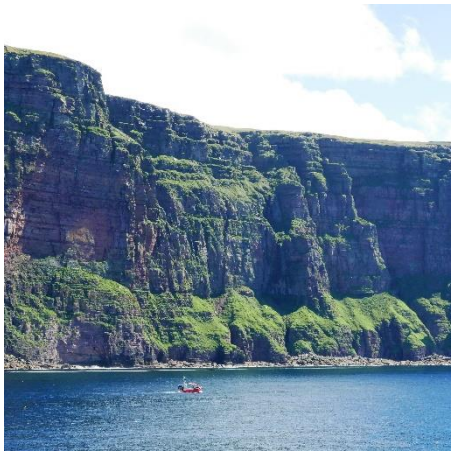

Scallop Management and Conservation Strategy West Coast Waters

Marine Scotland

Inshore Fisheries Outreach and Technical Support Framework

Lot 1 – Call Off Number 1

Final Report

12th July 2019

Submitted by:

MRAG

In association with:

Inmara

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Acronyms

Acronym	Definition
CCTV	Closed Circuit Television
CFP	Common Fisheries Policy
CPUE	Catch Per Unit Effort
DAS	Days At Sea
DNA	Deoxyribonucleic Acid
FAO	Food and Agriculture Organization of the United Nations
FMP	Fisheries Management Plan
HCR	Harvest Control Rule
ICES	International Council for Exploration of the Seas
IFCA	Inshore Fisheries and Conservation Association
IFMAC	Inshore Fisheries Management and Conservation
MCRS	Minimum Conservation Reference Size
MLS	Minimum Landing Size
MMO	Marine Management Organisation
MPA	Marine Protected Area
MS	Marine Scotland
MSC	Marine Stewardship Council
MSH	Minimum Shell Height
MSY	Maximum sustainable yield
NMP	National Marine Plan
PMF	Priority Marine Feature
PUKFI	Project UK Fishery Improvements
RIFG	Regional Inshore Fishery Group
SAC	Special Area of Conservation
SIWG	Scallop Industry Working Group
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SSB	Spawning Stock Biomass

Acronym	Definition
SSI	Scottish Statutory Instrument
SSMO	Shetland Shellfish Management Organisation
SWFPA	Scottish Whitefish Producer Association
TAC	Total Allowable Catch
USA	United States of America
VMS	Vessel Monitoring System
VPA	Virtual Population Analysis
WC-RIFG	West-Coast Regional Inshore Fishery Group

Table of contents

1 Introduction

1.1 Project Background

Scallops represent a valuable fishery resource in Scotland, providing an important source of revenue for the fishing industry and in turn providing valuable support to regional economies. The Scottish west coast is the most significant region for scallop production in Scotland in terms of landings, with a large proportion of the catches coming from within the boundary of the West Coast Regional Inshore Fisheries Group (WC-RIFG) (Figure 1-1). Given the national and regional importance of the scallop industry it is important to ensure that the management frameworks deliver long-term viability and sustainability of the industry.

In recent years there has been substantial discussion by industry stakeholders within the WC-RIFG of concerns in relation to the current status of the fishery and the potential for improved scallop management. The WC-RIFG prioritised consideration of the management of scallop fisheries in the region within their 2017 Fisheries Management Plan and have subsequently developed proposals for further management measures to be introduced within the WC-RIFG area to help safeguard and monitor local scallop stocks.

1.2 Project Scope

The scope of this project has been shaped by the fleet and geographic focus of the WC-RIFG scallop management proposals. The primary focus of these proposals is on fisheries targeting king scallop with towed dredges (and to a lesser extent by diving) within the inshore waters of Argyll and Mull in the WC-RIFG area. These fisheries target scallops from the North West and the West of Kintyre stock assessment areas.

The project scope also has some relevance to queen scallop fisheries in the area and to king scallop fisheries beyond the boundary of the WC-RIFG area targeting scallops from the same stocks.

1.3 Project Aim

This project seeks to provide a strategic context for management measures which have been proposed by WC-RIFG and examine the relationship between these proposals and the wider fisheries and marine ecosystem management objectives for the region. It has been divided into three phases:

- The first phase of the project was a review of relevant background to the west coast scallop fisheries in order to provide background to the management proposals to be included in this document. This includes an overview of the West of Scotland scallop fishery, examines the life history attributes of scallops, reviews the current understanding of stock status derived from Marine Scotland stock assessments and sets out the suite of management controls that are currently in place.
- During the second phase of the project a stakeholder engagement exercise was undertaken with the scallop industry, managers, academics and wider stakeholder interest groups to gain insight and understanding of the feasibility and potential implications of the WC-RIFG management proposals.
- In the third and final phase of the project the responses of the stakeholder engagement were collated and analysed. These responses provide the basis for a review of the WC-RIFG scallop management proposals and augment a wider discussion of the strategic approaches to scallop management on the west coast

This report summarises the conclusions from all three phases of the project and is the final reporting output.

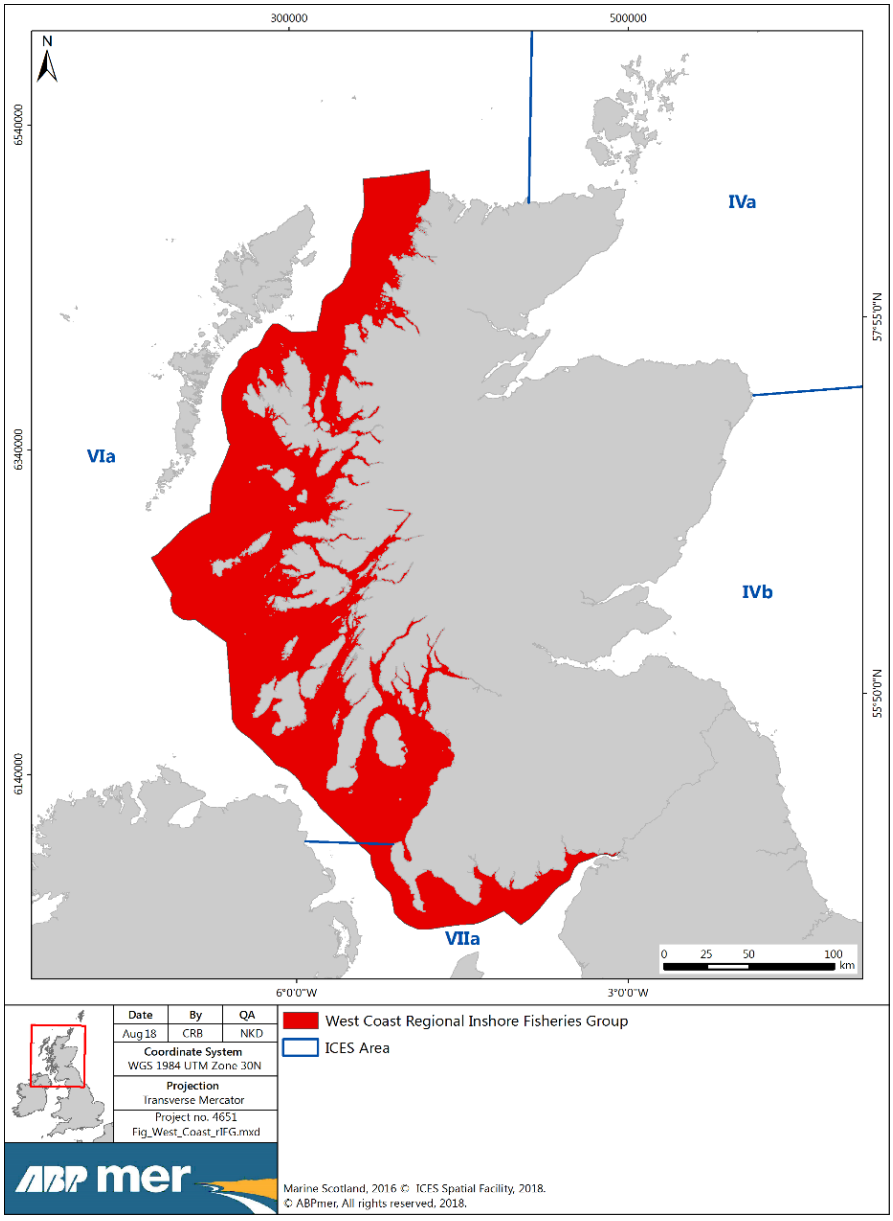


Figure 1-1: The West Coast Regional Inshore Fisheries Group area. (Source: *Marine Scotland 2016*).

1.4 Report Structure

The report is structured to initially provide essential background material to give important context to considerations of changes to management of scallop fisheries. This includes a description of the existing scallop fishery within the WC-RIFG area, in Section 2 of the report, highlighting typical patterns of operation. A description of the species biology, habitat preferences and the latest scientific understanding of stock status is described in Section 3. The final important element of background information is a description of the current level of management within the scallop fishery, which is provided in Section 4.

In Section 5, the report then explores, by way of example, approaches to management of scallop fisheries adopted elsewhere, before presenting the three WC-RIFG proposals in Section 6 of the report. The industry response to WC-RIFG proposals was informed by an

industry stakeholder engagement exercise and the results of this exercise are discussed in Section 7.

Finally, recommendations, both in relation to the WC-RIFG proposals and further areas of consideration are provided in Section 8.

Although the report does not provide a fully formed fisheries management plan (FMP) for west coast scallop fisheries, it is intended to provide a resource to inform the consideration of existing management proposals and to help shape future management proposals as part of a wider strategic exercise.

2 Characteristics of the West Coast Scallop Fishery

2.1 UK context

There are two species of scallop caught in UK waters, the king scallop (*Pecten maximus*) and the queen scallop (*Aequipecten opercularis*). King and queen scallop landings by UK vessels originate from five main geographical areas around the UK and France (Figure 2-1): the Isle of Man territorial sea, the Scottish west coast, the Scottish east coast, the western English Channel and the Baie de Seine. Scallop landings into the UK by UK-registered vessels as a whole decreased by 33% between 2013-2017. A recent analysis by Seafish indicated that LPUE (landings per dredge per hour at sea) has been stable between 2008 and 2012 and then declined between 2012 and 2016. This occurred in all UK sea areas with the exception of the northern North Sea (area 4a), but the extent of the decline differs between areas, with the West of Scotland (area 6a) exhibiting less of a decline than the Irish Sea (area 7a)[1]. In contrast, the value of the scallop landings in price per kilo increased by 18% since 2012[2].

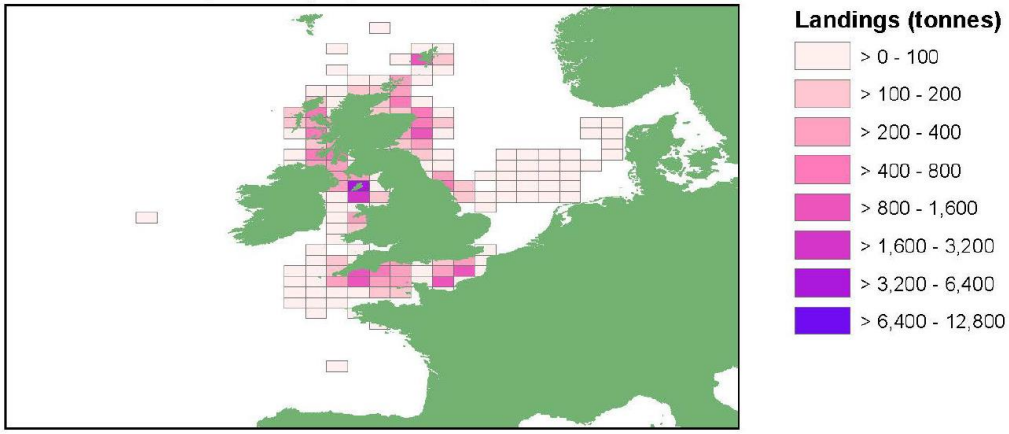


Figure 2-1 Map of king and queen scallop landings around the UK in 2016. (Source: *MMO, 2017 UK Sea Fisheries Statistics 2017*).

Scottish-registered vessels land 59% of all UK scallops, although 50% of this is landed into ports outside of Scotland Error! Bookmark not defined.**. Scallop landings by Scottish vessels into Scotland as a whole are relatively stable, fluctuating around an average of 10,288 tonnes between 2012 and 2017, with the associated value of scallop product having increased by 12.5% during the same period[3]. King scallops comprise the majority of scallop landings volume and value from Scottish waters, across all harvesting methods (**

Table 2-1). King scallops are valued on average at £2,600 per tonne, compared with queen scallops at £1,100 per tonne.

[1] Curtis, H. et al (2017). Seafish Economic Analysis UK king scallop dredging sector 2008 – 2016 2 nd Edition, final 2016 data. [online] Seafish.org. Available at: https://www.seafish.org/media/Publications/2nd_Edition_Scallop_report_FINAL_Dec2017.pdf

[2] Defra. 2017. UK Sea Fisheries Statistics 2017. https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017

[3] Dobby H., Fryer R., Gibson T., Kinnear S., Turriff J. & McLay A (2016). Scottish Scallop Stocks: Results of 2016 Stock Assessments. Scottish Marine and Freshwater Science Vol 8 No 21. Available on-line at: https://data.marine.gov.scot/dataset/scottish-scallop-stocks-results-2016-stock-assessments/resource/ef51abd9-910b-4c19-832e

Table 2-1 Volume and value of landings of scallops caught be Scottish-registered vessels in Scottish waters.

2017	*Volume (t)*		*Value (£)*	
	king	*queen*	*king*	*queen*
Total landings from Scottish waters, all gear types	8531.4	1154.8	21,856,500	1,295,400
Percentage of total	88%	12%	94%	6%

Within this project it was not possible to obtain detailed landings data for those catches originating from the inshore waters of the WC-RIFG area, because landings data are recorded by ICES statistical rectangle from which catches originate, which do not correspond to the RIFG boundary, although VMS data from the >15m vessels could be used for this purpose in future research. However, Marine Scotland provided a list of those rectangles which are predominantly inshore, thus providing a representative picture of the pattern of landings from inshore waters. The following sections describe landings reported as being caught from these 'inshore' rectangles, the rectangles classed as 'inshore' are listen in Annex 2.

2.2 West-coast inshore landing trends

The delineation between inshore and offshore in the following analysis has been based on ICES rectangles determined as 'inshore' in a list provided by Marine Scotland. Scottish west coast scallop landings (king and queen scallops combined) comprise 37% of scallop landings from Scottish waters and 96% of these originate from inshore.

King scallops comprise 98% of west coast inshore landings, with queen scallops making up the remaining 2%. Compared with landings from offshore, the west coast inshore fishery is also proportionately more important for king scallops than for queen scallops; the inshore area makes up 99.8% of king scallop landings, and 30% of queen scallop landings.

Landings of king scallops in 2017 using all gear and harvest methods from the west coast inshore area, were 3,480 tonnes and with a value of £8,850,000 amounting to 41% of total Scottish king scallop landings volume and value. Similar to the picture across the UK, there has been a declining trend in king scallop landings from the west coast inshore, decreasing by 22.5% over the last 6 years (Figure 2-2 a).

West coast inshore queen scallop landings exhibit a sharply declining trend decreasing by 93.5% between 2012-2017 (Figure 2-2 b), broadly replicating the trend for Scotland as a whole over the same period; landings of queen scallops by Scottish vessels into Scotland has decreased by 75%[14]. This is thought to be partly due to unusually high recruitment leading to increased landings earlier in the time-series, between 2009-2012[4].

[4] Www2.gov.scot. (2016). Consultation on New Controls in the Queen Scallop Fishery in ICES Divisions VIa and VIIa. [online] Available at: https://www2.gov.scot/Resource/0050/00507349.pdf.

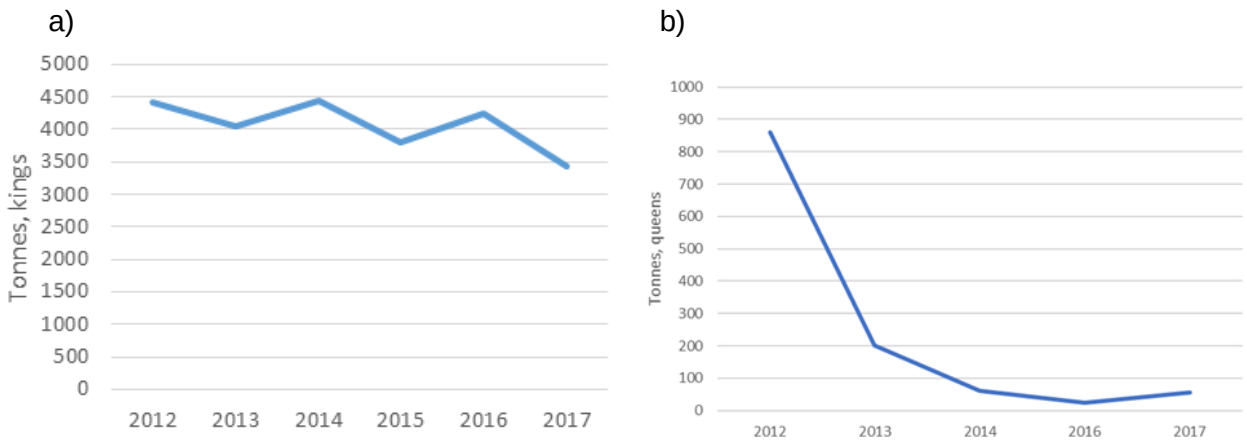


Figure 2-2. a) king scallop landings from the west coast inshore area, including all harvesting methods. b) queen scallop landings from the west coast inshore area, including all harvesting methods.

2.3 West-coast scallop grounds

Figure 2-2 illustrates the distribution of fishing intensity for vessels >15m within the WC-RIFG area based on VMS data as a proxy for effort[6]. The data indicates that there are a number of areas inshore where effort was greater, as depicted by the pink areas on the map, such as in the Tiree ground to the north-west of Mull, surrounding Gigha and to the south, and south of Islay. The value of the under-15 m dredge fishery in Scottish waters is depicted in Figure 2-3 as a proxy for relative fishing intensity. Within the WC-RIFG area, areas of greatest landings value for this fleet grouping are depicted by the blue areas on the map and correspond broadly with effort of the over-15 m fleet, noting that the time-series available differ slightly and the under-15m data are subject to variable coverage and may underrepresent dredge activity around Cambeltown, Islay and Jura[5]. The overlapping fished areas seem to be the west and south Islay, south of Arran, around the Isle of Cumbrae, and areas further south bordering the Irish Sea within the Mull of Galloway off Port William and Cairngaan.

[5] Marine Scotland (2014). ScotMap Inshore Fisheries Mapping in Scotland: Recording Fishermen's use of the Sea. Authors: A Kafas, A McLay, M Chimienti and M Gubbins. Scottish Marine and Freshwater Science Volume 5 Number 17. Available at https://www2.gov.scot/Resource/0046/00466802.pdf.

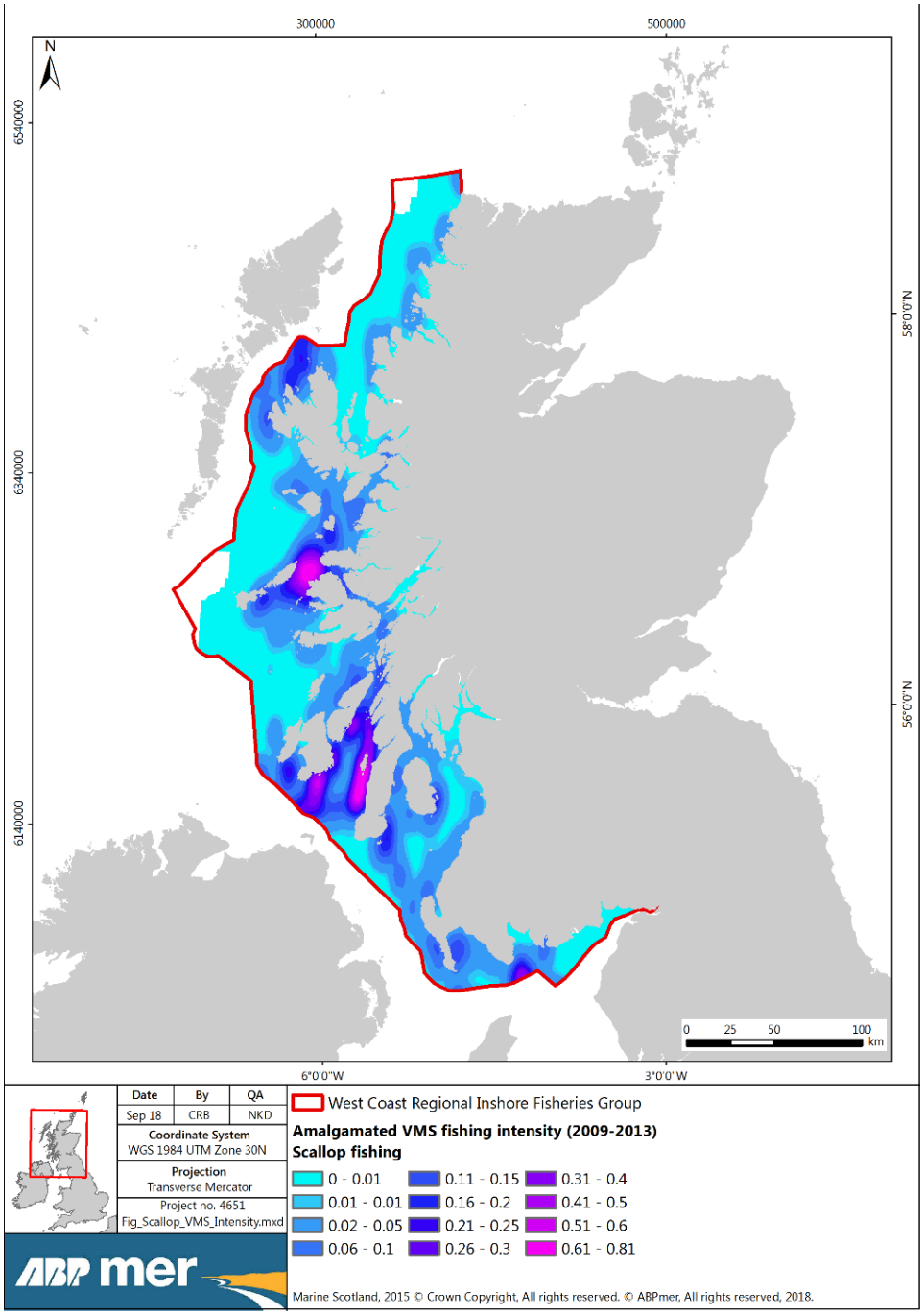


Figure 2-2. The distribution of effort of all vessels >15m, based on amalgamated VMS[6].

[6] The VMS data provides information on the location and identity for all UK registered commercial fishing vessels (>15m length) fishing for Scallop species for the period 2009-2013. This provides an indication of the most intense areas for Scallop in Scottish waters. The values contained within the layer should not be taken as an absolute representation of amount of fishing vessels in a given area. Rather, the VMS values are a product of the statistical model used. The analysis calculates the density of features (probability density function) in a neighborhood around those features (bandwidth of the kernel), hence the units refer to the amount of points per unit space (density estimates). Here, it can be considered as a proxy to fishing effort. Source: Marine Scotland, 2015. Scallop 2009-2013 amalgamated VMS intensity layer. http://marine.gov.scot/maps/777; http://marine.gov.scot/information/vms-amalgamated-fishing-intensity-layers-2009-2013.

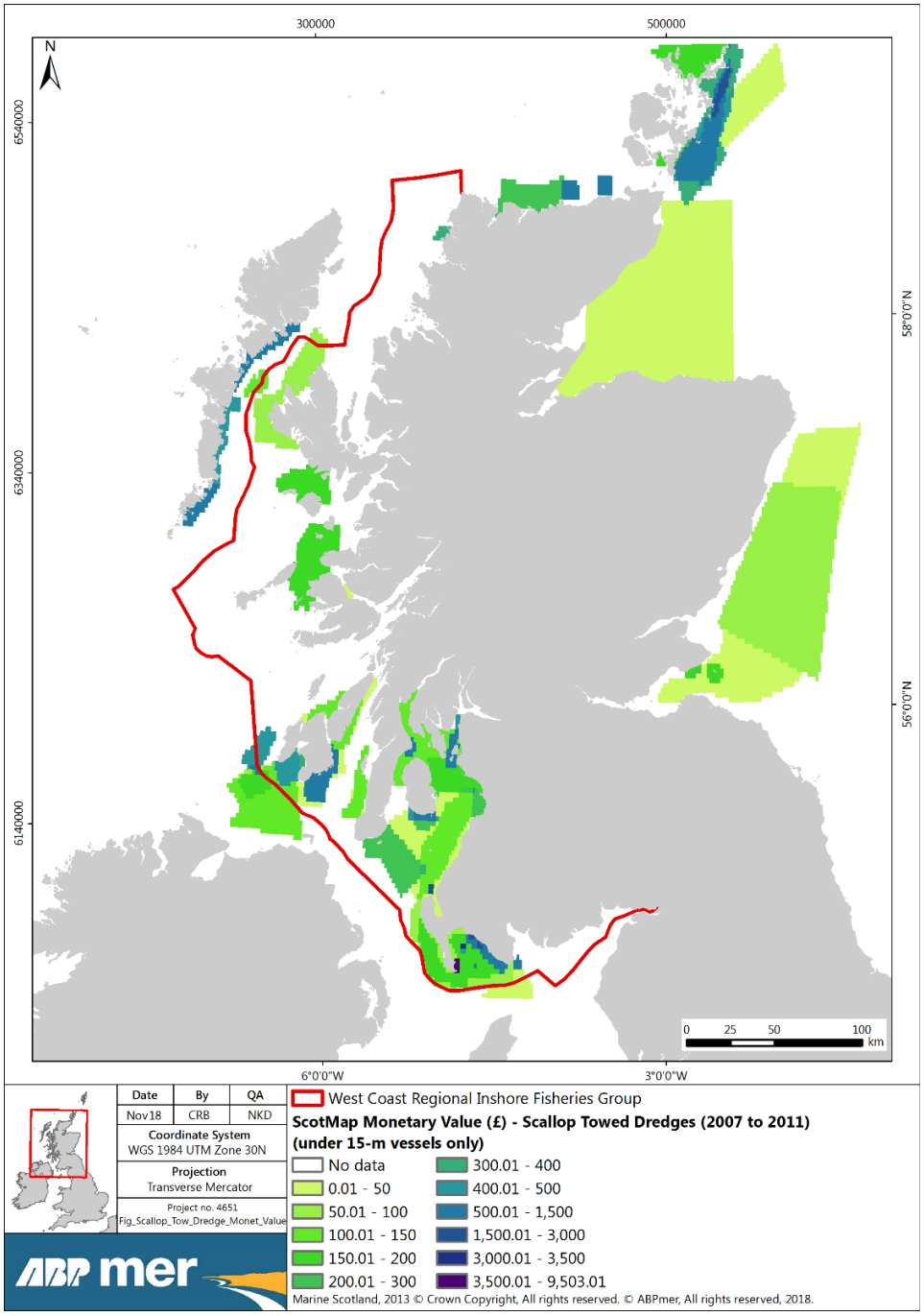


Figure 2-3. The value of scallops gathered from around the coast of Scotland by <15m vessels using scallop dredge gear[7].

2.4 Fleets and fishing methods

Throughout Scotland and across the UK, scallop vessels are often thought of as comprising three different sectors based on gear type, vessel length and geographical range; a day-boat dredge fleet mostly comprising under 10 m vessels and some 10-12 m vessels, a nomadic

[7] Source: Marine Scotland. ScotMap - Inshore Fisheries Mapping Project in Scotland. Available at http://marine.gov.scot/information/scotmap-inshore-fisheries-mapping-project-scotland. Note: The dataset, as of July 2013, is based on interviews of 1,090 fishermen. Individuals defined their fishing areas with variable levels of precision. The coverage provided by the ScotMap data set varies regionally.

dredge fleet comprising of 12-15 m vessel and over 15m vessels, and the hand-diving sector which operate inshore. The following analysis of the vessels fishing in the West coast inshore, has split all the vessels into four size classes, in order to investigate deeper into trends linked to vessel size.

Total landings of king and queen scallops from the west coast inshore area from vessels over 15 m in length decreased between 2012 and 2017 (Figure 2-4 a), whereas landings from the 12-15 m vessels have been variable, declining between 2012 and 2013 and since then, almost doubling in volume between 2013 and 2016 (Figure 2-4 b). In comparison, landings from under 10m and 10-12m vessels have been relatively stable.

Across all length groups, there has been a slight increasing trend in the number of vessels landing scallops (king and queen) harvested from the west coast inshore, from 89 in 2012 to 101 in 2017. The numbers of vessels landing king scallops in 2017 were relatively evenly split between day boats (<10m & 10-12m) and nomadic boats (12-15m & >15m) (see Table 2-2). However, the over 15m fleet land the greatest proportion of king scallops (67%) and 100% of queen scallop landings caught from the inshore area.

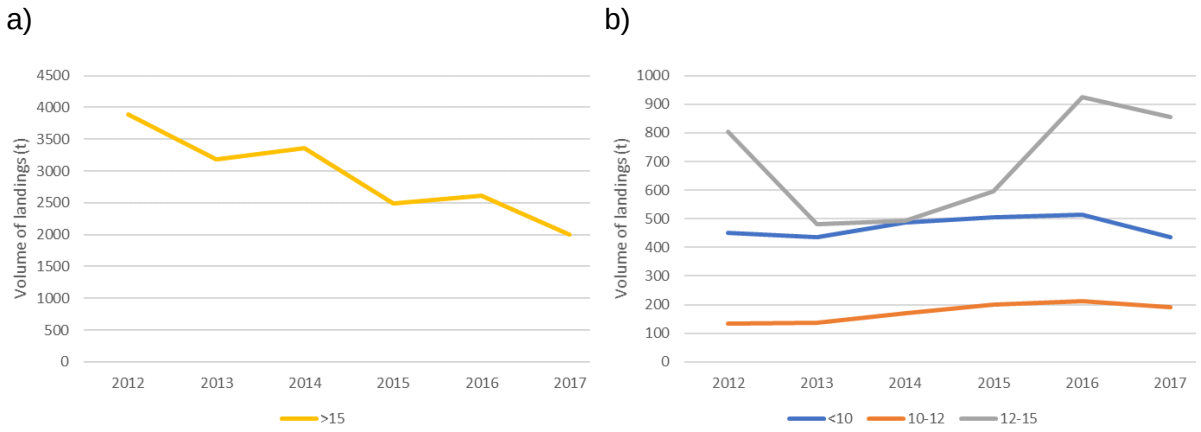


Figure 2-4. a) Landings of king and queen scallops each year from the west coast inshore from the >15m vessels; and b) Landings each year from the <10m, 10-12m, 12-15m vessels; shown on different graphs because of the difference in scale.

Table 2-2. Number of vessels and landings in different vessel-length categories for the West coast inshore king scallop fishery, all gear types in 2017

	Day boat		Nomadic	
	<10m	10-12m	12-15m	>15m
% of number of vessels	37.1	10.3	13.4	39.2
% of landings	22.8	5.3	13.5	58.3

King scallops are mainly caught using scallop dredges (84% of landings), with some also harvested by hand-diving (13%) and a small amount via mechanised dredges (3%); the latter may reflect an error in reporting of gear codes for scallop dredges and suction dredges, normally used for clams and cockles, or scallops may be taken as bycatch in that fishery (see Figure 2-5). Within the under 10m and 10-12m categories, the majority of landings come from hand-diving. Based on vessel size and gear type, the west coast inshore fishery can therefore be classified by three key sectors or 'metiers' all targeting king scallops: under 12m scallop dive boats, under 12m dredges, and over 12m dredges. Fifty-six percent of queen scallop

landings came from trawls and 44% came from dredges in 2017 (all from over 15 m length vessels), with none originating from the hand-dived sector.

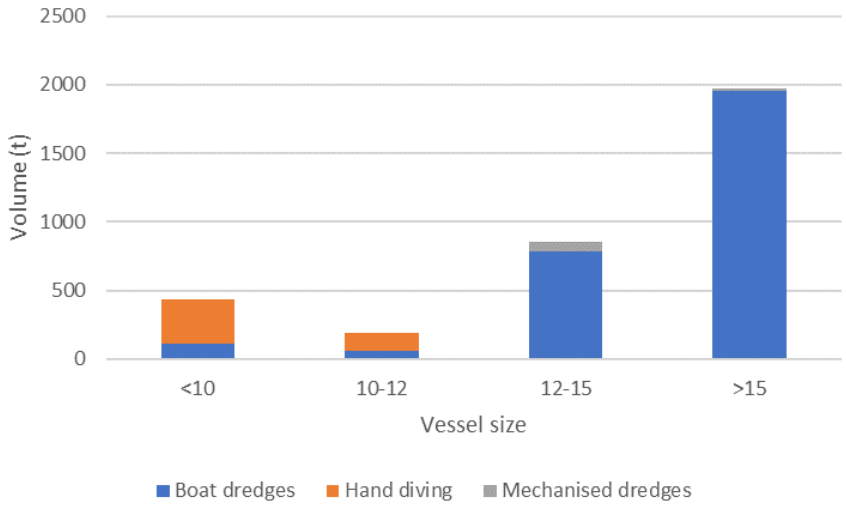


Figure 2-5. The proportion of landings from different gear types and vessel length (m), of king scallops in 2017, from the west coast inshore area.

2.4.1 Hand-diving

The hand-dived scallop sector is responsible for 3.2% of all king scallop landings from Scottish waters. The volume of the hand-dived king scallop fishery throughout Scotland increased by 56% between 2012 and 2017 (see Figure 2-6 a), and the value increased by 71%. Within the west coast inshore area, hand-dived scallop landings have also shown a steady increase in both landings volume and value (Figure 2-6 b), albeit showing a slight decline in landings in 2016. The west coast inshore fishery accounted for 51% of the total Scottish hand-dived king scallop landings in 2013, rising to 71% in 2017; the west coast inshore is therefore currently the most valuable region for the hand-dived scallop industry. The price per tonne for hand-dived scallops was £2,968, compared to £2,479 for dredged scallops in 2017 in the west coast inshore.

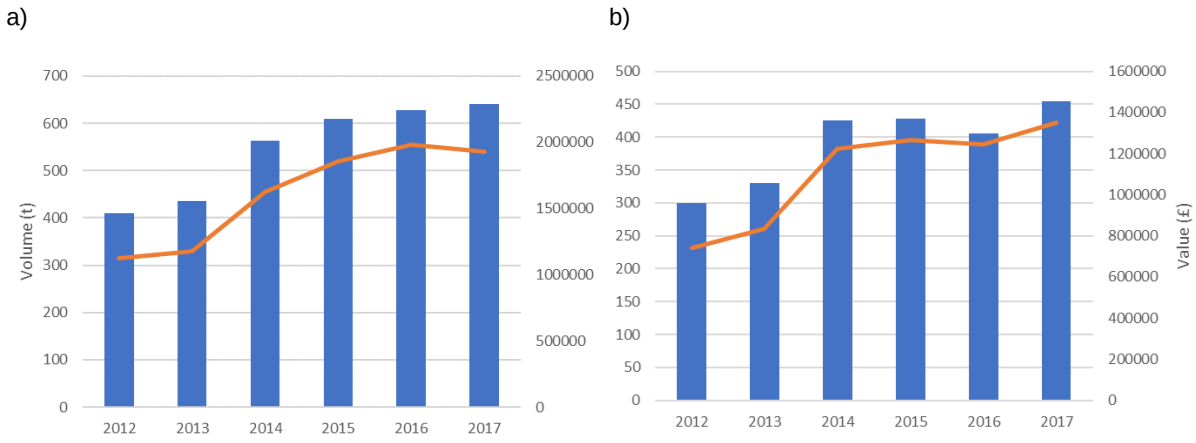


Figure 2-6. Volume (blue bars, left axis) and value (orange line, right axis) of the hand-dived scallop fishery in a) Scotland as a whole (king and queen scallops), and b) the west coast inshore area (comprised only of king scallops on the west coast).

The area of seabed available to scallop divers is relatively limited (compared to seabed available to dredgers), delineated by a depth range of 2-35 m (according to consultation with the west coast scallop diving sector), illustrated in Figure 2-7. Hand-diving for scallops is also restricted to locations by exposure to waves, which is not the case for dredge vessels. Therefore, it could be assumed that dredge vessels have a lot more of the seabed available to them for fishing. However, there are some areas where the topography, bottom composition or site designation (such as MPA) prohibits dredge vessels from fishing but divers are able to fish there.

The value of hand-dived scallops in Scottish waters is depicted in Figure 2-8 as a proxy for relative fishing intensity, and when compared with Figure 2-7, indicates areas targeted by divers encompass a variety of habitat types. Within the WC-RIFG area, key hand-diving areas are depicted by the dark blue areas in Figure 2-8, and include the bay between Fort William and Drummore, Maidens, the Summer Isles, Isle of Gigha and the upper Firth of Clyde, noting that the time-series covers 2007 to 2011 and therefore may be outdated. Proposal C from the Scallop Divers Association proposes measures in Marine Protected Areas (MPAs), one of which overlaps with an area of high intensity of hand-diving for scallops in the Sumer Isles.

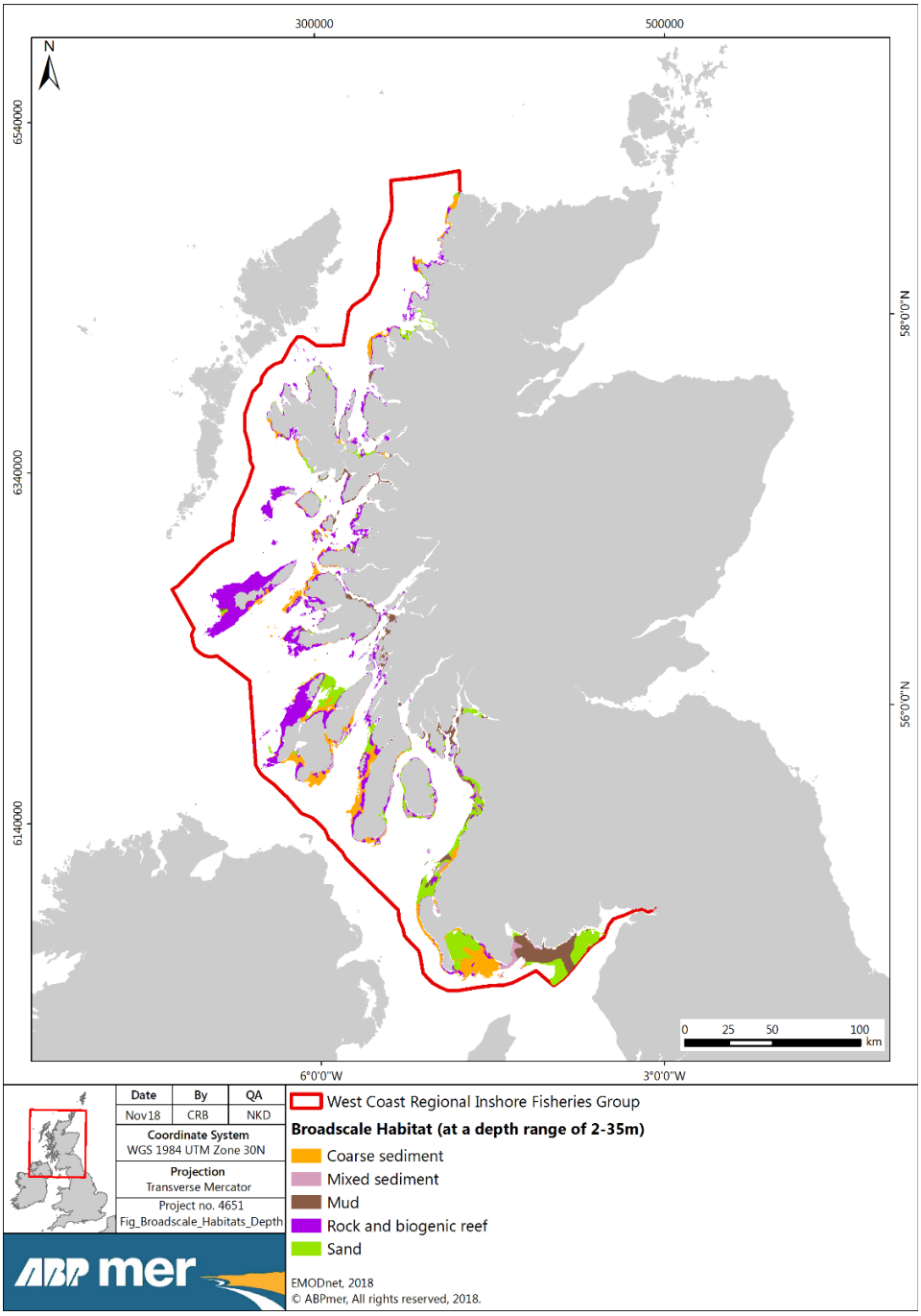


Figure 2-7. A map of the potential available areas for hand-diving, based on depth range and corresponding habitat types.

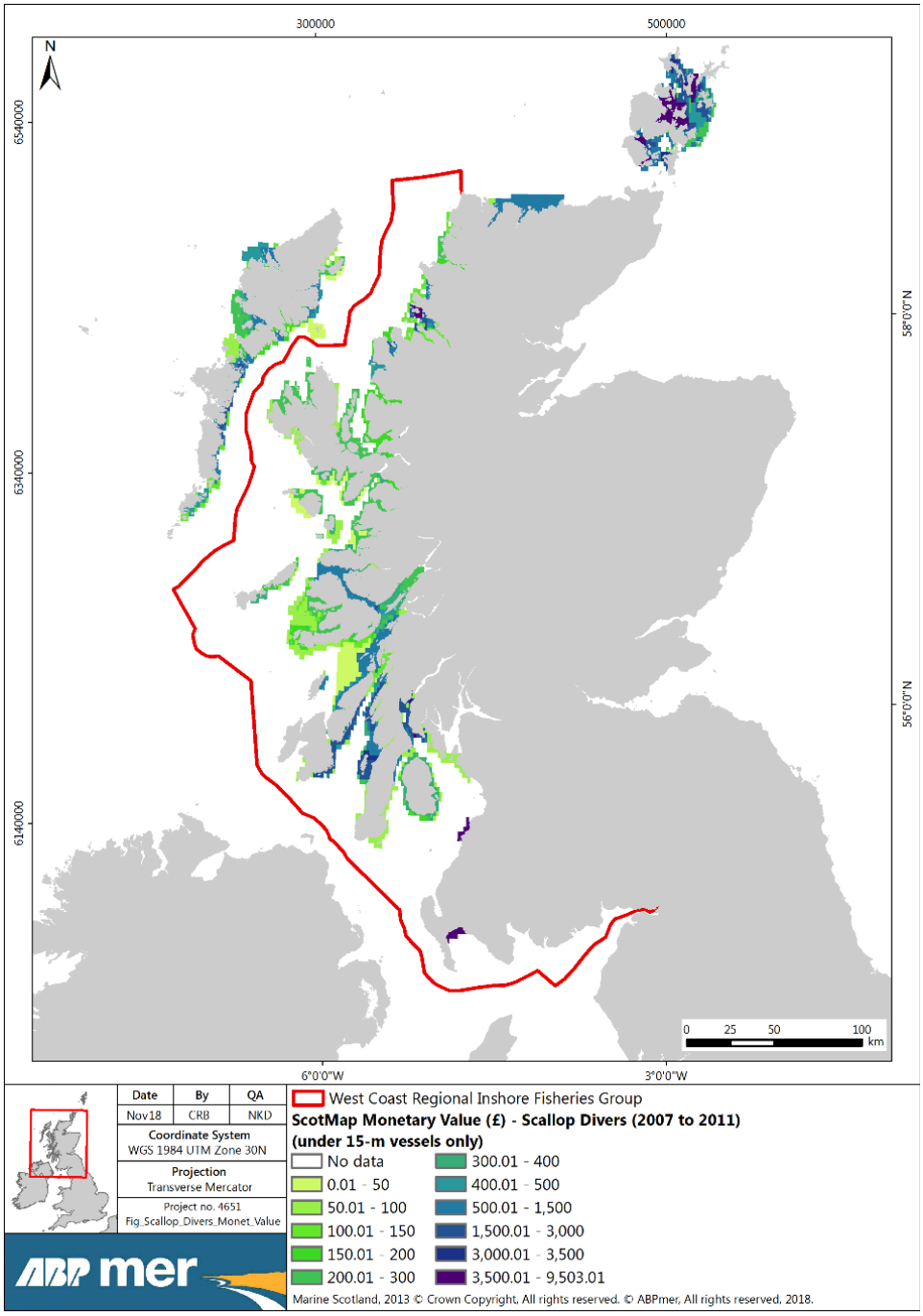


Figure 2-8. The value of scallops harvested by hand-divers on the west coast.

2.5 Seasonality

There are no pronounced seasonal trends in west coast inshore scallop landings (kings and queen scallops combined because the pattern was similar across both species) except that for both dredging and hand diving, landings increase over the summer months. Landings from the dredge fleet peak slightly in early summer (May–June) and again in late summer and early autumn (August–October) (see Figure 2-9). There may be seasonal patterns in landings by species at smaller spatial scales within the WC-RIFG, as a result of localised temporal closures (see Section 4.2.2).

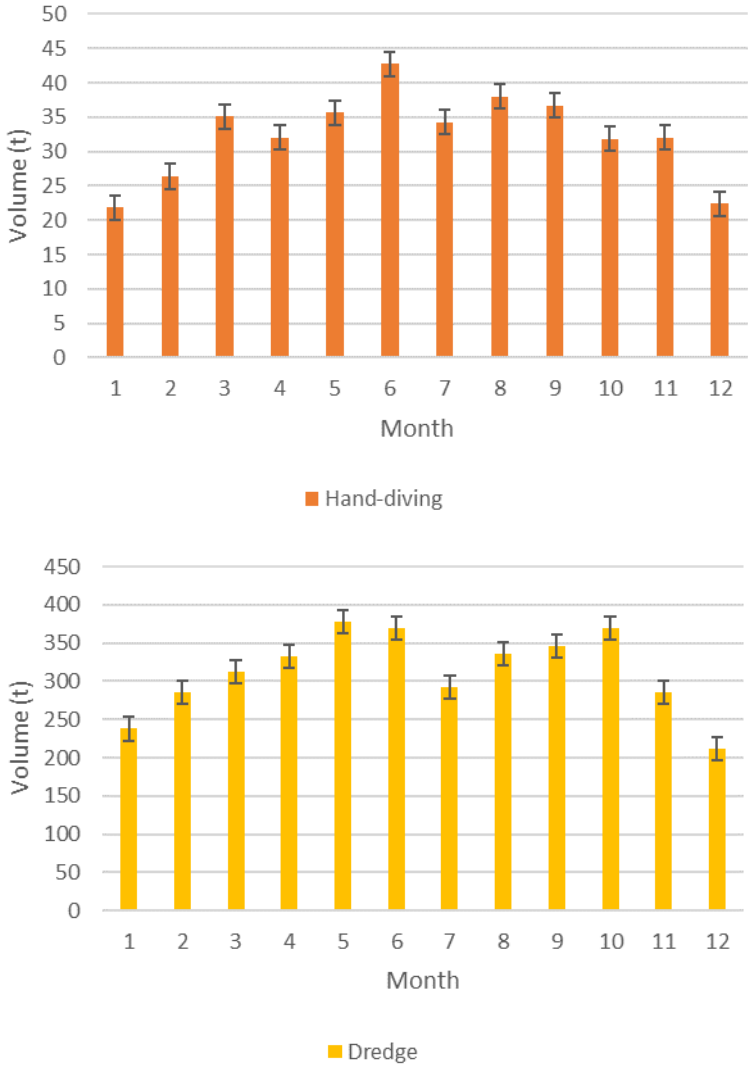


Figure 2-9. Monthly average landings (2012-2017) for hand diving and dredging in the west coast inshore. Error bars represent the range of interannual variation.

2.6 Ports

In 2017, king scallops from inshore areas were landed into 73 ports within the WC-RIFG area, a full list of which can be found in Annex 3 The top three ports for landings, Oban, Mallaig and Tobermory represent 27% of the total landings and are all situated close to or within the proposed areas for management within the WC-RIFG area. Figure 2-10 shows the top 15 landing ports which collectively represent 75% of the landings; landings are relatively evenly distributed across these 15 ports with the remaining 25% of landings distributed across the other 58 ports.

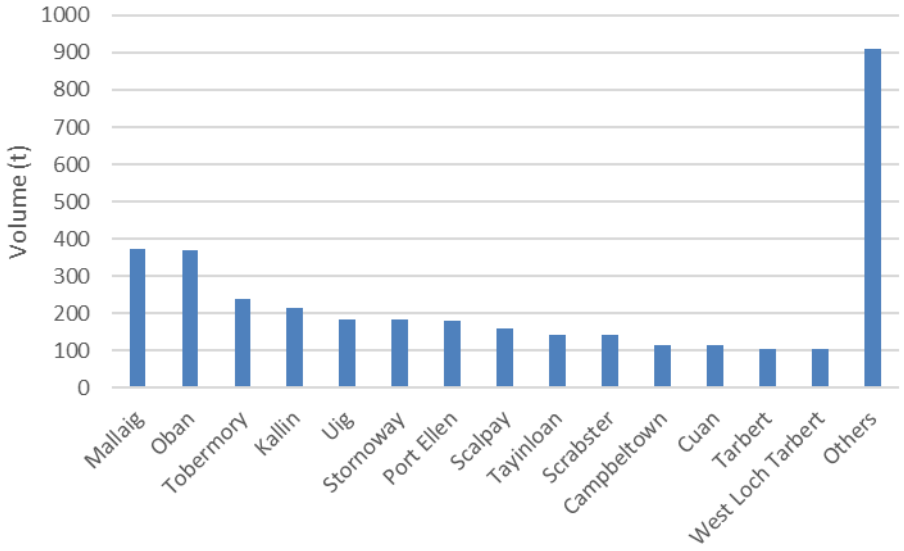


Figure 2-10. Volume by landing site of king scallops caught from the west coast inshore, showing the top 15 sites with the other 58 sites consolidated as 'others', from 2017

Queen scallop landings from the west coast inshore are split predominantly between two ports with 44% landed in Stranraer, and 40% landed in Campbeltown (Figure 2-11). In addition, queen scallops comprise 49% of all scallop landings into Stranraer from both inshore and offshore areas.

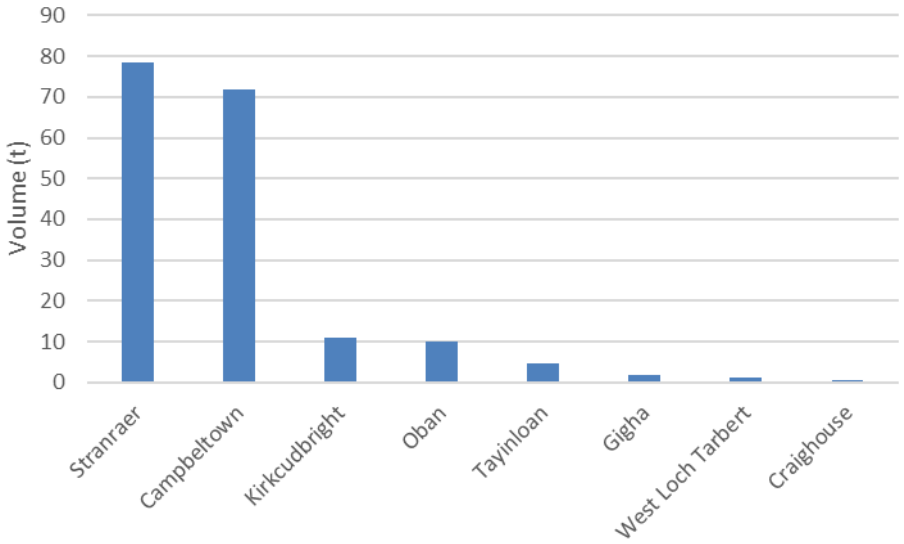


Figure 2-11. Volume by port of queen scallops caught from the west coast inshore area in 2017

Whilst it is possible for nomadic vessels from all around the UK to fish in the west coast inshore area, the data show that the majority of vessels fishing in the WC-RIFG area are Scottish registered (see Figure 2-12). Figure 2-13**Error! Reference source not found.** illustrates landings into Scottish west coast ports by vessels registered outside of Scotland; of these, France lands the most scallops into Scottish west coast ports.

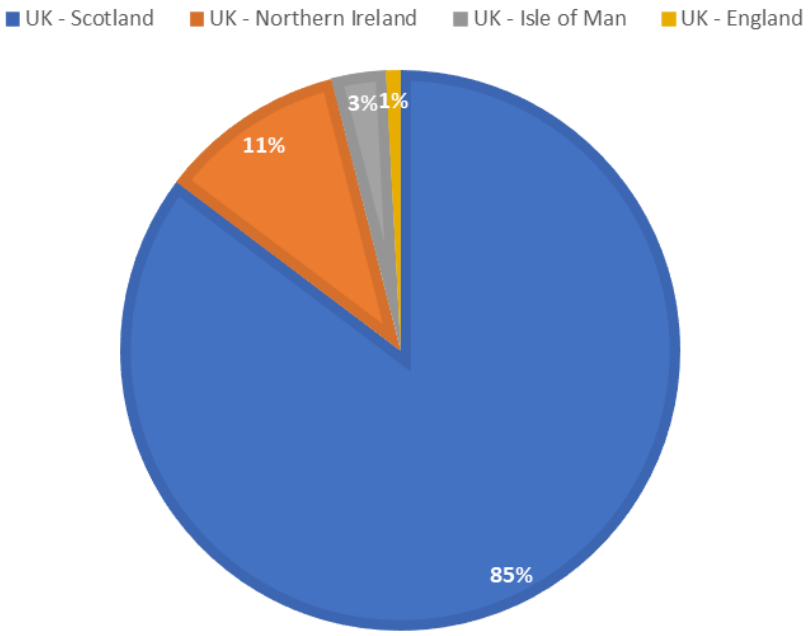


Figure 2-12. The proportion of landings in 2017 from the west coast inshore area, by vessel origin from the devolved administrations (all harvesting methods and vessel size included)[8].

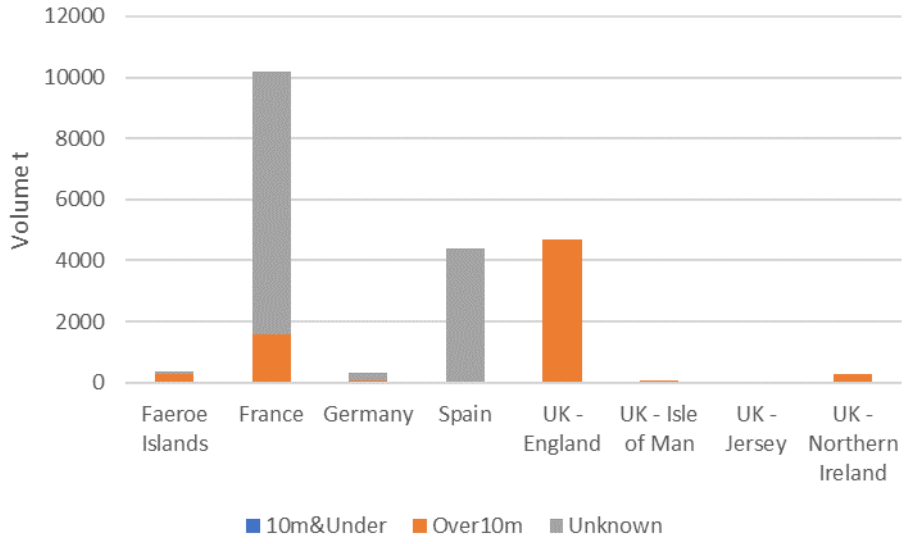


Figure 2-13 The proportion of landings in 2017 into ports in the west coast inshore, by vessel origin from all countries excluding UK-Scotland due to incomparable scales (all harvesting methods and vessel size included)[9].

[8] MMO 2017. UK Sea Fisheries Statistics. 2013 to 2017 fleet landings by ICES rectangle. https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017

[9] MMO 2017. UK Sea Fisheries Statistics. 2013 to 2017 UK fleet landings and foreign fleet landings into the UK by port

Of these Scottish registered vessels, the numbers of vessel from each administrative port can be seen in Figure 2-14, with Campbeltown, Oban and Ayr being the main administrative ports. Figure 2-15 focusses just on the >15m vessels and shows that of the Scottish over 15m vessels fishing in the west coast inshore area, 98% of landings come from vessels registered to ports in the west coast of Scotland. Similarly, all but one of the under 10m vessels are registered to the west coast.

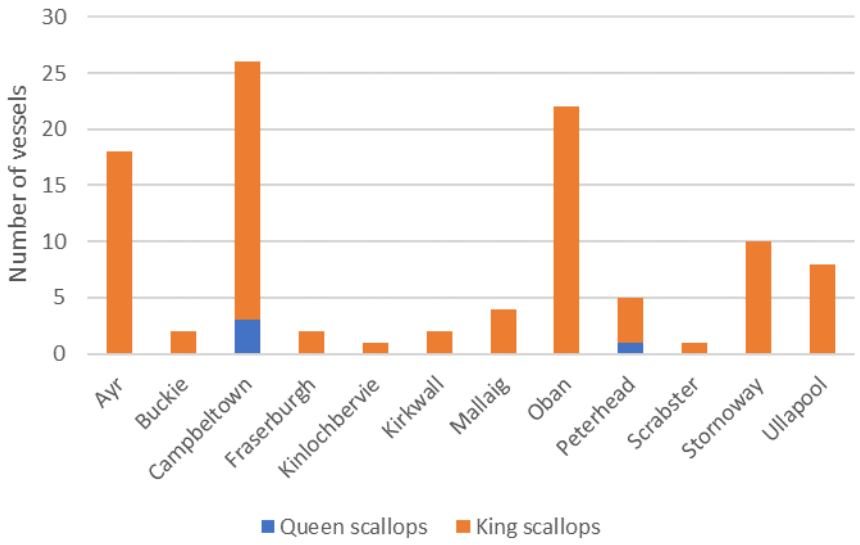


Figure 2-14 The number of vessels by administrative port and species landed, for landings from the west coast inshore area in 2017, all gear types.

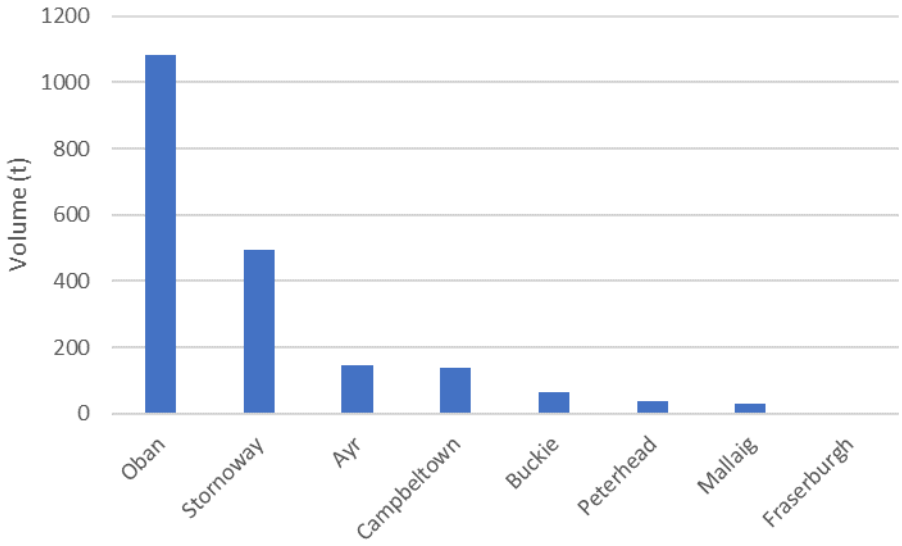


Figure 2-15. Landings of king and queen scallop by administrative (registered) port that vessels (>15m) fishing in the west coast inshore area are registered to (2017).

3 Biology and ecology

There are two species of scallop present in the WC-RIFG area, the king scallop (*Pecten maximus*) and the queen scallop (*Aequipecten opercularis*). The following section focuses on the king scallop, due to the relative scale and importance of its fishery; however, it also includes information pertaining to both scallop species, differentiating between the two where appropriate.

3.1 Life history characteristics

The life cycle of both scallop species comprises two main phases: a planktonic larval phase (i.e. in the water column), and a benthic phase (i.e. on the sea floor). The planktonic larval phase lasts between 11 and 30 days[10], depending on ambient temperatures. During this time they may travel as far as 10 to 40 km from their spawning site, but as the swimming ability of scallop larvae is low, their dispersal depends largely on localised or regional currents[10]. Populations that are spatially separate can therefore be linked through this dispersal, which has consequences for stock assessment, conservation and management.

After the planktonic larvae phase the scallops, which at this point are known as 'spat', begin to settle on or near the sea floor. Spat often settle onto hydrozoans and bryozoans, to which they attach by means of byssus threads; secreted filaments that many bivalves use to anchor themselves to surfaces. Once spat reach approximately 1 to 5 mm in diameter, they detach and re-settle onto the seafloor, where they take up their normal habit on the substrate[11]. Once settled, individuals undertake little active movement beyond small-scale movements of only a few metres, often associated with physical disturbance. This limited adult mobility can make scallops more vulnerable to localised depletion.

Scallops are permanent hermaphrodites, meaning that they each have both male and female reproductive organs. While this does not necessarily have direct implications for their management, it removes the possibility of sex-selective fishing impacts, which has been shown to reduce sperm-availability in other shellfish populations. Scallops are also highly fecund, that is they each produce large numbers of eggs at each spawning occasion; up to 2 million for a large scallop[12]. Spawning in both species occurs between April and October (Vause *et al*. 2007), although there is little information regarding the specific timing of peak spawning within the WC-RIFG area. Scallops are broadcast spawners, releasing large numbers of eggs and sperm separately, with fertilisation occurring as random encounters in the water column. This type of spawning is often considered to require a particular density of adult scallops, in order to result in successful fertilisation[13]. As such, maintaining areas of high scallop density is often considered as a useful tool for management and conservation, as it can contribute towards improved yield per recruit and reproductive output (dependent on a number of other contributing factors).

[10] Pennec, M., Paugam, A. & Le Pennec, G., 2003. The pelagic life of the pectinid Pecten maximus - a review. ICES Journal of Marine Science, 60, 211-233.

[11] Beukers-Stewart BD and Beukers-Stewart JS (2009). Principles for the Management of Inshore Scallop Fisheries around the United Kingdom. Report to Natural England, Scottish Natural Heritage and Countryside Council for Wales. Marine EcosystemManagement Report no. 1, University of York, 58 pp.

[12] Bell, E., Lawler, A., Masefield, R., McIntyre, R., and K.R. Vanstaen (2018) Initial assessment of Scallop stock status for selected waters within the Channel 2016/2017. ENG1402 European Maritime and Fisheries Fund & Defra CoFunded Project. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/722933/Scallop_assessment_2017_Final_V1.0.pdf

[13] Bayer, S. R., R. A. Wahle, D. C. Brady, P. A. Jumars, K. D. E. Stokesbury, and J. D. Carey. 2018. Fertilization success in scallop aggregations: reconciling model predictions and field measurements of density effects. Ecosphere 9(8):e02359. 10.1002/ecs2.2359. Available online at: https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecs2.2359

The king scallop is the larger of the two species, it usually grows to between 100 and 160 mm in diameter, although it can grow up to 200 mm. It is thought to mature at approximately 80 to 90 mm, which is usually at 2 or 3 years of age, but full reproductive age for king scallops is considered to be at 3 to 5 years[14]. Scallop fecundity has previously been shown to increase with both age and size[15], as such, larger and older individuals could contribute more effectively to reproductive output than smaller individuals.

Growth rates for king scallop vary around the UK coast, mostly as a result of differences in environmental and biological variables, including salinity, temperature, water depth, food supply and competition[16]. For example, higher growth rates have been reported for scallops in inshore grounds compared with offshore grounds[17]. Similarly, differences in king scallop growth rates have been determined within the English Channel, resulting in a MCRS of 110 mm in the Eastern English Channel and 100 mm in the Western English Channel. In June 2017, the MCRS for king scallops in Scotland was increased from 100 to 105 mm[18]; but as there is limited understanding of growth rates and size at onset of maturity of king scallop within the WC-RIFG, the potential effectiveness of this measure is not yet clear. Indeed, one of the proposed management measures from the WC-RIFG is consideration of a further increase in MCRS for king scallop to 110 mm, based on an assessment of the impacts of the Scottish-wide MCRS increase to 105mm, 12 months after adoption.

The queen scallop grows up to a maximum of 90 mm in diameter, maturing at approximately 40 mm and between 1 to 2 years of age[19]. The current MCRS for queen scallops in Scotland is 40 mm, and 55 mm in the Isle of Man Territorial Waters; however Marine Scotland, along with the other UK Fisheries Administrations, consulted upon a range of management options for queen scallops, including raising the MCRS to 55 mm in 2016/ 2017, which received a 94% approval in the responses[20] (see Section 4.2.1 for further details).

Excessive levels of fishing effort are believed to affect the size and age structure of scallop populations by removing larger individuals and skewing the population towards younger and smaller individuals[11]. In turn, the overall productivity of the population can be affected, as smaller individuals may not have reached full reproductive capacity. It is therefore important to monitor size and age structure of fished stocks over time in order to detect these potential impacts.

3.2 Habitat preferences

King scallops are common throughout the coast of the UK in scallop beds or areas of high density, a great concentration of scallop beds can be found on the west coast of Scotland and in the English Channel; queen scallops, likewise, are found all around the UK with high concentrations in the Irish Sea, around the Isle of Man, Shetland and the west coast of Scotland. Scallops of both species are predominantly found on sandy and sandy-gravel

[14] The Marine Life Information Network. Great scallop (*Pecten maximus*). Webpage. Available at: https://www.marlin.ac.uk/species/detail/1398

[15] Langton, R., Robinson, W., & Schick, D. (1987). Fecundity and reproductive effort of sea scallops *Placopecten magellanicus* from the Gulf of Maine. Marine Ecology Progress Series, 37(1), 19-25. Retrieved from http://www.jstor.org/stable/24825487 https://www.jstor.org/stable/24825487?seq=1#page_scan_tab_contents

[16] Minchin, D., 2003. Introductions: some biological and ecological characteristics of scallops. Aquatic Living Resources, 51, 509-580.

[17] Mason, J., 1957. The age and growth of the scallop, *Pecten maximus* (L.), in Manx waters. Journal of the Marine Biological Association of the United Kingdom, 36, 473-492.cited within https://www.marlin.ac.uk/species/detail/1398

[18] Scallop Conservation Measures. Scottish Government website. Available at: https://www.gov.scot/Topics/marine/Sea-Fisheries/InshoreFisheries/scallopconservation

[19] The Marine Life Information Network. Queen scallop (*Aequipecten opercularis*). Webpage. Available at: https://www.marlin.ac.uk/species/detail/1997

[20] Marine Scotland 2017 New controls in queen scallop fishery: summary of consultation responses. Available at: https://www.gov.scot/publications/consultation-new-controls-queen-scallop-fishery-ices-divisions-via-viia-9781788511537/

habitat, but may occasionally be found on muddy sand[14], and the Queen scallop also occurs amongst beds of horse mussels[21].

The predominant broad-scale habitats in the WC-RIFG area are mud, particularly within the Firth of Clyde and south-west and north-east of Skye; coarse sediment distributed throughout the WC-RIFG area; sand in the south of the WC-RIFG area, particularly to the south-west of Mull and small areas of mixed sediments (Figure 3-1). There are also relatively large areas of rock and biogenic reefs, particularly to the north of Islay, around Tiree and Coll and off the west coast of Rum. The broad-scale habitat types that correspond with scallop habitat are predominantly 'coarse sediment' (including coarse sand, gravel, pebbles, shingle and cobbles), 'mixed sediment' (heterogeneous sediments that incorporate a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud) and 'sand' (clean medium to fine sands or non-cohesive slightly muddy sands). These habitat types occur throughout the WC-RIFG region and are found both inshore and offshore (Figure 3-1). As such, there are a number of large areas of suitable scallop habitat in the WC-RIFG area, however, much of the area is not ideal for scallops.

[21] The Marine Life Information Network. Queen scallop (*Aequipecten opercularis*). Webpage. Available at: https://www.marlin.ac.uk/species/detail/1997.

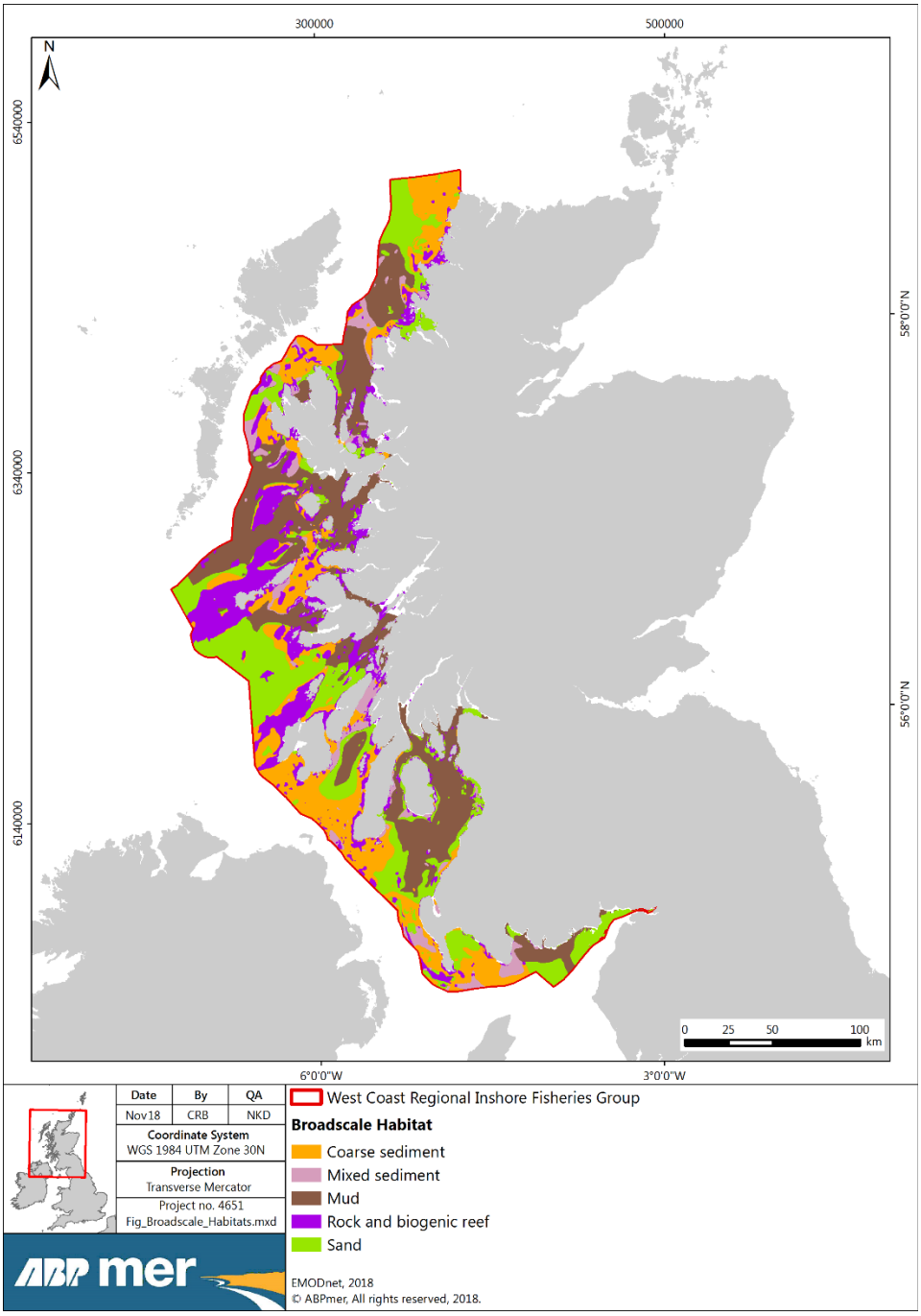


Figure 3-1: Habitats in the WC-RIFG area. Ideal scallop habitat is considered to include; 'coarse sediment', 'mixed sediment', and 'sand'. (Source: *EMODnet 2018*)

3.3 Stock assessment and status

In order to effectively conduct stock assessments and in turn determine the relevant scale for management, it is important that the biological stock boundaries are known and any differentiation within the stock or mixing with adjacent stocks can be defined[22]. However, the population structure of Scottish scallop stocks is not well understood[23]. Scottish scallop stock

[22] Andrews, J.W., Brand, A.R. Brand and T.J. Holt (2011) Isle of Man Queen Scallop Trawl and Dredge Fishery Public certification report. https://fisheries.msc.org/en/fisheries/isle-of-man-queen-scallop-trawl/@@assessments

[23] Dobby H., Fryer R., Gibson T., Kinnear S., Turriff J. & McLay A (2016). Scottish Scallop Stocks: Results of 2016 Stock Assessments. Scottish Marine and Freshwater Science Vol 8 No 21. Available on-line at: https://data.marine.gov.scot/dataset/scottish-scallop-stocks-results-2016-stock-assessments/resource/ef51abd9-910b-4c19-832e

assessment areas have therefore been determined in relation to historical characteristics of the respective fisheries and on the basis of ICES statistical rectangles[23], rather than on the basis of biological parameters.

The Scottish scallop stock assessment areas for king scallops are shown in Figure 3-2, and the ICES rectangles are provided in Table 3-1 The WC-RIFG area includes the North West, West of Kintyre, Clyde and Irish Sea assessment areas.

Table 3-1 Marine Scotland stock assessment areas on the west coast of Scotland.

Name of assessment area	ICES statistical rectangles
Clyde	39-40 E5; 40 E4 (eastern half)
North West	41-46 E1-E3; 42-46 E4
West of Kintyre	39-40 E2-E3; 39 E4; 40 E4 (western half); 41 E4
Irish Sea	35-36 E3; 35-38 E4-E6; 37 E7

The most recent regional stock assessments for king scallops were undertaken in 2016[24]. At present there are insufficient data available from the Clyde or the Irish Sea assessment areas to perform analytical assessments or to evaluate trends[24]. The assessments for the North West and West of Kintyre used a Time Series Analysis model, based on reported landings data up to 2015, catch at age data from annual scallop dredge surveys, and age and size frequency data collected as part of the market sampling programme conducted at landing sites around the Scottish coast. Due to limited port sampling before 2011, the time series of age composition available for the Clyde and Irish Sea assessment areas is of insufficient length for stock assessment purposes[24].

The Time Series Analysis model is considered to have a number of advantages over more typical Virtual Population Analysis (VPA), including its ability to cope with missing or poor-quality data and the provision of confidence intervals for estimated parameters (e.g. fishing mortality). However, the model is descriptive rather than predictive, and does not generate reference points such as Maximum Sustainable Yield (MSY), or limit reference points[25], and as such only allows interpretation of trends. Advice from Marine Scotland Science on the scallop fishery is therefore provided on the basis of historical values and trends in stock levels rather than being based on where how estimated stock metrics compare with reference points.

[24] Dobby H., Fryer R., Gibson T., Kinnear S., Turriff J. & McLay A (2016). Scottish Scallop Stocks: Results of 2016 Stock Assessments. Scottish Marine and Freshwater Science Vol 8 No 21. Available on-line at: https://data.marine.gov.scot/dataset/scottish-scallop-stocks-results-2016-stock-assessments/resource/ef51abd9-910b-4c19-832e

[25] A reference point may be a target, such as MSY, a point at which some management measure is triggered, or limit reference points such as the lower bound of a healthy level of the stock.

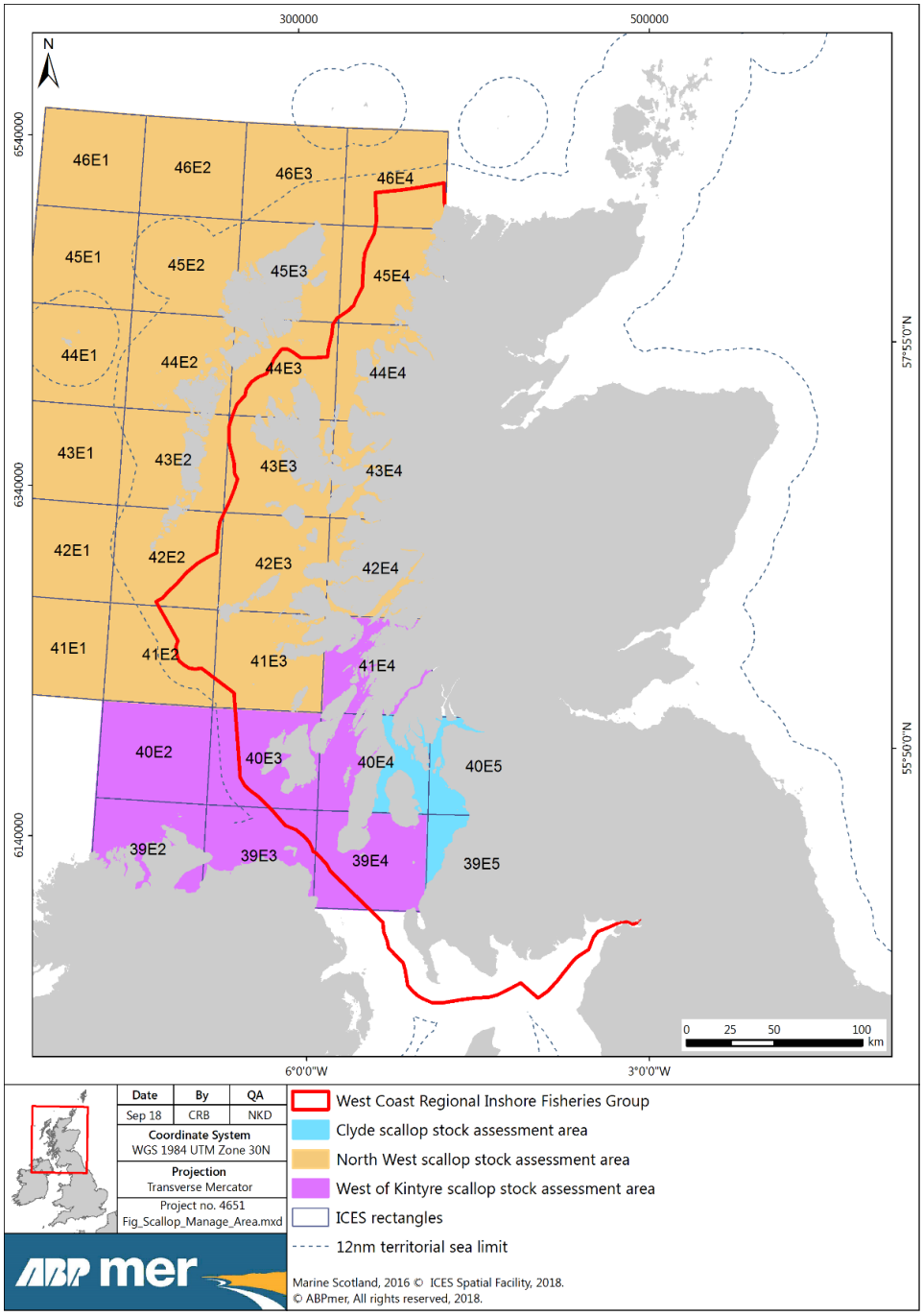


Figure 3-2 A map showing the ICES rectangles, 12nm limit and scallop stock management areas. (*Source: Marine Scotland National Marine Plan Interactive*.)

Figure 3-3 presents the results of the stock assessment for the North West stock. It highlights that a period of low recruitment in the mid-2000s followed high catches in the early 2000s. Catches have decreased since then, with recruitment and Spawning Stock Biomass (SSB) both showing improvements since 2010. Estimates of recent fishing mortality (F) are stable around the long-term average[24].

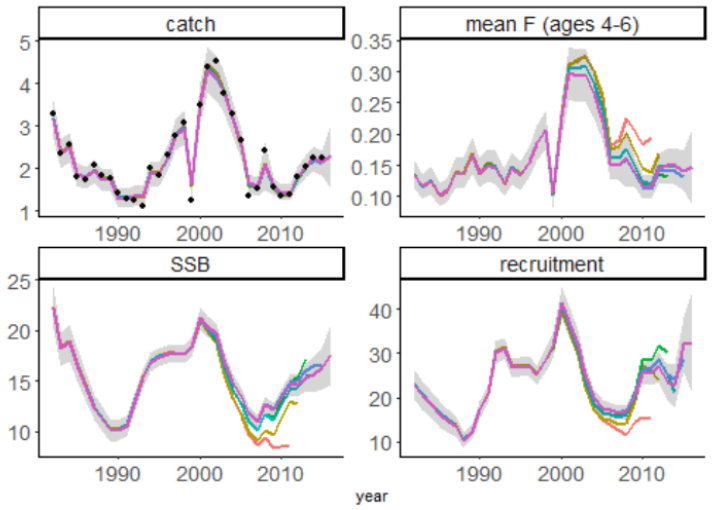


Figure 3-3 Stock assessment of the North West assessment area. Estimates of Catch, Mean F, SSB and Recruitment with 95% confidence intervals (grey shading). Catch and SSB are in thousand tonnes and recruitment in millions. *Source: Dobby et al., 2016*[26]

().

For the West of Kintyre stock, recruitment is estimated to have increased substantially since 2000, resulting in the highest estimated spawning stock biomass (SSB) in the time series in 2012. SSB has decreased slightly since then, but still remains relatively high compared to historical trends. Landings have been increasing since 2011, but estimates of fishing mortality (F) remain relatively low compared to the SSB, as a result of high estimated recruitment (Figure 3-4).

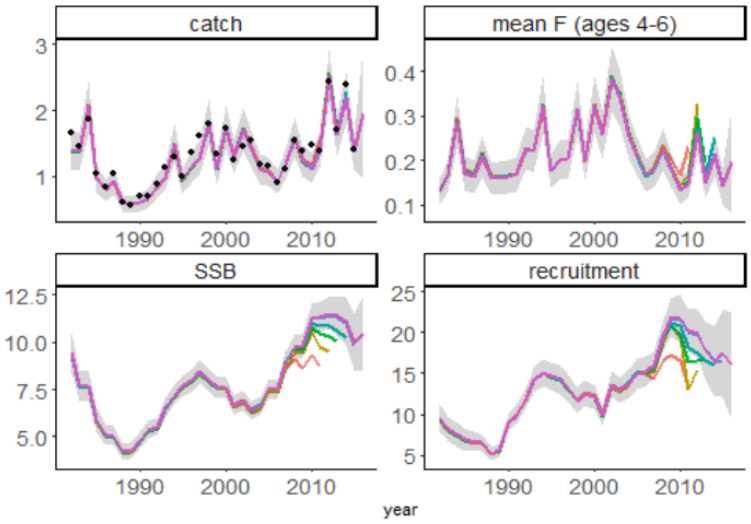


Figure 3-4: Stock assessment for the West of Kintyre assessment area. Estimates of Catch, Mean F, SSB and Recruitment with 95% confidence intervals (grey shading). Catch and SSB are in thousand tonnes and recruitment in millions. *Source: Dobby et al., 2016*

Marine Scotland Science advice for both the North West and West of Kintyre stock areas is for no increases in fishing effort. Although the stock assessments do not define management reference points (such as MSY) and are not updated annually, so do not form part of a formal

[26] Dobby H., Fryer R., Gibson T., Kinnear S., Turriff J. & McLay A (2016). Scottish Scallop Stocks: Results of 2016 Stock Assessments. Scottish Marine and Freshwater Science Vol 8 No 21. Available on-line at: https://data.marine.gov.scot/dataset/scottish-scallop-stocks-results-2016-stock-assessments/resource/ef51abd9-910b-4c19-832e

annual management advice cycle (as per ICES stock assessments), they do provide a useful guide for Marine Scotland management decisions. The assessment report also neatly summarises the challenge of scallop stock management in Scotland, in that it states that "*there is currently no mechanism for reducing fishing effort or landings which may in future be required in order to manage fishing mortality under an MSY approach*".

It is planned to update the stock assessment in 2019 and work to develop MSY reference points for North West and West of Kintyre areas is ongoing[27]. The WC-RIFG is also aiming to help fill some of the data gaps in stock assessment within the west coast, for example, there are insufficient data from the Clyde to perform analytical assessments or evaluate stock trends, but the Clyde Fishermen's Association are working on the initial stages of a stock assessment project.

Although connectivity of scallop stocks may be inferred by using a range of genetic methods (e.g. techniques that examine DNA diversity between populations), results showing high similarity in DNA diversity (i.e. population connectivity) may not necessarily indicate current physical linkages; transfer of genetic material may have historically occurred and may not still be occurring. Numerical and hydrodynamic modelling approaches to ascertain potential connectivity of populations may be a more appropriate and cost-effective method of gaining insight. In the future, there may be potential to apply tools recently created to model potential dispersal (and retention) of scallop larvae throughout the English Channel[28,29] and Irish Sea[30].

[27] Marine Scotland Science 2018 Personal communication.

[28] Szostek, L. 2015. Population characteristics and the environmental interactions of the king scallop fishery in the English Channel. Bangor University. School of Ocean Sciences. PHD Thesis

[29] Nicolle, A., Moitie´, R., Ogor, J., Dumas, F., Foveau, A., Foucher, E., and Thie´baut, E. Modelling larval dispersal of Pecten maximus in the English Channel: a tool for the spatial management of the stocks. – ICES Journal of Marine Science, 74: 1812–1825.

[30] Hartnett, Michael & Berry, Alan & Tully, Oliver & Dabrowski, Tomasz. (2007). Investigations into the transport and pathways of scallop larvae - The use of numerical models for managing fish stocks. Journal of environmental monitoring : JEM. 9. 403-10. 10.1039/b617035h.

4 Current policy and management

The management of UK scallop fisheries currently falls under the overarching legislation of the EU Common Fisheries Policy (CFP)[31]. Although there is little mention of scallops in the CFP, the overarching principles and objectives as well as many of the binding regulations that are contained within the CFP or within subsidiary legislation do relate to the operations of the UK scallop fleet operating in Scottish waters. This includes important elements such as licensing, data collection and control and enforcement. It is therefore useful to understand the legislative hierarchy that is applicable to the management of Scottish scallop fisheries.

4.1 EU-level management

Under the CFP, specific requirements for particular fisheries are applied through technical regulations[32]. For scallops, this legislation sets the Minimum Conservation Reference Size for king scallop for all EU vessels within all areas at 100 mm (and 110 mm in Area 6a North – Irish Sea) and 40 mm for queen scallop. This same legislation also, considering landing obligations, requires that 95% by weight of catches from dredge vessels must be marine bivalve molluscs.

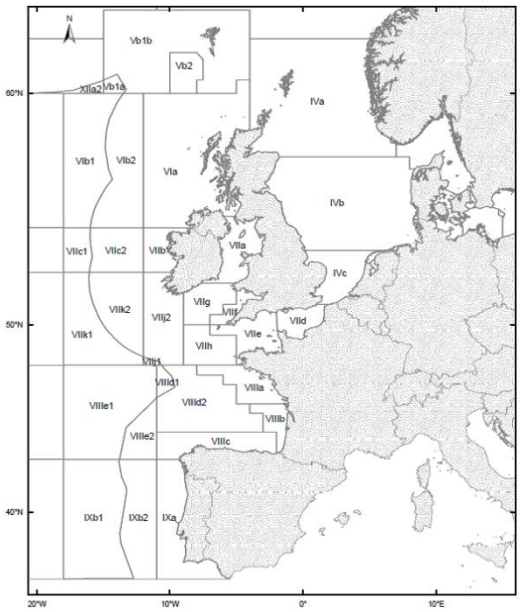


Figure 4-1. ICES Areas Around the UK

Scallop stocks are not currently subject to Total Allowable Catch (TAC) and there are no quotas in place for any scallop stocks. Furthermore, ICES[33] do not yet offer any advice in relation to scallop fisheries. However, since 2012 ICES have established a Scallop Assessment Working Group (WGScallop)[34] which examines science relevant to scallop fisheries including the consideration of stock boundaries, review of stock assessments, compilation of relevant data and consideration of wider issues relevant to scallop fisheries,

[31] REGULATION (EU) No 1380/2013Search for available translations of the preceding link••• OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC

[32] COUNCIL REGULATION (EC) No 850/98 of 30 March 1998 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms (OJ L 125, 27.4.1998, p. 1) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01998R0850-20150601&qid=1463153613173&from=EN

[33] ICES brings together scientists from 20-member countries and beyond to develop science and advice to support the sustainable use of the oceans: http://www.ices.dk/explore-us/who-we-are/Pages/Who-we-are.aspx

[34] http://www.ices.dk/community/groups/Pages/WGScallop.aspx

including the potential for Marine Protected Areas to support scallop stock management. Scientists from Marine Scotland Science are active participants in WGScallop.

Although there is no TAC for scallop there is an EU effort restriction, which applies to vessels over 15 m in length, fishing in western waters. This effort restriction applies to both king scallop and queen scallop, and under Council Regulation (EC) No 1954/2003 requires Member States to assess the level of fishing effort by vessels over 15 m in certain fisheries (including scallop) in each ICES area during a reference period 1998 to 2002, while also maintaining a list of fishing vessels registered to that Member State operating in those fisheries. Subsequently, Council Regulation (EC) No 1415/2004 defined the effort limits for Member States in these fisheries. This effort limit is of relevance to the west Scotland scallop fleet which is the subject of this study. The limits for UK vessels are 1,974,425 kW days per annum for the west of Scotland (Subarea 6) and Iceland and Faroes (Subarea 5, and 3,315,619 kW days for Subarea VII (which encapsulates the Irish Sea, West of Ireland, Porcupine Bank, Eastern and Western English Channel, Bristol Channel, Celtic Sea North and South, and Southwest of Ireland - East and West).

It should be noted that this effort limit does not alter from year to year in response to changes in stock status. So, whilst the effort regime does provide an overall cap on effort it cannot be seen as an adaptive stock management tool. In Subarea V and VI the UK has remained well below its effort ceiling (around 50% below)[35]. The UK effort cap has been more restrictive in Subarea VII. From around 2008, the UK effort cap was projected to be exceeded and for several years additional effort quota was traded from the French industry in return for some restrictions on UK vessels fishing in French waters. In addition, a days-at-sea scheme is now in place for UK vessels (>15m length) in Subarea VII. The UK Marine Management Organisation (MMO) sets a quarterly days at sea (DAS) allocation following consultation with the Scallop Industry Working Group (SIWG), which includes representatives of the Scottish scallop industry[36]. No such individual days-at-sea allocation exists for Subarea V and VI however, restrictions imposed on days-at-sea in Subarea VII may have contributed to an increase in effort being displaced into Subarea VI, resulting in an increase in overall effort within this subarea.

4.2 National management

Additional management measures have been introduced within Scotland and the UK, which augment the management applied at an EU level. Although none of these measures constitute complete stock management (i.e. adaptive management of exploitation rates in response to changes in stock status) they do apply additional and therefore more precautionary levels of management restriction on the fishery than the measures applied at the EU level. For example, in 1999 a restriction on licences was applied meaning that vessels over 10 m must have a scallop entitlement on their licence in order to dredge for scallops. To qualify for the scallop entitlement vessels had to have fulfilled the requisite track record.

A suite of restrictions was introduced by The Prohibition of Fishing for Scallops (Scotland) Order 2003[37] which applies to Scottish and relevant UK vessels only. This prohibits the use of certain dredge designs or adaptations and placed the limits on dredge numbers within Scottish waters. These have since been revoked and slightly amended following a further review[38] in

[35] Effort use statistics can be viewed on-line: https://www.gov.uk/government/collections/effort-use-statistics
[36] MMO pers. comms.
[37] The Prohibition of Fishing for Scallops (Scotland) Order 2003 http://www.legislation.gov.uk/ssi/2003/371/pdfs/ssi_20030371_en.pdf
[38] Cappell, R., Robinson, M., Gascoigne, J.& Nimmo, F. (2013). A Review of the Scottish Scallop Fishery. A Poseidon report to Marine Scotland. Published on-line at: https://www.gov.scot/Resource/0045/00450683.pdf

2013 and consultation exercise[39] in 2014. New limits applying to the number of Scallop dredges in Scottish waters are set out in the Regulation of Scallop Fishing (Scotland) Order 2017[40] as follows:

- 8 dredges per side in Scottish inshore waters (<6 NM);
- 10 per side in territorial sea of the UK adjacent to Scotland (6-12 NM); and
- 14 per side in remainder of Scottish zone.

The legislation allows for exceptions in certain circumstances and setting maximum bar length and makes further allowances if remote electronic monitoring system installed which allows dredge numbers to be inspected.

4.2.1 New controls in the queen scallop fishery

Following earlier consultations in relation to the Scottish king scallop dredge fishery, Marine Scotland consulted on the introduction of further management measures in the queen scallop fishery in October 2016. The proposals included measures to:

- Increasing the minimum conservation reference size (MCRS);
- Introducing an annual closed season; and
- Introducing limits on the number of vessels able to prosecute the fishery.

The consultation also included a further suite of measures with the potential to be implemented in the longer term (following further development). These were:

- Effort reduction measures;
- Catch quotas; and
- Closed areas.

The response to the consultation[41], published in August 2017, showed generally positive responses to the proposed measures. All of the UK Fisheries Administrations introduced a seasonal closure from 01/04/2018 to 30/06/2018 in 7a and 6a, which will be implemented annually.

4.2.2 Regional fishery restrictions

There are additional regional technical restrictions that have been imposed in some Scottish inshore areas. The often-quoted example is the Shetland fishery which has some different management controls in place and has been recognised for its good management with successful accreditation against the Marine Stewardship Council (MSC)[42] standard for sustainable fisheries. Responsibility for management of this fishery out to 6 NM is devolved to the Shetland Shellfish Management Organisation (SSMO) by the Shetland Islands Regulated Fishery (Scotland) Order 2012. Although this example provides useful insight into the potential for regional management of inshore scallop fisheries in Scotland, the legislative device that devolved management responsibility to Shetland and enables this regional management is not currently being considered on the west coast of Scotland. The Regulating Order enables

[39] Marine Scotland (2014). Consultation on New Controls in the Scottish King Scallop Fishery. Publ. Scottish Government, October 2014. ISBN: 978-1-78412-837-1 (web only). https://www.gov.scot/Resource/0046/00460382.pdf

[40] Regulation of Scallop Fishing (Scotland) Order 2017 http://www.legislation.gov.uk/ssi/2017/127/pdfs/ssi_20170127_en.pdf

[41] Marine Scotland. 2017. Consultation on New Controls in the Queen Scallop Fishery in ICES Divisions VIa and VIIa Summary of Responses. https://beta.gov.scot/binaries/content/documents/govscot/publications/consultation-responses/2017/08/consultation-new-controls-queen-scallop-fishery-ices-divisions-via-viia-9781788511537/documents/00523599-pdf/00523599-pdf/govscot:document/

[42] SSMO-shetland-inshore-brown-crab-and-scallop. https://fisheries.msc.org/en/fisheries/ssmo-shetland-inshore-brown-crab-and-scallop/

the SSMO to issue licences for the fishery and to place annual conditions on those licences, such as setting technical measures (i.e. gear restrictions or landing sizes) and requiring additional logbook reporting.

Other restrictions are applied in different locations around Scotland. For example, there is a seasonal closure for scallop fishing in Luce Bay[43] and a similar seasonal restriction from Loch Maddy to Stuley Island in the Outer Hebrides[44]. In addition, there are also seasonal restrictions on scallop dredging to reduce gear conflict and manage effort levels, including temporal restrictions which only allow fishing from Monday to Friday (e.g. in the Clyde).

There are also some measures which are focussed on other fisheries but which none-the-less restrict the activity of the scallop dredge fleet. For example, a proposal for a pilot project from the WC-RIFG for a small "crabbing box" (approximately 2 km x 10km) to the West of Mull (between the Treshinish Isles and Coll) was recently approved by Marine Scotland, following consultation[45]. Although this is a pilot focussed on the management of brown crab, it includes a measure to prevent mobile vessels, including scallop dredgers to enter within the zone during the period of 1st October to 31st January.

Regional spatial restrictions for conservation objectives

The west coast of Scotland has a number of designated sites, including Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Nature Conservation MPAs (Figure 4-2). A number of SACs and MPAs have already had management measures introduced, including restrictions on scallop dredging to protect conservation features of the sites (Figure 4-3). East Mingulay SAC, outside the WC-RIFG area, also had restrictions on scallop dredging introduced.

All existing permanent (year-round) and seasonal or temporal restrictions on scallop dredging are shown in Figure 4-3.

The Scottish Government is currently considering introducing a second phase of management measures in MPAs and SACs, which includes additional restrictions on scallop dredging in the WC-RIFG area, as well as in other scalloping grounds outside the area (e.g. Sound of Barra SAC) (Figure 4-4). These proposed 'phase 2' measures have been indicated in early draft stakeholder documents but have not yet been published for formal public consultation.

In addition to the existing and proposed restrictions on dredging in the MPAs and SACs, the Scottish Government is also considering additional restrictions outside of designated sites to provide protection for 'priority marine features' (PMFs). The PMFs are habitats and species that are considered to be marine nature conservation priorities in Scottish waters, and Marine Scotland is looking to see whether additional protection outside of existing designated sites is required for the most vulnerable PMFs in Scottish inshore waters. Management measures are not yet known, but a number of 'PMF illustrative management zones' have been published on the National Marine Plan interactive site (Figure 4-4). In August 2018 Marine Scotland consulted on protection for PMFs outside of the MPA network. They are considering the introduction of management measures for PMFs and scallop fishing grounds could potentially be affected. PMFs are a particular focus of environmental NGOs[46]. Regional management could be pro-active in addressing potential interactions between scallop dredging and PMFs.

[43] The Inshore Fishing (Prohibited Methods of Fishing) (Luce Bay) Order 2015 http://www.legislation.gov.uk/ssi/2015/436/pdfs/ssi_20150436_en.pdf

[44] The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Outer Hebrides) Order 2017 http://www.legislation.gov.uk/ssi/2017/48/contents/made

[45] https://www.gov.scot/publications/consultation-proposed-sites-host-inshore-fisheries-pilots-2017-outcome-report/

[46] LINK. 2018. LINK Marine Response to the consultation on protection for Priority Marine Features outside the Marine Protected Area network http://www.scotlink.org/public-documents/link-marine-response-to-the-consultation-on-protection-for-priority-marine-features-outside-the-marine-protected-area-network/

The maps below show a large number of designated and proposed sites with varying levels of restrictions. Spatial conservation measures have the potential to cumulatively affect the scallop fishing sector, with effort often displaced from fishing grounds into other areas, which in turn causes increased fishing pressure in those areas that remain open for fishing because the same amount of fishing effort in is now concentrated to a smaller area. There is concern over this displacement issue within the WC-RIFG area. To analyse the scale, nature and possible impact of any displacement, one would need to analyse VMS tracks and CPUE at high spatial resolution. Most inshore vessels are not required to have VMS so one of the proposals put forward by the WC-RIFG is for appropriate vessel tracking systems. VMS or iVMS on all vessels would enable better spatial management of MPAs and PMFs, but also would allow for displacement effects to be monitored and mitigated. Before any future spatial management of PMFs, displacement could be modelled to attempt to predict the knock-on effects and mitigate against them.

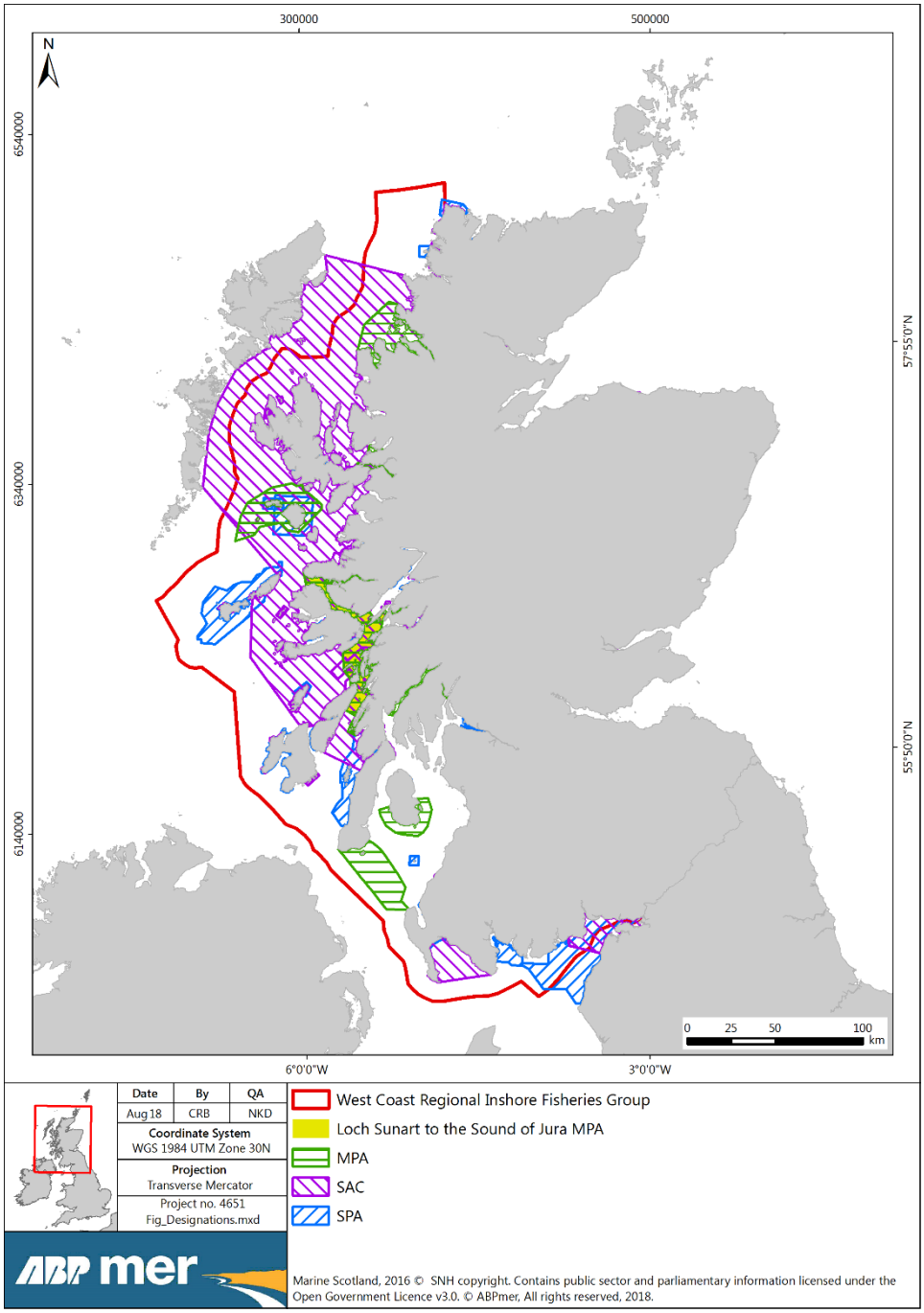


Figure 4-2: Designated sites in the WC-RIFG area.

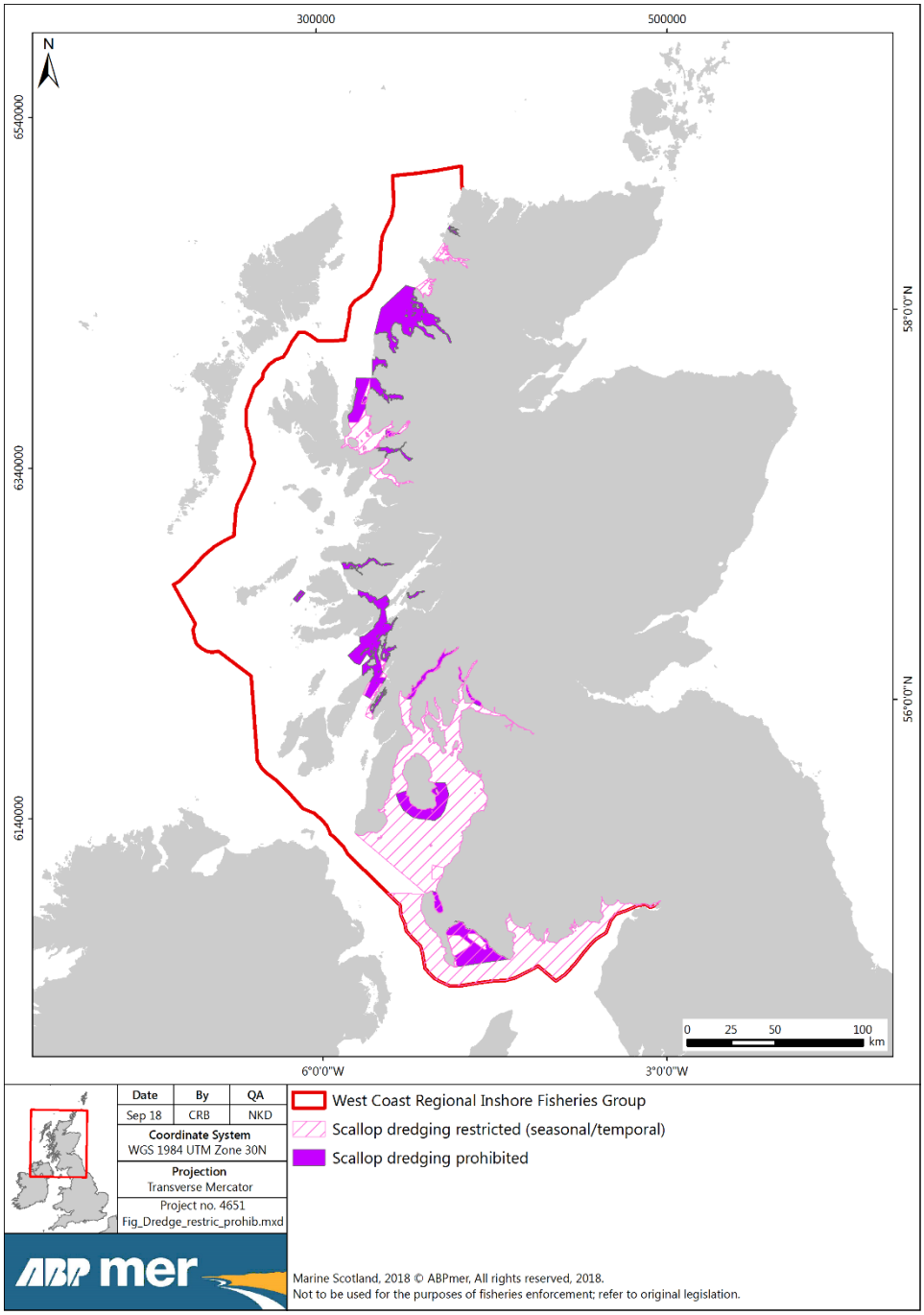


Figure 4-3: Prohibitions and restrictions on scallop dredging in the WC-RIFG area.

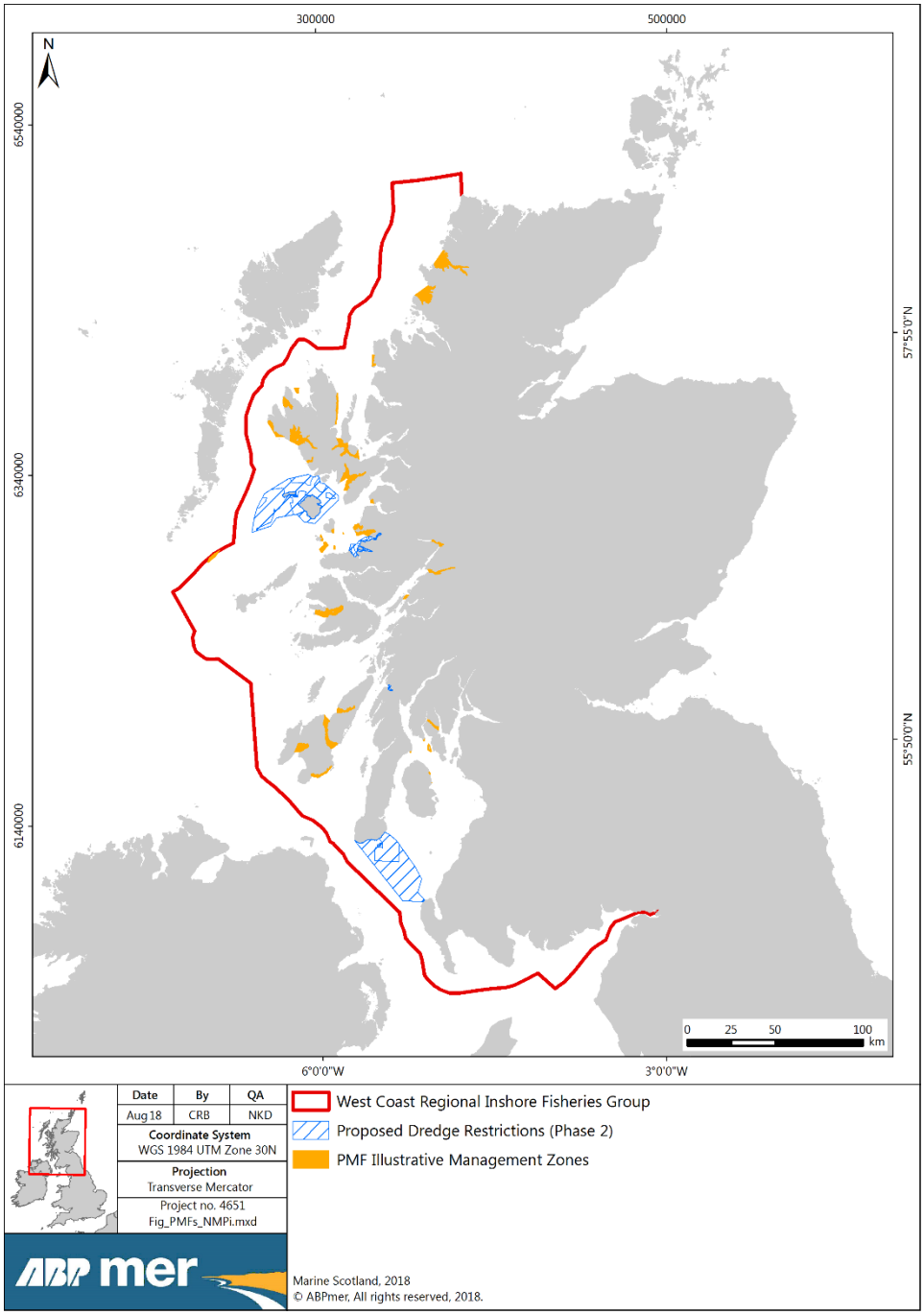


Figure 4-4: Potential restrictions on scallop dredging for nature conservation purposes in the WC-RIFG area.

4.3 The role of Regional Inshore Fisheries Groups (RIFGs)

The Scottish Regional Inshore Fisheries Groups (RIFGs) are non-statutory groups created by Marine Scotland to allow engagement between commercial fishermen and Marine Planning Partnerships and bring forward initiatives to improve the management of inshore fisheries (out to 6NM) in Scottish waters. The RIFGs provide the main conduit for commercial inshore fishermen to contribute to shaping management proposals in the waters in which they fish. This project on west coast scallop management has been initiated by the West Coast RIFG (one of 5 RIFGs in Scotland).

4.3.1 RIFG Objectives

The Scottish Government, through the adoption of the National Marine Plan (NMP), provides a structure and framework for the operations and strategic direction of the RIFGs. Marine Scotland also provides a chairperson for each RIFG. The guidance provided to RIFGs states that a key priority for RIFGs will be to produce a Fishery Management Plan and identify where strategic support is required to progress actions within those plans.

Marine Scotland defines the objectives for inshore fisheries management (which must guide the activities of the RIFGs) as set out below:

Key Objective

- To deliver sustainable use of the natural resource recognising national and international obligations, and safeguarding fish stocks while optimising the economic return for inshore fisheries and dependent communities.

Aims

- To encourage fishermen to take an active interest in the management of fish stocks and fisheries through their commercial activities.
- To encourage fishermen to identify issues impacting their local fisheries and bring forward workable management solutions, including identifying any development opportunities.
- To encourage fishermen to work with Marine Scotland in seeking to develop workable management solutions where necessary through legislative provisions.
- To encourage fishermen to participate and utilise the support structure available through the RIFG network.
- To encourage fishermen to contribute to the compilation of a localised evidence base to support stock management, fisheries management decision making and for marine planning purposes.
- To encourage individual fishermen to participate in evidence gathering trials aimed at improving local or national understanding of Scottish inshore fisheries or fish stocks.
- To encourage fishermen to bring forward and view local fisheries issues as part of a wider network of management through Marine Planning Partnerships and national bodies such as IFMAC.
- To encourage fishermen to recognise the ecosystem approach to fisheries management and the protection of the natural environment.

4.3.2 West Coast RIFG

The West Coast RIFG is a non-constituted body covers an area of inshore waters extending from Cape Wrath in the north to the national boundary with England in the Solway Firth. The structure of the WC-RIFG follows the Marine Scotland guidance, with a Management Committee supported by four geographic subcommittees namely, Clyde, Mull & Argyll, Solway and, West Highlands & Skye. These subcommittees reflect both the differences in inshore fishing within areas but also to distribution of current and future marine planning partnership areas.

WC-RIFG Aims

WC-RIFG have produced a Fisheries Management Plan, in accordance with the guidance from Marine Scotland. This states that the overarching strategic objectives for the West Coast RIFG are:

- Biological - to conserve, enhance and restore commercial stocks in inshore waters and the supporting ecosystem.
- Economical - to optimise long term and sustained economic return to local coastal communities that are dependent on inshore fisheries, and to promote quality initiatives.
- Environmental - to maintain and restore the quality of the inshore marine environment.

The WC-RIFG Fisheries Management Plan goes on to detail more specific aims for management within the area. These are reproduced here in Appendix 1. The document lists both general aims, which apply across the whole RIFG area and aims for each of the sub-committee areas. It is notable that within the general aims for the whole RIFG only 1 fishery specific objective is stated. This relates to management of the scallop fishery and reflects the high priority that this is given by the WC-RIFG:

> *Explore options for scallop management planning in west coast waters following voluntary closures imposed by WCRIFG in Loch Sunart in 2016. Concerns of ingression of large numbers of vessels and heavy impacts mean that measures are required as a priority to minimise effects and conserve resources.*

Within the Mull & Argyll sub-committee objectives a further strategic aim related to the scallop fishery is also highlighted:

> *Explore the potential for the development of locally based sustainable fisheries management measures including gear conflict resolution in waters West of Mull. The objectives are (a) to implement measures that will help conserve and enhance scallop stocks by controlling effort and, (b) protect, conserve and minimise gear conflict in a defined crabbing area. Demonstration and research for a 3-5year period will allow data to be gathered and help inform future local fisheries management.*

5 Approaches to scallop management

5.1 Key Management Characteristics

This section provides a brief summary of some of the key characteristics of successful scallop management, drawing on examples from elsewhere.

5.1.1 Management of scallop stocks

Scallops fisheries in the UK are typically subject to a lower level of management intervention compared to many other high value shared stocks. For example, stock assessments are less frequent, no catch limits (i.e. quota) exist and although some licence restrictions and limits on overall fleet effort do exist, concern has been raised about whether these are sufficient to restrict and control effort in a meaningful way. In particular there is no mechanism to adjust exploitation rates, at an appropriate scale, in response to changes in stock status (identified through stock assessment).

Best practice within fisheries management is based around the management of a defined 'stock'. Scientific advice is provided at the level of the stock and management, involving all relevant parties, should have mechanisms in place to adjust the exploitation rate accordingly. Ideally, the degree to which the exploitation rate changes in response to fluctuations in stock status is determined according to pre-defined Harvest Control Rules (HCR), which seek to maintain the stock at its target level (typically MSY) and avoid the stock from falling to a point where there is a risk of recruitment impairment.

Stock level management is not yet in place for many scallop stocks around the UK, including those within the WC-RIFG region. Although there are substantial constraints to introducing fully adaptive stock level management for scallop fisheries, this should remain the goal.

5.1.2 Management of the marine ecosystem

It is not only the need for careful stewardship of scallop stock status that is the driver for further management intervention. The wider ecosystem impacts of fisheries activities, beyond the impact on the target stock is an important consideration as part of an effective management process. This should include the impact of the methods of harvesting the stock on the wider ecosystem and the structure and functionality of seabed habitats, many of which contribute to the overall productivity of the marine ecosystem. Approaches to management which involve spatial restriction are often primarily focussed on reducing impacts of fisheries on sensitive or vulnerable marine habitat-forming species.

5.1.3 A strategic approach

A strategic approach to management may enable an important wider context to inform more focussed management interventions. Detailed management proposals should always be viewed within a wider strategic context. For example, a strategic approach should seek to:

- Recognise the importance of management of both the target stock and the marine ecosystem upon which the fishery relies. Ideally, management recognises these as equal contributors to overall management success.
- Recognise that management actions applied in an area may have unintended consequential impacts in another area (e.g. from displacement of vessel effort). For example, measures to safeguard particular stocks or habitats may increase the pressure on other stocks or habitats.

- Give careful consideration to the most appropriate spatial scale or jurisdiction for management intervention. If the aim of the management is to control stock levels, then intervention should be possible at the level of the stock. If the aim of management is at a wider ecosystem level then interventions within a single jurisdiction may need to be part of a wider management programme.

5.1.4 An appropriate level of precaution

Management of fisheries requires an appropriate level of precaution. The appropriate level of precaution is influenced by factors such as the level of potential impact (likelihood and consequence) and the level of information, where greater precaution should be applied in areas of higher uncertainly. This fundamental pillar of fisheries management is enshrined and defined in the FOA Code of Conduct for Responsible Fishing:

> 'States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.'

5.2 Commonly applied scallop Management Measures

In the following short section consideration is given to some of the management measures for scallop fisheries that have been effectively employed in other jurisdictions.

5.2.1 Spatial management measures

Scallops are particularly well suited to spatial approaches to management because scallops exhibit limited adult dispersal and by maintaining areas of high scallop density, future fertilisation success may be enhanced. Scallop fisheries are also likely to be subject to spatial restrictions, due the potential impacts of towed scallop dredge gear on vulnerable or protected marine habitats. Spatial measures therefore offer the potential of achieving both stock management objectives and wider ecosystem objectives. Spatial measures may also offer a potential to assist in addressing issues of gear conflict between different fleet segments.

Spatial measures typically involve complete cessation of certain fishing activities within a defined zone, but a benefit may also be derived from using rotational closures, or areas of varying degrees of protection, or closures at particular times of the year (i.e. spawning). As such, their placement, size and degree of protection must be informed by evidence on benthic habitat characteristics, and/or life history parameters of the scallop stock (i.e. larval dispersal patterns) and the spatiotemporal distribution of fishing activities.

Spatial management approaches are a feature of all of the inshore (and offshore) scallop management models showcased at the UK Scallop Management Conference in February, 2019 (see Table 5-1). Within the UK, spatially restricted measures are currently contributing to the management success in a number of scallop fisheries, including inshore waters of Shetland[47], and the Isle of Man[48] – where scallop regulations go beyond those of surrounding UK waters. However, effective management outside of these more tightly managed areas

[47] SSMO. 2018. Shetland Shellfish Management Organisation Regulations. https://www.ssmo.co.uk/site/assets/files/1/ssmo_regulations.pdf

[48] Isle of Man Government. IOM Licencing. https://www.gov.im/categories/business-and-industries/commercial-fishing/iom-licencing/

remains important and unintended consequences of spatial restrictions, including the issue of effort displacement, should be considered[49].

Table 5-1: A summary of management measures and controls utilised in other scallop fisheries.

		Inshore				Offshore		
		Shetland, Scotland	Isle of Man	Bay of Fundy, Canada	Saint-Brieuc, France	Patagonia, Argentina	Georges, Bank, USA	Georges Bank, Canada
Fishery characteristics	Approx. No. of Licences	22		55-61	225 (2007)	4		12
	Extent (NM)	0-6	0-12	0-7	0-12			
Effort limits	Restricted no. licences	✓	✓	✓	✓	✓	✓	✓
	Overnight curfews or hrs/day effort limits	✓	✓	-	✓			
	Vessel size/crew size		✓				✓	
	Process at sea						✓	
Monitoring	100% VMS	✓	✓	✓			✓	
	100% logbook and/or monitoring	✓	✓	✓	✓			✓
Spatial/ temporal measures	Spatial/rotational management	✓	✓	✓	✓	✓	✓	✓
	Seasonal closures		✓	✓	✓			
Gear restrictions	Dredge no. limit	✓	✓		✓	NA		
	Bar length restrictions	✓		✓		NA		
	Bar weight restrictions					NA		
	Dredge spacing					NA		
	Offshore dredge prohibited inshore			✓		NA		
	Minimum ring size				✓	NA	✓	
	MLS/MSH/meat weight	✓	✓	✓	✓	✓		✓
Catch limits	Daily catch limit		✓	✓				
	TAC		✓			✓		✓
	ITQs			✓			✓	✓
Management framework	Reference Points & HCR	✓		✓		✓		✓

5.2.2 Fishing effort control measures

Temporal closures

Periodic or temporal closures, such as night-time curfews, are often introduced in an attempt to distribute fishing mortality more evenly across a stock[50]; most commonly for seasonally

[49]Vaughan, Duncan. (2017). Fishing effort displacement and the consequences of implementing Marine Protected Area management – An English perspective. Marine Policy. 84. 228-234. 10.1016/j.marpol.2017.07.007. https://www.researchgate.net/publication/319040031_Fishing_effort_displacement_and_the_consequences_of_implementing_Marine_Protected_Area_management_-_An_English_perspective

[50] Kennth, E, et al.1968. The Confrontation with Ecological Complexity. Systems Analysis in Ecology, Science Vol.159, Issue 3813, pp. 416-417. http://science.sciencemag.org/content/159/3813/416

migrating stocks, such as spawning run salmon fisheries, to allow regular 'escapement' of fish across the season. Night-time closures are also regularly enacted in fisheries where violations are more prevalent at night and as such enforcement is especially difficult.

Increasingly, curfews are being introduced as management measures within UK scallop fisheries with the aim of reducing total effort on the stock. Night-time curfews exist within a number of the English IFCA districts[51,52], in Northern Irish waters[53], and the inshore waters of the Isle of Man[54] and Shetland[55]. The SSMO scallop curfew is between the hours of 21:00h and 06:00h, and was introduced with the aim of reducing overall effort on the stock. Importantly, the curfew was introduced alongside limits to the number of dredges and close control of licensing and access to the Shetland waters.

The successful implementation of periodic closures depends on the distribution and intensity of effort and the length of time that the stock is exposed to fishing effort, and importantly, how this changes once the curfew is introduced. Night-time curfews therefore can only reduce total effort if they are enacted in combination with limiting access to the fishery, limiting intensity of effort, and assuming that fishers are already fishing for periods that are longer than the proposed 'open hours' i.e. effort is saturated across the day. As smaller vessels are limited in their ability to fish overnight, overnight closures are more likely to disproportionately affect larger vessels.

There are additional arguments that support the introduction of night-time curfews, including that they may reduce gear conflict and mitigate excessive brown crab mortality, avoiding periods when brown crabs are most active and therefore more susceptible to dredges. However, conversely it can be seen as difficult to enforce and more crucially, may not be effective in leading to an overall effort reduction is the response of the fleet is to increase day time hours.

Days at sea effort limitation

Days at sea controls (DAS) are another mechanism for controlling overall effort and so control fishing mortality exerted on a stock (if the spatial extent of the DAS restriction covers the spatial extent of the stock). Effort control measures that use DAS are inherently related to fishing activity, and as such cannot be implemented without methods for effective monitoring and enforcement of the fishing activity itself[56]. Therefore, measures of this nature require additional measures, including the requirement for all vessels to have VMS.

Assuming that effort can be monitored effectively, the key issue with using DAS is in calculating precisely the desired level of effort across the fleet. DAS is sometimes considered a blunt tool as the relationship between fishing effort and fishing mortality is not always clear. This requires a significant amount of data, including a time-series of the effort of all operational vessels and how this links to changes in catches, in order to establish appropriate limits. Calculation is further complicated by the fact that the same number of DAS allocated to vessels of different lengths, capacity and gear configuration, in different places can and will result in variable effects on the stocks. Furthermore, there is scope to increase 'actual effort'

[51] http://www.southern-ifca.gov.uk/byelaws

[52] Cornwall Sea Fisheries District Scallop Dredge (Limited Fishing Time) Byelaw 2011.https://secure.toolkitfiles.co.uk/clients/17099/sitedata/Byelaws%20and%20orders/Cornwall_SFC/Scallop-dredge-limited-fishing-time-.pdf

[53] The Department of Agriculture and Rural Development(1) makes the following Regulations in exercise of the powers conferred by sections 19(1), 124(1) and (2) and 127(1) of the Fisheries Act (Northern Ireland) 1966(2) http://www.legislation.gov.uk/nisr/2008/430/made

[54] Isle of man Government. IoM licencing. https://www.gov.im/categories/business-and-industries/commercial-fishing/iom-licencing/

[55] SSMO. 2018. Shetland Shellfish Management Organisation Regulations. https://www.ssmo.co.uk/site/assets/files/1/ssmo_regulations.pdf

[56] Shepherd, J. Fishing effort control: could it work under the common fisheries policy? Fisheries Research, Volume 63, Issue 2, 2003, Pages 149-153. https://www.sciencedirect.com/science/article/abs/pii/S0165783603001255

per day, such as by fishing 'harder' (e.g. longer tows) as well as through increased efficiency (e.g. engine power). It is therefore often considered necessary to set effort limits at the individual vessel level, with detailed specifications for their utilisation[56], and to ensure recalculations of DAS after regular stock assessments.

5.2.3 Other technical measures

Gear Controls

Dredge limits per side are used in other scallop fisheries, particularly in inshore areas, to limit the overall effort and also ensure only smaller and lighter gears are used in more sensitive inshore areas. Dredge limits are already applied by the Scottish Government, which limits vessels to 8 dredges per side out to 6NM, 8 dredges per side between 6-12NM and 14 dredges per side beyond 14NM[57].

Increase in Minimum Conservation Reference Size (MCRS)

MCRS are already in place for scallop fisheries[58] and are a feature of all of the inshore scallop management models showcased in Table 5-1. However, there is the potential for these to be adjusted upwards in certain areas in order to introduce a greater degree of precaution, for example within inshore waters. This measure may also be used in certain areas to provide a greater degree of protection for mature adults in important nursery areas. Measures such as this, which aim to control the portion of the population that is subject to fishing effort, are based on the known biology of the stock. They consider stock-specific growth characteristics, size at onset of sexual maturity and the current size distribution of the stock, in order to allow scallops to reach a larger size before being removed. The theory is that by allowing the average size of scallops to increase, this in turn allows stocks to recover towards more natural size and age structures, and can contribute to improved reproductive output dependent on other contributing factors.

While it is not clear if the MCRS is currently at a level that is ensuring the majority of the stock reach sexual maturity due to the absence of growth and maturity data for the region, any increase in MCRS will inherently reduce effort on a portion of the population. Many studies of yield per recruit analysis have shown that increasing the average individual scallop yield is possible by delaying the average size at first capture[59].

Although a stock-recruitment-relationship has not been demonstrated for west coast scallops, the increase in scallop fecundity with age may provide a buffer against recruitment overfishing.

However, where different MCRS are used in different areas, consideration must be given to the effectiveness of enforcement and separation in the market.

[57] As set out in The Prohibition of Fishing for Scallops (Scotland) Order 2003

[58] https://www.gov.uk/government/publications/minimum-conservation-reference-sizes-mcrs/minimum-conservation-reference-sizes-mcrs-in-uk-waters

[59] Thouzeau, G., Robert, G., & Smith, S. (1991). Spatial variability in distribution and growth of juvenile and adult sea scallops Placopecten magellanicus (Gmelin) on eastern Georges Bank (Northwest Atlantic). Marine Ecology Progress Series, 74(2/3), 205-218. Retrieved from http://www.jstor.org/stable/24825825

6 WC-RIFG Management Proposals

The WC-RIFG have focussed considerable attention on the potential for improved scallop management within in the WC-RIFG area in recent years. This is in response to significant stakeholder concerns about declines in local catches and concerns about increases in scallop fishing effort in certain areas of west coast waters, potentially due to displacement of fishing effort from the Isle of Man and the designation of local MPAs (e.g. Loch Sunart).

This discussion and development of proposals has been done in accordance with the Marine Scotland guidance to RIFGs and follows the aims and objectives set out both at a national level and within the WC-RIFG Fisheries Management Plan.

Between 2016 and 2017, possible approaches to scallop management were the subject of substantial discussion within the WC-RIFG and in particular within its Mull Working Group and the Scallop Working Group. Following on from these discussions the WC-RIFG submitted three proposals to Marine Scotland for consideration in 2017. The full details for the proposals are provided below, but all involve some elements of the main management approaches outlined above and all are intended to augment the level of existing management in order to help deliver both stock and ecosystem conservation objectives.

The WC-RIFG proposals described above have not yet been adopted or implemented by Marine Scotland and are subject to further critical review as part of this project.

6.1 Proposal A

The first proposal submitted by WC-RIFG in July 2017 was for technical measures and restrictions to be applied to scallop dredging activities within an area defined by 2 lines. Within the boundary of these 3 lines the following measures would be applied:

- All vessels to have VMS or similar when fishing in the areas (licence condition);
- Potential to increase king scallop MCRS from 105 to 110 mm in zones (based on review of evidence);
- Overnight curfew (20:00h to 06:00h) for scallop dredging;
- Scallop dredgers allowed max of 22 fishing days per month across proposed areas.

There was a general level of agreement from within the WC-RIFG for these measures, although some wanted the proposals to go further (such as a weekend ban or an immediate increase in MCRS), whereas others, notably the Scottish White Fish Producers' Association, expressed concern that the proposals were insufficiently underpinned by science and that the overnight curfew unfairly discriminated against non-local boats.

The proposal defines three separate lines (Figure 6-1), and it is understood that the measures would apply to all waters inshore of these lines. The zones are in the vicinity of the Loch Sunart to Sound of Jura MPA (shown in yellow on the figure), in which scallop dredging is prohibited in some areas, permitted in some areas of the MPA all year round, and permitted seasonally in other parts (from 1 October to 31 March). The WC-RIFG also led a voluntary closure to scalloping in these derogated areas.

6.2 Proposal B

Proposal B, submitted in October 2017, was for time-limited technical measures and restrictions to be applied to scallop dredging activities in an inshore zone west of Mull (Figure 6-1). Within this zone the following measures would be applied:

- A further limit the number of dredges (beyond the restriction already applied by the Regulation of Scallop Fishing (Scotland) Order 2017) to a maximum of 6 aside;
- An overnight curfew for scallop dredgers (20:00h to 08:00h); and
- A requirement for additional data collection to monitor impacts of effort restriction and overnight curfew.

There was not universal agreement within the WC-RIFG for this proposal, with some fishers that fish the affected waters expressing particular concern. The Scottish Whitefish Producers' Association (SWFPA), again expressed concern that the proposals were insufficiently underpinned by science and that the overnight curfew unfairly discriminated against non-local boats.

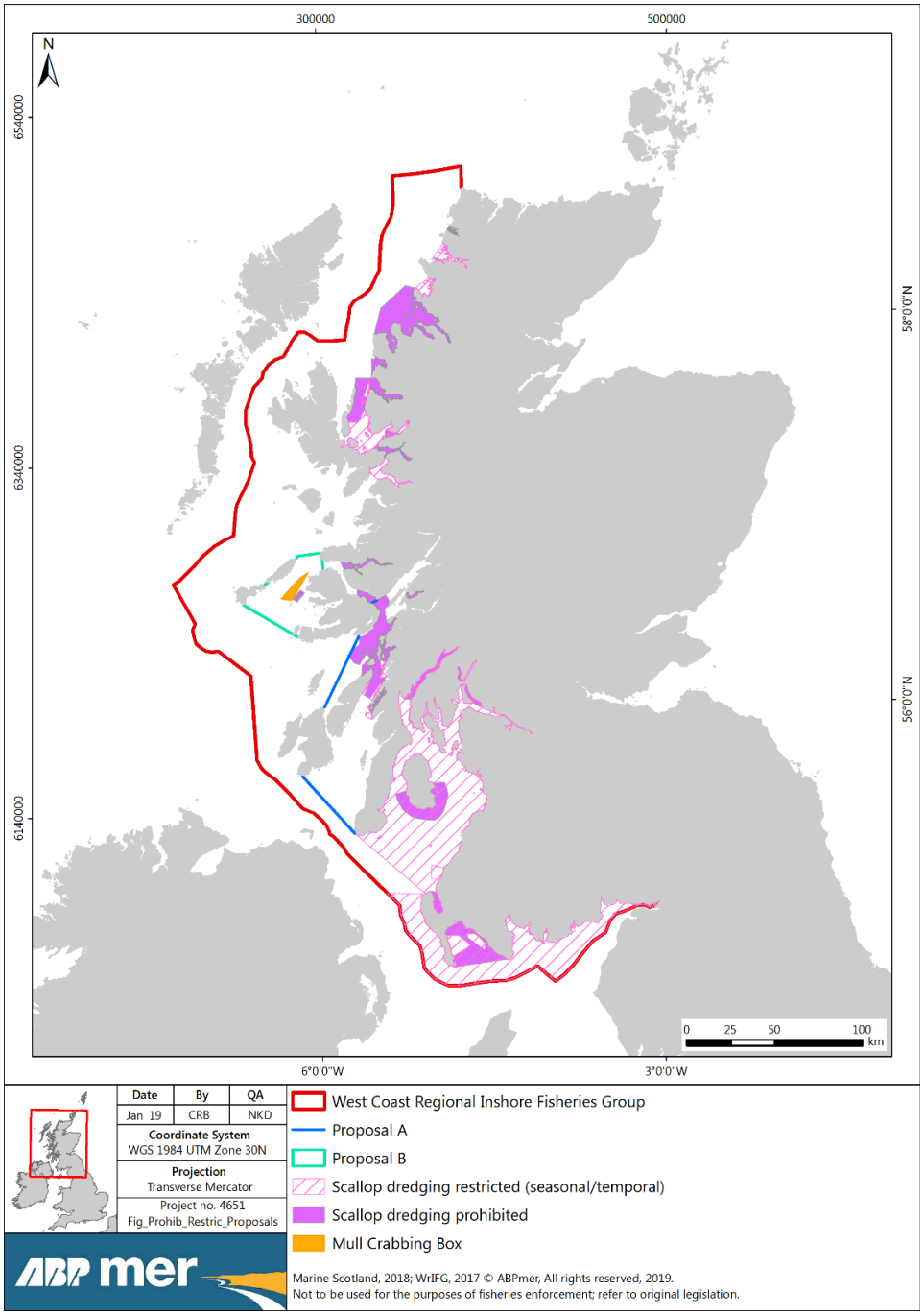


Figure 6-1 Proposed management areas for measures within Proposal A and Proposal B

6.3 Proposal C

An additional proposal submitted alongside Proposal A and arising out of the same discussion, was for an increase in MLS (to 120 mm) for hand-gathered (dive-caught) scallops taken from within designated MPAs (Figure 6-2).

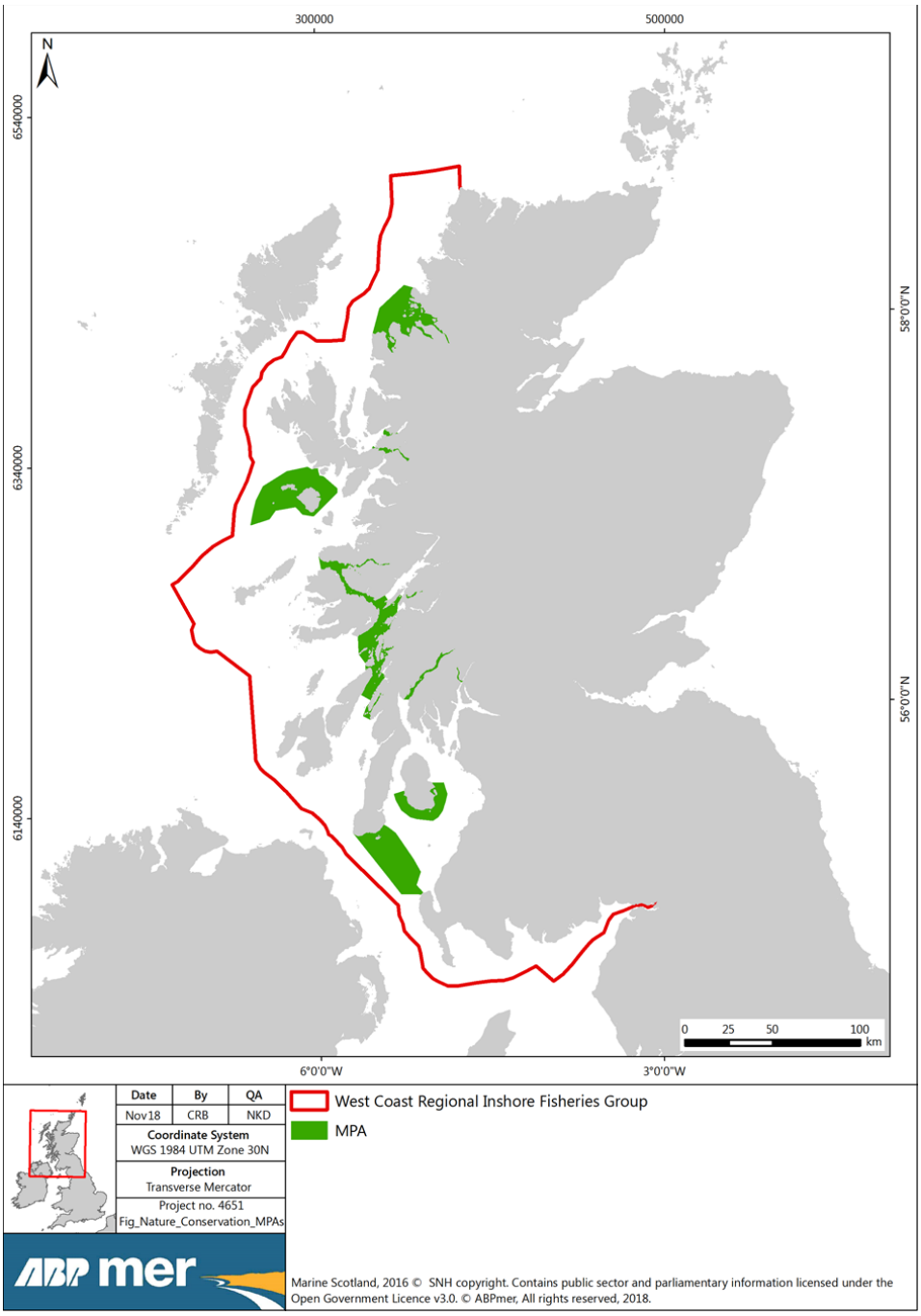


Figure 6-2 MPAs within which Proposal C would apply.

7 Review of WC-RIFG Proposals

7.1 Industry stakeholder perspectives

In order to provide an understanding of the range industry stakeholder perspectives of the three WC-RIFG scallop management proposals (described above) a semi-quantitative survey was undertaken in January 2019. Responses were invited from those that have engaged in commercial fishing of shellfish species within the proposal areas within the last 3 years and remain commercially active. The survey was therefore not open to all potential stakeholders, but deliberately focused on fishers, and due to the subject of the survey the majority of respondents were from the scallop sector.

(Note: It should be emphasised that this was not a full public consultation, but a targeted research survey directed to those that have fished in the proposal areas. Based on the survey results Marine Scotland and the WC-RIFG may wish to put one or more of the proposals forward to “all stakeholders” via their formal consultation framework).

An online questionnaire was developed in collaboration with industry representative that combined Likert scale questions (e.g. strongly agree, agree, disagree, strongly disagree) and provided the option for comment further. Standard demographic questions were also asked, along with vessel characteristics. The survey explored overall support for the proposed management measures and how fishers think the measures may influence vessel operating profit, stock status, effort displacement and ecosystem health. It also sought views on aspects relating to the implementation of the management measures and knowledge gaps. Each respondent was also asked to specify how many vessels they were representing in their response (as a skipper, vessel owner, crew or other representative). However, it was not possible to weight responses based on the number of vessels listed on a form, because some vessels were represented on more than one occasion (e.g. by a vessel owner and a fisherman's association). Therefore, each survey submitted was counted as a single response or 'item' in the analysis, regardless of the number of vessels listed in the single response.

The survey was disseminated widely via email to the West Coast Regional Inshore Fisheries Group, and all recipients were requested to forward it onto their own contacts (online and MS word option were available for responding). Stakeholders were given 4 weeks to respond, with several reminder emails circulated. Prior to the survey being circulated to fishers it was reviewed by key industry representatives from the WC-RIFG Scallop Working Group who helped develop the proposals, as well as the WC-RIFG Chair and Marine Scotland inshore fisheries team. In addition, telephone interviews were held with members of the WC-RIFG Scallop Working Group to agree the survey content and distribution approach, and a face-to-face meeting was held with one fisherman’s association on request. Only once the content was agreed by these industry representatives was the survey distributed more widely as described above (the final survey is shown in Appendix 4).

In addition to the questionnaire developed for industry stakeholders, telephone interviews were held with representatives from Marine Scotland Science, Scottish Natural Heritage and Marine Scotland Compliance to gain specific feedback on aspects of the proposals relating to their field of expertise.

The survey data collected was analysed accordingly using descriptive statistics within MS Excel and R. The full survey details and results are provided in Annex 4, but a shortened summary of the findings is provided here:

7.1.1 Results

In total 30 responses were received, the majority of which were from individuals representing single vessels, however 7 respondents represented multiple vessels (e.g. fisherman's association/federations, Producers Organisations and some vessel owners). The vessels represented were from six different marine regions (five Scottish regions plus Northern Ireland), half of which were from Argyll. In total 42 vessels were explicitly named in survey results that fish within the proposal areas. The majority of survey respondents (57%) were full-time scallop dredgers, followed by vessels that operated a mix of dredges and trawls (21%), followed by scallop divers (11% - some of which are also taking part in the razor clam trial[60]), with a small number of creel fishers also responding. In terms of vessel size, 31% of respondents represented vessels under 12 m overall length (and can generally travel 0-50 miles from their home port), 15% represented 12-15 m vessels (and can travel a wider range of distances), and 54% represented over 15 m vessels (most of which can travel more than 100 miles from port).

Overall support for proposals

The stacked bar chart below (Figure 7-1) shows the respondents overall support for the proposals, with the most favoured measure at the top and the least favoured at the bottom. Overall, there was more support for the proposals than opposition, with the exception of limiting dredge numbers to 6 aside (least supported measure).

The proposal that received the highest level of support was installing VMS on all vessels (93% support), followed by increasing the minimum landing size of hand-gathered scallops to 120 mm within MPAS (86% support, which included all divers that responded). The proposal that had the lowest level of support was a limit on dredge numbers to 6 aside (53% against, 30% for, 17% neutral), which is likely because the majority of dredge vessels (over 12m) currently operate 8 aside. The overnight curfews and the days at sea limit for scallop dredging had similar levels of support (60-63% for), but around a third of fishers opposed these proposals.

Bigger vessels (over 15m) that can travel furthest to fish (more than 100 miles), were most resistant to an overnight curfew and limiting days at sea. Vessel based in Argyll were divided on their views of limiting days at sea, whereas visiting scallop fishers from other marine regions were generally supportive of this measure. Several respondents felt that a 'blanket days at sea' limit was needed around the UK. Some also stated that 22 days is too high (most scallop dredgers that responded fish less than this) and an 18 - 20 days limit per month limit would be more appropriate, especially if an overnight curfew was not applied (as a compromise).

[60] See https://www2.gov.scot/Topics/marine/Sea-Fisheries/management/razors for more details.

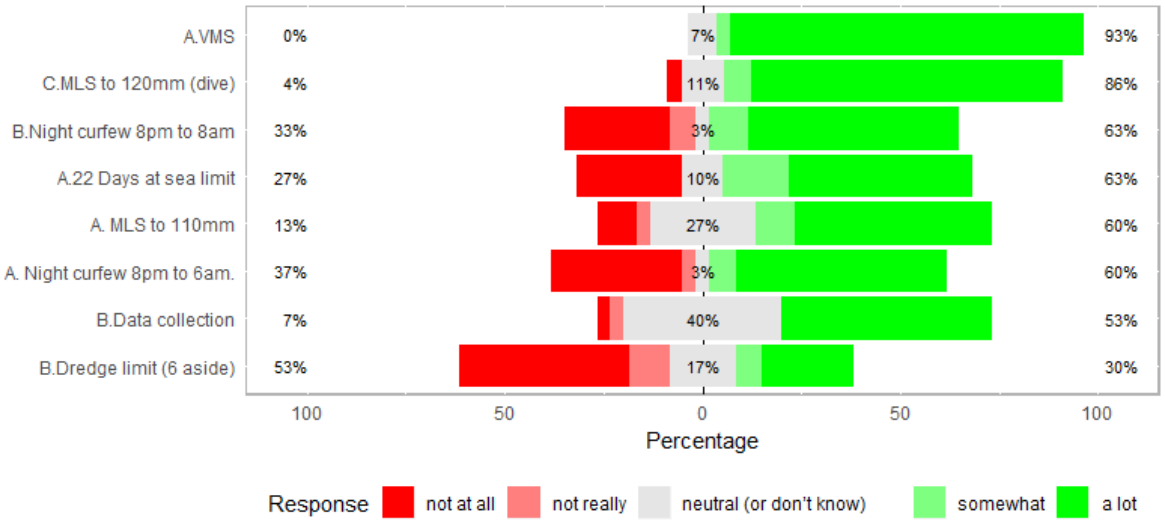


Figure 7-1: Stacked bar-chart showing overall level of support for proposed management measures

Data collection was supported by 53% of respondents, and 40% were neutral/unsure how to answer this question. It was suggested that “baseline and stock data should be collected and assessed before and after any measures are implemented” to show if measures have been successful. The majority of respondents also supported an increase in the MLS of king scallops to 110mm (60%), although 27% were neutral/unsure and 13% did not support an increase.

Key comments from respondents include: "These proposals can’t come quick enough. A short-term hit will produce a long-term gain and benefit us all in the long run. I hope to have 30 more years fishing and sensible measures such as those proposed is only a good thing", but “There is no science to back up the proposed management measures".

Applying identical versus different measures

A clear majority (79%) felt that it was more appropriate to apply identical measures across areas A and B, especially vessels that spend up to 100% of their fishing time in these two areas. It was generally felt that identical measures would be "simple for fishermen to understand and for enforcement", and "if they were different it would lead to confusion and be open to abuse".

Economic impact of measures

The stacked bar chart below (Figure 7-2) illustrates how fishers feel the proposed measures may impact their overall operating profits, with the most positive impacts at the top and the most negative at the bottom. Overall, data collection and VMS were viewed as potentially having a positive influence on business profits, as was increasing the MLS of hand dived scallops to 120 mm in MPAs. But respondents were divided in their views of how night-time curfews and limiting days at sea would impact their business. In terms of increasing MLS to 110 mm, 41% felt it would have a positive economic impact, particularly those who spend more than 75% of their fishing time in proposal area A. However, 34% thought it would have a negative economic impact and 24% were unsure. Nearly half the respondents felt that limiting dredges to 6 aside would negatively impact their business profits.

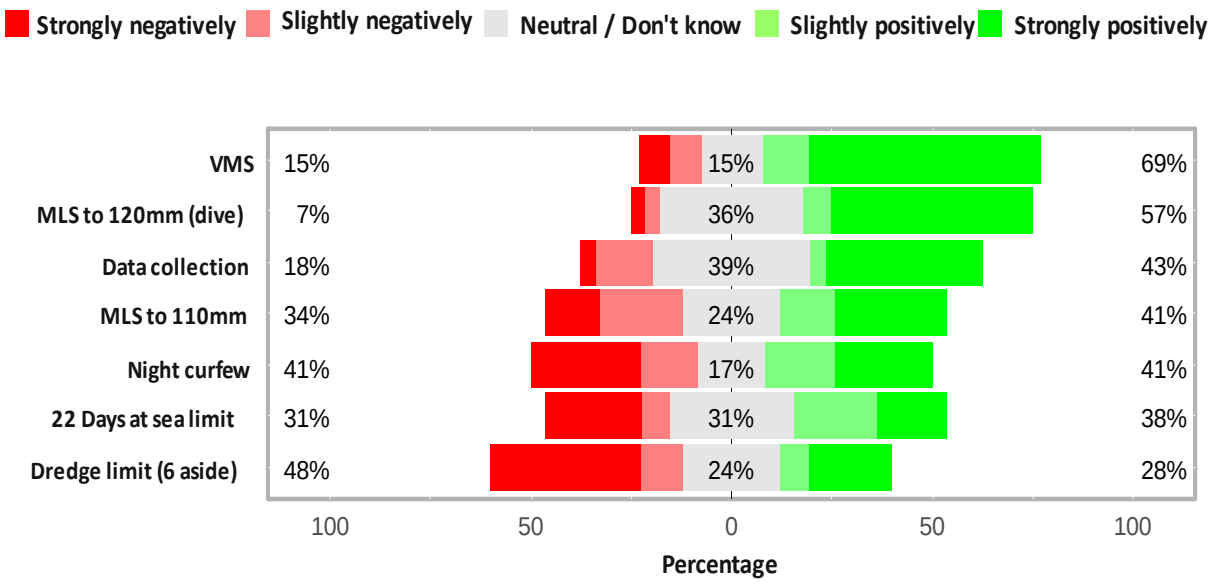


Figure 7-2: Extent to which respondents feel the proposed management measures will affect their overall operating profits of businesses (or businesses that that the survey respondent represents) over the next 5 years.

Stock status and perceived level of exploitation

Exactly half the of respondents felt that scallop stocks were overexploited, and half felt they were sustainably exploited. Scallop dredgers and trawler had mixed opinions, whereas scallop divers and static gear fishers generally felt that scallop stocks were overexploited.

The lack of effort control in the area, increased vessel mechanisation and “high levels” of fishing on a seasonal basis by nomadic vessels were quoted as reasons for perceived overexploitation, with several respondents stating they have observed declining catches despite increasing effort. The counter viewpoint expressed by respondents is that natural variation on the west coast is the main driver on scallop stocks (and not fishing effort) with cyclical "ups and downs" in abundance. Several fishers stated their catches have not declined over the years. However, one respondent stated that "at the moment we feel that scallops are sustainably exploited, however there is currently potential for this to slip into over-exploited if we are not careful".

Most respondents (77%) clearly thought that increasing the MLS of hand-dived scallops to 120 mm in MPAs would have the most positive role in safeguarding scallop stocks, followed by introducing VMS on all vessels (68%). The majority (57 - 61%) also thought that scallop stocks could be safeguarded by controlling effort (overnight curfew and/or limiting days at sea) and by increasing the MLS of king scallops to 110 mm. While some felt that the current list of measures would not be enough to safeguard stocks.

Safeguarding ecosystem health

The majority (56%) thought that increasing the MLS of dive-caught scallops to 120 mm, as well as installing VMS, would help safeguard a healthy ecosystem. While, most felt that the other measures would not safeguard ecosystem health.

Potential for Effort Displacement

An overnight curfew, followed by limiting dredge numbers to 6 aside, could potentially lead to the greatest displacement of effort (as seen in Figure 7-3), especially for larger vessels that fish overnight and have longer trips. Whereas the smaller 'day boats' are unlikely to be displaced because they cannot move further away to fish. The ‘22 days at sea’ measure may

force some vessels to travel elsewhere to fish for the other 8-9 days in a month, however the survey results and narrative suggest that most scallop vessels fish less than 22 days per month so in reality displacement may be less of an issue with the 'days at sea' measure. Respondents stated that vessels could be displaced to various locations around the UK, including; the East coast, Irish Sea, Minch, North Sea, or simply to the nearest scallop ground in the area. Effort may also be transferred to other fisheries, because many scallop dredgers also have Nephrops and queen scallop gear.

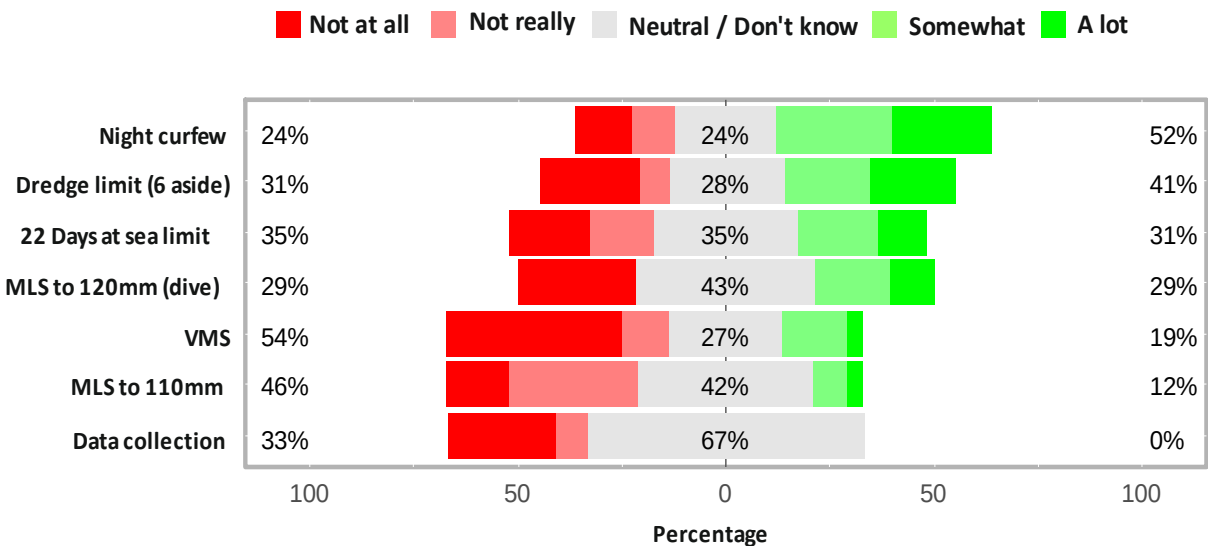


Figure 7-3: Extent to which fishers feel the proposed measures would displace fishing effort onto scallop grounds elsewhere.

Enforcement of measures, and voluntary versus statutory approaches

The vast majority of respondents felt that management measures would need to be statutory, with the exception of data collection (Figure 7-4). The majority of respondents also thought that all the measures were somewhat or very achievable to enforce, however there was some concern over Marine Scotland's capacity to do so at present. Therefore, VMS was seen as an essential requirement for enforcement in the first instance, provided the 'ping' rate was suitably frequent to detect fishing activity within the management areas (i.e. minutes rather than hours).

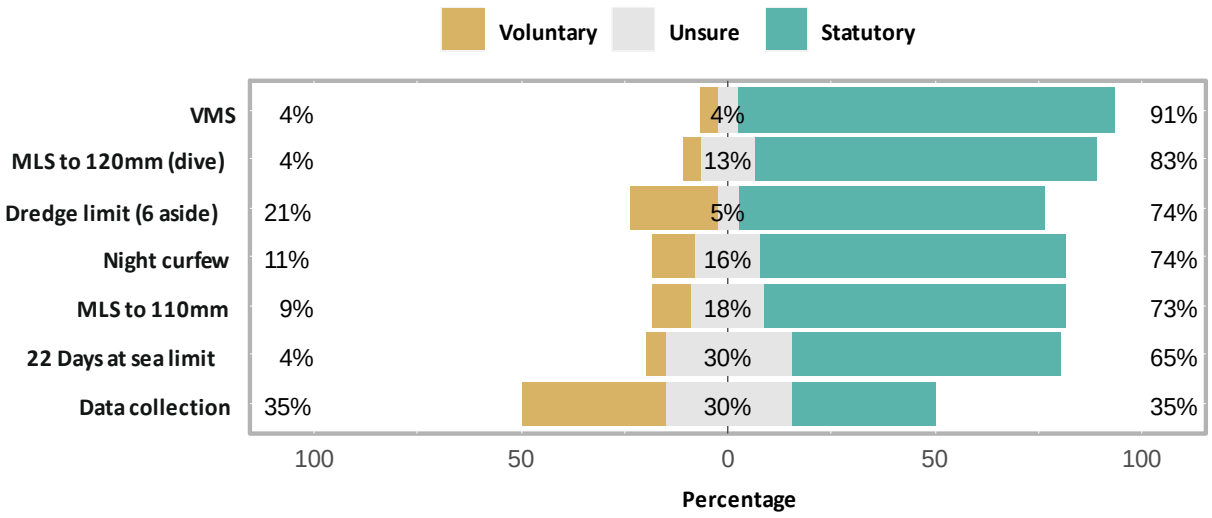


Figure 7-4: Fishers views on whether the proposed measures should be voluntary or statutory.

Further areas of research

Respondents to the industry stakeholder survey were asked to rank knowledge gaps which should be overcome to improve the evidence base for the proposals. The knowledge gaps are ordered below based their answers, from highest research priority at the top to lowest priority at bottom:

- Impacts of displacement of scallop effort onto other fishing grounds
- Socio-economic impacts of measures
- Stock characteristics (local size at maturity, larval dispersal, status, spawning patterns)
- Ecosystem response to management measures
- Fishing patterns (location of grounds, daily fishing patterns)

7.2 Further comments on WC-RIFG Proposals

Proposals A & B include measures to seek to reduce the overall exploitation rate of scallops, within defined areas. These include an overnight curfew, a reduction in permissible number of gears and (in the case of option A) a limit on effort (Days at Sea) within the area. This reflects concern on the part of some stakeholders that effort is currently too high in inshore waters.

Proposal A & C include provision to increase the size at which scallops may legally be landed. Proposal A includes consideration of the need for VMS to be adopted and Proposal B includes a requirement for additional data collection to monitor impacts of effort restriction.

As such, between the 3 proposals there are measures designed to limit the local exploitation rate of scallops, which include consideration of how this will be both enforced and monitored. The proposed measures therefore share some of the characteristics of scallop management which have been shown to be beneficial in other areas (as described in section 5 of this report).

7.2.1 Wider stakeholder perspectives

During stakeholder engagement, the perspectives on the WC-RIFG proposals were also sought from a number of relevant experts with specific knowledge of the regional context. Individuals included representatives of Marine Scotland (MS) Compliance, MS Science and Scottish Natural Heritage (SNH). Pertinent issues raised are summarised below against each of the proposed management measures.

Overnight curfew

MS Compliance indicated that an overnight curfew would be the most difficult to enforce, due to the difficulties in monitoring fishing activities at night, especially via air surveillance. MS Science suggested that in order for the overnight curfew to be practicable, all scallop vessels would need to have a full VMS system installed, e.g. such as Anchorlab equipment.

Limit on fishing days (22 days/month for scallop dredgers)

MS Science indicated that a limit on days fishing to 22 days per month would not necessarily represent ‘a decrease in fishing effort compared with current fishing practices’, which is also reflected in survey responses from fishers. It might act as a cap on current effort rather than an overall reduction. According to MS Compliance a 'days at sea' limit would be more practical to enforce than an overnight curfew, and would be a better match to how the fleet currently operates.

Restricting dredge numbers to 6 aside

Both MS Science and MS Compliance questioned whether a reduction in dredge numbers would be effective at reducing effort, given that there would be no means of preventing vessels from increasing fishing time to achieve equivalent catches. MS Compliance suggested that it may be better to explore the utility of a vessel length restriction rather than a dredge restriction in order to limit or reduce effort, but this would first require investigating the average length of vessels working in the proposed areas.

VMS and additional data collection

MS Science and SNH highlighted the numerous merits that installing VMS across all scallop vessels would bring, such as:

- evidence for the location of important fishing grounds
- availability of data to check vessel compliance
- availability of data for use in marine spatial planning; for example, to mitigate conflict between different 'users' of sea space
- combined with landings data, VMS data could also be used in CPUE models (although catch efficiencies may vary per boat).

In addition, SNH emphasised that the VMS transmission frequency (or 'ping rate') would need to be minutes rather than hours to detect fishing activity within the proposal areas.

MS Science were also supportive of collection of stock assessment data by industry, in areas that Marine Scotland do not survey but highlighted that if this involved fishing vessel surveys standardisation of catching efficiencies between different fishing vessels and any research vessel would be necessary.

Increases in MLS

MS Science explained that due to the relative growth/reproduction rates of scallops detecting impacts of recent increases in MLS (from 100 mm to 105 mm) on scallop recruitment would be unlikely before at least 2019, and most likely only be detectable four years after introduction. They highlighted that increasing the MLS is largely 'an act of faith' as it is very difficult to prove its effectiveness in terms of increasing stock in subsequent years because of the many confounding variables that influence scallop recruitment including natural variability, spawning time, food availability, and other factors such as hydrography and fishing. Increase in MLS would not necessarily result in a decrease in exploitation rate or fishing mortality.

Potential for Effort Displacement

Both MS Science and MS Compliance suggested that should effort displacement occur as a result of implementing proposed measures, vessels currently fishing in the proposal areas would most likely be displaced to the area to the North of Skye and the Minch which represent important scallop grounds.

Implementation of measures

MS Compliance suggested that the easiest way forward to implement any of the measures proposed would be to prohibit all scallop fishing (dredging) in the areas, and then allow vessels to apply for a permit to fish (dredge) for scallops in the proposed areas. Permit conditions and duration can then be specified, and this approach also allows Marine Scotland to place

conditions onto non-Scottish vessels (i.e. they would not need a Scottish Statutory Instrument[61] (SSI)). This was the approach taken for the Scottish razor clam trial[62].

MS compliance also suggested that where possible, management measures should apply to both dredging and trawling for scallops. This would be necessary to prevent vessels simply switching to trawls in order to target scallops in the proposal areas, and thereby circumvent the measures seeking to safeguard stocks.

Improving stock status through spatial/temporal management

MS Science reiterated that recruitment and SSB as estimated in the stock assessments for West Kintyre and the North West assessment areas increased substantially between 2005 and 2012. MS Science explained that if closed seasons were to be considered, it would be important to protect spat settlement areas through spatial measures, but advised that a better understanding of population connectivity would be required in order to implement such closures.

SNH would favour an approach to spatial management that protects habitats that function as scallop nursery grounds and larval settlement habitats. The current network of Marine Nature Conservations Areas (e.g. MPAs and SACs) offer some degree of protection to specific PMFs, however the primary management objective for these areas is to protect the features for which they were originally selected/designated and therefore represent 'conservation' objectives rather than fisheries management objectives. Going forward, SNH would be keen to encourage protection of features from a fisheries management perspective. For example, one approach could include a spectrum of fisheries management objectives to protect nursery area features, ranging from full closures to rotational closures, to seasonal closures. However, SNH pointed out that any spatial management measures would need to be appropriately scaled to the respective targeted fishery. In addition, while there may be short term costs to the fishing industry, there would be long-term benefits of protecting areas that act as nursery habitats for scallops.

7.2.2 Probable impact of WC-RIFG Proposals

With existing data, it is not possible to determine the extent to which the proposed measures would result in a reduction in exploitation rate for scallops within the three proposal areas. However, the measures may deliver some local ecosystem benefits by reducing, or at least capping, the level of dredge effort within the defined area. This may contribute to wider conservation objectives, although again, the extent of this ecosystem benefit cannot be quantified with existing data. Overall, it can be concluded that the three proposals introduce a slightly higher level of precaution into the management of scallops within the WC-RIFG area. These measures could therefore make a local contribution to future efforts to adopt a wider strategic approach to stock management. However, further analysis would be required to quantify this.

By contrast, there are some aspects of the proposals which could be augmented or strengthened to encompass some of the wider strategic issues at both a stock and ecosystem level.

7.2.3 Areas of Further Consideration

Links to current status of the stock and ecosystem

None of the proposals are directly connected to a particular scallop stock or make direct reference to the status of that stock. According to the 2016 stock assessments, both the West of Kintyre and the North West stock have shown improvements in stock status in

[61] https://www2.gov.scot/Topics/marine/Compliance/legislation
[62] See https://www2.gov.scot/Topics/marine/Sea-Fisheries/management/razors for more details.

recent years thanks to strong recruitment. In spite of this, advice in 2016 was for no further increase in effort. The assessment also recognises some uncertainties in the assessment and no further assessment has been undertaken since. So, the current situation is unknown and it is likely that the stock status will have changed. Industry stakeholders within the WC-RIFG have since expressed concern about declining catch rates. It is this concern over scallop stock status (across both stocks) that therefore drive the proposals for the adoption of more precautionary management measures in inshore waters. This is reflected in the fact that half of the industry stakeholders who responded as part of this exercise believed the stock to be currently over-exploited. Of these, all were from the scallop fishers with the exception of 1 creel fisherman. It is important to note that 50% of all *respondents* consider the stock to be overexploited, and 92% of respondents were scallop fishers, one response may represent multiple vessels (e.g. for an association or PO). Therefore, if we look at the number of individual vessels that constitute to each response (to this question of exploitation), then 27 vessels were named on the responses that felt stock was overexploited, while only 14 vessels were named on the responses that felt stocks were sustainably exploited. This draws to the conclusion that while "respondents" were split 50:50 on the rate of exploitation, if we take the number of vessels they are representing into account then *the majority (66%) of the fleet represented on the responses to this question felt that the stock is over exploited*, all of which (bar one) are scallop fishers (both dredge and dive). Therefore, there is evidently a high degree of concern from the scallop fishing industry regarding the level of exploitation.

However, the proposals also implicitly recognise that because much of the stock assessment areas (both West of Kintyre and the North West) lie outside of the WC-RIFG area, these management measures alone will not be sufficient to achieve overall stock management. The proposals are therefore intended to act as measures which may *contribute* toward overall stock management whilst contributing to more local population and ecosystem benefits.

Relationship to existing management

In this report the existing management measures in place for scallop fisheries in the WC-RIFG area are presented, including the areas closed to scallop dredge activity despite whether this management was explicitly put in place for scallop conservation or not. This therefore enables the three WC-RIFG management proposals to be seen as part of a suite of management measures, contributing to the management of both the scallop stocks and marine ecosystem in the WC-RIFG area. It does not appear that any of the 3 WC-RIFG proposals would contradict existing management or create an unacceptable loophole, but would instead augment existing management, in the areas which they cover.

Unintended consequences

The proposals do give some consideration for unintended consequences, notably with the inclusion of both VMS and additional data collection within the proposals. This recognises that the introduction of additional management is likely to create changes in the pattern of fleet activity which should be monitored to help ensure that introduced management measures do not create unintended consequences. However, further consideration of unintended consequences may strengthen the proposals.

It is not clear whether the proposals would lead to an overall reduction in the exploitation at the stock level. Therefore, although there may be benefits to the local population, because effort may be displaced to outside the proposal zones, the overall reduction in exploitation may be less evident at the stock level. Similarly, from a benthic habitat or ecosystem functionality point of view, although there may be localised benefits, these may be coupled to increases in habitat impacts in other areas, where they result in the displacement of effort.

Supporting and on-going data requirements

The proposals also give some consideration for the requirements of supporting data, both in demonstrating the need for management intervention and in demonstrating that any introduced management measures have achieved their objective. Additional data collection is included within Proposal B, although going forward, further detail could be provided within the proposal to set out both the scope and practicalities of additional data collection.

8 Recommendations

8.1 WC-RIFG Proposals

It can be concluded that further management intervention appears warranted for scallop fisheries within the WC-RIFG area due to the recommendation from Marine Scotland for not further increase in effort, and the support from industry for certain management measures. The industry has identified the need for further management and subsequently brought forward three proposals. The industry consultation exercise undertaken as part of this project shows that half of respondents consider the stock(s) to be over-exploited and there is a general level of support for further management intervention, although there are differences of view about which management approaches are favoured. There is also a general recognition that some management intervention could lead to improvements in stock health (although, again, there are differences of view about which measures will lead to greatest stock benefits).

The measures which were most positively viewed were for the introduction of VMS to all scallop vessels and increasing the minimum landing size of dive-caught scallops in MPAs (to 120 mm). Both of these measures appear to be warranted and are therefore recommended. The response to proposals to limit effort either by means of a days at sea limit or a curfew were also broadly positive, but there was a greater divergence of view across the industry. Effort control measures are likely to be part of the long-term solution to scallop management on the west coast and certainly warrant further consideration as part of a more strategic exercise where the management of the wider stock and issues such as effort displacement are more fully considered. Finally, there was least support for a further reduction limiting dredges to 6 aside. Respondents felt that this measure would fail to achieve the stated aims.

The industry consultation exercise also showed a high level of agreement for providing whatever management controls are introduced with a statutory and legally enforceable basis, recognising that voluntary measures are unlikely to be effective (or be perceived as being effective). Effective enforcement should therefore underpin which-ever proposals are introduced. The desire for management measures to have a statutory backing is contrary to the Marine Scotland Inshore Fisheries Management "Vision" for RIFGs[63] which states that:

> "Marine Scotland considers that in the first instance in all cases a voluntary partnership approach is the most appropriate to help resolve fishery management issues".

In addition, the industry consultation exercise also showed a high level of agreement for making whatever management controls are introduced to be duplicated across the zones, to reduce the potential complexity of having different controls in different adjacent areas. This should therefore be a recommendation which is carried forward.

8.2 Further Recommendations

Although further recommendations are provided here, it is important that these are seen in the context of the precautionary approach, defined in section 5.1.4 of this report. Although there is always the potential for further science and study this should not be seen as an automatic pre-cursor to management intervention.

Further recommendations may also include those which are beyond the remit of the WC-RIFG. This is particularly the case where recommendations relate to stock level management.

[63] Contained within the RIFG outline structure and functions document: http://ifgs.org.uk/files/2414/7886/1167/RIFG_-_Outline_Structure_and__Functions.pdf

8.2.1 Strategic considerations

The UK scallop fishery has been highlighted as a top priority for sustainable management in recent years due to the highly lucrative nature of the fishery compared to the relatively light allocation of resources for science and regulation. The fishery is now the key focus of a number of projects aimed at improving management. For example, as part of Project UK Fisheries Improvements (PUKFI), English Channel and Scottish scallop fisheries have undergone pre-assessments against the Marine Stewardship Council standard for sustainable fishing. PUKFI and associated collaborators, are working to address management gaps highlighted by the pre-assessment process, on a national scale across four focus areas: The North Sea, the West of Scotland, the Irish Sea and the English Channel. The aims of the WC-RIFG proposals and the PUKFI West of Scotland scallop Improvement Project are essentially aligned. Therefore, ongoing respective efforts aimed at improving management in the west coast region should be conducted in a coordinated manner to avoid unnecessary duplication of effort. The PUKFI pre-assessment and action plan should be available in the public domain later in 2019.

8.2.2 Management of overall exploitation rate

The WC-RIFG proposals could make a positive contribution to local fishery and marine ecosystem management, and may lead to a reduced local exploitation rate but in order to make a meaningful and robust contribution to overall stock health, management should seek to control the overall exploitation rate at a wider spatial scale (in response to changes in stock status). This must recognise that a reduction in effort in one area may not reduce the overall effort at a wider spatial scale or at the scale of the stock.

Furthermore, where management intervention successfully leads to local stock health improvements, consideration should also be given to whether access should continue to remain open to all vessels, including those without track record in the area. It should be recognised that in order to control the overall exploitation rate, some control over access is likely to be needed. However, control over access is also contrary to the Marine Scotland Inshore Fisheries Management "Vision" for RIFGs which states that:

> "As a general principle, RIFGs should not seek to constrain access to local fisheries but facilitate the maximum number of individuals to participate in the economic activity of commercial fishing".

However, more recently, the Scottish Government 2019 National Discussion Paper on 'the Future of Fisheries Management in Scotland' recognises that the challenge of achieving effective stock management whilst maintaining a principle of open access and states that for inshore fisheries management[64]:

> *"There is a compelling case for new legislation to improve the management of Scottish inshore waters. We intend to build on preparatory work undertaken for an inshore fisheries bill, prior to the EU referendum, and incorporate this into wider fisheries legislation. We will need to balance the desire for local management alongside the principle of free movement of vessels around the coast".*

And goes on to state that:

> *"We propose to follow the example of other parts of the British Isles and introduce a distinct licence or permit system to better regulate fishing activity*

[64] https://www.gov.scot/binaries/content/documents/govscot/publications/publication/2019/03/national-discussion-paper-future-fisheries-management-scotland/documents/future-fisheries-management-scotland-national-discussion-paper/future-fisheries-management-scotland-national-discussion-paper/govscot%3Adocument

> *within the Scottish 12 nautical mile zone. As is the case with licences and permits for Crown Dependency licences, or English IFCA (Inshore Fisheries Conservation Authority) permits, these would sit alongside the current UK fishing licence and be required before undertaking any commercial fishing activity. Scottish Ministers could add conditions to these licences to better regulate fishing activity. However, any new fisheries measures would still be subject to the necessary consultation process".*

Such an approach would likely prove useful for the management of inshore scallop resources and would provide an opportunity to control overall rates of exploitation in a more meaningful way over a wider stock area. Once this is in place, then a mechanism for controlling fishing effort in order to allow adaptive stock management informed by stock assessment (with a defined harvest control rule) and associated Marine Scotland scientific advice appears achievable.

In seeking to control the overall exploitation rate the relationship between vessel effort and the overall exploitation rate (fishing mortality) should be further explored, to ensure that effort restrictions lead to direct changes in exploitation rate. Factors such as gear configurations, vessel efficiency and age-at-first-capture are important considerations.

8.2.3 Understanding of the stock

Stock definition

The potential exists to enhance the understanding of stock dynamics and so better inform decisions about the most appropriate jurisdictional scale to apply management interventions. Stock identity is poorly understood and the 'stock' areas are currently defined according to ICES statistical rectangles, which do not align with biological or jurisdictional boundaries (for example of the RIFGs). This would likely require further information on the dispersal of scallop larvae and connectivity of scallop populations or 'stocks', on the west coast. Advancing knowledge within this area is desirable but is likely to require modelling of dispersal and connectivity of all scallop stocks, at scales which are inappropriate to the WC-RIFG area alone.

Stock Assessment

There is the potential for the frequency and accuracy of scallop stock assessments to be increased. A key constraint is the availability of resources to enable this, however, for such a high value and regionally important fishery the allocation of further resources to this would appear to be warranted. The Marine Scotland scientists involved in the stock assessment work have already identified a number of potential further improvements in the process. For example, the current stock assessment model applied to Scottish scallop stocks is descriptive rather than predictive, with no estimate of absolute abundance and no defined reference points. As such this allows interpretation of trends, and can inform more precautionary management approaches, but it does not provide a basis for adaptive management where exploitation rates are adjusted in response to changes in stock level. The greater the level of uncertainty in stock assessments and the greater the time period between stock assessments, the greater the need for a more precautionary approach to management.

Local life history characteristics

Connected to the question of stock definition, referred to above, is the potential for further exploration of scallop life history characteristics, which may inform management decisions about local spatial and temporal management interventions. For example, improved understanding of the timing of peak scallop spawning periods, the distributions of spat and pre-recruits and the distribution of suitable habitat may help to inform WC-RIFG measures to protect primary settlement habitat and adult habitats, via spatial or temporal measures (as

used in other scallop fisheries). Further understanding of growth rates and size at onset of maturity for scallops within WC-RIFG waters, taking into account localised variations may also be used to determine the suitability of MCRS.

8.2.4 Understanding of fleet operational patterns

In order to successfully introduce any spatial and temporal management measure, including those described above, it is paramount to have a good understanding of where fishing is taking place and the manner in which it is being conducted.

Although there is relatively good understanding of fleet operational characteristics and patterns, some further detail would be required to reliably model the outcomes of more subtle changes in management at a finer spatial scale. For example, it cannot be determined from existing data how many vessels currently operate with more than 6 dredges per side, and as such whether this measure would have a significant impact on reducing overall effort and subsequently fishing mortality. Similarly, it has not been possible to model how many vessels would be affected by an overnight curfew, or a limit on the number of days fished per month within tightly defined zones.

8.3 Conclusions

- Scallops fisheries make an important and valuable contribution to Scotland's rural economy. Large scallop catches are derived from the inshore waters of the West of Scotland so it is vital to ensure that the management frameworks in place are sufficient to safeguard the long-term sustainability of both the scallop resource and the marine ecosystem which supports the fishery. This is key to ensuring the long-term viability of the scallop sector and associated businesses.
- UK scallop fisheries are generally subject to less management intervention than many other high value shared fishery resources and although there is a broad scale effort cap there is no effective mechanism in place to adjust exploitation rate in response to changes in stock status.
- There are a number of examples of scallop fisheries in other jurisdictions which are regarded as well-managed, which have a far greater degree of management intervention than is the case in the West of Scotland inshore scallop fishery.
- Concern has been expressed by industry stakeholders about the level of exploitation in the West of Scotland inshore scallop fishery and half of industry respondents to a survey conducted to inform this management review feel the fishery is currently likely to be over-exploited.
- The WC-RIFG identified scallop fisheries as being a priority area within their 2017 Fisheries Management Plan. Since then, the WC-RIFG have put forward proposals for further management intervention in inshore scallop fisheries in the West Coast of Scotland. These industry calls for further measures to be implemented demonstrates that there is an appetite and a case for further management intervention.
- Although there is clearly the potential for some local management measures which may achieve some localised benefits, other management measures are likely to require a more strategic approach which takes account of the wider spatial impacts on defined stocks and issues such as the displacement of fishing effort.
- The industry consultation exercise used to inform this study showed that:
    - There is a strong support for whichever measures are implemented to be applied on a statutory rather than a voluntary basis. There was also strong

support for measures to be applied in an identical way across inshore zones, to minimise the complexity for fishers moving between zones.

- There is strong support for the introduction of VMS across all scallop fisheries.
- There is strong support for the introduction of 120 mm MCRS on dive-caught scallops from MPAs.
- Whilst there is clear recognition of the need for effort control, there was some divergence of views about which approach would be most effective and have the least economic impact.
- The effort control measure with most support was for a limit on days at sea. This has been effectively applied in other scallop fisheries. Although there was some support for an overnight-curfew, responses indicated that this would be likely to create more displacement issues and was therefore less supported. There was least support for a further reduction in the number of dredges to be allowed in inshore zones.

- Where industry proposals for management intervention show a good level of support and where these are deemed to be effective in similar fisheries (or likely to contribute to on-going management efforts) these should be put forward for public consultation with the view to implementation.
- Measures to control effort will be most effective when applied at a spatial scale which is relevant to the wider stock and explicitly recognises the potential unintended impacts of effort displacement. This is likely to require engagement beyond the WC-RIFG. Further steps should be taken to explore scallop management at this wider and more strategic level in order to ensure the fisheries' long-term sustainability.
- The potential of a licencing/permitting approach to better regulate fishing activity within the Scottish 12 nautical mile zone, is included within Scottish Government 2019 National Discussion Paper. A similar approach was also referred to by MS Compliance during engagement for this project. Such an approach would likely prove useful to enable a more strategic and adaptive approach to the management of inshore scallop resources and would provide an opportunity to control overall rates of exploitation in a more meaningful way over a wider stock area.
- Spatial measures which look to protect spat settlement habitat, or seasonal closures at spawning or spat settlement time would also offer potential to contribute to a strategic management approach and therefore warrant further investigation. This offers the potential for both ecosystem objectives and fisheries objectives to be more explicitly linked. Scallop fisheries are well-suited to this approach to management and should be explored further.
- Given the high value of the fishery and the concern expressed both by the industry, over the current level of exploitation, and wider stakeholders, over the associated ecosystem impacts of scallop fisheries, there is a strong case and clear potential for further science and more frequent stock assessment and for issues such as stock definition and larval dispersal or settlement patterns to be explored in more detail.

Annex 1 WC-RIFG Aims

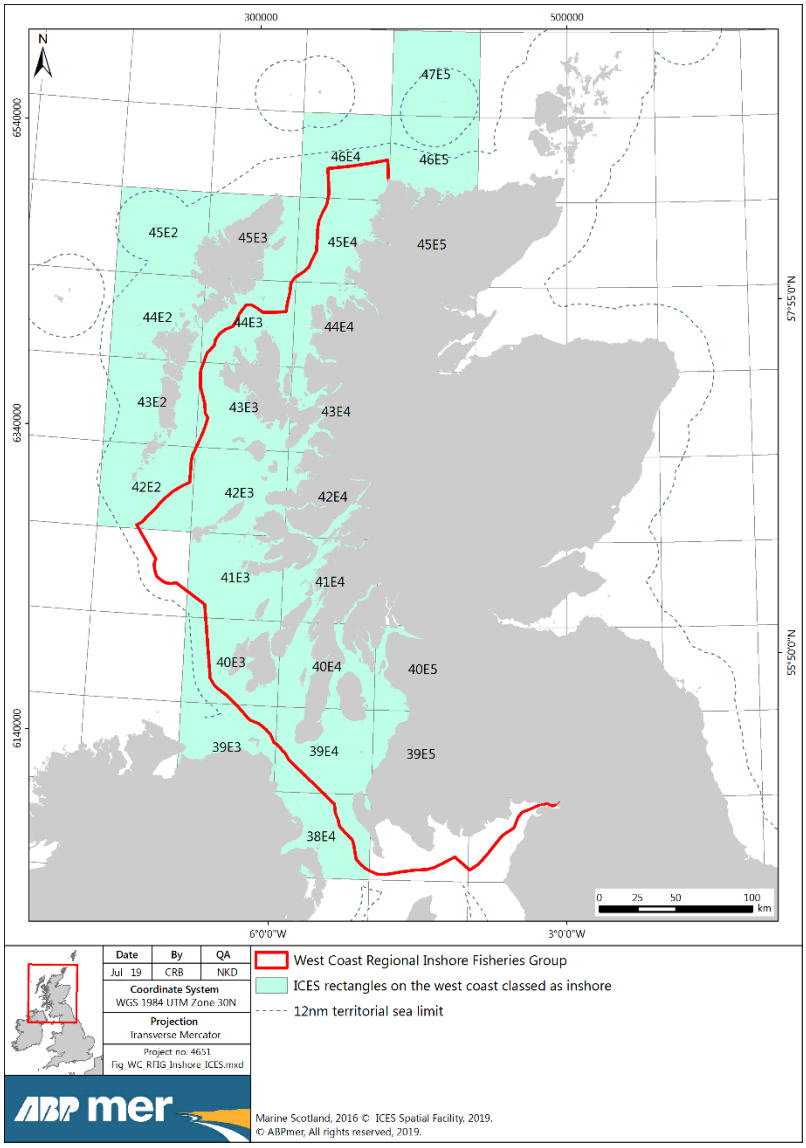
The following Strategic Aims for the WC-RIFG area are from the West Coast RIFG Management Plan 2017. These are split into those which are general applying to the entire WCRIFG area and others that are geographically specific (according to subcommittee areas)

General Aims

- Work with and inform agencies such as Marine Scotland and SNH in the development of management plans for MPAs/SACs/SPAs to ensure that statutory processes take full account of inshore fishing interests in designation and management processes.
- Respond where appropriate to marine statutory consultations such as marine licences, aquaculture proposals, marine planning, etc, where WCRIFG members submit details for responses or alternatively in line with WCRIFG position statements.
- Encourage fishermen to bring forward and view local fisheries issues as part of a wider network of management including Marine Scotland, Marine Planning Partnerships and national forums such as IFMAC.
- Develop position statements that are consistent with the objectives of the National Marine Plan but also reflect the expectations of the WCRIFG. Position statements will be appended to this plan and will be used to advise parties proposing developments in coastal waters of WCRIFG's general stance though these may also be supported by site specific criteria. The following areas have been identified for position statements:
    - Marine Cable Laying contracts
    - Coastal/Marine Pipeline contracts
    - Marine & Coastal Construction contracts
    - Dredging & Deposits in Marine/Coastal Waters
    - Port & Harbour Developments
    - Inshore Recreational Developments
    - Offshore Renewable Developments (wind/tidal)
    - Fish Farming (all types)
    - Sea Weed Farming
    - Non-native Invasive Species
    - V-Notching
    - Creel Escape Panels
    - Litter
    - Pollution
- Explore options for scallop management planning in west coast waters following voluntary closures imposed by WCRIFG in Loch Sunart in 2016. Concerns of ingression of large numbers of vessels and heavy impacts mean that measures are required as a priority to minimise effects and conserve resources.

Annex 2 ICES rectangles classed as ‘west coast inshore’

List of the ICES rectangles classed as ‘west coast inshore’ by Marine Scotland, where the majority of area in that rectangle is within 6nm.



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44E4
45E2
45E3
45E4
45E5
46E4
46E5
47E5

Annex 3 Landing ports within the WC-RIFG area

Achiltibuie	Gareloch	Macduff	Talmine
Ardrossan	Gigha	Mallaig	Tarbert
Arran	Girvan	Ness	Tayinloan
Balvicar	Glenuig	North Harris	Tayvallich
Barra	Greenock	Northbay	Tiree
Bracadale	Gruinard - Aultbea	Oban	Tobermory (Isle Of Mull)
Broadford	Islay	Port Appin	Toberonochy
Brodick	Kallin	Port Ellen	Torridon
Bruichladdich	Kilchoan	Port William	Troon and Saltcoats
Buckie	Kinlochbervie	Portaskaig	Uig
Campbeltown	Kirkcudbright	Portree	Ullapool
Carradale	Kyle	Salen	Ulva Ferry
Colonsay	Kylesku	Scalpay	West Loch Tarbert
Corpach	Largs	Scrabster	Talmine
Craighouse	Leverburgh	Shieldaig	Tarbert
Crinan	Loch Buie (Mull)	South Uist and Eriskay	Tayinloan
Cuan	Loch Carnan	Stockinish	
Dunvegan	Lochboisdale	Stornoway	
Fraserburgh	Lochinver	Stranraer	
Gairloch	Lochmaddy	Stromness	

Annex 4 Industry stakeholder survey in relation to the WC-RIFG Scallop Management Proposals

Methods

A semi-quantitative survey was designed to gather feedback on the proposals from fishers, specifically those that have engaged in commercial fishing of shellfish species within the proposal areas at any point in the last 3 years and are still commercially active. The survey was therefore not open to all potential stakeholders, but deliberately focussed on fishers. The survey combined Likert scale questions (e.g. strongly agree, agree, disagree, strongly disagree) with the option to comment further. Standard demographic questions were also asked, along with vessel characteristics. The survey explored overall support for the proposed management measures and how fishers think the measures may influence overall vessel operating profit, stock status, effort displacement and ecosystem health. It also sought their views on aspects relating to the implementation of the management measures and evidence base / knowledge gaps.

Before the survey was circulated to fishers it was reviewed by key industry representatives from the WC-RIFG Scallop Working Group, as well as the WC-RIFG Chair and Marine Scotland inshore fisheries team. Once the content was agreed, the survey was disseminated widely via the West Coast Regional Inshore Fisheries Group, and all recipients were requested to forward it onto their own contacts (online and MS word option were available for responding). The final survey is shown in the Appendix.

Each survey submitted was counted as a single response or 'item' in the analysis. It was not possible to weight responses based on the number of vessels listed on a form, because some vessels were represented on more than one occasion (e.g. by a vessel owner and a fisherman's association). The data collected from the Linkert scale questions were classed as ordinal, and analysed accordingly using descriptive statistics within MS Excel and R. Results were interpreted by plotting the responses to questions as bar charts (frequency counts, percentages). In addition, bar plots were used to assess if there were any factors that may influence the way respondents answered questions (e.g. a vessels gear type or home port region). Additional comments submitted by respondents have also been summarised in the results.

Results

Note on interpreting diverging stacked bar charts: They main Likert-type responses were plotted using diverging stacked bar charts, where the responses are centred around the neutral value, with the less-than-neutral values plotted to the left, and the more-than-neutral to the right. Using these plots, it is easy to compare how fishers responded to different questions.

In total 30 responses were received, representing vessels from 6 different marine regions (5 Scottish regions plus Northern Ireland). However, the majority (50%) of respondents were from Argyll. Of these responses, 8 were vessel owners, 16 were both vessel owners and skippers, 2 were skippers (but not vessel owners), 1 was a Producer Organisation, 1 was a Fisherman’s Trade Organisation and 1 was a Fisherman’s Federation. In addition, the majority of responses were from individuals representing a single vessel, however 7 out of the 30 responses represented more than one vessel. The list of organisations that respondents were associated with is shown in the Appendix. Multiple vessels were often listed in one response (e.g. for vessel owners), and in total 42 vessels were explicitly named that fish within the proposal areas.

Target species and gear type of vessels:

In total, 79% of respondent's vessels target scallops, 8% target other shellfish (e.g. crab, lobster, Nephrops, razor clam) and 13% target *both* scallops and a mix of other shellfish (Figure 8-1). The majority of respondents were scallop dredgers, followed by vessels that operated a mix of dredges and trawls, followed by scallop divers (some of which are also take part in the razor clam trial), with a small number of creel fishers also responding. In terms of vessel size, 31% were <12m overall length and can generally travel 0-50 miles from their home port, 15% were 12-15m (and can travel a wider range of distances), and 54% were >15m (most of which can travel >50 miles from port).

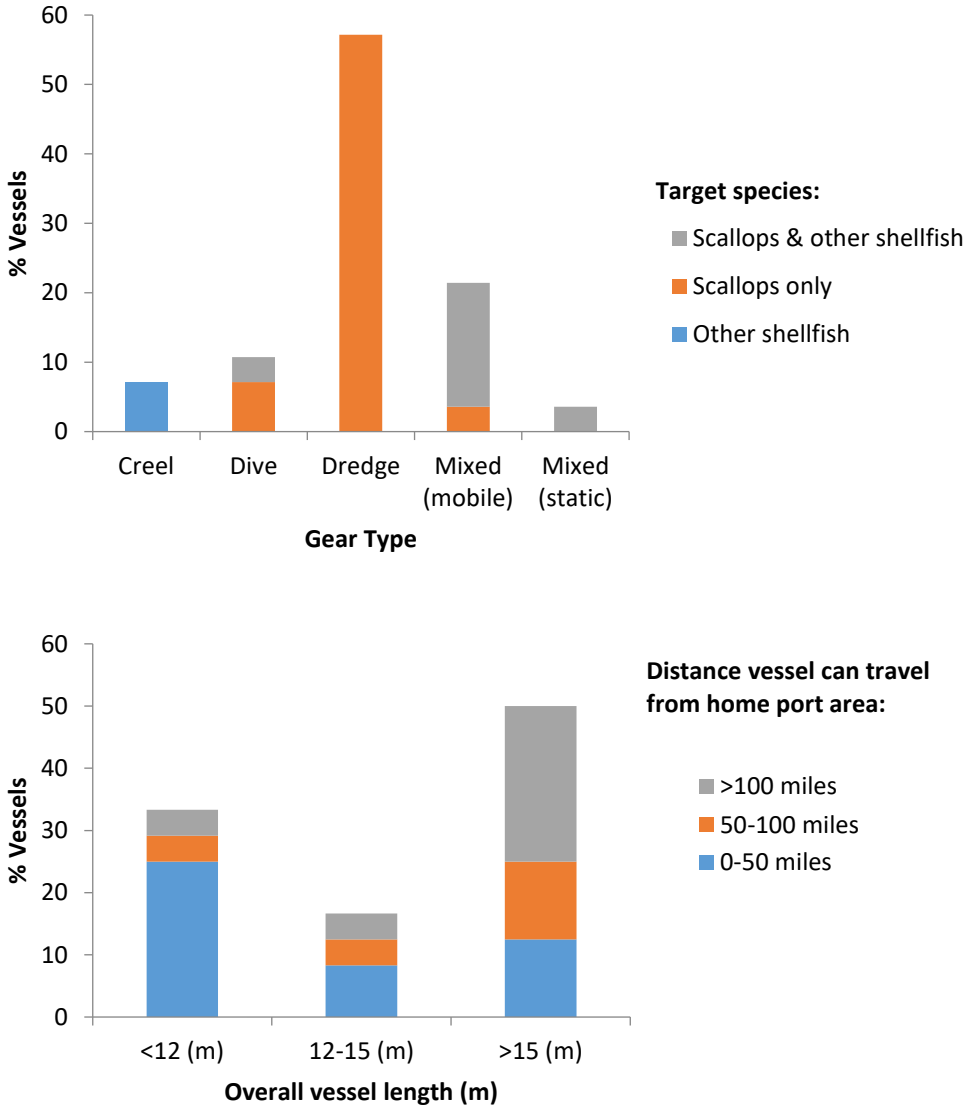


Figure 8-1: Characteristics of respondent's vessels by gear and target species (top), and by overall vessel length and distance the vessel can travel from its home port (bottom).

Overall support for proposals:

The stacked bar chart below (Figure 8-2) shows the respondents overall support for the proposals, with the most favoured at the top and the least favoured at the bottom. Overall,

there was more support for the proposals than opposition, with the exception of limiting dredge numbers to 6 aside (least supported measure). However, there were also fairly strong contrasting views for some of the measures (e.g. the days at sea limit and overnight curfew).

To what extent do you / your vessels support the proposed management measures?

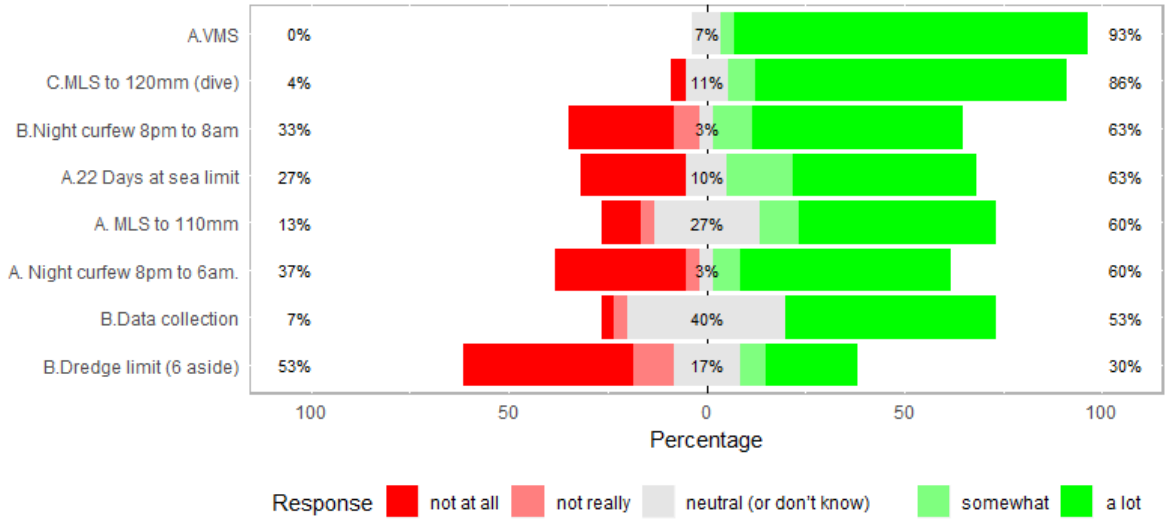


Figure 8-2: Overall level of support for proposed management measures.

The proposal that received the *highest level of support* was installing VMS on all vessels (93% agreement), followed by increasing the minimum landing size of hand-gathered scallops to 120mm within MPAS (86% agreement, which included all divers that responded). The proposal that had *the lowest level of support* was a limit on dredge numbers to 6 aside (53% against, 30% for, 17% neutral). The overnight curfews and the days at sea limit for scallop dredging had similar levels of support (60-63% for), but around a third of fishers opposed these proposals. Data collection was supported by 53% of respondents, and 40% were neutral/unsure how to answer this question. The majority of respondents also supported an increase in the MLS of king scallops to 110mm (60%), although 27% were neutral/unsure and 13% did not support an increase.

Supportive comments from respondents include: "*These proposals can't come quick enough. A short-term hit will produce a long-term gain and benefit us all in the long run. I hope to have 30 more years fishing and sensible measures such as those proposed is only a good thing", and " I've always felt that a curfew and raising the minimum landing size would be the simplest and most effective way of increasing the scallop stocks".*

Non-supportive comments include: "*There is no science to back up the proposed management measures*", and "*any further restrictions will be catastrophic*" to the business of scallop dredgers (given the restrictions already in place with MPAs).

In terms of restricting dredge numbers to 6 aside, there were comments that the vast majority of scallop dredge vessels operate 8 aside (not 6 aside) so this measure would exclude most vessels from fishing in the area. It was also suggested that a curfew starting later at night e.g. 21:00hrs or midnight would be more acceptable and allow vessels to remain profitable. In terms of limiting days at sea, it was suggested that 22 days is too high (most scallop dredgers fish less than this) and an 18 - 20 days limit per month limit would be more appropriate. In addition, it was felt by some scallop dredgers that it would be more practical to *not* have an overnight curfew, but instead reduce the total number of days that a scallop dredger can fish in the area (e.g. to 15 days per month).

Overall level of support for an overnight curfew: The findings indicate that larger vessels (>15m) that can travel greater distances from their home port are most opposed to the curfew (i.e. 'nomadic vessel'), especially those from the Solway (Figure 8-3). Argyll respondents were divided in their views, with 9 against and 6 supportive of an overnight curfew. Vessels that spend more time fishing in proposal areas A and B are slightly less supportive of an overnight curfew. There were no clear trends between the type of gear a vessel is operating and their level of support for an overnight curfew.

Overall level of support for a limit on fishing days (22day/month for scallop dredgers): Fishers with vessels based in Argyll were strongly divided on their views of limiting fishing days per month, with 40% opposing and 53% supporting a limit (Figure 8-4). The majority of vessels from other regions were strongly supportive (82% of which have fished in proposal areas A&B). In addition, larger vessels that can travel furthest from their home port (i.e. nomadic vessels) were least supportive of the effort limit, as were those that spend more time fishing in the proposal areas (Figure 8-4). Gear type had little impact on respondents' views. One comment that was reiterated in several different ways was that "*A blanket scallop days at sea regime UK wide is desperately needed, it is easily policed and would have the same effect on all rather than just impacting on some as these proposed regulations would".*

Overall level of support for restricting dredge numbers to 6 aside: This was the least supported of all the proposals, with a number of vessels from all regions opposing the idea. As with other proposals, the larger vessels that can travel furthest from their home port were least supportive of limiting dredge numbers to 6 aside. However, 17% were also neutral/undecided (Figure 8-5).

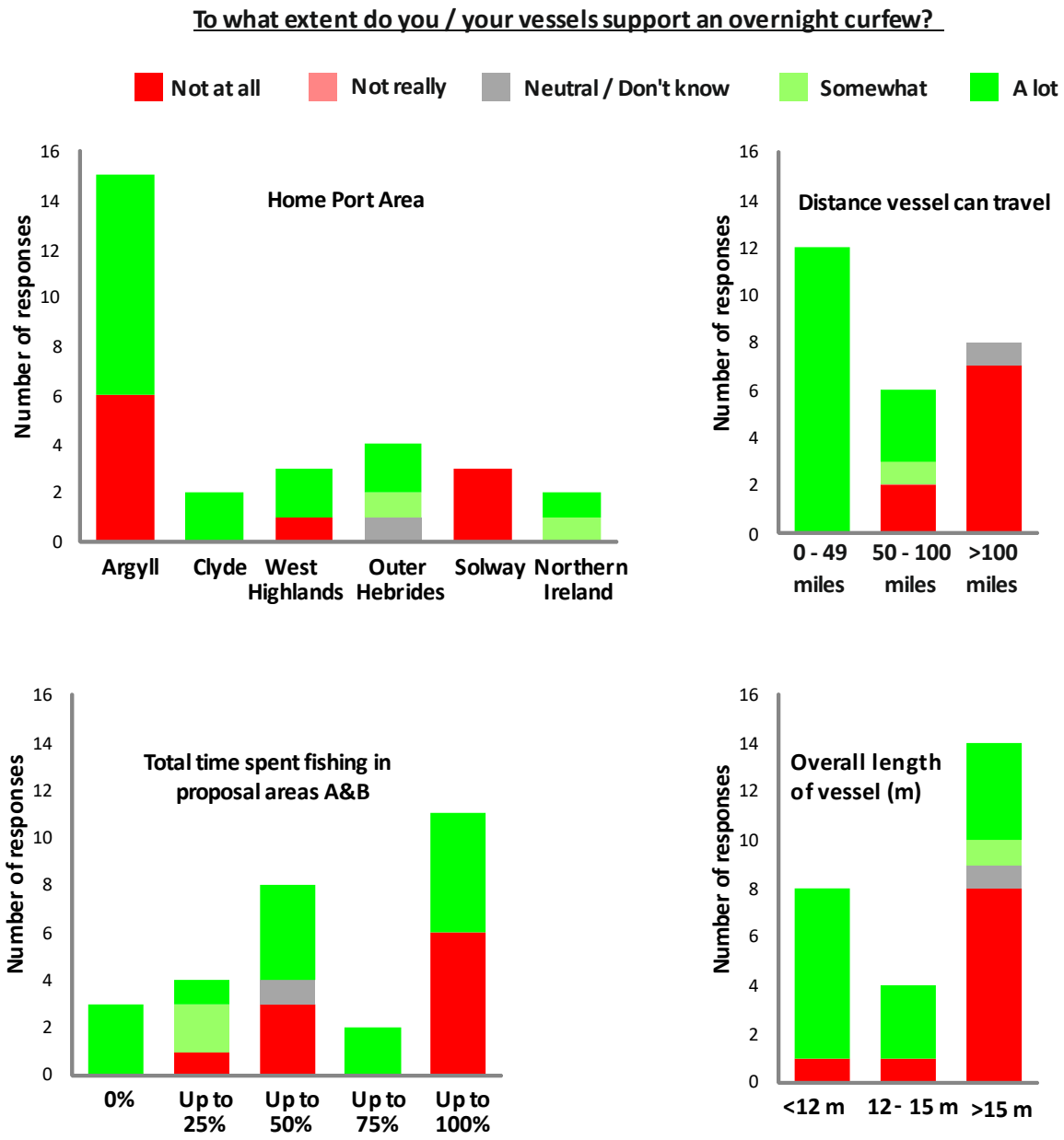


Figure 8-3: Overall level of support for an overnight curfew, breakdown by region, distance a vessel can travel, total time spent in proposal areas and vessel overall length.

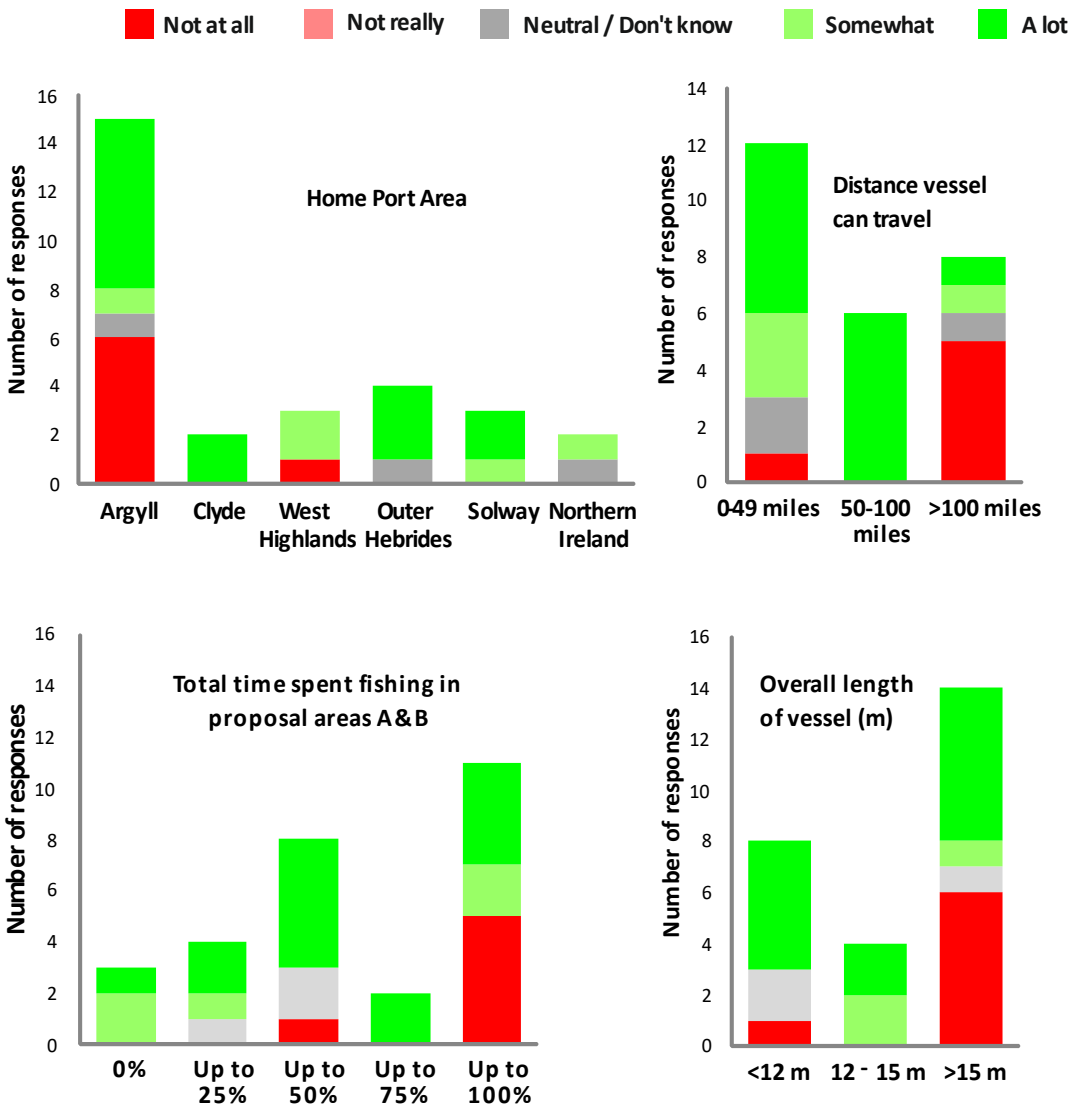


Figure 8-4: Overall level of support for a limit on fishing days (22day/month for scallop dredgers), broken down by region, distance a vessel can travel, total time spent in proposal areas and vessel overall length.

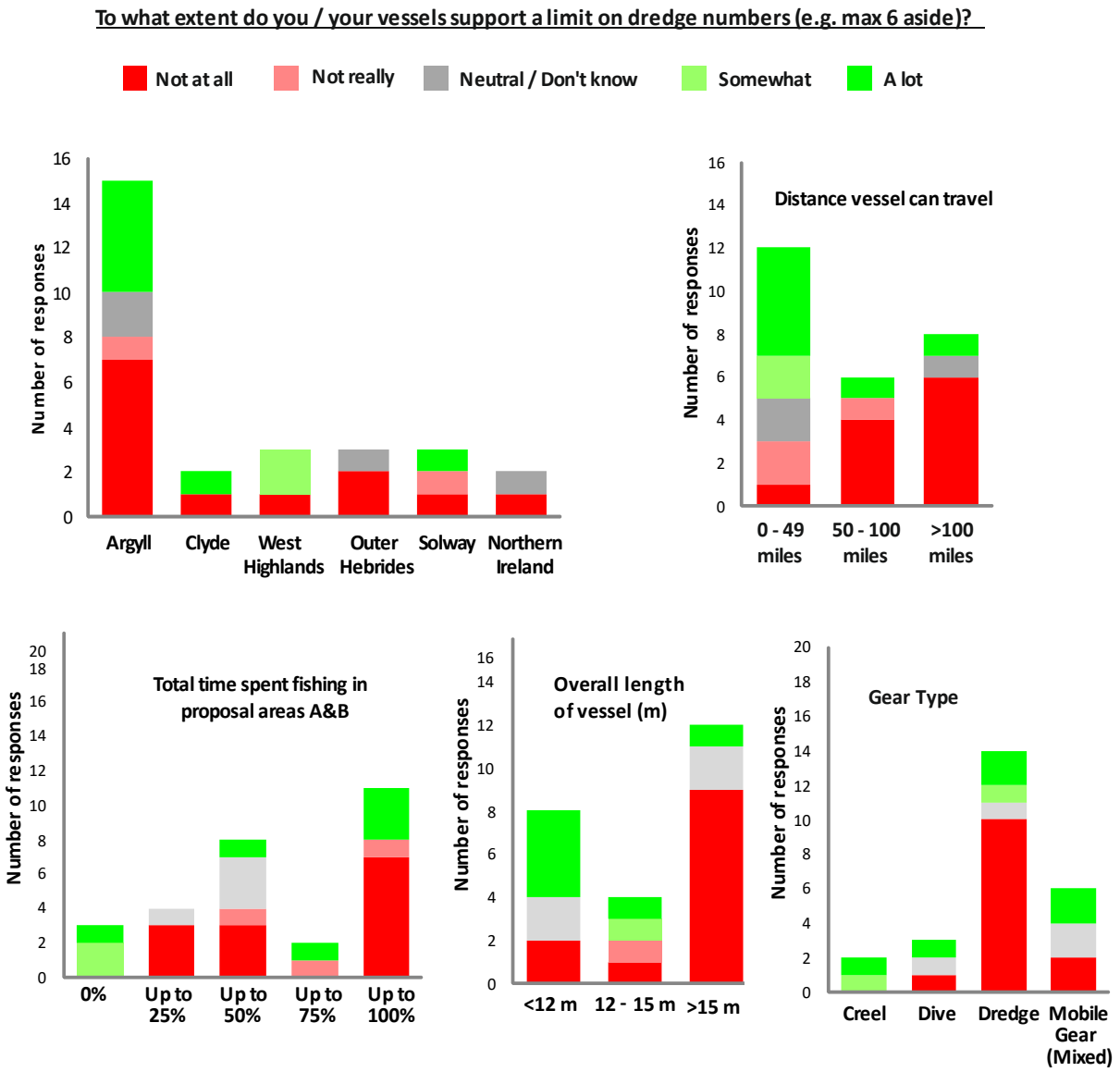


Figure 8-5: Overall level of support for restricting dredge numbers to 6 aside, broken down by region, distance a vessel can travel, total time spent in proposal areas and vessel overall length.

Applying identical versus different measures in proposal areas A and B:

The question asked was " Is it justified for different measures to be applied in each area, or is it better to have identical measures applied in both areas covered by Proposal A and B? A clear majority (79%) felt that it was more appropriate to apply identical measures across areas A and B (Figure 8-6), especially vessels that spend up to 100% of their fishing time in these two areas (as can be seen from plots below). It was felt that identical measures would be *"simple for fishermen to understand and for enforcement*". Other comments include "*I feel if they were different it would lead to confusion and be open to abuse"* and "*If possible, measures should be identical whilst recognising that spatial measures may be required and fine-tuned for some areas*".

Is it justified for different measures to be applied in each area, or is it better to have identical measures applied in both areas covered by Proposal A and B?

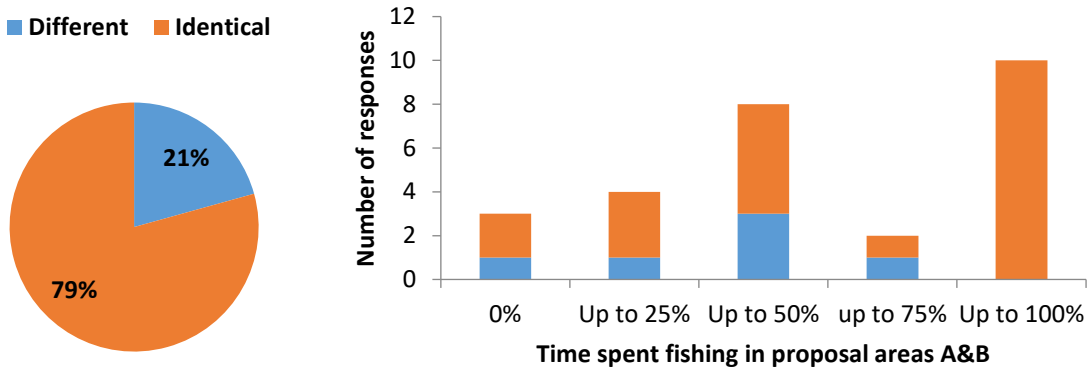


Figure 8-6: Percentage of respondents that felt identical versus different measures should be applied in proposal areas A and B (left) and according to the total time they spend fishing in the proposal areas.

Economic impact of measures:

The stacked bar chart below (Figure 8-7) illustrates how fishers feel the proposed measures may impact their overall operating profits, with the most positive impacts at the top and the most negative at the bottom. Overall, data collection and VMS were viewed as potentially having a positive influence on business profits, as was increasing the MLS of hand dived scallops to 120mm in MPAs.

To what extent do you think the proposed management measures would affect overall operating profit of your fishing business (or the businesses you represent), over the next 5 years?

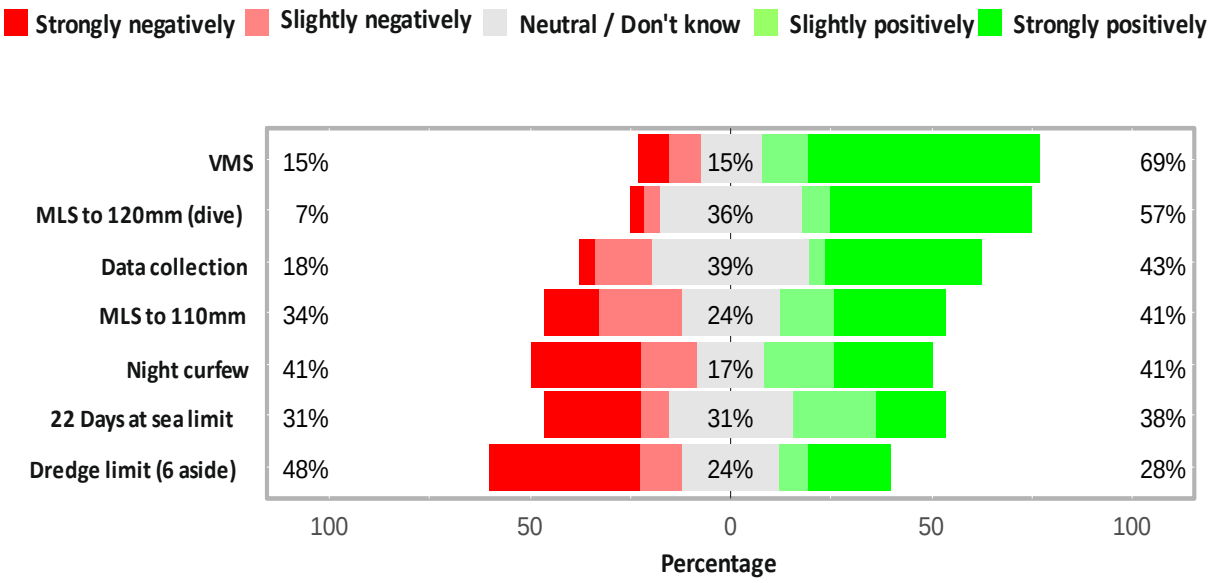


Figure 8-7: Extent to which respondents feel the proposed management measures will affect their overall operating profits.

Respondents were divided in their views of how night-time curfews would impact their business, with 41% feeling it would have a positive effect and 41% feeling it would have a

negative effect. **Figure 8-8** shows that larger vessels (>15m) that can travel furthest from their home ports all felt an overnight curfew would have strongly negative impacts on their businesses. Whereas smaller vessels that cannot travel as far to fish (up to 50 miles) generally felt an overnight curfew would have positive impacts on their business.

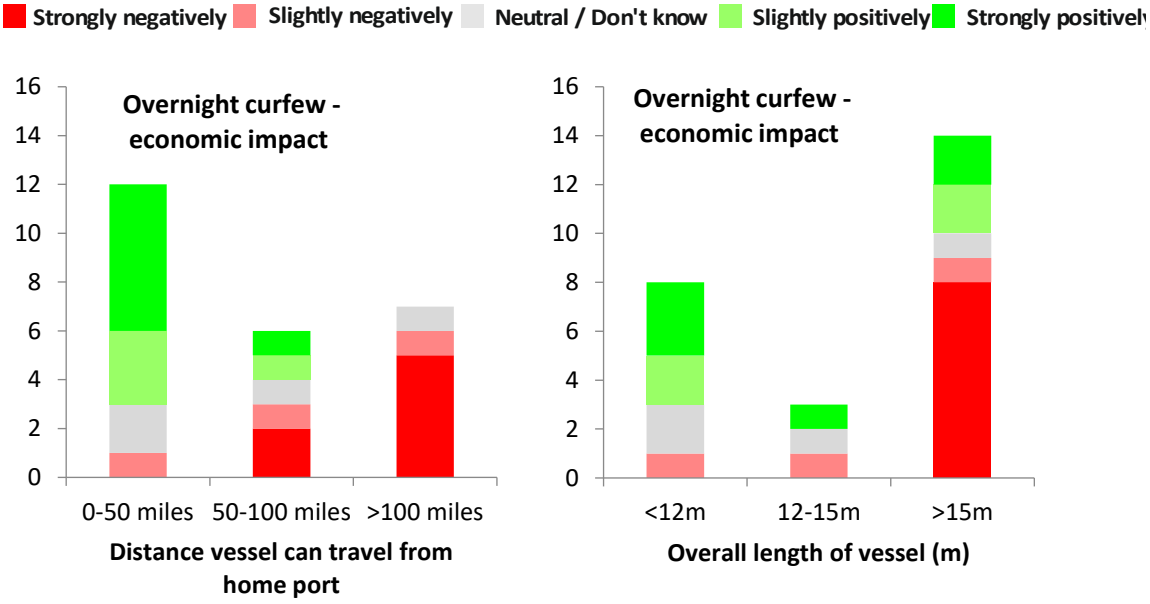


Figure 8-8: Extent to which fishers think an overnight curfew would affect overall operating profit of their fishing business over the next 5 years, broken down into distance a vessel can travel from its home port (left) and vessel size (right).

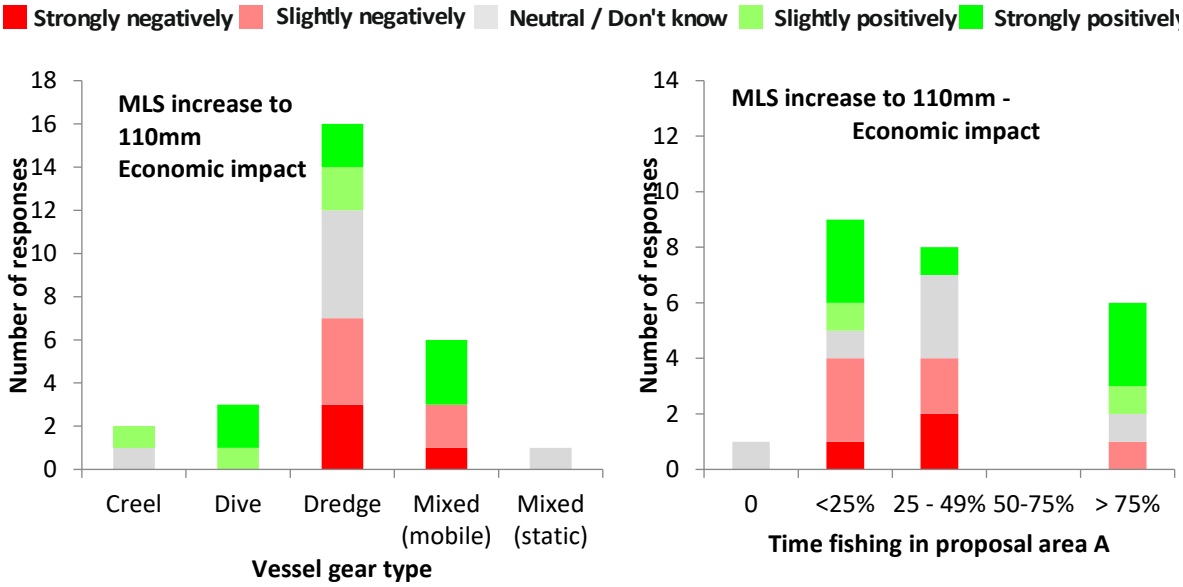


Figure 8-9: Extent to which fishers think increasing King scallop MLS to 110mm would affect overall operating profit of their fishing business over the next 5 years, broken down into gear type (left) and total fishing time in area A (right).

In terms of increasing MLS to 110mm (**Figure 8-9**, above), 41% felt it would have a positive economic impact and 34% thought it would have a negative economic impact. Of those, all scallop divers stated increasing the MLS would have a positive effect on their operating profits, whereas scallop dredgers were strongly divided in their views. Those who spent more than

75% fishing time in proposal area A generally thought increasing MLS to 110mm in the area would have positive economic impacts.

Respondents were similarly divided on the economic impacts of a days at sea restriction (38% positive and 31% negative). Larger scallop vessels (>15m) that can travel more than 100 miles to fish generally stated that a 'days at sea limit' would have a negative effect on their business operating profits (**Figure 8-10**). The 38% who felt it would have a positive economic impact tended to be vessels <12m (dredge, dive and creel) that can travel between 0-50 and 50-100 miles to fish. There were no clear trends between the amount of time a vessel spends fishing in proposal areas A and B, and their views of the economic impact if a days at sea restriction.

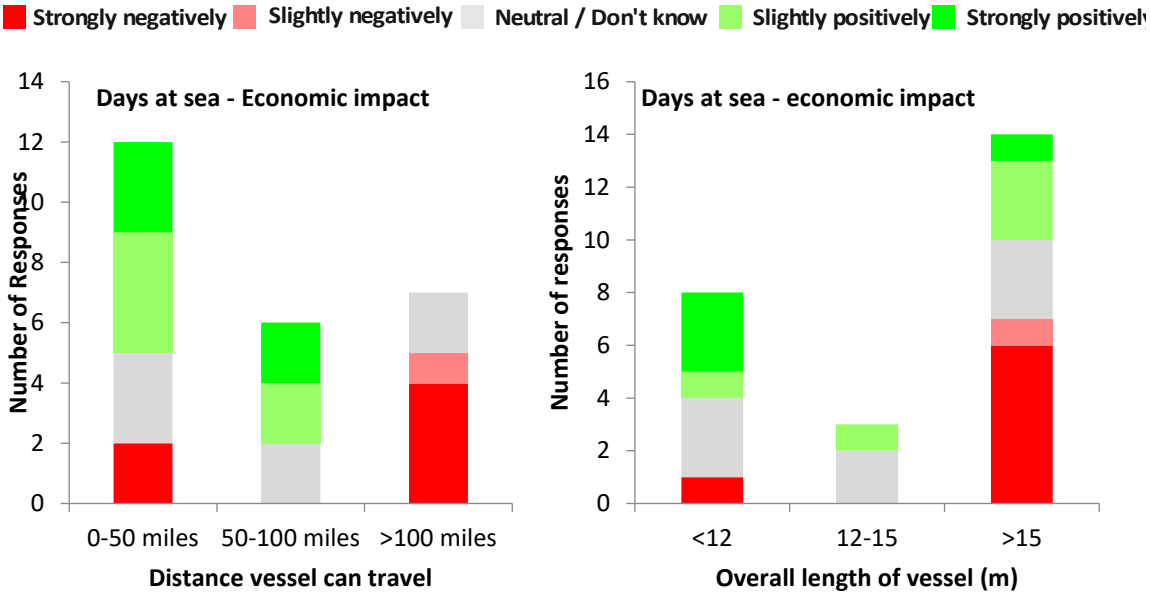


Figure 8-10: Extent to which fishers think a 'days at sea' limit would affect overall operating profit of their fishing business over the next 5 years, broken down into distance a vessel can travel from its home port (left) and vessel size (right).

The majority of respondents (48%) felt that limiting dredges to 6 aside would have a strongly negative economic impact (**Figure 8-7** and **Figure 8-11**), most of whom were operators of scallop dredge vessels bigger than 12m (across all regions). Only 28% felt a dredge limit would impact their business profits positively, and these were generally operators of smaller vessels (<12m) that either dredge or dive for scallops. However, there were two scallop dredgers >15m from Argyll that felt it would have a positive economic impact for their businesses (**Figure 8-11**). Thus, limiting dredgers to 6 aside may primarily benefit smaller local day boats.

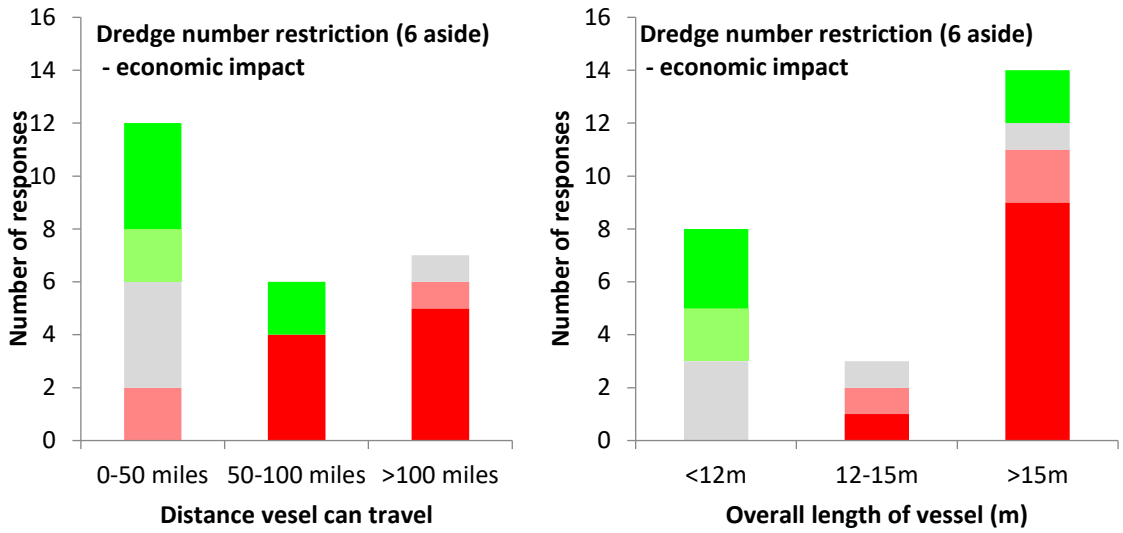


Figure 8-11: Extent to which fishers think limiting dredge numbers (6 aside) would affect overall operating profit of their fishing business over the next 5 years, broken down into distance a vessel can travel from its home port (left) and vessel size (right).

Positive economic comments include: *" There may be a temporary cost to increased MLS in MPA's however there should be long term benefits"; " There would be a good living to be made at scallops if measures are taken" ; " The night time curfew would shortened my working day by two hours, but overall it could decrees effort and improve scallop stocks", and: "Additional and meaningful spatial data collection can only be a positive for industry and managers".*

Negative economic comments include: *"I'm working with 8 aside, and limit of 6 dredges aside will have big economical impact"...; " What would the impact be on shore jobs, gear makers, transport and processors?"; "This would have a negative effect on me and my crew and the vessels viability as a business".*

Stock status and perceived level of exploitation

Respondents were asked whether they felt scallop stocks were under-exploited, sustainably exploited or overexploited on the west coast of Scotland, and were cleanly divided in their views (50% over exploited: 50% sustainably exploited - **Figure 8-12**). None of the respondents felt that scallops were underexploited. Scallop dredgers and trawlers had mixed opinions, whereas scallop divers and static gear fishers generally felt that scallop stocks were overexploited. There were no other fleet descriptors that could explain the divide in views.

Those who believe stocks are overexploited suggested it's because there is currently no closed season or effort restriction for scallop fishing on the west coast making it a "free for all" (apart from the Clyde), and hence stocks are at a historical low. One line of thought is that stocks started to decline when boat design and technology advanced allowing vessels to travel further to fish, some fishing for 24 hours in a day. "Heavy fishing" by nomadic vessels on a seasonal basis is also perceived to be an issue for stocks, with adverse effects to the local fishing community. A number of vessel owners and skippers stated their catches have diminished over the years, while effort has increased (CPUE declined). There was also an observation that "*spat has significantly reduced over the last few decades, indicating substantial declines in spawning biomass*", and "*the only areas where there are positive signs*

are within the recently designated MPA's and the Firth of Lorn SAC which has been closed to mobile gear for a far longer period".

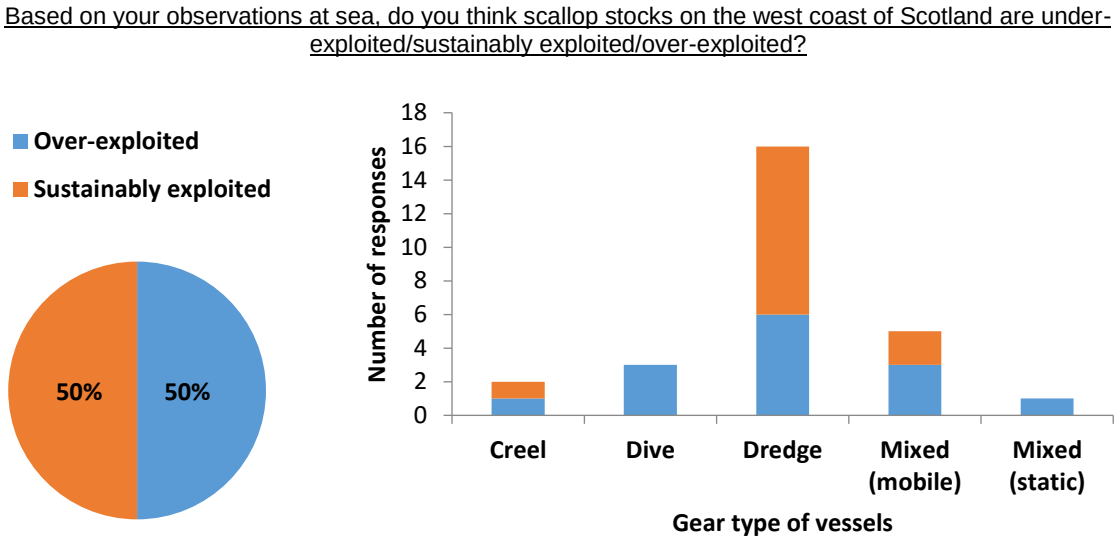


Figure 8-12: Respondents views on level of scallop exploitation (left), broken down into gear type the vessel operates.

The counter viewpoint expressed by survey respondents is that natural variation on the west coast is the main driver on scallop stocks (and not fishing effort) with cyclical "ups and downs" in abundance. Several scallop fishers stated they have been fishing on the west coast for decades, and not seen a decline in catches. Some fishers also felt that displacement caused by closures of some MPAs to scallop dredgers was the main issue, increasing the pressure on scallop stocks elsewhere. One respondent stated that "*at the moment we feel that scallops are sustainably exploited, however there is currently potential for this to slip into over-exploited if we are not careful*".

Measures to safeguard scallop stocks:

Respondents were asked "*To what extent do you think the proposed management measures would help safeguard king scallop stocks?*", and their answers can be seen in the stacked bar chart below (**Figure 8-13**). Respondents clearly thought that increasing the MLS of hand-dived scallops to 120 mm in MPAs would have the most positive role in safeguarding scallop stocks, followed by introducing VMS on all vessels. The majority (57 - 61%) also thought that scallop stocks could be safeguarded by having an overnight curfew on scallop dredging, increasing the MLS to 110mm and limiting days at sea. Interestingly, some respondents who stated they would suffer economically due to these measures still recognised that they could help safeguard scallop stocks (except for limiting dredge numbers). The majority (64%) thought data collection would have little role in safeguarding scallop stocks.

Several respondents stated that reducing effort would be positive for scallop stocks, while others suggested that the current list of measures would not be enough to safeguard stocks. The issue of displacement was raised again, as it could potentially lead to overfishing in other areas.

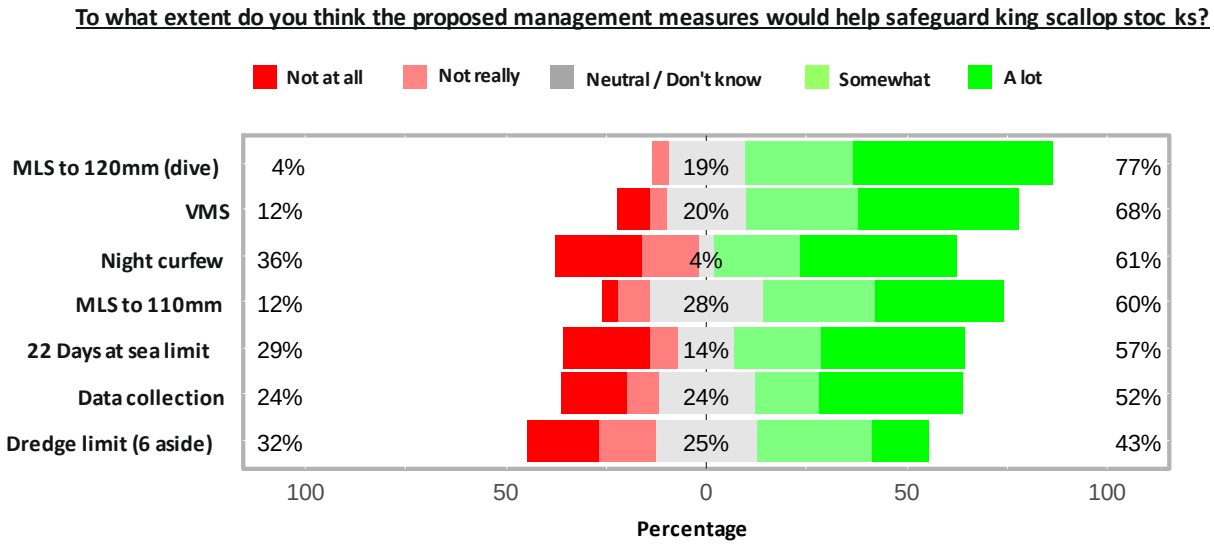


Figure 8-13: Extent to which fishers feel the proposed measures would help safeguard scallop stocks.

Potential for Effort Displacement:

The stacked bar chart below illustrates the extent to which the management measures could displace scallop fishing effort onto grounds elsewhere (**Figure 8-14**). An overnight curfew followed by limiting dredge numbers to 6 aside could potentially lead to the greatest displacement of effort (especially for larger vessels that fish overnight and have longer trips). The smaller 'local' scallop vessels or 'day boats' are unlikely to be displaced because they cannot move further away to fish.

There were strongly divided views regarding displacement and the effects of limiting days at sea and increasing the MLS of dived scallops to 120mm. Whereas the majority felt that VMS, data collection and increasing the MLS to 110mm would not lead to displacement.

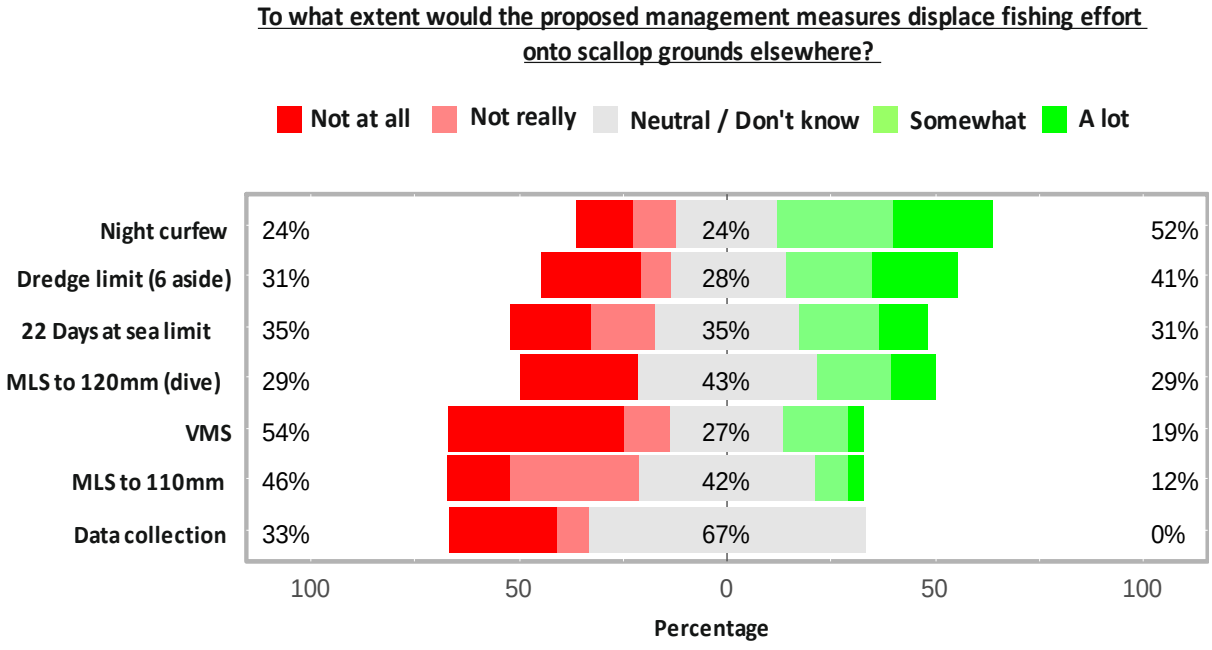


Figure 8-14: Extent to which fishers feel the proposed measures would displace fishing effort.

Respondents stated that vessels could be displaced to various locations around the UK, including; the East coast, Irish Sea, Minch, North Sea, or simply to the nearest scallop ground in the area. Effort may also be transferred to other fisheries, because many scallop dredgers also have Nephrops and queen scallop gear. In addition, seasonal closures of the Isle of Man scallop fishery displace vessels to the west coast of Scotland (where there are more limited restrictions), and this has created some tension amongst the west coast vessels. It is felt by some that "*if there were management measures in place (on the west coast) it would not be as attractive" to IOM vessels"*.

Safeguarding a Healthy Ecosystem

The majority (56%) thought that increasing the MLS of dive-caught scallops to 120mm, as well as installing VMS, would help safeguard a healthy ecosystem (**Figure 8-15**). Respondents were divided in their views on how increasing MLS to 110m would influence ecosystem health. While, most felt that the other measures would not safeguard ecosystem health (see bar-chart below).

While reducing fishing effort and gear size/weight may help reduce the 'footprint of fishing', some respondents felt these measures will not safeguard the seabed ecosystem because once the habitat structure is damaged by dredging it can take months-years to recover. In addition, one fisher made the point that "*it seems a fallacy that by reducing gear you reduce impact; you don't as it simply takes more passes for the same return which will obviously have more impact on the seabed*". Counter to this, some scallop fishers feel that dredges do little long-term damage to the seabed, and can in fact enhance other fisheries (e.g. prawn and crab).

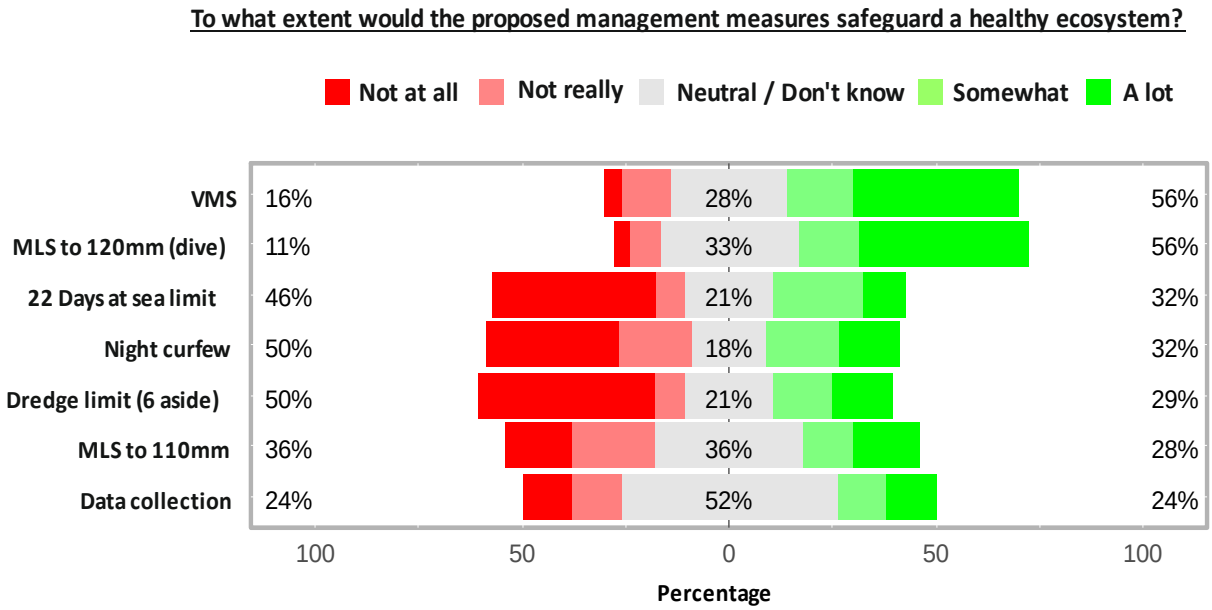


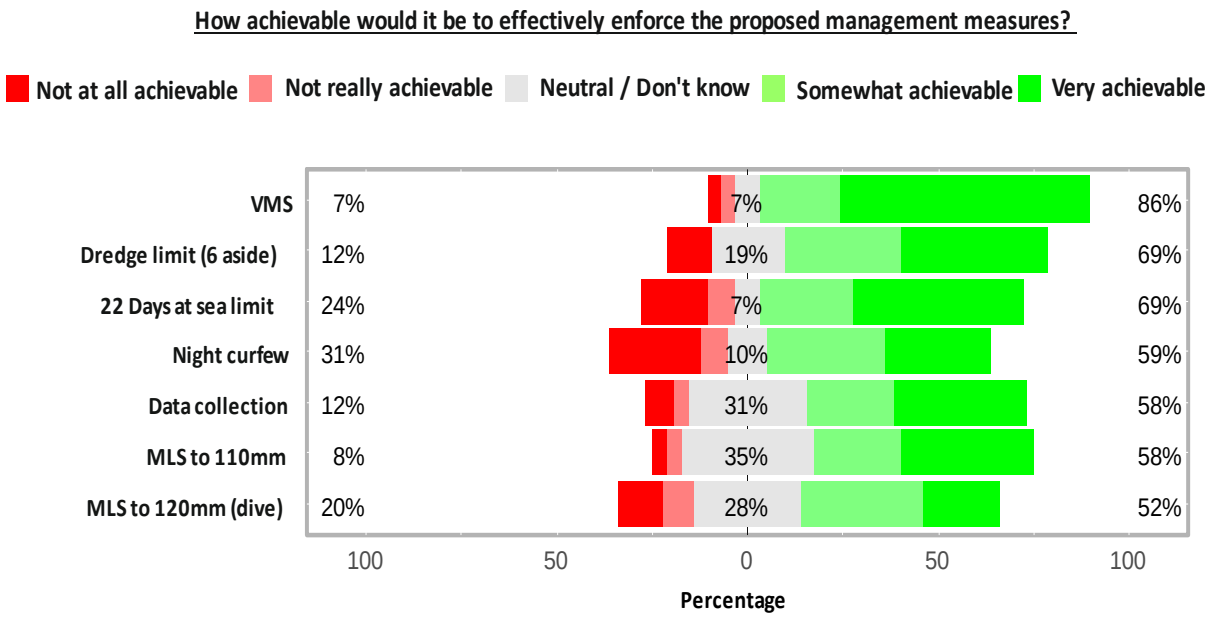
Figure 8-15: Extent to which fishers feel the proposed measures would help safeguard a healthy ecosystem (e.g. by reducing impact to seabed habitats).

Enforcement of management measures

Fishers were asked "How achievable would it be to effectively enforce the proposed management measures?". The majority thought that all the measures were somewhat or very achievable to enforce (**Figure 8-16** below). Measures that were seen as the 'easiest' to enforce were the use of VMS, a dredge limit of 6 aside and a limit on days at sea. In addition, VMS was seen as an essential requirement for enforcing the other measures. Fishers feel that

an overnight curfew would be the least achievable effort restriction to enforce, and 38% felt it would not be achievable to enforce data collection. There was a high level of uncertainly about how an increase in MLS would be enforced for the proposal areas, however 52-58% felt it was achievable.

Many fishes feel that if appropriate vessel monitoring equipment is introduced to all vessels then all of the measures would become achievable to enforce. Some measures may only require vessels tracks to be recorded at a suitable 'ping rate' for enforcement to be achievable (e.g. days at sea limit and overnight curfew), while others would require gear sensors and CCTV to effectively enforce the measure (e.g. dredge limit of 6 aside and increasing the MLS in specific areas). However, some also felt that Marine Scotland have been unable to enforce fishing restrictions within MPAs, and are doubtful they would have the capability to enforce these measures.



- **Figure 8-16:** Stacked bar chart showing fishers views on how achievable it would be to enforce the management measures

Voluntary versus statutory implementation

The vast majority of respondents felt that management measures would need to be statutory, with the exception of data collection (**Figure 8-17**). Comments include; **"***If the measures aren't statutory then all it takes is one breach and it will lead to another boat following suit, then the whole proposals will fall apart. Not everyone would adhere to voluntary measures. It must be statutory*", and; "*Voluntary basis management only works to a certain level and can lead to false accusations and misleading rumours. Statutory measures are in the hands of an independent regulatory authority and therefore cannot be (ordinarily) disputed*".

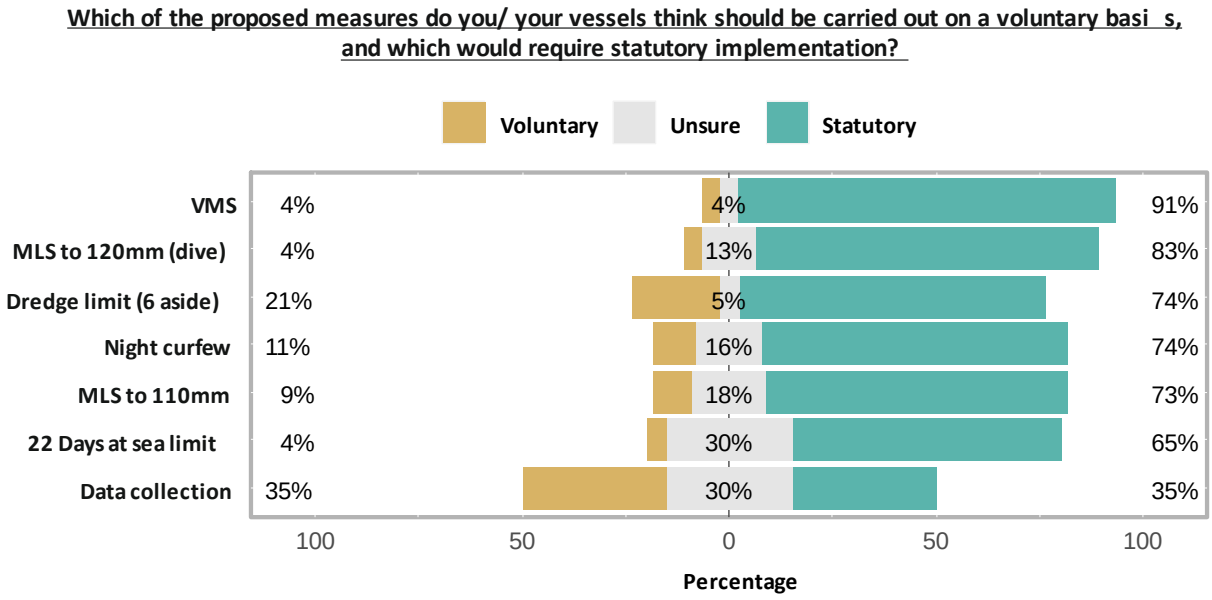


Figure 8-17: Fishers views on whether the proposed measures should be voluntary or statutory.

Evidence gathering to improve knowledge gaps:

Respondents were asked to rank 5 different knowledge gaps in terms of the need to improve the evidence base for the proposals. The knowledge gaps are ordered below based their answers, from highest research priority at the top to lowest priority at bottom:

1) Impacts of displacement of scallop effort onto other fishing grounds
2) Socio-economic impacts of measures
3) Stock characteristics (local size at maturity, larval dispersal, status, spawning patterns)
4) Ecosystem response to management measures
5) Fishing patterns (location of grounds, daily fishing patterns)

Other research priorities that fishers think are important include (in no specific order);

- The effect of fish farming on scallop spawning patterns and larval survival
- Setting benchmarks of recovery for the seabed, based on previously undisturbed habitat
- Safety implications, and importance of proposal areas as 'sheltered and safe' fishing grounds
- Application of Article 17 of the CFP to scallop fisheries

Other measures suggested by respondents:

The questionnaire asked “Do you think there are other scallop management measures that would be more appropriate for the proposed areas and why?**”.** A list of other measures proposed by fishers are given below:

- Weekend ban on scallop dredging, which is “easy to police and very effective in areas further south where its already in force” (i.e. the Clyde);

- Seasonal closures in the summer months from April to September, specifically to provide some protection to stocks at a time when they are spawning and are most under pressure from larger visiting vessels (from Isle of Man);
- Restrict access to Scottish vessels only (Isle of Man vessels not permitted to fish in proposal areas);
- Greater access to MPAs for dredgers with appropriate vessel tracking equipment to allow them to still fish in the areas but avoid protected features, which may alleviate some of the issues of effort displacement;
- Contrary to the above, greater restrictions on scallop dredging within MPAs and stricter enforcement of existing fisheries management measures within MPAs.

In addition, some felt that any management measures should be underpinned by scientific evidence and align with other UK work on wider scallop management (e.g. the work being done by the Scallop Industry Consultation Group and PUKFI), however no specific alternative measures were given.

Organisations that respondents are members of / associated with:

Western Isles Fishermen Association
Clyde Fishermen's Association
Scottish White Fish Producers Association
Scottish Scallop Divers Association
Western Inshore Scallop group (WISG)
Scottish Creel Fisherman's Association
Mallaig and North West Fisherman's Association
West of Scotland Producer Organisation
Mull Fishermen's Association
Northern Ireland Fish Producers Organisation