision of underpinning science and advice is the responsibility of the Department of Environment, Food and Rural Affairs (DEFRA), generally through the outputs of the Centre for Environment, Fisheries and Aquaculture Science (CEFAS). The Government of the Isle of Man (Crown Dependency) contracts the provision of these services to Bangor University for its territorial waters. Agri-Food Biosciences Institute (AFBI) undertakes scientific survey and assessment in Northern Ireland's waters for Department of Agriculture and Rural Development (DARD NI).

King scallop stock status in Northern Ireland, the Isle of Man and Wales are of less direct concern (other than potentially for source-sink population dynamics) in the context of Scottish vessel activities, as local and regional management regulations almost entirely exclude them (although occasional landings are made into these locations by Scottish vessels). The majority of landings (and effort) outside Scottish waters are around the English coast. This is primarily due to the more favourable access (discussed in section 4).

3.1.2 Scottish assessment

The Scottish scallop stock 'assessment areas' (Figure 18) have been defined on the basis of historical fishery distribution (the best proxy for stock distribution at that time). ICES has recently agreed provisional spatial definitions for scallop stocks across northern Europe. Across most of the region these definitions were based on distinct scallop fishing grounds as observed from VMS data and supported in some cases by particle tracking studies. Around the coast of Scotland the stock definitions largely adhere to those currently in use in the MSS scallop stock assessments with the exception of the 'East Coast' area, which has been extended to cover the whole of ICES Division IVb.

The reality is that the geographic distribution of a natural population will be defined by biology, physiology and population dynamics of that species, and will never conform exactly to management areas. For species such as scallop that are relatively long-lived, highly fecund and broadcast spawn to produce dispersive planktonic larvae (ultimately spat), it is realistic to assume a high degree of adult population overlap and larval exchange between assessment areas. In the simplest sense, this suggests that stock in one management area will have a high probability of being linked in some way to others (and the estimates of recruitment (from MSS assessments) in neighbouring assessment areas show significant correlation), but the current reality is that meta-population or 'source – sink' dynamics for scallop populations around the British Isles are poorly understood.

The linkages between management areas, or between populations/sub-populations within an area, may range between relatively insignificant quantities of genetic exchange to one of high dependency; in the latter case the settlement and recruitment in one area may be entirely based on spawning success in another. The genetic source of recruitment and hence connectivity between populations also varies from year to year. Although it is not possible to account for the actual relationships between Scottish assessment areas, the geographic extent and dynamics of scallop suggest that it is reasonable to assume that some interrelationship between 'straddling' stocks and/or populations.

Geographic variability in the extent of scallop fisheries has defined where Scottish scientific resources have been concentrated historically. This has resulted in a situation where some

assessment areas can be subjected to formal analyses of stock status, but not others (Howell et al. 2003; Howell et al. 2006; Anon, 2010; Dobby et al. 2012), as illustrated in Figure 18.

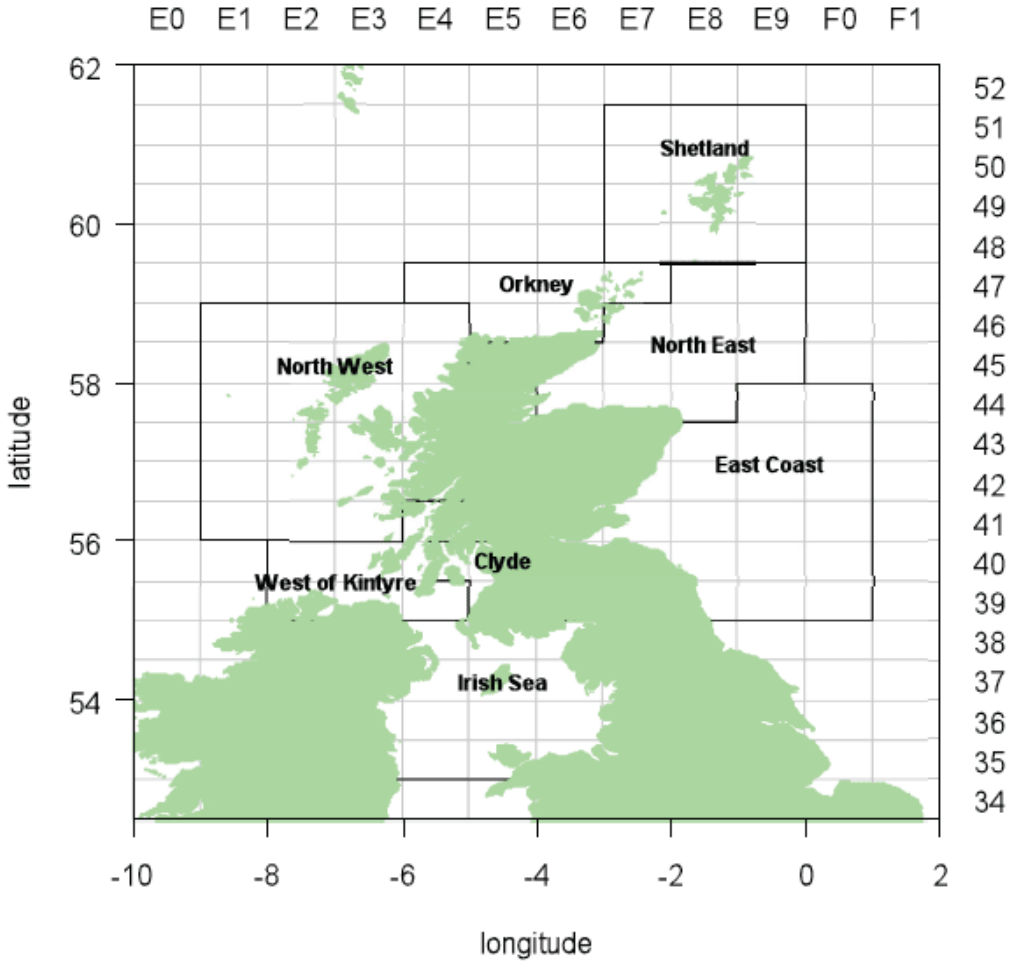


Figure 18 Scottish scallop assessment areas (Marine Scotland, 2012)

The discrepancy between the assessment of 'populations' and management of 'stocks' is further complicated by the current development of dive fisheries in many areas, which co-exist alongside dredge activity. Total landings and age composition from dive fisheries are included in the MSS assessments.

Although dive fishing for scallop is more environmentally benign than the use of dredges, and therefore more acceptable to the public, the cumulative effect of dive and dredge fisheries is often overlooked. The more traditional dredge fisher targets scallop on softer sediments, and potentially to greater depths than divers operate. Divers often target areas and substrates in which dredge vessels cannot operate. In the absence of detailed pre-recruit data, there is a risk that the relatively efficient removal of scallop from smaller areas by divers may reduce the occurrence of what would have represented a 'refuge' in the past, and that these havens from dredge fisheries have contributed significantly to historical SSB. While dived areas are comparatively small (and currently the risk is probably low), un-managed growth of the dive sector has the potential to create this cumulative impact on scallop stocks.

Additionally, although some age 2 specimens may attain a size exceeding MLS (in some areas at least), they display low catchability in commercial dredges. Divers would be legally entitled to harvest some of this year class (although they tend to target larger individuals), and as it contains

both immature and mature individuals, this has the potential to create more pressure on stocks. In many regions there is little or no understanding of these metapopulation dynamics and so the cumulative impact of these fisheries is unknown. There is a need to understand how these two types of fisheries can co-exist together within an effective data collection and management framework that provides sufficient protection to the relevant stock.

3.1.3 Minimum Landing Size

The main function of MLS is to protect fisheries pre-recruits from fishing mortality until they have had the opportunity to contribute to population reproduction, and therefore the size defined as MLS is often based on an understanding of the size/age that the relevant species becomes mature.

Once MLS has been set to allow the majority of individuals to reproduce before recruitment to the fishery, this being an essential initial step to avert stock decline, further increases in MLS serve to expand spawning stock biomass by permitting subsequent annual reproductive events by protected mature specimens. This distinction is important in the context of Scottish king scallop fisheries, where an increase in MLS to 110 mm shell length has been proposed as a management measure, but subsequently met with significant opposition from industry due to the associated economic consequences (Anon, 2012).

Size-at-maturity is currently unpublished for Scottish scallop stocks, but may be geographically variable. Some age 2 scallops sampled are immature, but these are seldom present in landings due to low catchability, at least in dredge gears. Most age 3 specimens are mature (Dobby, MSS, personal communication). A more detailed evaluation of size-at-maturity by MSS is ongoing, and should inform management of the fishery to ensure that first spawning of the vast majority of individuals is assured by setting appropriate MLS based on reproductive physiology.

For Clyde, Irish Sea and Orkney there are no fisheries independent surveys and only a limited quantity of commercial sampling data either due to the relatively small size of the fishery or difficulties obtaining samples. Therefore no analytical assessments can be presented for these areas. They are principally being monitored through trends in landings statistics and market-based sampling (the Irish Sea is also assessed by the Isle of Man). 'East Coast' data relate mainly to surveys and landings data. Scientific data collection within the 'West of Kintyre', 'North West', 'North East', and 'Shetland' areas has been relatively extensive over the last two decades, involving a combination of routine annual directed surveys and fisheries-dependent sampling.

Until recently, assessment areas deemed to have sufficiently robust data by MSS were the subject of age-based Virtual Population Analysis (VPA) (see Anon, 2010). The outputs from the main analytical stock assessment methodology employed in the 2012 publication, Time Series Analysis (TSA), differ from previous reports (e.g. Fish and Shellfish Stocks 2010, Howell et al. 2006); making direct comparison between output parameters (e.g. biomass, recruitment, fishing mortality) difficult, but MSS scientists conclude that the results from these methods (VPA and TSA) displayed 'good agreement' and the new approach represents and improvement on the old method.

3.1.4 Current status

The most up-to-date stock assessment information provided by MSS for king scallop in Scottish 'assessment areas' (based on ICES statistical rectangles), includes data up to 2010) (Dobby et al. 2012). The assessment considered a number of different data sources to provide advice to those responsible for fisheries management.

Data included landings information from all sources (e.g. dive, dredge) and nations (Scotland, England, Wales, Northern Ireland and the Isle of Man) relevant to the Scottish zone. Time-series datasets collected by MSS during routine 'market-based' sampling' of landings along with indices

from research surveys were also included. A detailed description of the types of analyses conducted in relation to data sets is presented in Dobby et al. (2012).

The current assessment of stock status and associated scientific advice for king scallop stocks in 'Scottish assessment areas', as defined in the 2012 MSS publication (Dobby et al. 2012), are summarised in the following table. Stock status indicators derived from 2005 – 2007 data (Anon, 2010) are included to show recent approximate trends, but data are not directly comparable. Basic descriptions of the scientific terminology used are provided to aid non-technical readers.

Table 3 Summary of advice on scallops per management area (Source: Marine Scotland Science)

'F' = Fishing Mortality: an indication of the scale of population removal by fishing

'SSB' = Spawning Stock Biomass: an indication of the size of the population able to contribute to reproduction

Recruitment: an indication of the size of the component of the population smaller than MLS, which will subsequently 'recruit' (grow) to the fishery

Area	Stock Status (2012)	Current Advice (Dobby et al. 2012)	2005-2007 Stock Status (Anon 2010)
Clyde	No assessment	None specified	Not assessed
East Coast	Landings sporadic, no analytical assessment. Recent poor recruitment resulting in SSB declining (survey-based assessment)	None specified	Not assessed
Irish Sea	Not formally assessed	No increase in effort	Not assessed
North East	Stable SSB & recruitment, F above long-term average	No increase in F	Fluctuating SSB & recruitment
Shetland	Stable SSB & recruitment, F above long-term average	No increase in F	SSB and recruitment stable
North West	SSB & recruitment and catch stable but at a low level. F has declined	Consider increasing SSB, no increase in F	SSB and recruitment declining
Orkney	No assessment	None specified	Not assessed
West Kintyre	Stock 'reduced', high F	Reduce F, Increase SSB	SSB and recruitment declining

Based on the most recent data available, it is clear that the 'health' or status of scallop stocks exploited by Scottish vessels varies widely with geographic location. For most areas where relatively robust data collection protocols have permitted analytical assessment, recruitment and spawning stock biomass appear stable, but F continues to increase in some areas suggesting a need for management action to reduce fishing mortality.

Due to the indicators of reduced SSB and poor recruitment, Marine Scotland Science has proposed management measures that have the potential to achieve desirable changes in these stock parameters. An increase in minimum landing size was proposed as a means to increase both recruitment and spawning stock biomass. Various mechanisms to reduce fishing mortality, based around the restriction/reduction of fishing capacity (vessel) or total effort, were also listed (Dobby et al., 2012).

3.1.5 Local assessment

The Shetland Islands Regulated Fishery (Scotland) Order 2012 or 'Regulating Order' provides for the management of scallop stocks within 6 nm by the Shetland Shellfish Management Organisation (SSMO). The organisation currently manages the stock based on scientific reports provided locally by NAFC Marine Centre under an MoU with MSS as this area represents the Shetland assessment area mentioned above.

Local management is primarily based on a 12-year time series of landings per unit effort (LPUE) data, derived from the submission of logbooks to the SSMO as a condition of licence. Pre-defined management actions are assigned to arbitrary levels of LPUE rather than directly to biologically relevant population parameters. Although a VPA is conducted using the available data, it is not used for management purposes. In recent years LPUE has remained relatively high when compared to the 10-year average.

The type of local area approach to assessment developed in Shetland may be refined and partially adopted for other areas where scallop stocks are exploited in inshore waters, but consideration must be given to the additional resource implications of producing assessment on such scales. In Shetland the Local Authority has historically provided these resources, but in the current financial climate and considering that this is a non-statutory function, this may not be a realistic option for other Local Administrations within Scotland.

Landings and market data could be combined with, VMS data (or similar) or the MSS fishery independent survey data to provide management advice at a finer spatial scale. This would enable the management of current assessment areas, or where appropriate, sub-divisions of these as local management units. The resources required to achieve this must be balanced against the potential improvements to resource management and this is not possible in the absence of detailed stock distribution and dynamics data. Therefore improvements in scientific knowledge on Scottish scallop populations should be a priority.

3.1.6 Assessment in Non-Scottish waters

No formal assessments or associated management advice is readily available for UK waters beyond Scottish, Welsh, Northern Irish or Isle of Man jurisdictions. Landing and/or landings per unit effort data have been interpreted as suggesting 'relatively healthy stocks in the majority of 'English waters', especially the English Channel. However, data pertaining to critical parameters for effective management, such as recruitment and spawning stock biomass estimates are lacking (Anon, 2011). As yet, good effort data (VMS) for the inshore fleet is also lacking, preventing much confidence in these assessments of positive stock status.

Due to the multinational fishing activity and multiple jurisdictions present in the Irish Sea area, there are significant challenges for both assessment and management. For example, currently, there is poor data availability and no management advice in relation to English and Welsh vessels operating in the Irish Sea.

The recently formed 'ICES Working Group for Scallop' met for the first time in Ireland in September 2013. This represents a positive step toward collaboration in Irish Sea assessment. Although the

nations involved have varying data availability, sampling programmes and management regimes, it is hoped that the group will help to harmonise outcomes.

Indexes of total abundance generated by Bangor University through visual camera sled surveys and catch sampling within the waters under the jurisdiction of the Isle of Man, suggest that catches should not be allowed to increase. Although no formal scientific advice has been issued in relation to the wider Irish Sea by the Marine Institute in Ireland, during recent correspondence their Senior Scientist Dr. O. Tully stated, 'We (Republic of Ireland) have a CPUE (catch per unit effort) index derived from logbook data and other information on dredge numbers and tow duration for the Irish and Celtic Seas. The index is positive suggesting strong recruitment in recent years. Landings are increasing and substantial, although our fleet is smaller than in the past. We market sample in Wexford (south coast) where we can track bags of scallop back to date of fishing and ICES rectangle. We have no surveys. Total mortality estimates (crude cohort analysis based on age composition of the landings) are high, and there is a restricted age distribution.'

3.2 EVALUATION OF CURRENT SCIENTIFIC ASSESSMENTS

Data for some Scottish assessment areas are the 'best available' relative to other UK waters, but spatial dynamics are 'poorly understood'. When comparisons are drawn with other areas, there is a risk that stock status may be erroneously deemed more positive in a situation where less complex data is monitored in relative isolation.

Scottish vessels are also operating in other UK waters and are to an extent dependent on scallop resources that are not adequately assessed. Scotland has invested significantly (relative to others) in progressing scientific understanding of scallop stocks within its waters for several decades, and it is important to share knowledge and approaches.

The general role, activities and resource constraints of the scientific community are rarely explained or fully understood in the context of fisheries management. Some general principles relating to scientific assessment may be useful in addressing this issue for some readers, and therefore this section attempts to begin with a very basic 'placement' and description of science within the management process.

A stock assessment provides fisheries managers with the information about a stock that they require for management – it provides an estimate of the past and current state of the stock – a picture of how the stock changes over time. Assessment methods can be considered simply as statistical and/or mathematical models of varying complexity that use pre-defined assumptions about input data and functional parameters to estimate things relating to the stock or fishery under scrutiny. Assessments should be considered as a best estimate at a given time by one or more specified individuals. It is an imperfect scientific art.

Once a time series of data are established, scientists can be reluctant to alter data collection protocols or analytical treatment of data, as this may create the need for an entirely new 'starting point'; time series datasets become more 'scientifically valuable' as their duration extends. Scientists that change methodology will generally aim to evaluate the 'comparability' of old and new methods, an example of which can be seen in the recent changes introduced by MSS (VPA to TSA). The need for such continuity is based on the current lack of 'reference points' within Scottish scallop fisheries (Shetland is the exception), which necessitates scientists comparing current and historical data that are as standardised as is possible as the primary means of assessment.

Reference points (see Caddy, 2004 for review) are specified 'targets' (e.g. desired SSB) to be achieved or 'limits' that should not be exceeded (e.g. a minimum acceptable biomass). Reference points are often based on maximum sustainable yield (MSY), which is not always possible to determine and 'proxies' must be used. This is true of many mollusc, including scallop, and crustacean

(crab and lobster) species for which a stock recruitment relationship cannot be defined (preventing the setting of F_{MSY}).

The output parameters from assessment can be used to set reference points for the purposes of fisheries management, but so can other datasets that have not been subject to any form of analysis or transformation to generate estimates (and potentially increase error). Recruit indexes derived from catch sampling or LPUE are examples of data that can inform management if used appropriately. The setting and monitoring of reference points that are based on robust data sources and definition of associated actions to take if they are not achieved (target) or approached (limit) represents an opportunity to create an interface between assessment and management.

Scientific opinion relating to the 'best currently available' or 'optimal' means by which to monitor and assess stocks is highly divergent within the UK, and more so globally (Hilborn, 2002; Caddy, 2006; Barange, 2006; ICES 2010). In general non-technical terms, the scientific debate surrounding assessment for stocks such as scallop centres on what spatial scale and what type of data are best taking into account the limited stock-recruitment relationship.

It may not be possible to collect the required data in a suitable way, or the 'population' dynamics may violate model assumptions. Therefore providers of science must make a semi-subjective decision about which method is most suitable for the data available based on general rules and principles. Although it would seem most sensible to collect data with knowledge of the way that it will be utilised, requirements often change. Some stakeholders believe that when the management of stocks themselves is problematic due to uncertainty in assessments, that monitoring of fleet performance and effective enforcement may be more appropriate. There is no single 'right' way in which it can be done (ICES, 2010). The vast majority of credible scientists do however agree on one defining principle:

The provision of science and advice should remain distinct but not detached from and fully interfacing with the process of actual management (i.e. scientists should not manage).

For the majority of fisheries areas, including those within the Scottish zone, the collation and use of fisheries-derived data available at a resolution that is useful for scientific assessment and management purposes is limited. VMS now provides one such opportunity, particularly with it now being mandatory for all over 12m vessels and so accounting for the great majority of the scallop fleet. Although the submission of EU logbooks is also mandatory, the spatial resolution of the data collected (by ICES rectangle) gives only a general overview of performance without consideration of associated effort or other fleet behavioural, management or market driven changes (each of which can impact overall landings).

Some general level of effort can now be assigned to larger vessels required to operate VMS, but for the majority of <12m vessels there is little or no effort information available. The exception is Shetland, where the local Regulated Fishery Order (2012) requires the submission of logbook data on a 5 x 5 nm resolution as a condition of annual licensing, and VMS systems have been fitted to some smaller vessels in a pilot funded by the Scottish Government's 'Fishing Industry Science Alliance' (FISA). There are other established global examples where VMS and logbook data have been successfully combined (Lee et al. 2010; Gerritsen & Lordan, 2011).

Fishing data are under- or unutilised as information sources or data validation sources, but such data represents an opportunity to stimulate less detached co-working between scientists, managers and industry. The use of fisheries-derived data is recognised as an effective way to provide additional information to assist management decision making, cross-validate or add value to independent scientific data and engage industry participants with the wider science and management process (Burch et al. 2010).

3.3 IMPROVING SCIENTIFIC SUPPORT TO MANAGEMENT

In line with Scottish Government policy, management (including that proposed within this report) should wherever possible be based on sound science and some Scottish assessment areas show good levels of information, but the current understanding of stock health throughout the entire area exploited by Scottish vessels (inside and outside Scottish waters) falls short of that requirement.

Considering the variability in data availability and quality between 'fisheries areas' and the lack of understanding relating to population structure and dynamics, there is presently no single, ideal scientific method that can be applied to the assessment of Scottish scallop stocks.

Scotland has more detailed information relating to scallop stocks than elsewhere in the UK, but there is a lack of a formal process between the provision of scientific advice and the act of management.

The methods currently used to provide assessments are well established, but they do not necessarily provide information on a scale or in a format that is useful for local management, and this will become more of an issue as IFGs embark upon the process of policy development.

Although reasonable for large areas covered by nomadic vessels or shared with other nations, the relatively broad-scale assessment area-based management focused on recruitment and SSB may prove increasingly unsuited to local management. Data must be sufficiently robust to allow scientists to answer the questions asked of it by management, but the 'data poor' situation currently prevailing in some assessment areas becomes very pronounced at the scale of local management area.

One solution to the provision of data at a finer spatial scale is to support current scientific efforts with more fisheries related data. Independently validated fisheries data represents 'sampling' on a level that could not be replicated through scientific endeavour alone. Shetland provides an example of how science and industry data have been combined to achieve a 'locally relevant' management framework based on a limit reference point system using industry data with independent validation. The system is by no means perfect, continues to evolve and may not be suitable for all areas, but it provides a working example of content and equally important, the process by which a local resource is assessed and managed.

Reference points are not used for scallop fisheries in Scotland (with the exception of Shetland), but limit reference points based on both scientific and fisheries derived datasets may offer an effective way in which to begin to address the current lack of synergy between science, management and industry. The use of reference points relating to stock, environmental, social and economic considerations should be evaluated as a practical means to assess and manage Scottish stocks in the near future (particularly those in inshore areas).

The evolution of IFGs in Scotland will no doubt place growing pressure on MSS, with unrealistic resource requirements to inform local management areas. Management groups may quickly find themselves in a position whereby data to inform decision-making is neither available nor feasible for MSS to collect. The application, level of redundancy, cost-benefit and suitability of current scientific activities need to be considered against the likely data requirements that will be relevant for each type of 'management unit'.

Electronic data recording systems are now an affordable reality for most sizes of vessel (certainly any which work scallop dredges). Unlike retrospective scientific assessments that are produced at best annually, fishing data can be assessed periodically during the year and is particularly useful detecting changes in fleet behaviour (which can impact on the results of assessments) and the impact of management measures. The collection and evaluation of spatial referenced fishing data would strengthen and validate assessments, even if not used directly for management itself.

3.4 SUMMARY

- Scotland has more detailed scallop stock information than elsewhere in the UK, but there is still a lack management flowing from scientific advice.

- The appropriate scale for scallop management units in Scotland should be informed by science. Management demands should then drive the ongoing provision of scientific advice and the data collected.

- An independently chaired, **multi-stakeholder workshop** should be conducted to determine the scientific information needed to manage Scottish scallop fisheries in the short, medium and long-term. This should identify:

- Whether appropriate **types of data** necessary for the management are already collated or alternative systems should be developed.

- The **spatial resolution** on which data should be collected, which will be dictated primarily by the geographic extent of appropriate management area (which may differ from existing assessment areas).

- The **scientific resources** required to deliver scientific advice to scallop management.

- I**mproved links** between science and management, and a clearer co-operative understanding of **shared responsibility** with industry and other stakeholders.

- **Fishing data** are generally underutilised for management of Scottish scallop fisheries. Scallop management should be informed by spatial referenced catch/landings per effort data of an appropriate resolution. The use of VMS and logbook data for all scales of scallop vessels will provide the necessary fisheries-dependent data to support ongoing survey.

- The use of fishing data could inform the development of **reference points** that will provide a more cost-effective, practical and responsive method by which to manage stocks than through analytical assessment of biomass/population parameters in isolation.

4 MANAGEMENT AND TECHNICAL MEASURES

4.1 CURRENT REGULATORY FRAMEWORK SURROUNDING SCALLOP FISHERIES

4.1.1 European-level regulation – the Western Waters effort regime

Since scallops are not subject to EU quotas, there is not a great deal of direct European-level management or regulation for scallops, the exception being a minimum landing size and minimum ring diameter (72mm) for scallop dredges. The minimum size for king scallops is set at 100mm except in Subareas VIIa and VIId (Eastern English Channel and Irish Sea) where it is 110 mm (it is also 110mm in some other areas via local regulations which apply only to UK vessels). For queen scallops it is 40mm.

The CFP does, however, affect on scallop fisheries via effort management in some areas via the Western Waters effort regime. This regime for effort control applies to fisheries for demersal fish, crabs and scallops in ICES Subareas VI, VII and VIII (around the south and west coasts of the British Isles), and applies limits on total effort per fleet for vessels over 15m. The effort limits (in kW days at sea) are set for different sub-areas, allocated to member states and fleet segments – the relevant segment for scallops being the mobile shellfish fleet.

The origin of the Western Waters regime goes back to the full incorporation of Spain and Portugal into the CFP in the 1990s. Both countries have a large fishing fleet with a tradition of fishing in external waters, and the Western Waters effort regime was put in place to address 'local' concerns (i.e. from the UK, France and Ireland) about an excessive influx of Iberian fishing effort into Subarea VII in particular. The maximum total effort per member state and per fleet segment was allocated based on a reference period of 1998-2002. After 2000, UK fishing effort in this area declined, so the UK has until recently not needed any active management measures to respond to the Western Waters regime, having plenty of 'spare' effort available.

With greater restrictions being imposed elsewhere, there has been displacement of UK effort into scallop fishing into Subarea VII in particular in recent years, which has resulted in an increase in effort on scallops in Subarea VII of ~50% from 2001-2011, according to MMO (DEFRA 2011). In 2010, the level of UK scallop effort in Subarea VII exceeded for the first time the UK limit under the Western Waters regime. The limit was reached in early November 2010, but fishing activity continued until the end of the year, resulting in an effort overshoot of around 25%, which was covered by swap of effort with other member states. DEFRA attempted in 2011 to request additional effort under the regime, but could not provide the necessary evidence to support the request, and was therefore obliged to institute active management of effort in the fishery in order to avoid sanction by the European Commission. In 2011, the fishery was closed in October but reopened in November after further effort swaps.

In 2012, the UK fisheries administrations instituted an effort management regime for scallops in Subarea VII, which provides for non-transferrable quarterly limits on days at sea for all vessels entitled to fish scallops in this area. These limits can be extended if effort swaps can be made, but the onus to identify swaps has been moved on to the industry, via an industry management group.

In July 2013, DEFRA (on behalf of the devolved administrations) concluded an agreement with France which gives the UK additional kW days at sea for scallops in Subarea VII in return for increased management measures. On the UK side, this provides an injection of additional effort to keep the UK fishery going, while on the French side, it excludes UK vessels from contentious areas on the French side of the Channel where there has been conflict in the recent past between UK and French scallop fishermen. The agreement applies to the end of 2013 and will be renegotiated for 2014 in November 2013.

The agreement includes the following provisions:

- Closed period for Subarea VIId 1 August – 30 September 2013 for all scallop fishing;
- UK scallop vessels excluded from an area off northern Brittany from 1 August until the end of 2013 (in Subarea VIIe – see figure 19);
- A transfer from France to the UK of 450,000 kW days of scallop effort for Subarea VII, not to be used south of the median line in Subarea VIIe (an increase of ~14% of the UK's allocation).

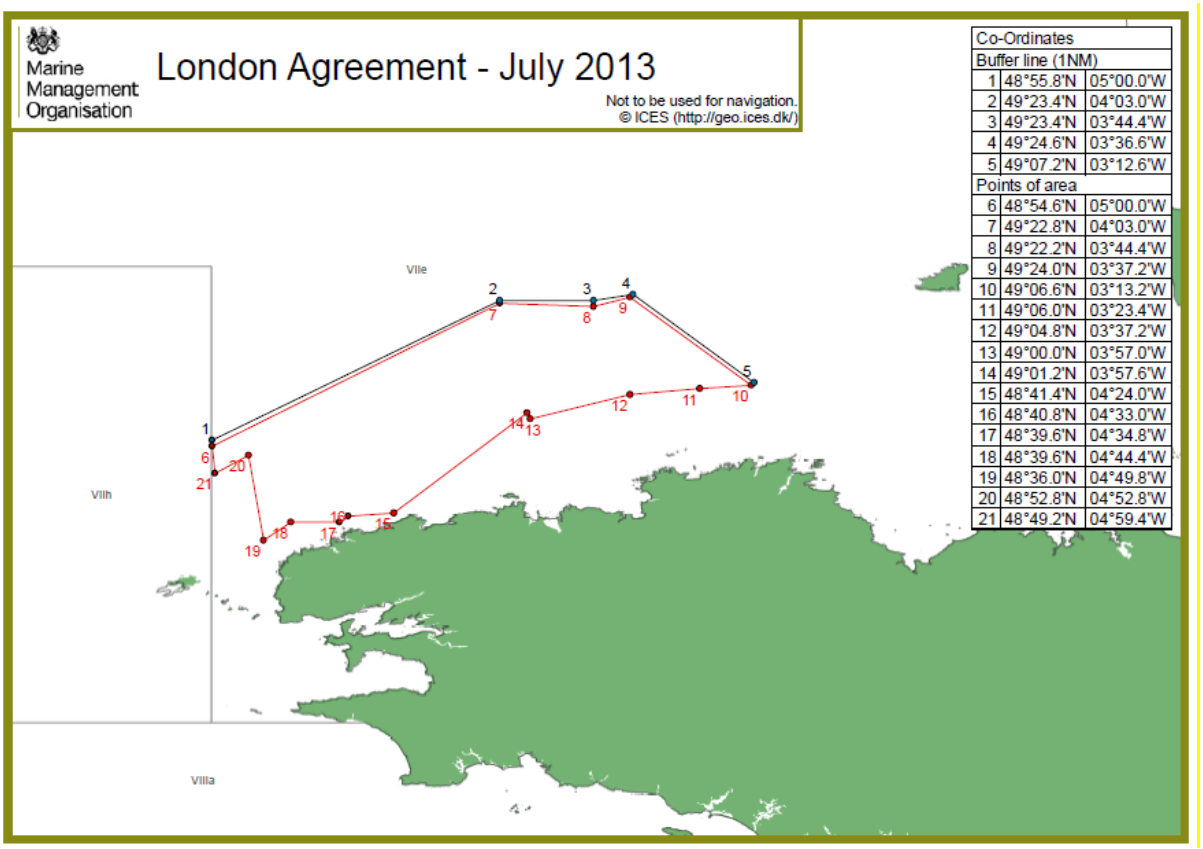


Figure 19 Agreed exclusion area for UK scallop vessels under the London Agreement with France (Source: MMO, 2013)

4.1.2 UK member nation regulations

Jurisdictions and legislation

For the purpose of clarity for the remainder of this discussion, table 4 summarises the various fisheries management jurisdictions around the UK with responsibility for scallop management. Note that it excludes the framework provided by the EU as set out above – dealings with other member states go via DEFRA (except in the case of Jersey which can work directly with French regional jurisdictions under the Granville Bay Treaty - but there is no scallop fishery in this area). Relevant legislation for scallops for each jurisdiction is summarised in table 5, while MLS and limits on dredges per side are summarised in table 6.

Table 4 Jurisdications applicable to UK scallop fisheries

Home nation	0-1 mile	1-3 miles	3-6 miles	6-12 miles	outside 12 miles
Scotland	Marine Scotland*				
England	Inshore Fisheries and Conservation Authorities (IFCAs)			Marine Management Organisation (MMO)	
Wales	Welsh Government, Department for Agriculture and Food (closed to scallop dredging)	Welsh Govt. (dredgers <10m only)	Welsh Govt.		
Northern Ireland	Northern Ireland Government, Department for Agriculture and Rural Development				
Isle of Man	Isle of Man Govt. (non-Manx vessels excluded)		Isle of Man Govt.		MMO
Jersey	Jersey govt.**				MMO
Guernsey / Alderney	Guernsey / Alderney govts**		MMO		

* Except Shetland where management is devolved under Regulation Order to Shetland Shellfish Management Organisation.

** No scallop fishing in these areas

Table 5 Legislation specific to scallop fisheries

Jurisdiction	Relevant legislation	Key provisions
Scottish waters	Inshore Fishing (Scotland) Act 1984, Prohibition of Fishing for Scallops (Scotland) Order 2003*	• max. 8 dredges per side out to 6 miles, 10 per side out to 12 miles and 14 per side outside 12 miles • various specifications as to type of dredge, length of tow bar, number and configuration of rings, teeth etc.
English waters and those areas managed by MMO	Scallop Fishing (England) Order 2012	• max 8 dredges per side out to 12 miles • if VIId and VIIe visited on the same trip, scallops <110mm must not be carried • various technical specifications as to gear size and configuration Note: IFCAs may impose stricter regulations in their area via byelaws – see below
Welsh waters	Scallop Fishing (Wales) Order 2010; Scallop Dredging Operations (Tracking Devices) (Wales) Order 2012	• scalloping restricted to vessels <221 kW • closed season 1 May – 31 October each year • closed area <1 mile from shore, plus others (see below) • scallop dredging in area 1-3 miles only permitted for vessels <10m with max. 6 dredges total • area 3-6 miles – max. 8 dredges total • area 6-12 miles – max. 14 dredges total • various technical specifications as to gear size and configuration • all scallop dredgers must carry working VMS at all times when operating (regardless of vessel size)
Northern Ireland	Conservation of Scallops (Regulations)	• maximum 6 dredges per side

waters	Northern Ireland 2008	• minimum size 110mm • restrictions as to fishing times (nights, weekends) • various technical specifications as to gear size and configuration
Manx waters	Sea Fisheries (Queen Scallop Fishing) Bye-laws 2013	• only 20% queenie bycatch allowed if using king scallop dredge • no use of dredges within queenie conservation zone (all of area within 3 miles, plus some additional areas to 12 miles) • fishing exclusion zones – closed to all mobile gear • closed season 1 April – 31 May • all scallop dredgers must carry working VMS at all times when operating (regardless of vessel size) • restrictions as to fishing times Note: EU regulations do not apply within Manx territorial waters

* Marine Scotland is engaged in work to update scallop regulations in Scotland, of which this report forms a part

Table 6 MLS and dredge restrictions under UK jurisdictions

zone (n. miles)	England*	Scotland	Wales	Northern Ireland	Isle of Man
0-1	8 per side	8 per side	banned	6 per side	25 feet total width
1-3	8 per side	8 per side	3 per side	6 per side	
3-6	8 per side	8 per side	4 per side	6 per side	40 feet total 8 per side
6-12	8 per side	10 per side	7 per side	6 per side	
12+	no limits	14 per side	no limits	no limits	n/a
MLS kings (mm)	110 (VIId), 100 (elsewhere)	110 (VIIa), 100 (elsewhere)	110	110	110

* tighter restrictions by individual IFCAs are summarised below

4.1.3 Local regulation

Systems in UK nations

The individual UK nations have different systems, and different amounts of provision in place for the devolution of inshore fisheries management to the local level. Some have no real provision for local management (except in the case of Shellfish Several or Regulating Orders – see below), nor, perhaps do they need it. In England, fisheries management out to 6 miles is devolved to the Inshore Fisheries and Conservation Authorities (IFCAs), although English and EU legislation still applies in these areas. In Scotland, local fisheries management, via Inshore Fisheries Groups, is still at an early stage of development, but has progressed in some areas.

English IFCAs

The IFCAs in England were formed under the Marine and Coastal Access Act 2009, replacing the Sea Fisheries Committees (SFCs). There are 10 IFCAs altogether (Figure 20). IFCAs, like SFCs, are responsible for the management of inshore fisheries out to six miles, but also have a wider remit than the SFCs, notably covering aspects of marine conservation (protection of Marine Conservation Zones in their area). IFCAs have the power to make and enforce byelaws, including emergency byelaws. They operate via a committee of local stakeholders, including MMO, English Nature, local authorities and the fishing industry, supported by a small number of technical and enforcement staff.

In relation to scallop fisheries, most of the IFCAs have some byelaws in place, leading to stricter management in English waters inside 6 miles than table 5 and Table 6 above would suggest. The IFCA regulations for scallops are summarised in Table 7.

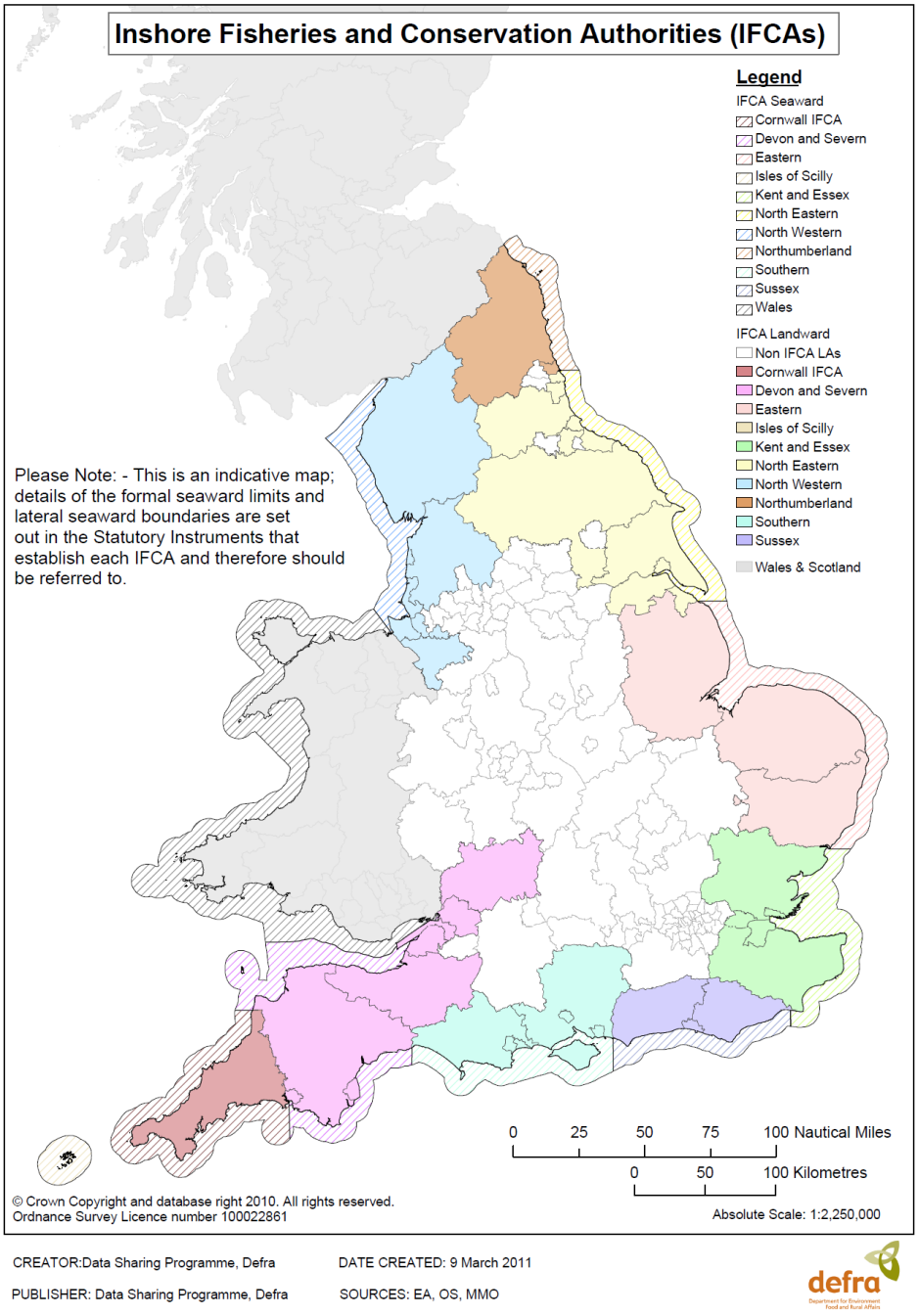


Figure 20 English Inshore Fisheries and Conservation Authorities (Source: Defra, 2011)

Table 7 Summary of IFCA byelaws.

IFCA	Max. total dredges	MLS (kings, mm)	Closed season?	Closed areas?	Gear size / design restrictions?	Vessel size / power restrictions?*	Fishing time restrictions	Option to close shellfish beds?	VMS for all scallop boats?
North Western		110			design of dredge must be approved	yes – variable depending on area		yes	
Devon and Severn	12		July-Sept	SACs with 'reef', areas set aside for fixed gear	yes	<15.2m within 3 miles	0700-1900 only	yes	required
Cornwall	12			SACs with 'reef'	yes	<16.5m only	0700-1900	yes	
Scilly**	4				yes				
Sussex			June-Oct			<14m only			
Southern	12				yes	<12m only	0700-1900		
Kent and Essex		110			yes	<17m, <221kW for towed gears		yes	
Eastern	10		July-Sept	No dredging within 3 miles in north, closed areas in south	yes			yes	
North Eastern	10		July-Sept	No dredging within 3 miles				yes	
Northumberland	10			Proposed	yes				

*Most IFCAs make some exception for vessels with a track record prior to regulation **currently under revision

Local management in Scotland

In Scotland six Inshore Fisheries Groups (IFGs) assist in identifying localised management proposals around the coast. IFGs were created out of the Strategic Framework for Inshore Fisheries, which identified a "need for more localised management around the Scottish coast and sought a system that would put fishermen at the heart of the decision making process" (Scottish Executive, 2005).

IFGs are tasked with engaging with commercial fishermen operating in their area and developing local management proposals. Each IFG is made up of an Executive Committee comprising catching sector representatives, an independent Chairman proposals, assisted by an Advisory Group of stakeholders including Government Agencies and other organisations with an interest in the marine environment.

From 2009 to 2012 six pilot IFGs produced management plans for their area, which include specific measures relating to scallops or more general measures that will include the scallop fleet. A list of these measures is identified in Table 8 below. The IFG boundaries have now been amended so that the whole of the Scottish coast is now covered by IFGs, with the exception of Shetland, which has its own management arrangements.

The plans represent for the most part a consensus of stakeholders in the fisheries. It is important to note, however, that outside the IFG process there are already local management measures for scallops in place in Scotland – particularly in relation to zoning for different types of gear.

Table 8 Summary of proposed IFG management and objectives relating to scallop

IFG	Issues identified	Management objectives	Management measures proposed
Moray Firth	Lack of data; competition with other users (marine renewables, conservation)	Sustainable fishery; monitoring; access to traditional grounds	Engage with the SFC Scallop Working Group, provide data via local reporting, support development of lower impact gear, ensure scallops stocks considered in spatial planning
Outer Hebrides	Latent effort, lack of data, environmental impact, image	Better conservation methods in the fishery	Increase MLS to 110mm, develop logbook, develop more selective and lighter gear, adopt Good Practice Guide
North West	Stock decline	To protect and enhance king scallop fisheries	Engage with the SFC Scallop Working Group, investigate stock dynamics, increase MLS, limit catch by unlicensed and hobby fishermen
South East	Lack of data; competition with other users (marine renewables, conservation); lack of uptake of lower impact gear	Sustainable fishery; monitoring; access to traditional grounds	Engage with Fisheries Management and Conservation group, provide data via local reporting, ensure scallops stocks considered in spatial planning, consider potential for local permitting scheme for management of the fishery
Small Isles and Mull	No specific objectives for scallop fisheries – fleet is largely nomadic and there was agreement that management was best undertaken at national level		
Clyde	Lack of data	No specific objectives for scallops – not enough data	Increase MLS to 110mm; Code of Conduct (for all fishers); limits on catch for unlicensed fishers

The issues identified, objectives and management measures proposed in each of the IFG plans are summarised in Table 8. Limited data at a local scale is noted as a key issue (as it is by MSS – Dobby et al. 2012). On the east coast, there is concern about loss of fishing grounds to other users (marine renewables and conservation) – this is considered below. The development (and uptake) of lower-impact gear and other forms of good practice is also identified by some, as is the option of an increase in the MLS. Most IFGs also identify a need to engage with national-level groups.

Shellfish Regulating Orders

The Sea Fisheries (Shellfish) Act 1967 (including some amendments in Scotland) give fisheries administrations the power to use Shellfish Regulating Orders to devolve management of shellfish fisheries, including shellfish culture systems, within a defined area out to six miles maximum. In England, the grantees of the order are generally the IFCAs, while in Wales and Scotland, the grantees are generally a body established for that purpose – examples are the Menai Strait Fishery Order Management Association (for mussels) and the Shetland Shellfish Management Organisation (the only one that currently exists in Scotland). Both the Shetland and the Menai Strait fisheries have been successful in as much as they have achieved MSC certification; Shetland is discussed further in the case studies below.

4.2 EFFECTIVENESS OF CURRENT REGULATIONS IN SCOTLAND

4.2.1 National regulation

An analysis of the effectiveness of existing regulations requires a review of the status of the factors under regulation – i.e. the state of scallop stocks and the health and profitability of the fisheries (regulation associated with the wider environment is considered below). A review of stock status and stock assessment for Scotland is given above and is summarised here, along with a review of stock status elsewhere in the UK, so that the effectiveness of other UK regulatory regimes can be considered.

As noted by Dobby et al. (2012) the drivers of changes in recruitment for king scallops are not well understood, and there is not a well-defined stock-recruit relationship – i.e. it is not clear that reduced spawning stock biomass leads to lower recruitment unless stocks are severely depleted. This does not mean, however, that scallops cannot be overfished, since depletion of adult biomass will make the fishery more inefficient and less profitable, and may make recruitment more variable (Beukers-Stewart and Beukers-Stewart 2008). Thus, there is no guarantee that following the advice given by MSS will lead to an immediate, or even long-term increase in recruitment. Plus, the scientific advice has a rational and precautionary basis, but it does not take economic considerations into account.

The current status of Scottish scallop stocks (as described in section 3.1.4) in some areas of Scotland leads to the conclusion that management may not be sufficient. In particular, we can identify the following problems (many of which are also identified above in the review of the science base):

- There is a lack of data from small vessels (the majority of the fleet) that are not required to submit logbooks, making stock assessment difficult for several areas. The OHIFG management plan also identifies this problem, even in an area (the North West) where an assessment has been carried out by MSS.
- Effort restrictions are in place (limited licensing, limits on dredges per side, technical measures) but these may not be sufficient to halt or turn around the increase in fishing mortality in some areas. MSS propose measures including limits on kW days or landings, or spatial and/or temporal closures. (The Outer Hebrides IFG note in their management plan that seasonal area closures have been regarded as a management success by the industry in the Outer Hebrides.)
- There is a particular problem with management of the Irish Sea – highlighted by MSS – because of the multitude of jurisdictions and because the fishery targets a mixture of king and queen scallops using different gears for different species and in different areas. In particular, king and queen scallops are often confounded in logbook data. Queen scallops

have a somewhat different life history to kings, since they mature smaller and don't live as long, so stock assessments that confound the two species risk being meaningless for either.

- Profitability of the under 15m fleet as identified by several IFG plans (and evidenced in section 2.4).

4.2.2 Shetland Shellfish Management Organisation (SSMO)

The recent renewal of the Shetland Islands Regulated Fishery (Scotland) Order 2012 provides the SSMO with the authority to manage shellfisheries inside the 6 nm zone of the Shetland Islands until 2028. The authority, devolved from the Scottish Ministers through the provision of the Sea Fisheries (Shellfish) Act 1967 (a) and the Sea Fisheries Act 1968 (b), was originally issued 13 years ago for a period of 10 years, with a 3 year renewal granted in 2009. The Regulating Order permits the SSMO to impose restrictions and make regulations, license all shellfish activity, charge a toll for licence, create reserves, remove juveniles for the purposes of cultivation and provide exemptions for scientific purposes. The SSMO is a company limited by guarantee that does not have a 'membership' and is governed by local stakeholders. The Board comprises 6 local fishermen, 3 each being nominated by the Shetland Fishermen's Association and Shetland Inshore Fishermen's Association, 2 local processors, two Local Authority Councillors and an independent Chair drawn from the Local Community Council. The SSMO is funded partly from annual licence renewal fees and non-statutory grant support from the Economic Development Unit of Shetland Islands Council.

Management decisions are based on assessments provided by the local NAFC Marine Centre, also a non-statutory grant recipient of the Local Authority. LPUE is used as the basis for limit reference points with management actions being triggered when arbitrarily selected thresholds are reached. As a condition for 'no new entrants to the fishery' is triggered at relatively high LPUE (compared to 13 year average), there has effectively been a cap on participants for several years. Existing licensees are permitted to apply for vessel replacement however. The majority of vessels are restricted to 8 dredges a side, and all are required to adhere to a 9pm to 6 am curfew within the 6 Nm zone. The majority of fishing occurs in waters <4 Nm from shore, but a small number of fishermen with larger vessels have developed a tendency to fish within the curfew zone during permitted hours and move outside 6 Nm when the curfew is in force. Currently there is no dive fishing licenced due to concerns over its cumulative impact. Fishermen are required to report landings, effort and environmental interactions by 5 Nm SSMO squares on weekly basis as a condition of their licence. The SSMO has established a spatial management plan that excludes dredge fishing from any areas that contain biogenic reef habitats (e.g. maerl, horse mussel, eel grass) listed in the EU Habitats Directive. The fishery obtained full MSC accreditation in 2012. However, this was conditional and the SSMO is required to provide evidence of incremental progress (annual audits occur) in a number of key areas to retain the standard for the 5 year duration.

The availability of funding in Shetland, which has historically been relatively wealthy, has been a key enabler in permitting the Local Authority to fund non-statutory functions associated with local fisheries management. The seafood industry in Shetland is estimated to be worth around £300 million per annum to the local economy, and in a small island community with high dependency on fishing, this has provided justification for such investment in economic development (through effective and efficient fisheries management). Local investment has essentially paid for both assessment (NAFC) and management (SSMO) to be delivered on a relevant local scale, with the Regulating Order providing for local policy making. The availability of data has been fundamental to applying for and obtaining a Regulating Order and underpinning the development of a management framework. Although some aspects of the assessment and management framework in Shetland may have application in other local areas (e.g. spatial management plans, high resolution logbook data), the economic cost of providing

the underpinning data must be considered along with potential funding sources. Recent economic challenges in Shetland have led to cutbacks in both statutory and non-statutory functions, with increasing emphasis on the latter; the long-term maintenance of supports must be a consideration when embarking on local initiative.

It is also worth noting that IFGs have been developed in a distinctly different manner to the SSMO, the former developing a management plan and then seeking to establish data collection programmes without local policy making powers, the latter having concurrent data collection activities and policy making powers as it developed. Again, the availability of funding to provide science to underpin an application for the original Regulating Order has probably represented the differentiating factor in these development pathways. Not all active fishermen in Scotland support the use of local Regulating Orders however, primarily due to concerns relating to maintenance of transparency and equity under local control. Even in the advent of much greater devolved management to local areas across Scotland, Marine Scotland will be required to maintain an active quality assurance and auditing role and to advice ministers on the adequacy of devolved management in relation to sustainability and Good Ecological Status (GES).

4.3 RELEVANT MANAGEMENT MEASURES USED ELSEWHERE

4.3.1 English IFCAs

As shown in Table 7 above, the IFCAs in England each have their own approach to the management of scallop fisheries, leading to a complex patchwork of management measures within the English six Nmile zone. IFCAs have a statutory requirement to ensure the sustainable exploitation of stocks within their jurisdiction, as well as to protect marine habitats – at least those within conservation zones. In addition, a frequent (often implicit rather than explicit) objective of IFCA management measures is to protect a local fishery (resource and fleet) from incursions by vessels from other parts of the UK.

IFCAs have two general approaches to regulating fisheries via byelaws. In a typical 'regulatory' type approach (used by most IFCAs), the byelaws provide a list of restrictions, within which fisheries are free to operate. In a 'permitting' approach (currently being tested by the Devon and Severn IFCA, and used for gear by the North Western IFCA), the byelaw requires fishermen to obtain a permit, which gives the IFCA more flexibility to review would-be operators on a case-by-case basis, but presumably also requires more inputs from the IFCA.

Although it leads to spatial complexity, the freedom that IFCAs have to make byelaws, including emergency byelaws, responding to local circumstance, has been effective in addressing local issues. For example, most of the IFCAs have a byelaw that allows them to close shellfish beds if they are considered to be depleted (e.g. following a decline in catch rates or a survey). While this is mostly used in relation to mussel and cockles beds, it gives the IFCA scope for adaptive management on a fine spatial and temporal scale. Likewise, IFCAs have been the key management tool used to address the question of appropriate assessments for fisheries in European marine sites (discussed in detail below) – their knowledge of local fisheries and waters allows them to prioritise rapidly the likely high risk issues and if necessary to put byelaws in place to ensure protection. It also ensures a 'joined up' approach – appropriate assessments of fisheries are carried out by IFCA staff who know the areas, fisheries and individuals involved and who can balance economic and environmental priorities in a rational way.

As noted above, it is not easy to find data/evidence on scallop stock status in IFCA areas, in order to assess the effectiveness of their approach in relation to stock management. IFCAs have only been operating for a few years, and they do not have the resources to undertake stock surveys except where it is required under the management regime (e.g. for fisheries such as cockles), or possibly

where a problem has been identified. Nonetheless, it seems in principle as if the ability of IFCAs to respond directly to local concerns should give scope for good management.

One concern about extending the IFCA model to Scotland might be the need for appropriate protection for the nomadic fleet, which contributes significantly to landings and value for scallops in Scotland. In fact, these interests can be heard within the IFCA model, as witness the abandonment of the Scilly IFCA of a plan to ban scallop dredging in their six Nmile zone, following objections from mainland-based interests, including the South Western FPO[3]. Conversely, there may be a perception that too much consideration for the nomadic fleet may result in local and conservation interests being set aside. It may be that IFGs can exchange experiences with IFCAs on where this balance can best be found.

4.3.2 Wales

As noted above, Wales has some of the strictest regulation on scallop fishing in its waters, under the Scallop Fishing (Wales) Order 2010. Aside from restrictions on gear and a ban on scallop dredging fishing inside one mile, there are significant closed areas throughout Welsh waters (Figure 21), which have been put in place for conservation reasons (they fall mainly within European NATURA 2000 protected areas). VMS is also required on all scallop dredgers regardless of size – reported anecdotally to be a significant cost but one that is worth bearing for access to some productive grounds.

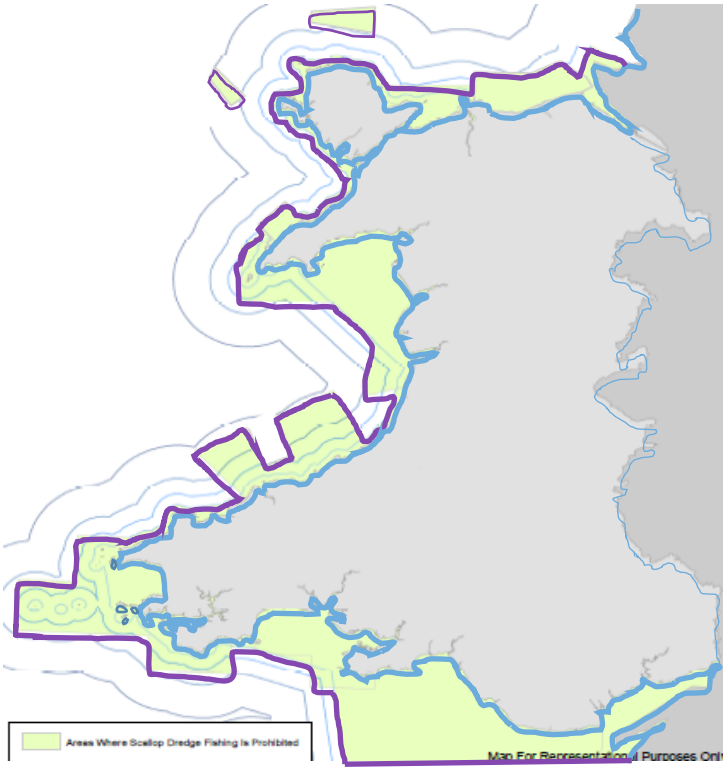


Figure 21 Areas in Welsh waters closed to scallop dredging (purple line) (Scource: Welsh Assembly Government)

(Pale contours indicate the 1, 3, 6 and 12 Nmile limits)

[3] See http://www.scillytoday.com/2013/08/07/scillys-ifca-drops-proposed-ban-on-scallop-dredging/

The large area closures in west Wales (Cardigan Bay) came about after a campaign by various NGOs[4] to ban scallop dredging close to the shore and in protected areas, over concerns about environmental impacts on bottom habitats and on cetaceans (for which Cardigan Bay is known). It was initially proposed to close the whole bay. The industry, however, collaborated with Bangor University on a project to map sensitive habitat areas, and as a result they retained some open areas in places where the habitat was not deemed to be vulnerable to dredging impacts.

Again, it is difficult to assess what the result of this tightened management has been on scallop stocks and fisheries, because data are limited. Bangor University started an annual survey in 2012, and a preliminary report of the 2013 findings suggests that densities from 2013 are similar or higher (but analysis remains to be done) (Lambert 2013). Data on landings quantity and value from MMO are currently only available to 2011. Nonetheless, this type of strong, spatially based management may be appropriate in areas i) with a strong impetus to habitat protection (e.g. with a high density of marine SACs with vulnerable features, and/or a strong marine tourism industry) and/or ii) where there is a strong aspiration for eco-certification of the fishery. Certainly, the industry-research partnership that has developed as a result of the need for habitat mapping by the industry for their negotiations with NGOs and the Welsh Government has been beneficial for all stakeholders.

4.3.3 Isle of Man fishery

The Isle of Man scallop fishery is widely reported as a fishery that has 'turned itself around' via stricter management Its Queen scallop fishery is, along with Shetland, one of the few scallop fisheries to obtain MSC certification. Fisheries-independent surveys show an additional benefit of the queenie management measures is the increasing king scallop abundance on the grounds (Figure 22).

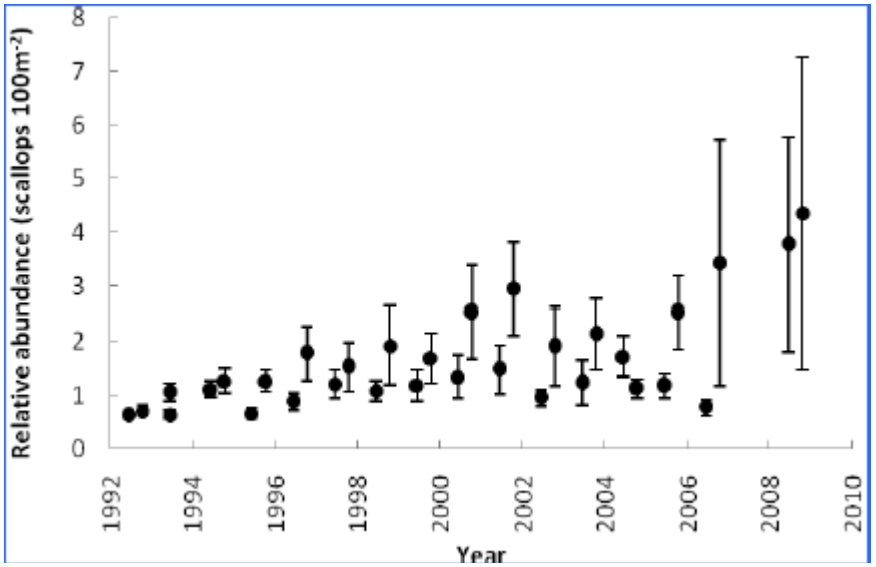


Figure 22 King scallop abundance from all survey areas in Isle of Man (Source: Bangor University)

Note that the picture is more variable for individual areas[5]

In using this fishery as a case study it is important to emphasise from the start that this fishery is mainly targeting a different species to that under consideration here (queen scallops *Aequipecten opercularis* rather than king scallops *Pecten maximus*). Queen scallops have a shorter life cycle,

[4] See for example Save Cardigan Bay, Friends of Cardigan Bay

[5] See http://fisheries-conservation.bangor.ac.uk/iom/documents/6_000.pdf

reaching maturity ~30-40mm and living less long. This life history makes them more productive and therefore potentially easier to manage from a fisheries point of view. Nonetheless, the suite of tools used by the Manx government to regenerate and control the fishery is of wider interest for scallop fishery management. It is, however, important not to confound the two species.

The Isle of Man fishery is managed via:

- limited licensing within 12 miles, including a zone for Manx vessels only within 3 miles;
- a change of gear – queenies are targeted with otter trawls or 'gate gear' – toothless dredges;
- large 'queenie conservation zones' where trawling is the only fishing method permitted – including the whole zone out to three miles, and large sections out to 12 miles;
- king scallops may be targeted with normal scallop dredges (outside the conservation zones), but then only 20% queenie bycatch is permitted;
- 110mm MLS for king scallops;

The use of trawls rather than dredges in king scallop fisheries is not possible because the species behave differently. The Isle of Man example does, however, demonstrate the potential benefits of closed areas. A long-standing closed area close to the former marine laboratory at Port Erin showed scallop densities 10 times higher than outside, biomass 20 times higher and egg production 33 times higher (Beukers-Stewart and Brand[6]). Bangor University also note increased recruitment in recent years[7] – which could be a result of this improved management. According to Hart (2006) there is no evidence from US stocks that increased biomass from closed areas has lead to increased recruitment.

4.3.4 French scallop fisheries

France is Europe's second largest producer of scallops after the UK, as well as the biggest market for UK scallops. The main French scallop fisheries inside 12 miles lie in the Baie de Seine and the Baie de St. Brieuc, on the north coast. The local Comité Regional de Pêche (Regional Fisheries Committee) manages both of these fisheries. These organisations are relatively similar to the English IFCAs in structure and function, except that they have jurisdiction out to 12 miles rather than 6.

The St. Brieuc Bay fishery in particular offers an interesting case study of the French approach to fisheries management, which is highly structured and heavy on the public purse, in contrast to a more hands-off approach in most of the UK. The fishery developed during the 1960s and by the early 1970s was already very over-exploited (maximum landings were 12,500 tonnes in 1973, declining to only 1,000 tonnes in 1990). Throughout the 1980s and 1990s the fishery was extensively restructured: the number of licences was slashed, with preference given to local boats, a total allowable catch (TAC) was introduced, and limits were placed on the size and engine power of vessels as well as the time at sea. Vessels are now limited to less than an hour's fishing a day, three days a week. There is also restocking of the area with juvenile scallops produced at a culture facility in Brest.

This approach obviously aims to maximise employment and social benefits by favouring the maximum number of small-scale fishermen, rather than aiming to maximise the efficiency and profitability of the fishery overall, particularly in relation to management inputs. Although participation in the fishery remains profitable for fishermen due to high scallop densities underwritten by restocking, as well as a guaranteed minimum price, this profitability is underwritten

[6] See http://www.coastms.co.uk/resources/0c2eee41-ff33-48c7-8ce6-0355077f68f5.pdf

[7] See http://fisheries-conservation.bangor.ac.uk/iom/documents/6_000.pdf

by extensive public subsidy, including a large-scale annual survey and stock assessment programme and a monitoring and control system costing an estimated €1.5 million per year (Binet, 2010). It does not seem likely that this type of management system is feasible in the UK.

4.4 CONCLUSIONS ON REGULATION OF SCALLOP STOCKS AND FISHERIES

- Evidence from the above case studies suggests that management of inshore scallop fisheries can be effective at a local level – e.g. the examples of the English IFCAs, the Isle of Man and Shetland. The IFGs in Scotland have proposed management plans for inshore fisheries, including scallops, developed via a participatory framework. Providing the IFGs with more powers, expertise and resources to implement these plans, could be successful for important inshore scallop fisheries in the long term. Not all the IFGs agreed, however, that local management was the best approach for scallop fisheries.
- The example of the Isle of Man, as well as Subarea VIId in the Channel, suggests that an MLS of 110mm can be effective at maintaining a stable fishery even when fishing effort is relatively high, as noted by Bangor University[8]. Three of the IFGs propose an increase of the MLS to 110mm (but three do not). Nonetheless, this information is anecdotal and it is difficult to establish a causal relationship between MLS and recruitment and the economic impact of such a move must be considered.
- The standard means of controlling fishing mortality in scallop fisheries (gear restrictions, including controls on dredges per side) is convenient, but not completely effective if effort really needs to be controlled or reduced (as per the advice from MSS – Dobby et al. 2012).
- The most appropriate measure depends on the objectives of regulation – e.g. strict rules on dredges per side can be effective if the desire is to maintain a fishery for small, local vessels only, as in Wales. MSS suggest other methods of controlling effort, including limits on landings or kW days (as already exist under the Western Waters regime) or time/area closures. Economic and enforcement considerations are again key – time/area closures are best enforced via universal provision of VMS, while limits on landings or effort require management, e.g. via POs, who may have limited resources.
- Seasonal, rotating or permanent closed areas appear to be effective management tools in some areas. The two former are probably best dealt with at local level - although rotating closed areas have been effective offshore e.g. on Georges Bank in the NE USA. Permanent closed areas (for dredging or for towed gear) may well come about as a consequence of the management of European marine sites – as they have in many English IFCA districts – see below. It is not clear how much effect these will have, if any, on the health of scallop stocks, since this is not their objective, but it is expected to displace scallop effort from certain areas.

[8] See http://fisheries-conservation.bangor.ac.uk/iom/documents/6_000.pdf

5 INTERACTION WITH THE ENVIRONMENT AND OTHER USERS

5.1 THE IMPACT OF SCALLOP FISHING ON THE MARINE ENVIRONMENT AROUND THE SCOTTISH COAST

5.1.1 Impacts of scallop dredges

It is a fact that scallop dredging causes damage to life on the seabed ('benthos'). Scallops live on the bottom, although not actually attached to it, and to fish scallops, fishing gear therefore has to make forcible contact with the bottom. This is particularly true of king scallops which are more sluggish swimmers than queen scallops. Perhaps more importantly, scallops tend to live in areas of clear water and strong currents,m which also provide excellent habitat for many other benthic species, and thus naturally have high benthic biodiversity. This can often include unusual and 'charismatic' species such as soft corals, seafans and sponges (Figure 23), which are obviously highly vulnerable to destruction by a scallop dredge.

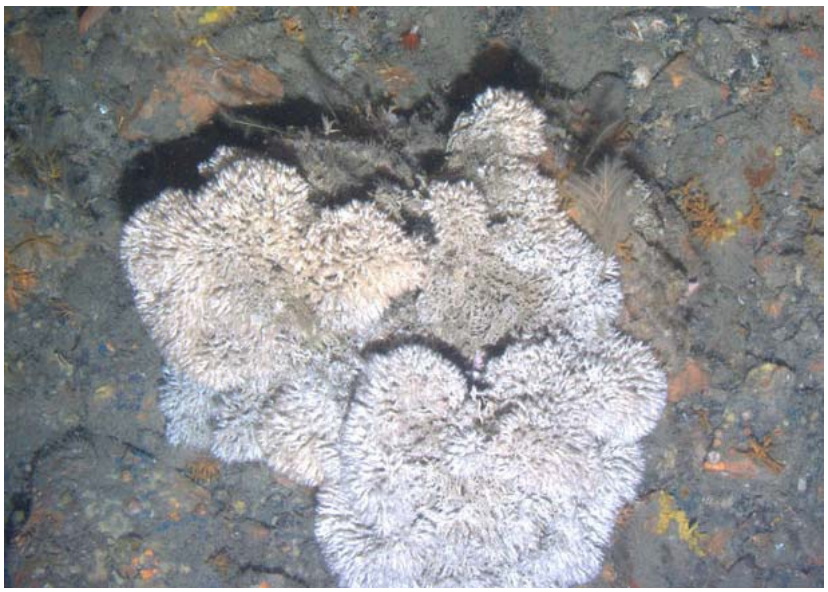


Figure 23 Cold water coral Lophelia pertusa at East Mingulay Reef SAC (source: MSS[9])

The main means of reducing environmental damage by scallop dredges are therefore two-fold: i) alter the fishing gear, or ii) restrict scallop fishing the most sensitive areas. As noted above, the Isle of Man has used both these options and scallop fishing has also been restricted the Firth of Lorn. Unfortunately, while scallop gear can be made less destructive it cannot be made non-destructive; gate-gear dredges and trawling are still highly problematic in habitats such as those shown in Figure 23. The more effective approach for these vulnerable habitats is therefore to keep scallop dredges out altogether, via closed areas.

Shetland provides an example where the SSMO developed and implemented a series of closed areas to protect biogenic reefs from dredge fishing (Shelmerdine et al, 2014). Sites confirmed as containing maerl, horse mussel beds or eel grass have been closed since 2010 using the powers conferred by the Shetland Islands Regulated Fishery (Scotland) Order (2012 and previous Order).

[9] See http://www.snh.gov.uk/docs/B749424.pdf

5.1.2 Management of scallop dredging in European marine sites

Nearly all the existing marine protected areas around the UK at present are designated under the European Natura 2000 system under the EU Habitats and Wild Birds Directives and implemented by the UK devolved administrations. These areas are called marine Special Areas of Conservation (mSACs) and Special; Protection Areas (SPAs) under the Birds Directive.

According to the Habitats Directive, mSACs in a given member state should cover cumulatively a representative sample of a wide variety of marine habitats, including habitats of relevance to scallop fisheries such as estuaries, large shallow inlets and bays and reefs (which includes rocky areas with high benthic biomass of species such as soft corals and sponges).

Activities within SACs are permitted as are new developments as long as these 'plans or projects' have been assessed (as per Article 6(3) of the habitats Directive) and are found to not hinder recovery to or maintenance of 'favourable status' of the designated features. Member States must report periodically to the European Commission on the status of these features, with sanctions in place (in theory at least) if favourable status is not maintained or recovered. The statutory conservation body, Scottish Natural Heritage (SNH) in Scotland oversees and advises on this process.

In the UK, fishing has up till now generally been regarded as an ongoing activity rather than a 'plan or a project' and has therefore not been subject to appropriate assessment (with some exceptions). Environmental NGOs have been putting pressure on DEFRA and Natural England in recent years to require appropriate assessment for fishing within SACs and SPAs as a matter of course, and scallop dredging has been at the forefront of this debate. A campaign backed by legal opinion by the Marine Conservation Society (MCS) and ClientEarth[10] has now resulted in the recognition in the UK that fishing constitutes 'a plan or a project', and hence should be subject to a system of appropriate assessment in mSACs.

In Scotland, SNH is currently undertaking a risk assessment of fishing in European Marine Sites In light of advice from SNH the Scottish Government will consider whether any additional management is required. If so orders under the Inshore Fishing (Scotland) Act 1984 may be used to put management in place including options such as voluntary measures or licence conditions.

In England, the management of mSACs out to 6 Nmiles is the task of the IFCAs who are taking a risk-assessment approach: the type of fishery (fishing gear) and the qualifying features of the mSAC are considered, and the likely risk of impact is categorised as 'red', 'amber' or 'green'. IFCAs have been advised by Defra to prioritise assessment and the necessary management of the fishery / feature combinations categorised as 'red'. Assessments outside 6 miles are being carried out by DEFRA. In general, fisheries using towed gear are categorised as 'red' for areas with qualifying features such as reef or seagrass.

Table 8 above shows that several IFCAs have already created closed areas for dredging or towed gear in parts of SACs with reef or seagrass features (Devon and Severn, Cornwall, Eastern and North Eastern, with Northumberland considering it). The SAC is mapped to identify the location of vulnerable habitats, a buffer zone determined and (in combination with a requirement for VMS to monitor vessels' location) fishing is permitting to continue in the less sensitive areas – similar to the outcome for Cardigan Bay discussed above. It is probably reasonable to assume that exclusion zones for scallop dredges, or for all towed gear, in sensitive areas, will become the norm in the UK over the next few years.

[10] Correspondence between the NGOs and MMO is available on the MMO website: http://www.marinemanagement.org.uk/protecting/conservation/habitats_directive.htm

5.1.3 Possible MPAs

The UK signed up to creating an 'ecologically coherent network' of marine protected areas by 2012 (although as usual these deadlines are subject to some flexibility). This aspiration is to some extent met by the existing network of European marine sites, but an ecologically coherent network requires that a wider range of habitats and species are given explicit protection than those specified in the Habitats and Birds Directives. In order to meet this requirement, Scotland is putting in place an additional set of protected marine sites, which will be called Nature Conservation Marine Protected Areas (MPAs). The location, size and regulation of these new protected areas are still under discussion at the moment. A programme is underway to consult stakeholders about the location of MPAs, as part of a wider project called Planning Scotland's Seas (consultation closed 13 November 2013).

Final decisions on sites will be taken based on a balance between ecological and socio-economic considerations with a presumption of sustainable development. The timetable is for the first designations to start in 2014 and for the network to be complete, with management plans in place, by 2016. There are 33 proposed new MPAs, plus four 'search areas', which are still in evaluation.

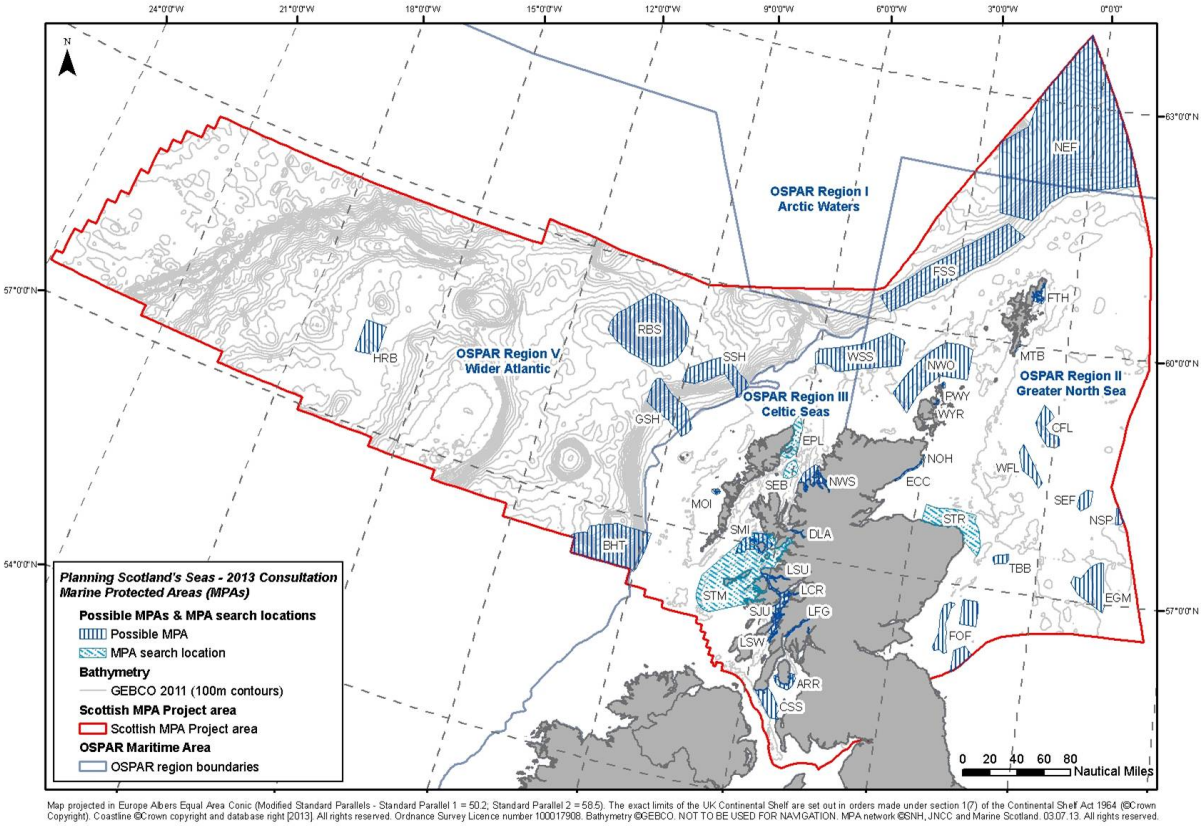


Figure 24 Possible MPAs (dark blue) and MPA search locations (pale blue (Source: Marine Scotland[11])

A comparison with VMS data for vessels targeting scallops (2012 –Figure 10) shows that the areas where scallop dredging is most likely to overlap with MPAs are in the inner Hebrides - west Kintyre, Sound of Jura, Sound of Mull, around Rum and Eigg; plus possibly some areas off the east coast.

[11] See http://www.scotland.gov.uk/Topics/marine/marine-consultation

Potential conflicts in these areas will presumably be dealt with via the marine planning consultation process, currently underway.

5.2 MARINE RENEWABLES

As noted above, the MPA project is part of a wider marine planning exercise in Scotland, which also addresses offshore marine renewables. A draft national marine plan (including the possible MPAs as discussed above) is currently out to consultation. Significant areas are under consideration for tide, wave and wind power generation (Figure 25).

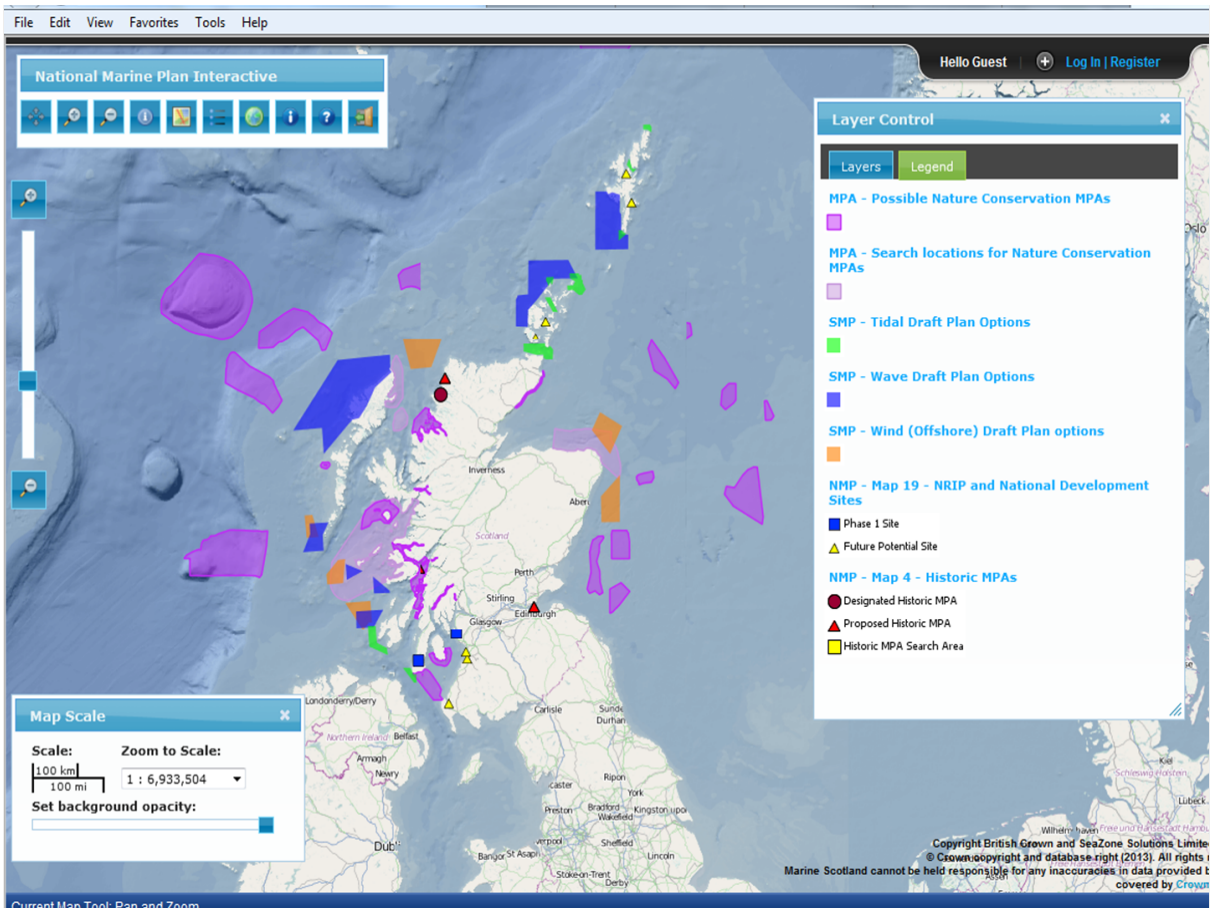


Figure 25 Interactive marine plan showing MPAs (pink) and renewables development (green), wave power (purple) and wind power (orange) (Source: Marine Scotland[12])

A comparison with 2012 VMS data for scallops shows three potential conflict areas with scallop dredging: a small area of scallop ground off the southwest tip of Islay proposed for tidal power generation, and the two areas of proposed wind farms off the east coast. These issues are under discussion via the marine planning process.

Further areas of conflict may exist in areas such as Shetland where smaller vessels have not been required to carry VMS. A tidal power device has recently been proposed for the area to the west of Shetland, and consultation with the SSMO and analysis of logbook data has revealed a high level of scallop fishing activity within the search area and along proposed cable routes to shore. Industry has voiced concerns in relation to the loss of these fishing grounds, but also the consequences of

[12] See http://www.scotland.gov.uk/Topics/marine/marine-consultation

displacing effort to other areas. Challenges to the placement of this device have only been possible due to the high-resolution data available from inshore logbooks for this area .

5.3 IMPACTS OF SCALLOP DREDGING ON OTHER FISHERIES

5.3.1 Conflicts with fixed gear

The incompatibility of fixed and towed gear has been a source of conflict in fisheries for many years and in many areas. In Scotland, examples include *Nephrops* fisheries (creel vs. trawl), and around the UK, scallop dredge fisheries have come into conflict with crustacean pots in various areas. While instances involving scallop dredgers do occur, some stakeholders suggest this issue is overplayed and static v static gear conflict is more prevalent and problematic than scallopers towing away gear.

The basic method of dealing with mobile v static conflict is to set areas aside for each fishery (or for fixed gear fisheries). This can be done in several ways:

- statutory zoning of an area for different gear types – e.g. Loch Torridon *Nephrops*
- statutory closure of areas to towed gear, either for fixed gear fisheries or for environmental protection – e.g. Lyme Bay
- segregation of fisheries by voluntary agreement (often sooner or later put on a statutory footing) – e.g. the Inshore Potting Agreement in South Devon.

The three examples above have all been relatively successful in reducing conflict while maintaining profitable fisheries. Problems have, however, arisen. The areas closed to towed gear can act as a magnet for fixed gear fishermen from far and wide. This has posed a problem for the Loch Torridon *Nephrops* fishery in terms of the management of the stock (and MSC certification), while for Lyme Bay it has also raised concerns in relation to the conservation objectives of the closed areas (concerns over damage of soft corals by high densities of fixed gear). Enforcement is also a requirement, even where the closed area has been designated by agreement of local fishermen – VMS is a useful tool in addressing this issue[13] (Devon and Severn IFCA 2012). Participatory designation of closed or fixed-gear areas can therefore be useful, but not sufficient alone to address fisheries management issues in a given area.

5.3.2 Bycatch

Scallop fisheries may also conflict with other fisheries (or create environmental concerns) because of bycatch, although damaged scallops may be the most significant bycatch (Beukers-Stewart and Beukers-Stewart 2008). A survey of bycatch in the Shetland scallop fishery (Shelmerdine, 2010) notes bycatch of commercial species including brown crab, queen scallops and juvenile monkfish, although most bycatch is of non-commercial species (sea urchins, horse mussels, starfish). A review of bycatch in the Isle of Man king scallop fishery is summarised in Table 9 (Veale et al. 2001), although these data are now quite old.

[13] See http://www.devonandsevernifca.gov.uk/sitedata/Misc/final_report.pdf

Table 9 Bycatch in the king scallop fishery, Isle of Main (1994-95)

Taxon	Species	Frequency in catch	Sensitivity
scallops	queen scallop	high	medium
starfish	*Anseropoda placenta*	low	high
	Asterias rubens	high	low
	Astropecten irregularis	medium	medium
	Crossaster papposus	high	medium
	Porania pulvillus	medium	low
urchin	*Echinus esculentus*	high	medium
	Spatangus purpureus	medium	high
whelk	*Buccinum undatum*	medium	medium
	Colus gracilis	low	medium
	Neptunea antiqua	medium	medium
crab	*Cancer pagurus*	medium	medium
	Pagurus spp.	medium	medium
octopus	*Eledone cirrhosa*	low	medium

The main bycatch is queen scallops (regulations limit this to 20%), and several species of echinoderms, some of which are robust (starfish), but others (urchins) are more sensitive to dredge impacts. The overall impact of dredge fisheries on these populations is unknown in most places.

A review of fish bycatch in the Isle of Man queen scallop fishery (Craven et al. 2013) also noted a monkfish bycatch, along with smaller catches of flatfish (lemon sole and plaice). Some potentially vulnerable elasmobranch species were also taken as bycatch in the Isle of Man fishery, including cuckoo rays and lesser-spotted dogfish. They note, however, that fish bycatch rates were generally low, and lower in king scallop than queen scallop nets.

Overall, most scallop dredge bycatch is of non-commercial species, and we have not found an example where a significant conflict has arisen between scallop fisheries and other fisheries due to the question of bycatch per se (leaving aside the more general question of habitat damage). Issues such as bycatch become relevant in relation to stock assessments for the management of fisheries targeting the bycatch species, where all sources of mortality need to be quantified. It is also a relevant question in relation to MSC certification.

5.4 CONCLUSIONS IN RELATION TO ENVIRONMENTAL INTERACTION

- Designation and management of a representative MPA system is a statutory requirement, as is consideration of fisheries impacts in existing and future MPAs. It is reasonable to keep damaging gear out of key vulnerable areas, while leaving less sensitive areas open for economic activity, including scallop dredging, as far as possible.
- With sufficient information on the extent of features, the use of appropriate buffer zones to protect relevant interest features where necessary and the use of VMS, fishing activity may be able to continue in well-defined areas within MPA boundaries rather than a ban on mobile gear within MPA boundaries. Some English IFCAs are taking this approach.

- Inshore MPAs are more likely to be supported when there is a local sense of ownership, with at least some management decisions are taken at local level. Non-local stakeholders such as visiting vessels still need to have a voice in this process. The balance between local management and wider national interests remains to be found in Scotland.
- Conversely, the marine spatial planning process is highly developed in Scotland relative to the rest of the UK, and potentially provides a forum whereby conflicts between scallop fishing, conservation and other non-fisheries users can be discussed and resolved.
- The population-level impact of scallop dredging on bycatch species, including species of echinoderms, gastropods, crabs, octopus and fish, remains to be quantified.

6 SCENARIO DEVELOPMENT

The following tables were developed to establish which options are to be considered in more detail. The sequential process can be described as:

1. Identification of potential measures in relation to specific objectives (Table 10)
2. Assessment of measures
3. Development of scenarios & application of measures under those scenarios (Table 11)
4. Assessment of short-term and long-term impacts of scenarios on scallop fishery subsectors (Table 12)

The measures examined include:

- Effort management measures (changes to licensing, individual effort allocations, seasonal and temporal closures and size restrictions);
- Technical measures (dredge limits, bar length limits);
- Other management measures (increased MLS, quota);
- Environmental management (closed areas and eco-dredges); and
- Monitoring & enforcement (VMS, CCTV, revised logbook detail)

The measures are assessed in terms of enforceability, industry acceptance, cost and overall effectiveness (Table 10). The impact of certain measures will only be understood when the scale is determined. For example, while a cap on effort is generally acceptable to industry, the removal of scallop entitlements is more contentious. The overall scale of the measure will also determine how effective it is in achieving its objective and the cost of its implementation.

Other measures are only likely to be effective in conjunction with other measures. For example spatial management would require the comprehensive use of VMS to monitor vessel locations.

Table 10 Assessment of potential management measures in the Scottish scallop fishery

Control Measure	Objective	Notes	Easily Enforceable	Industry acceptance	Cost to Implement	Effective
Effort management						
Capping of entitlements	Limit input of effort	Restrict overall fleet fishing capacity, Ineffective at vessel level	Y	Y	Low	Partly – latent capacity remains
Reduction in number of entitlements	Reduce potential effort in fishery	Reduce overall fleet fishing capacity, Ineffective at vessel level	Y	N	Low to very high	Yes, but depends how much
Individual effort allocation	Efficiency	Equitable means to define & police allocation needed. Expected to result in fleet contraction.	Y	N	Medium	Yes
Seasonal Closures	Recovery of fishing grounds	Must define rationale (biological, market, effort reduction).	Y	Y	Low	Yes –for fisheries
Real time closures	Temporary reduction in effort	Difficulty in defining & measuring trigger and removal reference points and relevant spatial scale.	Y (if used with VMS)	N	Medium	N
Size/capacity restrict < 6Nm	Reduction in effort within relevant area	May be considered less equitable than technical restrictions by zone (that do not totally exclude)	Y (if used with VMS)	Y	Low	
Size/capacity restrict < 12Nm	Reduction in effort within relevant area	May be considered less equitable than technical restrictions by zone (that do not totally exclude)	Y (if used with VMS)	Y	Low	
Curfew	Reduce effort & gear conflict	Greater impact on smaller vessels with less range. Larger vessels move offshore to avoid curfews	Y	Y	Low	Yes

Technical measures						
Dredge limitations	Reduce effort	In isolation, may not reduce overall fleet effort due to increased activity and non-compliance	N	Y	Low	Partly – open to non-compliance
Bar length restrictions	Reduce effort	Compliance with dredge limitation ensured. Not necessarily resulting in overall effort reduction	Y	Y	Low	Yes
Other fisheries management measures						
Increase MLS	Increase spawning stock	May result in higher spawning and recruitment. Larger average size in landing desirable for processor	Y	Y	Low	Possibly
Quota (ITQ, IQ or total fleet)	control total outputs from fishery	Costly and difficult to administer and enforce. Unclear stock information for quota setting	Potentially difficult	N	High	Yes
Environmental management						
Closures within MPA & buffer zone	Environmental: Reduction in habitat impact	May not be necessary in all areas, need defined by conservation objectives for given area. Areas must be clearly defined (e.g. by depth contour etc.), policed and monitored. Displacement likely.	Y (if used with VMS)	Y	Low	Yes
Closures to priority features & buffer zone	Environmental: Reduction in habitat impact	Highly negative impact by dredges on biogenic reef formations. Areas must be clearly defined, policed and monitored. Displacement likely.	Y (if used with VMS)	?	Low	Yes
Eco-dredges	Environmental: Reduce habitat impact	Debatable extent habitat impact is reduced; is phased introduction by replacement	Y	N	Medium (low if phased)	?
Monitoring and enforcement						
Inshore VMS	Information: supports spatial management,	Means to enforce spatial management policies and curfew. Improved information to support management.	Y	Y	Medium	Y

	improves data					
CCTV	Compliance with gear/catch regulation	Impractical for smaller vessels. Potential compliance use for vessel with bar restriction	y	N	Medium - high	Yes
Increased logbook detail	Information: Improved assessment & management data	Higher resolution data particularly relevant for inshore assessment and management	Y	N	Medium	Y

Scenarios are used to examine the likely impacts of different suites of measures on the resource, the various sub-sectors of the Scottish scallop industry and the marine environment. These are summarised below.

6.1 STATUS QUO

With no change to the current management regime, it is assumed there are no additional measures introduced. In the short-term this results is a 'business as usual' situation (increasing fishing capacity), but the numerous issues listed in this review remain.

Over the longer term inshore effort would be expected to reduce as the expanded fleet continues to make a loss. Levels of gear conflict increase as the inshore areas become more congested. The stock depletion identified in certain areas becomes more widespread.

The under 15m sector (already with marginal profitability) becomes unviable, but continuing fishing effort prevents stocks from recovering. Prices remain static and the poor public perception of scallop dredging continues. The dive sector may be more resilient with the selectivity possible and low running costs, but is unable to grow and marketing hampered by issues with the wider fishery.

Scottish Government unable to demonstrate sustainability and good ecological status.

6.2 MAXIMISING PROFITABILITY

Under this scenario it is assumed that the efficiency of the scallop dredge fleet improves via a cap on effort, the removal of latent effort and an increased MLS of 110mm. The targeting of high-density, suitably sized beds reduces overall effort further (along with operational costs). In the short-term, landings are reduced as a result of the increase to 110mm MLS. Vessels and scallop processors both struggle to remain profitable. Marketing (to capitalise on an improved reputation of Scottish scallops in terms of quality and responsibility) increases prices, but only partially compensates for the reduced volume.

In the longer term volumes do increase as harvestable sizes enter the fishery from productive beds with suitable growth levels. Some important areas, such as the Clyde and West of Kintyre may not reach previous volumes. Reduced volumes are partially compensated by increased prices and the effort limitation ensures fewer vessels are operating in the fishery.

With improved management of the fishery comes the opportunity to increase efficiency further through all vessels, or at least the larger nomadic vessels receiving an individual effort allocation. If tradable this is likely to result in consolidation of effort amongst fewer vessels, increasing efficiency further.

6.3 MAXIMISING YIELD

This scenario assumes the fishery is managed to MSY (as opposed to maximum economic yield as advocated above). As such the current MLS of 100mm, expected to enable the majority of the stock to spawn before first harvest, is retained.

In the short term catch volumes are maintained or may increase as no cap in effort is introduced. Therefore, a situation similar to the status quo can be expected. In the long term however, a reduction in landings would be expected as current exploitation is showing signs of over-fishing. A reduction in landings may be required to bring the fishery into line with MSY. Improved stock information would be needed to determine MSY and then greater management of input (effort) or output (landings via quota) would be needed in order to manage fishing mortality at MSY.

The long terms impacts depend on whether MSY is indeed found and the fishery operates to this. The unclear stock/recruitment relationship could result in large landings fluctuations year to year,

causing difficulties for vessels and processors. With no significant change to fishing operations, the reputation of Scottish scallops cannot be improved and prices remain static.

6.4 GREEN FUTURE

This scenario represents a combination of tightly controlled harvesting at or below MSY (through a reduction in effort) along side more restrictive spatial management for MPAs and interest features as well as the use of gear with reduced benthic impact.

The benefits to the scallop resource and the wider marine environment are evident, as are benefits to divers that gain from resource increase, operation in some areas closed to dredging and a less degraded environment.

For inshore vessels the scale of impact is dependent on the scale of closures in relation the vessels' range. This highlights the need to be proportionate around the Scottish coast. The impact on offshore vessels is expected to be less significant if alternative open areas could be found.

Marketing efforts are applied to gain from Scottish scallops' green credentials.

6.5 DECENTRALISED LOCAL MANAGEMENT

This can be considered as an advanced stage of current Inshore Fisheries Group initiative. Offshore (outside 6Nm) waters continue to be managed in the current centralised manner, but inside 6Nm localised management is likely to restrict access. This is expected to favour local inshore vessels and the dive sector with greater limitations on the offshore fleet.

The demand for local-scale science to inform management has to be addressed through data collected from the vessels themselves. This includes the use of VMS for all scallop vessels to inform temporary spatial restrictions for stock conservation or zonation between static and mobile gear.

Whether the impact from this change is positive or negative (for all segments of the scallop fishery and the environment) will be dependent on whether localised management processes are effective. Poor local management is as bad as poor centralised management.

Marketing to take advantage of locally sourced and managed stocks is possible and should benefit inshore and dive-caught sectors, as will the exclusion of larger vessels. Large vessels are expected to be displaced to offshore waters, which will be significant on the West Coast where the grounds are almost entirely within the 6 Nmile limit. There is therefore a risk that landed volume could decrease substantially as large vessels must fish elsewhere, such as in English waters. This highlights the need to manage all elements of the fishery equally, as the onshore sectors in many ports are to a great extent dependent on the volume of landings derived from the larger vessels.

6.6 DEREGULATED

This scenario assumes the current size restrictions (dredges per side) are removed as part of Scottish management removing any measures that are additionally restrictive. The MLS of 100mm is maintained as this is an EU level MLS.

With a lack of effort control and no size limit there is a strong likelihood of localised depletion of stocks that would prevent the viability of smaller vessels. For a time the nomadic fleet may tolerate this with the inter-annual rotation practiced currently, but in the long term widespread stock depletion is likely.

Table 11 Scenarios and associated measures

Scenario/Objective	General Description	Potential measures applied
No Change	Status Quo maintained. Conflict between inshore scallop/creel and offshore vessels. Some level of non-compliance, regulations difficult to enforce. Static prices. Poor public perception. Stock considered in depleted condition in many areas.	• No additional measures applied.
Maximise Profit	Increased efficiency of fleet and/or better price for product achieved. Not from increased volume of landings – sufficiently high CPUE maintained to ensure efficient vessel operations.	• Effort cap • Removal of latent effort. • Increase MLS • Marketing efforts to gain from improved reputation (quality & responsibility) • Possible introduction of individual effort allocation.
Maximise Yield	Fish close to or at biological maximum sustainable yield. As stock considered to be fully or over-exploited in many areas, probably requires a reduction in current landings.	• Retain 100mm MLS • No effort cap (but some reduction when MSY found) • Improved science to establish MSY
Green Future	Stock maintained at or above B_{MSY}. Dredge contact time and impact reduced, especially in areas with important biodiversity or features sensitive to physical disturbance. Expansion of diver fishery. More efficient harvest reduces overall footprint of fleet	• Reduction in effort • More restrictive dredge limits in inshore zone. • Closure of MPAs • Precautionary closure where reef features identified • Compulsory use of eco-dredge • Marketing efforts to gain from green credentials
Decentralised local management	Management decision making for inshore waters (0-6) devolved to local management groups. Essentially an advanced stage of current Inshore Fisheries Group initiative. Offshore (outside 6) waters continue managed in current centralised manner	• Assume more restrictive dredge limits to reduce larger vessel activity in the 0-6Nmile zone (i.e. by bar length). • Inshore curfew. • Introduction of inshore VMS to enable localised management of under 15m vessels.
Deregulated	Removal of current national restrictions to allow fleet to operate in a more openly competitive manner within the Scottish zone	• Scottish dredge limits inshore and offshore removed. • 100mm MLS remains (the EU level MLS).

Table 12 Short-term and long-term impacts of scenarios on scallop fishery sub-sectors

	Impact of Scenario			
	Scallop Resource		Habitat/Environment	
General Scenario	**Short-term**	**Long-term**	**Short-term**	**Long-term**
a) No Change (Status Quo)	Geographically variable, but generalised by depletion, low/unpredictable SSB and fluctuating recruitment	Where SSB limited, average reduction in recruitment and increasingly widespread depletion	Insufficient protection for priority marine features and MPA. High probability of negative interactions	More widespread and increased probability of negative interactions with fishery
b) Max Return (Profitability)	Greater proportion of stock left in situ (if 110mm protection of 2 more year classes compared to status quo)	Positive as potential increase in SSB & more robust to recruitment fluctuations, but stock/recruitment relationship unclear.	Without spatial management controls or effort cap, no impact or even negative if increased fishing to maintain yields	No additional impact when availability of 110mm increases. Positive if focus on productive beds = smaller footprint.
c) Max Yield (Volume)	Unknown - insufficient scientific data, & recruitment unpredictable. Risk of overfishing high as management of stock (rather than fleet) problematic	Uncertainty with biomass-based management, makes probability of overfishing very high. Unless highly restrictive management, stock depletion and potential collapse	Without spatial management controls or highly restrictive effort cap, high probability of negative interactions between fishery and environment	As per short-term
d) Green Future	Spatial restrictions on fishing, potentially positive if MPAs for nursery or spawning stock refuges. Less certain if established for other interest features (e.g. maerl).	Potential for increase in SSB and recruitment. Stock size may increase if displaced effort not concentrated in unrestricted areas	Greater spatial restrictions protect vulnerable priority features with probability of physical disturbance. Less damaging gears (eco-dredge} reduce impacts in open areas.	Potential for 'spread' or extension of benefits from increased biodiversity in protected areas. Less degradation from eco-dredge in open areas.
e) Decentralised (local) Management	Positive if management unit appropriate & effective management introduced. Otherwise neutral.	See left	See left	See left
f) Deregulated	High probability of widespread stock depletion and significant reduction in SSB. Risk of stock collapse high.	See left	Increased probability in negative interactions with increasing uncontrolled effort	Significant and sustained risk to priority species/habitats features Reduction in ecosystem services from degraded environment.

Table 12. Continued.

	Impact of Scenario			
	Offshore Vessels		Inshore Vessels	
General Scenario	**Short-term**	**Long-term**	**Short-term**	**Long-term**
a) No Change (Status Quo)	No significant impact	With stock displaying signs of overfishing in some areas, potential for reduced economic viability.	With stock displaying signs of overfishing in some areas and with restricted fishing range, ongoing poor economic viability	Reduced effort as loss-making vessels leave, but latent effort remains free to enter, preventing good profits for remaining vessels.
b) Max Return (Profitability)	Increased MLS & yield. With ability to relocate to and from favourable/unfavourable areas and land at multiple ports/counties, negligible impact.	Increase over current profitability if high density beds with higher yield targeted. Must be linked to effort control to incentivise this approach.	Initial reduction in net economic return if achieved by increased selectivity (MLS and/or quality)	If higher meat yield and quality attract increased prices, improved profitability.
c) Max Yield (Volume)	Comparable to current operational status quo. No impact	Signs of overfishing in some areas, potential for reduced economic viability and/or need for increased relocations	Comparable to current operational status quo. No impact	With stock displaying signs of overfishing in some areas, potential for reduced economic viability
d) Green Future	Reduction in total fishing area available, but probably not significant within geographic range. Minor impact.	Reduction in total fishing area available, but probably not significant within geographic range. Minor impact.	Dependent on total area closed and its relative importance. Ranges between none and significant impact	Dependent on local impact of greener policies on stock size. Could range between highly negative to highly positive in relation to economic viability
e) Decentralised (local) Management	Likely to result in implementation of measures that reduce ability to fish in inshore waters. Significant impact	Displacement from inshore waters. Reduced profitability if confined to offshore waters.	Initial period of reduced competition from larger vessels as local measures developed and implemented. Increased viability	Assuming appropriate and equitable management in place, more viable inshore fisheries.
f) Deregulated	Greater freedom to operate within the Scottish zone. Increased effort, landings and profitability. Increased competition.	Expanding effort and landings highly likely to result in increasingly severe local depletion of stocks spreading to create unviable fishery	Increased competition from larger vessels no longer constrained by regulation. Reduced viability	Expanding effort and landings highly likely to result in increasingly severe local depletion of stocks spreading to create unviable fishery

Table 12. Continued.

	Impact of Scenario			
	Diver Fishers		Post-Harvest Sector	
General Scenario	**Short-term**	**Long-term**	**Short-term**	**Long-term**
a) No Change (Status Quo)	No significant impact	Stock depletion, reducing viability of all fishing types. Diving possibly more resilient due to selectivity	Continued issues with seasonal misalignment in supply and demand	Static prices and continued competition from foreign import substitutes
b) Max Return (Profitability)	Profitability of diving higher than dredge, but at lower volumes. Higher quality landings already, so overall, low net impact	More likely to impact dredge fishery. Dive fishery probably able to avoid any competition from dredge by niche marketing	Short-term reduction in landings, but what is landed of higher quality/better size grade.	Closer alignment of supply and demand. Better reputation for a premium product.
c) Max Yield (Volume)	Dive fishers not realistically able to increase yield per diver, but number of divers could increase to increases yield	Potential for reduced availability of larger scallop if dredge related fishing mortality increased. Localised depletion possible with increase in dive activity.	Continued or worsened supply and demand issues. Static or falling prices. Inability to access niche/quality markets. Difficulty in building 'Scottish brand'	Fluctuating and unpredictable supply due to stock depletion. Reduced reputation. Failure to be competitive against cheaper, consistent supply imports.
d) Green Future	Likely to benefit from increased spatial restrictions of dredge fishery, even if divers also excluded from some MPAs	Benefiting from spill over from MPA/protected areas, as unlikely to be excluded on same terms as dredge.	Increased ability to build Scottish brand on 'sustainability'. Likely lower volumes with better chance to balance supply and demand	Opportunity to build reputation for higher quality, 'responsibly fished' Scottish products.
e) Decentralised (local) Management	Variable with area. Resistance to diving in some areas where no current activity. Less likely where it already occurs.	Benefiting from reduction of large vessel dredge effort in inshore areas, where diving activity occurs.	Opportunity to work with local stakeholders and management to match supply and demand, and influence quality standards	Potential to develop stronger market identity for locally managed fisheries with quality and 'responsibility' focus
f) Deregulated	Negative impact if dive requirements loosened and increased participation. Negative impact from increased dredge effort.	Expanding effort and landings highly likely to result in increasingly severe local depletion of stocks spreading to create unviable fishery	Short-term increases in landings may not match seasonal demand. Potential for reduction in prices. Food safety and quality concerns damage market.	Depletion of fisheries leading to supply shortage. Possible increase in price, but likely reputation damage to Scottish products (food safety, environment, quality)

The above table illustrates that each scenario has short and long-term impacts that may be positive for some sub-sectors of the scallop fishery, but negative for others. In a wider context, the Economic Strategy of the current Scottish Government reflects the practical reality that the selection of one single scenario, as presented in the tables above, would likely result in undesirable outcome(s) for each or all of stock, environment or industry. A 'greener' future may not yield a 'wealthier' future in the short term. One measure may result in failure to deliver 'equity' or a 'fairer' economic landscape for all stakeholders.

Potential conflicts between 'opposing' considerations must be identified and addressed in order to prevent stagnation and decline. Many of the stakeholders consulted during this review identified a failure to achieve this as an ongoing issue for Scottish scallop fisheries. Consultation with stakeholder revealed a number of re-occurring themes that can be summarised as:

- Opposing interests/conflict between the inshore and offshore sectors leading to 'political' stalemate and no action.
- Non-compliance with existing, poorly enforced (due to lack of practicality) regulations.
- Science not always providing the appropriate 'evidence' required to inform management & no resulting management action.
- No clearly identifiable, pro-active 'management body', with instead an approach where individual policies in isolation are consulted upon (that will seldom be agreed upon due to conflicting stakeholder interests).
- No shared industry or centralised strategy for the future management or the resource.
- Environmental impact of dredge fishery, that is subject to few spatial restrictions.
- Economic stagnation (for the inshore fleet).

The final point on economic stagnation clearly draws much of its origin from those proceeding it. It is clear that many of these issues reaffirm the need for change, but that they are sufficiently fundamental and significant that a common short-term solution for all does not exist. A long-term approach to changing the way in which scallop fisheries are assessed, managed and policed must be adopted, with particular focus on:

- Requirement of science to provide evidence appropriate to management scale & a formal process requiring management to act on it.
- A more identifiable, transparent and accountable decision-making process (distinct from 'consultation on policy' approach). This must manage 'stock and environment' as priorities, and despite opposing stakeholder opinions and perspectives. Social and economic considerations should influence decision-making when stock and environment are sustainable.
- A long-term management plan with strategic objectives for the fishery, implementation processes and timelines. This should occur on a 'whole fishery level', but be adaptable for local or regional areas where effective devolved management structures develop.
- Devolved or decentralised management should only occur when written procedures for transparent decision-making are in place, effective localised management is highly likely, and a centralised oversight and audit function is maintained.
- Enforcement of EU and national conservation policies in relation to habitats.
- Adoption of practical and more 'remotely' enforceable fisheries regulations.
- The development of Scottish scallops as a premium, responsibly-sourced product.

7 OPTIONS

The following section considers the specific measures identified in the previous sections in more detail in light of the potential impacts as identified in the scenarios. No single scenario is followed as these extremes are shown to disadvantage certain sub-sectors. However, the scenarios, individual measures assessment and feedback from stakeholders have helped to identify a range of measures to deliver the fishery management objectives of a sustainable Scottish scallop fishery.

The proposed measures are evidence-based and wherever possible are based on sound science. However, the precautionary approach suggests that a lack of sound science should not be an excuse for inaction if there is general consensus on those actions.

7.1 MANAGEMENT OF SCALLOP STOCKS

7.1.1 Effort management

Fleet capacity trends show overall reductions in the number of vessels over the last 10 years, but the number of active vessels has remained stable. Scottish scalloping effort has historically been distributed throughout UK waters, effectively limiting the hours fished in Scottish waters, which was declining up to 2010 (Figure 8). However, recent figures show significantly more effort in Scottish waters in 2011 and 2012, driven by Western Waters effort restrictions. With a general picture of declining stocks and further restrictions elsewhere in the UK there is a significant risk that current Scottish fleet capacity is leading to overexploitation in Scottish waters.

There was a near unanimous view from stakeholders interviewed during this review that effort had expanded to unsustainable levels. With anecdotal evidence of some vessels non-compliance with dredge limitation, high fleet capacity, large latent fleet capacity, the management of fishing effort in any meaningful way is not currently possible.

The introduction of the 'Buyers and Sellers' regulations has led to many vessels claiming rights to, and subsequently maintaining scallop fishing entitlement, but not engaging in the fishery at any time. Currently available information prevents the true scale of the problem being quantified, but there is clearly excess capacity in the fishery and capping current capacity is necessary.

It is also necessary to stop the 'piggy-backing' of licenses onto a single entitlement. In the current system a single license with an entitlement could be combined with other licenses (with or without entitlement) to create a much larger capacity license with entitlement. This creates the potential for significant increases in fishing capacity with scallop entitlement and the practice should be stopped.

Some inshore vessels wish to reserve the right to move to scallops (as a comparatively unregulated fishery) when fishing opportunities are limited in other fisheries. While some flexibility in operations for inshore vessels is essential to work with varied and seasonal inshore fisheries, the potential to activate scallop entitlements and the ability to accumulate these onto large vessels undermines management of the fishery. Therefore preventing the activation of remaining inactive entitlements is needed to cap effort.

An argument against the removal of license entitlements is that entitlements are an asset that adds to the value of the license. Determining the scale of this asset is difficult as scallop entitlements are not traded in isolation. However consultations as part of this review suggest that an average of £1,000/tonne for a whitefish + scallop license could be expected and a whitefish license alone is thought to be £7-800/tonne. Therefore the value of a scallop entitlement may be £2-300/tonne. This gives some indication of the scale of the asset.

The licensing review consultation[14] proposes that vessels that have not caught scallops in the last seven years shall have their entitlement removed. It also suggests that vessels with entitlements will be given six months to retain their entitlement by rigging their vessels for scalloping (a significant financial investment) and show that they have landed scallops.

This is a useful first step and consultations revealed that a seven year reference period appears about right in terms of industry acceptability. How effective the measure will be in removing latent capacity remains to be seen. The status of other fisheries in 2014, particularly Nephrops will determine how many will chose to activate their scallop entitlement. A further cut and additional measures, namely limiting the potential for licence aggregation is likely to be necessary.

7.1.2 Minimum Landing Size

Recognising that stocks appear to be in decline overall, taking a precautionary approach suggests that some action to increase SSB and the potential for recruitment is required.

Despite the uncertainty relating to the biological basis for increasing MLS, the majority of stakeholders consulted during this review viewed the measure favourably, including Marine Scotland Science. The generally held view is that the measure would 'increase recruitment', but it is more accurate to suggest that 'increasing MLS would on average increase the potential for increased recruitment'. Increasing MLS aims to increase SSB (rather than to permit first spawning prior to harvest, which already occurs at 100mm).

Market sampling data kindly supplied by the Inshore Ecosystem Group of MSS have permitted a crude evaluation of the relative scale of likely changes in landings that may occur in the short term if an MLS of 110 mm was implemented (Table 13). These figures should not be taken as absolute values, but a comparative guide to the scale of impact.

Table 13 short term reduction in landings from an inceased MLS based on 2010/2011 landings

Assessment Area	% of landings below 105 mm	% of landings below 110 mm
Clyde	26%	57%
East Coast	0%	5%
Irish Sea	0%	0%
North East	0%	18%
North West	2%	19%
Orkney	0%	4%
Shetland	0%	3%
West of Kintyre	14%	41%
Total landings	**16%**	**41%**

Source: MSS market sampling data

Numbers and mean size-at-age summary tables for seasonal market sampling during 2010/11 were used to identify age groups that might become unavailable to fishers within each assessment area. It is not possible to provide a more detailed analysis based on the summary tables provided, but a

[14] Published 16th December 2013, consultation closes 10th February 2014.

more detailed analysis could be undertaken using the actual size profile of landings or raw data (a task beyond the scope of the current review).

In a few cases, mean size-at-age was just above or below 110 mm, and it must be appreciated that a variable component of the many thousands of individuals measured to obtain this average would have fallen below or above the proposed MLS in the 2012 consultation. However, if MSS market sampling of landings for the given year are taken as representative of total landings, the figures derived probably represent a reasonable indication of the geographic variability in potential changes in landings in the year following an introduction of 105mm and 110 mm MLS.

Data suggest that any additional spat settlement (the start of potential biological benefit) arising from an increase to 110mm will take between 4 – 6 years (market sampling size-at-age) to recruit to the fishery, this being the first potential opportunity for economic return arising from the increase in MLS. A 105mm increase may take 1-2 years (depending on the growth rates in different areas). Although it could be assumed that both biological and economic benefits may accrue in the long term, it should be remembered that the stock recruitment relationship is unpredictable for this species. It is unclear what proportion of this decoupling of the recruitment relationship occurs due to pre- and post-spat settlement, and what part density dependent and independent process play. Although increasing MLS could be considered precautionary, in the absence of these types of information it is important that the socio-economic consequences of changes to MLS are well understood and considered alongside the potential biological benefits.

A shortage of supply means that the undesirable nature of small scallop at post-harvest processing has not resulted in industry standards that reject these smaller sizes. It remains a difficult task to assess the overall economic and social impacts of increasing MLS in each area or for each participant in the fishery, but Table 13 indicates the proportions of current landings that would be unavailable with a move to 105mm and 110mm.

Even where large reductions are foreseen such as the Clyde and West of Kintyre (areas that account for the bulk of inshore landings), representatives of local vessels are in favour of an increase to 110mm. This could in part be seen as a protectionist stance as larger vessels may find it more difficult to achieve the catch per unit effort required for viable operation. Although market sampling data shows there would be at least a short-term (approx. 5 years) decrease in landings based on current effort, at least one processor interviewed felt that this may be offset by increased quality and prices paid back to vessels.

In summary, most inshore scallop vessels, some processors and few large vessel operators are in favour of an increase to 110mm. Most large vessel operators and processors consulted favoured a staged increase to 105mm. Marine Scotland Scientists have previously recommended an increase, even though the stock/recruitment relationship is unclear. The reasons for favouring the measure vary from better ensuring sustainable stocks, improved marketing, better long-term returns and restricting volume fisheries in certain areas.

Based on increasing SSB, the suggested increase to 110 mm shell 'length' is quite arbitrary, and lacks a firm biological basis. Considering the potential economic impact on industry and reduction in overall supply in some areas (impacting the onshore sector) in the short term, there is a good case for a lower intermediate MLS of 105mm that allows both an assessment of its impact on recruitment and time for other SSB building measures to be implemented prior to a further increase to 110mm.

7.1.3 Spatial reserves

It is appropriate to adopt a more holistic view that considers/incorporates other measures that have the potential to increase recruitment. Along with increased MLS, spatial reserves represent another mechanism by which to increase SSB. This is particularly the case in inshore areas where the

establishment and policing of 'reserves' already occurs informally, but without the necessary regulatory protection.

Spatial reserves work and are more likely to be respected if nominated by the industry themselves and established in close association with all stakeholders. The introduction of VMS on all vessels, including under 12m would greatly facilitate enforcement of these areas.

7.1.4 Curfew

The 0-6 mile area has the most fishing activity (including scallop effort), particularly for the West of Kintyre and Clyde areas (IFG areas 4 & 5 in Table 14), which account for the great majority of Scottish landings. Data from Marine Scotland shows that around 30 to 40% of landings are from within the 0-12Nmile zone and until this year (2013), all sizes of scallop vessels fished within 6 miles for the majority of the time. The 0-6 zone also exhibits the greatest variety of habitats and comparatively greater biodiversity compared to offshore areas. As described above, there is broad industry agreement that there may be excess capacity in the inshore zone.

Table 14 Distribution of landings in Scottish inshore waters (source: Marine Scotland)

	% of total catch	0-6 miles	6-12 miles
Total	**100%**	**81%**	**19%**
1 South East IFG	5%	34%	66%
2 Moray Firth IFG	1%	100%	0%
3 North West IFG	4%	100%	0%
4 Small Isles & Mull IFG	41%	93%	7%
5 Clyde IFG	41%	99%	1%
6 Outer Hebrides IFG	5%	100%	0%
7 North Coast non-IFG	1%	43%	57%
8 East Coast non-IFG	0%	10%	90%
9 Orkney non-IFG	1%	14%	86%

An inshore curfew (e.g. 10pm to 5am) is a widely supported measure that would have a number of potential benefits including:

- Inshore effort limitation;
- Reduced gear conflict;
- Improved safety & working hours for crews; and
- Aid enforcement (landings occur within specified times)

Limiting inshore effort is perhaps the primary driver for this measure, but this is only likely to be effective with the effort cap proposed above as more scallop entitlements could become active. It should also be implemented along with the mandatory introduction of VMS for all scallop dredgers as proposed below. It may also be the case that the gear conflict issue is overstated in relation to scallop dredgers (conflict within the static gear sector is more prevalent), but no fishing at night could certainly reduce instances of dredgers towing through static gear.

Inshore fishing interests have advocated the measure to effectively prevent larger vessels from fishing in inshore waters. However, larger vessels may not be excluded from an area (unless further size restrictions are applied) and could continue fishing further offshore at night if conditions permit.

In some cases, such as ports limited by tide, curfews may need to be more flexible and here local determination (e.g. via the IFG) would create locally appropriate regulation that is more likely to be respected and self-policed.

7.1.5 Bar length

Dredge limitation is a relatively ineffective means to reduce effort in isolation (as some vessels have the capacity to fish constantly and repeatedly in the same area) and there is some evidence to suggest that a small minority of participants do not comply with current regulations. Fisheries compliance vessels are easily monitored through publicly available tracking systems and cannot approach non-compliant vessels with sufficient ease and pace to gain evidence of illegal fishing practices. Bar length restrictions are much more effective in limiting the number of dredges (dredges are attached to the bar) that can be used by a vessel. These have not been introduced due to a number of operators suggesting that the carrying and swapping of bars at sea (as different areas with varying regulations are transited) is an unsafe practice.

In practice a small vessel that is only designed to operate up to 8-a-side would not stow a longer bar for operating outside 12 Nm and therefore would not need to carry spare bars, while a large vessel able to fish 18-a-side would have sufficient capacity to safely stow an additional pair of bars for inshore operation. The stowage of additional bar lengths should not adversely affect the stability of a vessel if stowed correctly. Operation of heavy gear in poor conditions requires sound judgement by the skipper, but this applies to nearly all fishing and changing bars is no different.

There is understandable concern from owners of large nomadic vessels that the additional restriction of 14 dredges per side would mean that 3 sets of bars may be required: short for inshore, medium for the 14 dredge limit in Scottish waters outside 12 and longest for operating with no dredge limit (up to 18 a side in practice) in other UK waters outside 12. It is therefore suggested that the 14-a-side dredge limit outside 12nmiles should be replaced by a simple bar length rule for inside 12 (equating to the current 8 per side inside 6) and no limits outside 12. This would simplify regulations, be consistent with other devolved administrations and help to compensate vessels for the additional restrictions in Scottish inshore waters proposed in this report.

7.1.6 Monitoring and enforcement

Fishing data is not widely used to monitor Scottish scallop fisheries, despite being a good indicator of average fleet performance, and by proxy stock health (when other factors such as change in fleet behaviour are known). Spatially referenced data of an appropriate scale are useful both in stock/fleet management and informing marine planning in an increasingly competitive 'seascape'.

Marine spatial planning will be progressed by Coastal Partnerships over the coming decade, and VMS and high resolution data provide a means to identify important fishing grounds when development plans are evolved. Shetland provides an example where data of this kind has been used during the planning (and compensation) phase of both petrochemical and renewable energy development, and to manage the fishery itself. If decentralised inshore management becomes a reality in Scotland, as is intended, then decision-making bodies will require access to landings and effort data by all vessels fishing within its jurisdiction to make reasoned judgements.

The collection of accurate effort data (e.g. vessel dredge hours) would also permit a more responsive and informed approach to managing the wider scallop resource. VMS is now a cheap, affordable and accurate means to record spatially reference data that is used widely for other fleets within Scotland and globally. Although many scallop vessels carry VMS, some do not, and rarely are the systems used to implement spatial management (e.g. closed areas). Mobile scallop gears have a proven impact on seabed habitats, and therefore compliance with spatial restrictions is essential. VMS provides not only a means to communicate the location of closed areas directly to fishermen (they can be added to systems in many cases) to prevent accidental infringement, but also represents a cost effective 'remote' enforcement tool.

CCTV systems are already used on the larger vessels, including scallopers, for the vessel owners own management purposes. CCTV is in use in other fisheries within Scotland for compliance purposes (e.g. demersal discard cameras). The technology is available, relatively affordable and protocols for the delivery, collection and inspection of hard drives already exist. Marine Scotland Compliance view this initiative as practical and desirable. However many operators are concerned that the introduction of CCTV to monitor bar length compliance, could ultimately be used for additional measures such as reviewing by-catch.

7.2 DIVE FISHERY

The growing interest and participation in scallop dive fishing needs to be supported, but managed carefully in relation to increasing cumulative effort in the fishery. Diving is more efficient at removal than dredging over relatively small areas when compared to dredges and can access grounds that have not previously been subjected to dredge fishing mortality. Although increasing MLS has been proposed as a potential means to bolster SSB, the overall benefit may be reduced when a greater proportion of the reproductive population is subjected to fishing mortality. As the source-sink dynamics of scallop reproduction and recruitment are poorly understood, it would be wise to manage the further development of scallop dive fisheries in a 'capped total effort' manner that accounts for dredge activity also.

Marine Scotland should support the scallop dive sector in its efforts to improve safety and compliance by Scottish scallop divers. should work with Scottish Scallop Divers Association to improve the legitimacy of the sector and develop Scottish dive caught scallops as a premium brand.

7.3 SCIENCE

Individual management measures that are proposed to ensure the future viability of stocks, but not backed by clear and compelling scientific evidence can be countered with concerns relating to social or economic viability of coastal communities. This understandable stalemate does however result in long delays to changes in management practices. This creates a situation of disconnect between science and management. The MLS debate is a clear example of the way multiple considerations negate the management of stock through population-based criteria alone. However, if viewed in a positive manner with a strategic vision of how to resolve these issues, they could be seen as a difficult start to a process of moving toward 'ecosystem management', a process that considers all of the various factors at management level (Barange, 2005).

The availability of data is often a primary factor in defining the balance between economic and social benefits of a fishery and its associated negative impact on stock and environment. However, data relating to the societal, community-based benefits of scallop fishing are not well developed for many areas, leaving an agenda primarily focussed on the environment. As many participants in scallop fisheries and post harvest processing live in relatively small coastal communities, the income derived from their activities will pass back into local economies. A greater understanding of the socio-economic benefits of scallop fishing is needed.

The specific options in relation to scientific assessment are summarised in section 4 and presented in the recommendations in the following section.

7.4 ENVIRONMENTAL MANAGEMENT

The current ongoing development of a network of Marine Protected Areas in Scotland and the wider United Kingdom aims to provide some level of protection to areas that are important in the context of biodiversity. The protection of certain interest features and the continuation of scallop dredging

over the same ground are not compatible. As scallop dredging can cause damage to sensitive habitats with a single fishing event, the adoption of a precautionary approach to access is warranted. This is under way in England with Defra advising IFCAs as a matter of urgency to establish areas closed to mobile bottom gear for interest features susceptible to damage from certain gear types.

Scottish Natural Heritage indicated that they will define conservation objectives for each MPA and allow the competent management authority (Marine Scotland) and industry to define how they will meet these objectives. However, experience suggests that this process may be protracted and it is recommended that closure of MPAs with the relevant interest features should occur on a precautionary basis until evidence that fishing activity (and subsequent enforcement) can be aligned with conservation objectives. Fishing within MPAs or MPA buffer zones must coincide with mandatory carrying of VMS to ensure a high degree of confidence that specific areas and buffer zones will not be fished.

There should also be management of the impact of scallop dredging on the environment outside of MPAs. There is anecdotal evidence that the current level of protection afforded to biogenic reef formations (priority features in Annex I of the EU Habitats Directive) is lacking. These features occur in many areas outside the current MPA network, and there are published data that detail significant damage when interaction with dredges occurs. VMS provides a means to communicate the location of suspected or confirmed habitats of this type to enable temporary closure while the extent of these features is mapped. These types of precautionary and dynamic closures have been used successfully in the Shetland inshore fishery.

Traditional spring dredges can be set and towed in varying ways depending on local conditions. Regardless of the way in which gear is configured, it is a documented fact that disturbance of the seabed does occur as a result of fishing activities. The adoption of less damaging practice and gear should be viewed as a sector-wide goal to reduce environmental impact and support the marketing of Scottish scallop as a high quality, responsibly-sourced product.

A number of manufacturers have attempted to reduce dredge impact by bringing less damaging 'eco-dredges' to market. Although some fishermen have begun to use these types of dredges as more traditional rigs become worn, many claim that their fishing efficiency is sufficiently reduced and their cost inflated so as to render dredging unviable. However, manufacturers argue that significant fuel savings (25% less fuel is suggested) may compensate reduced fishing efficiency. The costs and benefits of gear innovations in the dredge fishery should be independently evaluated to inform decision-making on gear restrictions.

7.5 POST-HARVEST

The above measures and processes are proposed to improve the governance of the Scottish scallop resource. There are also post harvest and marketing issues to address. However these are ultimately dependent on a sustainable resource. By implementing the above measures, the sustainability of the resource can be proven and its responsible harvest will be evident. This should positively contribute to industry (e.g. Scallop Association) and public sector efforts to improve the image and market for Scottish scallop as a sustainable, premium product.

8 RECOMMENDATIONS

The following section presents the specific recommendations of the review team:

8.1 FISHERIES MANAGEMENT

8.1.1 Joined-up management:

The dredge fishery and the dive fishery target the same resource and therefore management of each segment should be under an overall management plan of the Scottish scallop fishery (that supports local IFG planning).

8.1.2 Cap effort and remove latent capacity

The total number of scallop entitlements within the fishery should be reduced to include only active scallop vessels (as per license review consultation proposals), with an important additional restriction to prevent upsizing of existing vessels (e.g. total VCU cap). Further management of effort is required and should be applied when there is a better understanding of relationship between nominal effort and F in the fishery.

8.1.3 Increase in Minimum Landing Size (MLS)

An initial increase from 100mm to 105mm is proposed as some stock conservation and market benefits are expected. This will reduce, but not remove the short-term economic impact on the industry compared to an immediate move to 110mm. Maintaining this increase for four years provides sufficient duration for changes in recruitment arising from the increase to be detected in research dredges and market sampling. The economic impact on the sector should also be assessed throughout this four year period and the costs and benefits of any further MLS increase should be explored.

8.1.4 Spatial reserves

To protect locally important scallop beds from over-exploitation and support recruitment into the fishery, Marine Scotland should work with IFGs to identify fishery reserves within the 0-6Nmile zone. These could be permanently closed to all forms of fishing or opened and closed on a rotational basis as informed by monitoring.

8.1.5 Bar length

Bar length restrictions should be implemented within specific zones in Scottish waters to replace the current dredge restrictions. To avoid the need to carry two sets of bars and to partly compensate for other restrictions proposed, the dredge limit outside 12Nmiles could be removed, bring Scottish regulations into line with other UK waters. Additional effort restrictions (i.e. a reduction in permitted bar length) for inshore zones should be considered when the impact of such measures is better understood (i.e. CPUE reduction and displacement of vessels).

8.1.6 Inshore Curfew

A curfew should be introduced prohibiting scallop fishing within 6 Nmiles of shore between agreed hours of the night. The details may vary seasonally and some flexibility could be agreed in the case of tide-limited harbours.

8.1.7 Dive fishery

The dive-caught scallop sector should be considered a full partner in the future management of the Scottish scallop fishery. The Scottish Scallop Divers Association (SSDA) should be assisted by Marine Scotland in its efforts to improve safety and compliance by Scottish scallop divers and to develop Scottish dive caught scallops as a premium brand.

8.2 ENVIRONMENTAL MANAGEMENT

As the structure of these recommendations illustrates, management of the environment should be distinguished from management of the fishery: although these are inter-dependent, each has different objectives.

The management of Scotland's environment is a far wider than the scope of this review. However, the ToR sought comment on environmental mitigation and the review has identified some environmental management issues that have implications for the Scottish scallop fishery and these are described below.

8.2.1 Marine Protected Areas

Scallop dredging should be excluded from MPAs with interest features sensitive to dredge impact (i.e. biogenic reefs). Detailed mapping of features with adequate buffer zones and compulsory VMS on all mobile gear vessels should enable these specific areas to be closed to fishing and the continuation of fishing elsewhere within MPA boundaries without impacting those interest features. The competent authority should approve written plans describing the alignment with conservation objectives and the measures to ensure full compliance with area-specific terms and conditions.

8.2.2 Biogenic reef habitats/priority features

Areas where significant biogenic reefs or 'beds' are believed to occur (see Shelmerdine et al. 2014 for definition) should be confirmed by a competent authority and mapped then managed as per MPAs above. Where precautionary closure has occurred and a habitat is not subsequently identified, the area can be re-opened.

8.2.3 Eco-dredges

An independent and robust analysis of alternative dredge technologies is required to identify comparative catching efficiency, benthic impact and associated costs and benefits.

8.3 SUPPORTING MEASURES

The following measures support both fishery management and environmental management objectives:

8.3.1 VMS and higher resolution data collection

The fitting of an appropriate VMS system should be mandatory for all vessels engaged in commercial scallop fishing (including dredge and dive methods) to demonstrate compliance with spatial management and provide data to inform science.

8.3.2 Quality and marketing initiatives

Management improvements will result in improved governance (fishery & environment) and this enhancement of the reputation of Scottish scallops should be capitalised on with quality and marketing initiatives.

8.4 SCIENCE

- The appropriate scale for **scallop management units** in Scotland, should be informed by science. Management demands should then drive the ongoing provision of scientific advice and the data collected.

- An independently chaired, **multi-stakeholder workshop** should be conducted to determine the scientific information needed to manage Scottish scallop fisheries in the short, medium and long-term. This should identify:

- Whether appropriate **types of data** necessary for the management are already collated or alternative systems should be developed.

- The **spatial resolution** on which data should be collected, which will be dictated primarily by the geographic extent of appropriate management area (which may differ from existing assessment areas).

- The **scientific resources** required to deliver scientific advice to scallop management.

- I**mproved links** between science and management, and a clearer co-operative understanding of **shared responsibility** with industry and other stakeholders.

- **Fishing data** are generally underutilised for management of Scottish scallop fisheries. Scallop management should be informed by spatial referenced catch/landings per effort data of an appropriate resolution. The use of VMS and logbook data for all scales of scallop vessels will provide the necessary fisheries-dependent data to support ongoing survey.

- The use of fishing data could inform the development of **reference points** that will provide a more cost-effective, practical and responsive method by which to manage stocks than through analytical assessment of biomass/population parameters in isolation.

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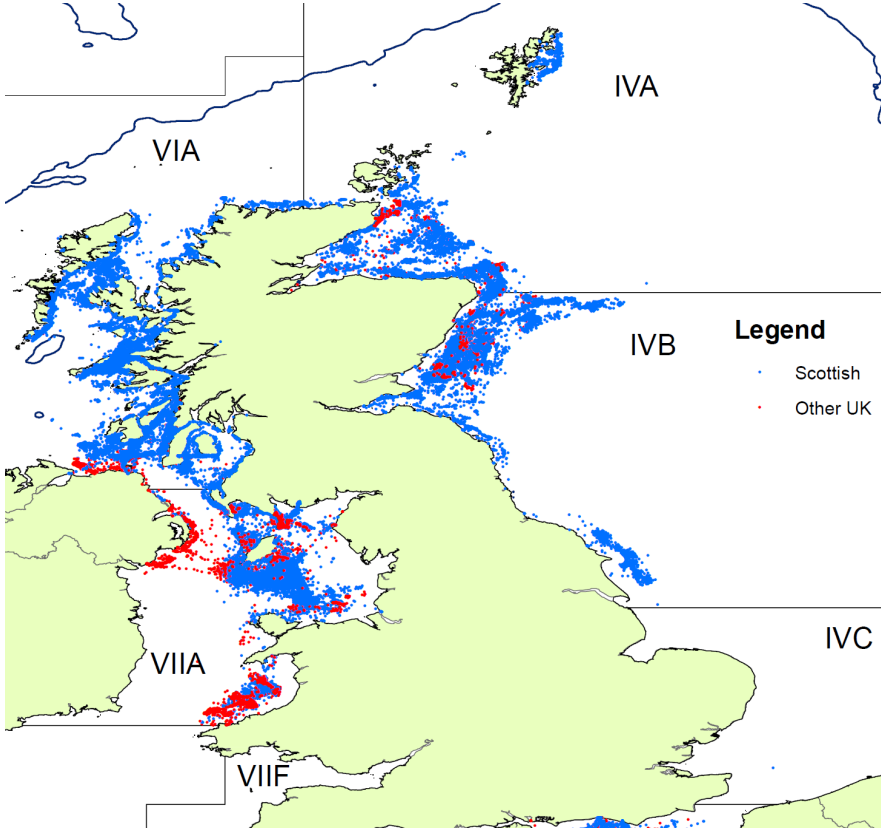
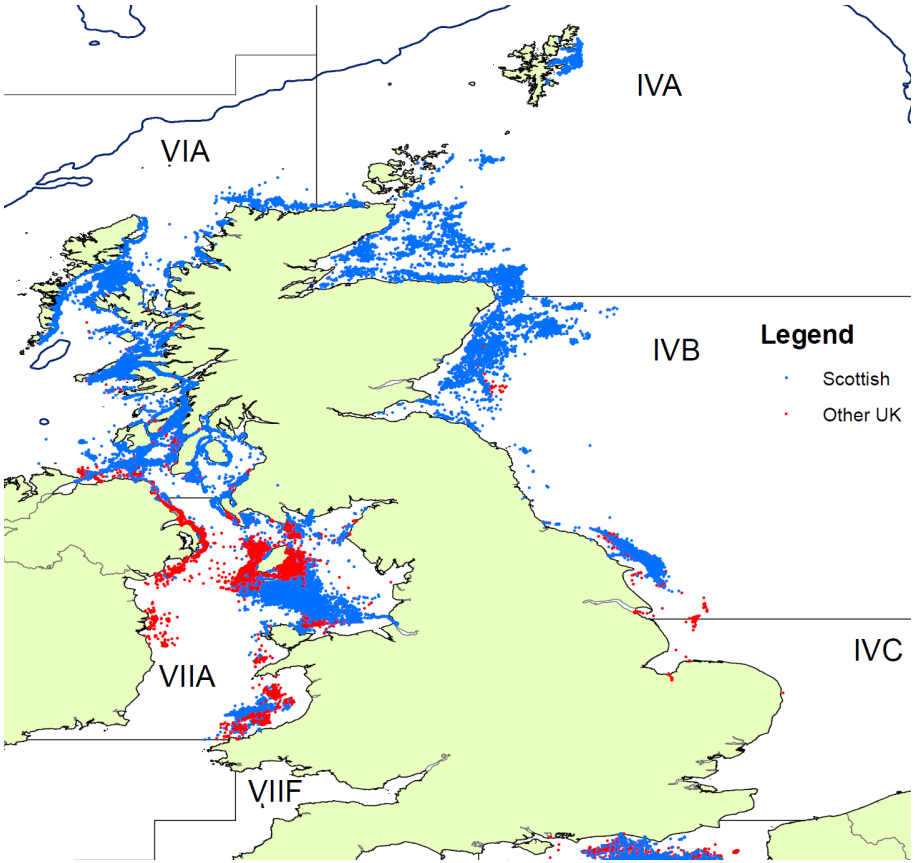
APPENDICES

APPENDIX A: VMS DATA FOR SCOTTISH (BLUE) AND OTHER UK (RED) VESSELS TARGETING SCALLOPS 2008-2011 (SOURCE: MARINE SCOTLAND, 2013)

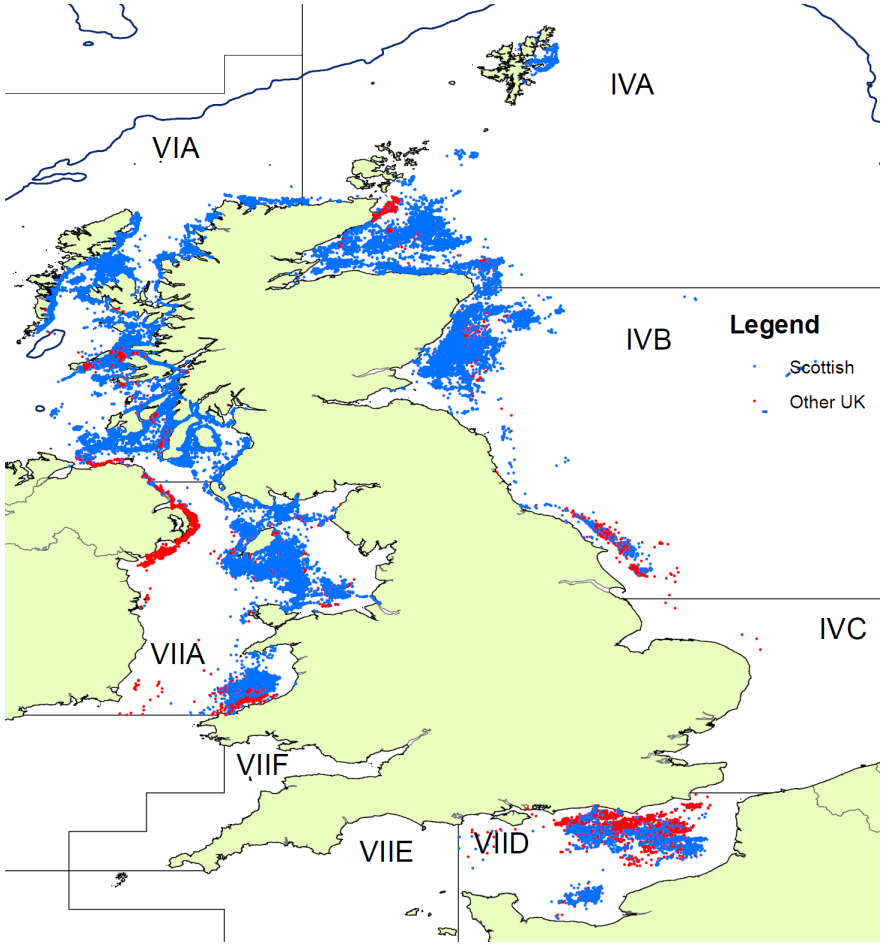
2011



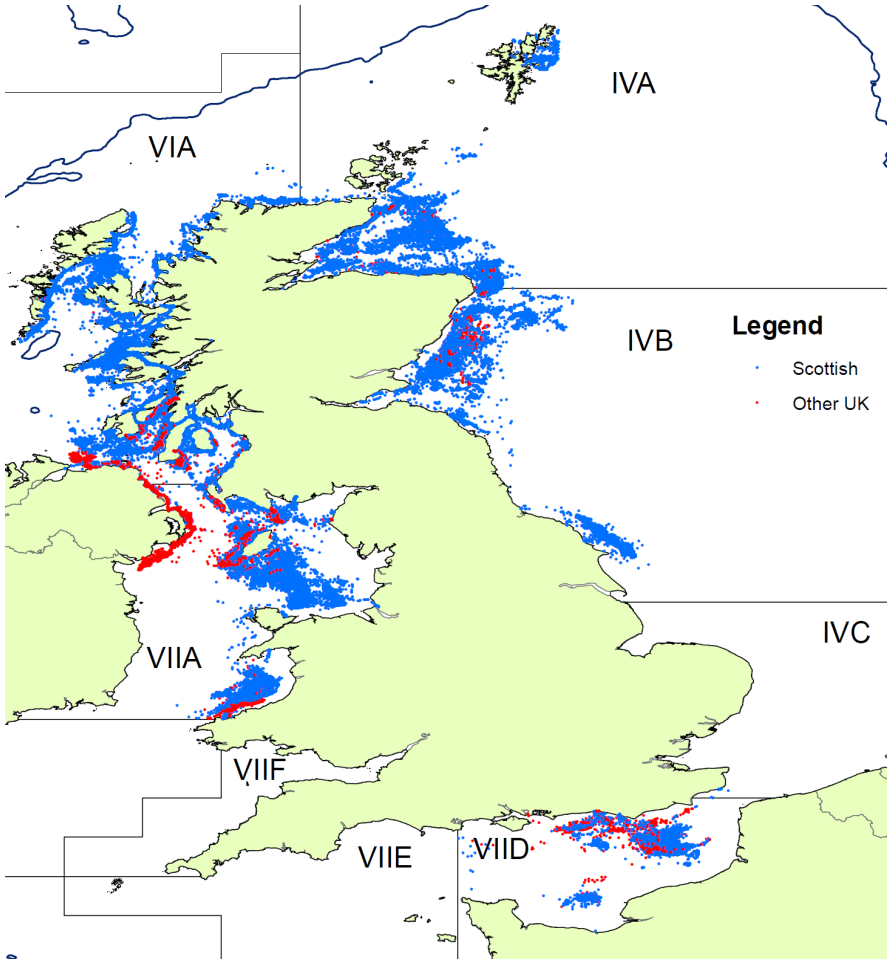
2010



2009


IVA
VIA
IVB
Legend
Scottish
Other UK
IVC
VIIA
VIIF
VIIE
VIID

2008


IVA
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Legend
Scottish
Other UK
IVC
VIIA
VIIF
VIIE
VIID