Department of Environment, Food and Agriculture
Rheynn Chymmltaght, Bee as Eirinys

ISLE OF MAN
SCALLOP MANAGEMENT BOARD

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Reiltys Ellan Vannin

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A Long-Term Management Plan for the Isle of Man King Scallop Fishery

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Policy Contact:	Fisheries Division, Tel: 01624 685857, Email: fisheries@gov.im

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0.0 Executive Summary

The Department of Environment, Food and Agriculture (‘**the Department’**), its independent fisheries science contractors (‘**IFSC**’, Bangor University School of Ocean Sciences), and the Isle of Man Scallop Management Board (‘**SMB**’) agree to adopt and implement a Long-term Management Plan (‘**LTMP**’) for king scallop (*Pecten maximus*) fishery resources within the Isle of Man territorial sea.

The LTMP is needed to address resource and management challenges, which arise from the natural variability of scallop resource abundance and dynamics, but also the insufficient fishing effort controls and potentially excessive levels of exploitation due to the catching capacity of the existing fleet. Without addressing the latter, the fishing capacity of the scallop fleet is such that economic viability is compromised in the context of catch quotas, and preclude a long-term bioeconomic approach to setting a scallop Harvest Control Strategy (‘**HCS**’). By adopting a LTMP, the approach to addressing these challenges shall be strategic and specific, and progress towards objectives shall, wherever possible, aim to be measurable and verifiable.

This document is the first version of the LTMP, and may be subject to change as and when the Department, in consultation with its IFSC and the SMB, deem is necessary to incorporate amendments or addendums. The LTMP shall be reviewed every 5 years and, if necessary, a revised version shall be published.

This document sets out a description of the resource, historic exploitation, and the long-term and short-term aims and objectives for the future of the fishery and the resource. It is, therefore, a strategic policy document that sets out high-level considerations by linking with other relevant Isle of Man Government strategy documents, and adds technical and analytical detail as appropriate.

The long term objectives include:

LTO 1 Primary Objective: Good Environmental Status and UNESCO Biosphere principles
LTO 2 Management is based on an optimised Harvest Control Strategy (HCS), *which includes*
- Biologically Sustainable Limits
- Bio-economic capacity management
- Appropriate Harvest Control Rules
- Considerations of Recruitment
- Effective Spatial Management

LTO 3 The Ecosystem Approach
LTO 4 Quality Seafood
LTO 5 Safety and Wellbeing
LTO 6 Energy Efficiency and Climate Change

The short term objectives include:

STO 1 Implement new/amended technical restrictions and specifications relating to dredge-gear
STO 2 Implement a Capacity Reduction Programme
STO 3 Termination of Grandfather Rights (GFRs)
STO 4 Implement a voluntary Research Contribution Scheme
STO 5 Internal Review of the Scallop Management Board (membership and processes)
STO 6 Establish decision-making guidelines for spatial management
STO 7 Adopt a quantitative stock assessment that produces biomass-linked advice
STO 8 Develop and test Target Reference Points (TRPs) and Limit Reference Points (LRPs) to guide in-season adjustment of Harvest Control Rules
STO 9 Develop and test a decision-making framework for area-based catch thresholds
STO 10 Develop and test a decision-making framework for Relative Benthic Status / Fishing Intensity thresholds
STO 11 Develop and test a decision-making framework for adjusting TAC between seasons
STO 12 Develop and test a decision-making framework for adjusting TAC in-season
STO 13 Adopt a decision-making framework for a bio-economic approach to setting Daily Catch Limits (DCLs)
STO 14 Assess and determine the feasibility and opportunity of a sustainable dive-caught scallop fishery
STO 15 Assess the efficacy of resource-implications for the introduction of Remote Electronic Monitoring (REM)
STO 16 Fleet Economics data-collection
STO 17 Fleet emissions & climate-change impacts

The Department, in consultation with its IFSC and the SMB, shall publish an annual HCS framework document that aligns the harvest strategy for each king scallop fishing season with the objectives of the LTMP. The HCS documents shall incorporate the use of specific Harvest Control Rules (‘**HCRs**’), technical-conservation measures, and decision-making frameworks, which together shall optimise the management of the fishery outcomes to balance the various strategic priorities and objectives.

Isle of Man Territorial Sea - An ‘Inshore’ Fishery

The overall aim of the LTMP is to ensure a biologically sustainable, and ecosystem-based management approach to the Islands kings scallop resources, whilst maximising the long-term socioeconomic benefits to the industry and the Islands economy. This will be achieved by balancing resource use against wider ecological and environmental impacts, which must be monitored, mitigated and managed using the best-available evidence, and a precautionary approach where supporting evidence is incomplete.

Fundamental in framing this aim is the recognition that the fishery is, by definition, an **inshore fishery**, and its strategic management should give consideration to **inshore sector** socio-economic requirements. The interpretation of these terms is important:

> **Inshore fishery** means fisheries that occur within the territorial sea area; and
> **Inshore sector** means vessels that are 221 kW or less in engine power.

1.0 Identification and Description of the Fishery

1.1 Fishery to which this plan applies

Fishery name:	The Isle of Man King Scallop Fishery
Species covered:	King scallop (*Pecten maximus*)
Fishery location:	Those waters lying within 12 nautical miles of the baseline from which the breadth of the territorial sea adjacent to the Isle of Man is measured, but not extending beyond a line every point of which is equidistant from the nearest points of such baselines adjacent to the United Kingdom.
Fishing method(s):	Toothed-dredge Diver-caught (not yet developed)

Term of plan:	25 years (with five 5-year review phases)
Date of next review:	June 2027 (5-years), or earlier (as required)
Key authors:	Isle of Man Government Department of Environment, Food and Agriculture Bangor University School of Ocean Sciences The Isle of Man Scallop Management Board.

1.2 Description of the Fishery

1.2.1 Historical Overview (2000-2020)

This section provides an overview of the fishery since 2000. For further details on the fishery pre-2000, please refer to Brand & Prudden (1997).

The king scallop (*Pecten maximus*) fishery in the northern Irish Sea (ICES Area VIIa, north of latitude 53° 30' N) has had significant economic importance for several decades. Between 2000 and 2021, king scallop landings by UK and Manx-registered vessels using dredges in this region totaled 107,855 tonnes (Source: IFISH 2, ICES 2020). At current prices and yield (18% yield and £11.00 per kg), the estimated present value of these landings is £213.5 million. ICES Statistical Rectangles 36E5, 37E5, and 38E5, centered on and around the Isle of Man territorial sea, were the reporting areas with the greatest volume of landings equal to 66,753 t (~62% of the total) over the same period, with a present estimated value of £132.2 million (Source: IFISH2, DEFA paper logbooks).

Management of the king scallop fishery within the Isle of Man territorial sea has developed over time, largely in a reactive manner in response to emerging situations, such as significant and/or periodic increases in fishing effort, which have presented challenges to the stock(s) and the fishery.

Prior to 2010, there were 226 vessels that had access to scallop resources in the *extended territorial sea* (i.e. 3-12 NM zone) by virtue of holding a general Isle of Man Sea Fishing Licence and a UK Fishing Licence with a Scallop Entitlement[1]. Access was not capped, and the number of vessels may have increased at any time should a UK Licence-holder apply for an Isle of Man sea fishing licence. Note that foreign (non-British) vessels did not have access to scallops under the London Fisheries Convention 1964.

Of the 226 vessels, 145 had a permit to fish inside the 0-3 NM zone by virtue of being less than 50 ft in registered length. Of the 226 vessels with access to the 3-12 scallop resources, 80 had an engine capacity greater than 221 kW, defined hereafter as '**offshore vessels**'. From 2000 to 2010, the king scallop fishery was subject to the Sea Fisheries (Scallop Fishing) Bye-laws 1999 (as amended). These bye-laws imposed:

- a closed season from 01st Jun – 31st October (inclusive);
- a curfew on fishing within the 0-3 NM zone (1800-0600) and the 3-12 NM zone (2100-0500); and
- technical 'dredges-a-side' restrictions in the 0-3 NM (corresponding to 5-a-side) and in the 3-12 mile zone (corresponding to 8-a-side).

During the 2007/2008 and 2008/2009 fishing seasons, the Isle of Man king scallop fishery was subject to unprecedented fishing effort, with notable increased participation of large nomadic offshore vessels, which was concentrated at the start of the fishing season and resulted in significant declines in CPUE over a very short-

[1] the Department had not yet introduced a Species Specific Licence for king scallops, and access was therefore automatic to those vessels that had a general Isle of Man Sea Fishing Licence, subject to also have a Scallop Entitlement on the UK licence

period of time. The ‘race-to-fish’ phenomenon led to concerns within industry and the Department in relation to effective management of king scallop fishing in the Isle of Man territorial sea.

As a result the Department launched a consultation on a range of potential new management measures prior to the 2010/11 season. The Department partially implemented a number of the proposed management measures through the Sea Fisheries (Scallop Fishing) Bye-laws 2010, and reduced access to the fishery.

The Department received strong objections to exclude ‘offshore’ vessels from the fishery both UK Devolved Administrations (‘DAs’) and UK industry groups. Therefore, at the suggestion of UK DAs, the Department allowed access for a number of offshore vessels by introducing ‘Grandfather Rights’ (‘**GFRs**’), which allowed for continued access for vessels over-221 kW subject to demonstrating a track-record in the fishery of at least 50 scallop fishing days during the 2008/2009 and 2009/2010 fishing seasons. Consequently, 23 offshore vessels retained access to the fishery under GFRs. As such, capacity was not reduced as much as anticipated and, in addition, no termination date was established for the GFRs other than GFRs expire upon the sale or transfer in ownership of the vessel. At present, there are 6 vessels remaining in the fleet with GFRs.

The Department also extended the curfew in the 3-12 as proposed, despite similar opposition from UK industry and UK DAs. The Department also introduced a reduction in the dredges-a-side restriction in the 3-12 that corresponds to the present 7-a-side limit. The Department did not implement specific maximum tow-bar lengths in the 2010 bye-laws, nor provision to implement temporary Daily Catch Limits (‘**DCLs**’). The decision to not include these provisions was due to strong objections from the same sectors that opposed the 221 kW limit and the extended curfew in the 3-12 NM zone.

It was a further six fishing seasons until the fishery was again reviewed. By 2016, landings (t) and effort (kW days) within ICES Statistical Rectangles 36E5, 37E5 and 38E5 increased significantly. The trigger for the review arose from the observation of continued increases in fishing effort, and a decline in landings (-9.2 %) between the 2014/15 and 2015/16 seasons following unprecedented landings in 2014/15 of 4,329 t. These data also show that landings-per-unit-effort (‘**LPUE**’) had been declining since 2012/13.

The Department held a further consultation in 2016 on ‘Proposals for Future Management of the Isle of Man King Scallop Fishery’, with an accompanying impact assessment produced by the independent scientific advisors from Bangor University.

The principal outcome of the consultation and subsequent implementation was the removal of licences from vessels that could not meet the following DAS track-record criteria, whereby:

During the four king scallop fishing seasons 2011/12 to 2014/15 inclusive;

- Vessels <15 m were required to demonstrate 50 DAS fishing for scallops in ICES Statistical Rectangles 36E5, 37E5, 38E5.
- Vessels >15 m were required to demonstrate 26 DAS fishing for scallops in ICES Statistical Rectangles 36E5, 37E5, 38E5.
- In addition, access to the 0-3 NM zone was based on a track-record methodology that incorporated VMS data and electronic log-book data over the period 2010–2016, applying combined criteria of; number of years fishing in 0-3 NM, number of days fishing in 0-3 M, fishery landings attributed to 0-3 NM and ‘economic link’ (proportion of landings to Manx ports versus non-Manx ports).

The requirement for a track record of 50 DAS and 26 DAS (for <15 m and >15 m vessels respectively) represented an overall participation rate of only 6% over the 4 fishing seasons, and accounted for the Western Waters Effort Regime (‘**WWER**’) days-at-sea (‘**DAS**’) allocation on a pro-rata basis. This resulted in the number of eligible and licensed vessels reducing from 154 vessels to 94 vessels in the 3-12 NM fishery, of which 42 also met the criteria for access to the 0-3 NM inshore area.

No action was taken on the introduction of a restriction on tow bar length due to a lack of agreement on the specifications for such measures, nor on the introduction of a weekend ban. Preferences for a Total Allowable Catch (‘**TAC**’) and quota-based management system were noted within the consultation responses, along with the suggestion to remove GFRs from offshore vessels. The curfew in the 0-3 NM (no fishing between 1800-0600) was also extended to the rest of the territorial sea.

Finally, the Department extended the remit of the pre-existing Queen Scallop Management Board to include the king scallop fishery, in recognition of the fact that the two fisheries overlap, interact and have a common group of stakeholders. This resulted in a combined SMB, which facilitates industry input into Departmental decision-making in both scallop fisheries, and with representation from all sectors of the industry.

In addition to the 2016 king scallop fishery review, the Department simultaneously launched a separate consultation on an inshore marine zoning plan for the 0-3 NM area of the territorial sea, which outlined a number of options relating to the designation of areas that would be closed to mobile gear fishing ('static gear & conservation zones'), as well as areas that would be subject to restricted/limited fishery access 'fisheries management zones' ('**FMZs**'). As a result of this consultation, over 50% of the 0-3 NM was designated as Conservation Areas, in which mobile gear fishing was either prohibited or greatly restricted. These Conservation Areas, and other marine protected areas, were subject to a further consultation in 2017, and subsequently designated as Marine Nature Reserves (MNRs) with the Manx Marine Nature Reserves (Designation) Order 2018[2], which formalised the framework of spatial management in the 0-3 NM zone.

The 2017 consultation also resulted in an Isle of Man Government policy document *A management plan for the 0-3 NM zone of the Manx Territorial Sea* (GD 2019/0098), which included policy approval for the inshore Fisheries Zones, i.e. those parts of the 0-3 NM not designated as MNRs, to be co-managed with industry. The co-management system (yet to be formally established) is to be based on multi-year Fishery Zone Management Plans ('**FZMPs**') to be developed by industry for each individual FZ, subject to Departmental approval and oversight, and managed through an Association of industry stakeholders with 0-3 NM access.

Immediately following the review of the fishery in 2016, and despite the reduction in fleet capacity from 154 vessels to 94 vessels, fishing activity for king scallops within ICES Statistical Rectangle 37E5 was subject to intense and unprecedented fishing effort during November 2016, which resulted in record landings from a geographically limited area. A total of 1,532 t was landed from within 37E5, predominantly from a small area northwest of the Isle of Man known as 'Targets' ('**TAR**'), which was more than a three-fold increase compared to the average tonnage landed during the same period over the preceding 9 years. The catches were reportedly dominated by newly recruited scallops.

Some vessels reported daily landings in excess of 8,000 kg, and average LPUE in November 2016, at over 8 kg / kW DAS, was even greater than that observed during the start of the 2009 fishing season. The concentration of intense fishing effort within a small geographical area (2 NM x 2 NM) led to industry concerns regarding the scallop stock impacts in that area being raised with the Department.

Additional concerns raised by both catching and processing sectors in the UK and Isle of Man relating to over-supply of scallops and effects on market prices, indirect mortality of juvenile scallop populations resulting from bycatch, and the wider ecosystem integrity of the area, resulted in the Department introducing a temporary DCL of 1,400 kg with effect from 15th November. By this date, over 1,066 t had already been landed from within 37E5 resulting from over 100,000 kW DAS of fishing effort.

The DCL was implemented by way of licence condition, and remained in effect until 10th January 2017. It is now viewed by the SMB and the Department that the DCL should have been in place prior to the start of the fishing season on the 01st November 2016 in order to prevent overfishing.

A DCL has remained in place for the Isle of Man king scallop fishery since the 2017/18 fishing season, and is adjusted both between and within seasons based on recommendations from the SMB having considered the best available scientific and consideration of socio-economic perspectives. It has been an important component of the pre-LTMP management framework. The overall aim of the DCL is to indirectly manage fishing effort (by controlling landings) using a risk-based, precautionary approach based on the best available data. The overarching principles of the DCL are to:

- avoid complete economic depletion of fishing grounds;
- to ensure the TAC is not exceeded, and that fishing opportunities are available until the end of the season, i.e to avoid a "race to fish" phenomenon;
- maintain ecosystem integrity by controlling effort, and to
- ensure that the DCL acknowledges socio-economic requirements of the fleet, and market demand.

A breakdown of the DCL by season is presented below, noting Covid effects on Market demand and price since March of 2019/20 season.

Table 1. The Daily Catch Limit (DCL) set for the Isle of Man king scallop fishery 2016/17 – 2020/21

Season	DCL	Notes
2016/17	1,400 kg	Applied 15 Nov 2016 – 10 Jan 2017 only
2017/18	1,050 kg	01 Nov 2017 – 27 Nov 2017 initially, reducing to 700 kg thereafter

[2] The only exception is the Ramsey Bay MNR, which allows for a limited and restricted fishery each December.

2018/19	700 kg	-
2019/20	560 kg	Increased to 630 kg for the period 05 Dec 2019 - 22 Dec 2019 only.
2020/21	700 kg	-
2021/22	700 kg	-

Prior to the start of each fishing season since 2017/18, Bangor University has undertaken an assessment of king scallop abundance data (based on a fisheries-independent survey dataset maintained since 1992), and provided a stock advice report to the Department and the SMB. The report presents an index-adjusted TAC recommendation for the Isle of Man king scallop fishery.

Following endorsement from the SMB, the Department approved a TAC for the 2017/18 fishery set at 3,203 t. The methodology used to establish the initial TAC was not biomass-linked due to the absence of a reliable biomass assessment, but was instead based on the average landings from the previous 5 years. Total landings recorded within the Isle of Man territorial sea was 3,009 t (or 94% of total theoretical catch opportunities). By following the guidelines for ICES data-limited stocks, the TAC agreed by the SMB for subsequent seasons have reduced by -20% annually until 2020/21 to correspond with declines in the survey abundance index.

Table 2. The Total Allowable Catch (TAC), Landings, and % of TAC realised 2016/17 – 2020/21

Season	TAC	Landings	%	Notes
2016/17	NO TAC	4,150 t	-	-
2017/18	3,203 t	3,009 t	94 %	-
2018/19	2,562 t	1,832 t	72 %	-
2019/20	2,049 t	1,186 t	58 %	Covid19 affected during 2020 Q2
2020/21	2,049 t	1,727 t	85 %	Covid19 & Brexit affected. No update to the long-term time series data, but with industry-led data to inform decision-making.
2021/22	2,049 t	-	-	-

In addition, spatial management of fishing activity, informed by annual scallop population abundance data, both within the 0-3 NM and 3-12 NM, has been developed since the review in 2016, and has been the product of close collaboration between fisheries scientists (Bangor University), the Department, and industry representatives via the SMB.

Spatial management has been a useful tool for a number of purposes, including permanent protection of vulnerable or protected features (within the MNRs), protecting high-densities of juvenile scallops in temporary closures outside the 3 NM, and, more recently, effort management in specific high-densities patches of post-recruits; however, formal rule-based decision guidelines have not been developed for introducing temporary closures, and importantly, for triggering and managing a re-opening of temporary closures, with consideration of indirect consequences such as displacement and socio-economic impacts.

Ahead of the 2020/21 fishing season, the SMB developed a new approach to spatial management in the Isle of Man territorial sea by implementing a DAS limit to specific Restricted Access Areas (‘**RAs**’), which limited vessels to 1 day per week in the RAs characterised by high densities of post-recruit scallops.

These innovative spatial approaches, supported by high-resolution industry survey data, are considered to have been successful on a localised scale where high density populations have been found to be present, in terms of planning and monitoring the fishery. However, the overall scallop fishery continues to face challenges relating to overall fleet capacity and effort management.

By the outset of the 2021/22 season, the number of vessels that were eligible for an authorisation to fish for king scallops in the Isle of Man 3-12 NM had reduced further to 83 vessels (including 72 vessels with active licences, 5 licences currently ‘on hold’ with DEFA, and 6 licences that are yet to be renewed for the 21/22 licencing period). Of those eligible vessels (‘the current fleet’) 36 have access to the inshore 0-3 NM area. The decline in vessel numbers (fleet capacity) since the 2016 review has been the result of ‘natural wastage’, whereby vessels leave the fishery and are not replaced by owners.

In December 2020, the SMB submitted a Discussion Document on a LTMP for the Isle of Man king scallop fishery to DEFA. This was followed by a SMB meeting in February 2021, which resulted in a commitment for the SMB and DEFA to launch a public consultation on the high-level principles of an LTMP, and consideration of specific initial proposals that would be aligned with these principles. A consultation was launched in August 2021 for a period of 12-weeks. Responses indicated a clear desire for, and recognition of the need for a LTMP.

Despite the decline in the number of vessels that may access the Isle of Man king scallop fishery, overall *potential* capacity[3] was considered by the SMB, the Department, and Bangor University to be well in excess of any reasonable expectation of sustainable catching opportunities. This perspective was presented in the context of initial Bioeconomic Modelling ('**BEM**'), which indicated that if all 83 eligible vessels wished to prosecute the fishery on a full-time-basis (achieving approx. 90 DAS per season), and if all those vessels were allowed to retain a volume of scallops that allowed for minimum daily income to be attained, the fishery would require a TAC of ~6,500 t. This resource requirement is several times greater than the current TAC, and beyond any reasonable expectation of a sustainable TAC considering that landings from the territorial sea have never historically been this high (including pre-quota and pre-entry restrictions).

It was accepted that sustained stock improvements and a bioeconomic approach to managing an inshore scallop fishery in Manx waters would be difficult to achieve whilst *potential* fishing capacity required such significant volumes of stock biomass to provide for economically viable fishing. In other words, it was evident that the fishery would be subject to inevitable cycles of boom-to-bust overexploitation until such time that the overcapacity of the fleet matched the available resource or until further interventions were made by the Department.

Finally, whilst the DCL had been recognised as an important HCR that had prevented boom-to-bust overfishing since its pre-season implementation in 2017, and had promoted stock recovery in several important fishing grounds, the DCL had been unable to respond to increasingly severe socio-economic conditions throughout much of the fleet. Impacts on trade arising from the UKs exit from the European Union ('**EU**') and the impacts of the coronavirus pandemic on market demand had resulted in deflated prices, and the volume of scallops permitted under the DCL was insufficient to ensure the socio-economic requirements of the inshore fleet were sustainable (see section 1.2.4).

The requirement, scope, and specific proposals were jointly consulted on by the SMB and the Department in August-October 2021. This document was subsequently developed by the Department, and endorsed by the SMB, prior to implementation. The document aims to outline the strategic approach to managing, monitoring, and developing a sustainable inshore scallop fishery in the Islands territorial sea, and is implemented at a critical point in the history of the Isle of Man king scallop fishery. It is the first attempt to establish a long-term strategic approach to inshore king scallop fishery management in the British Isles.

1.2.2 Biology of the Target Stock

The scallop (*Pecten maximus*) occurs along the European Atlantic coast from northern Norway, south to the Iberian Peninsula, and is found from the low tide mark to over 100 m, but is most common in waters of 20-70 m.

Scallops are found on clean firm sand and fine gravel and in currents which provide good feeding conditions. Scallop can be present in densities of 5-6 per 100 m^2 although a more normal density is 0.5-2 per 100 m^2 in areas that are subject to fishing mortality. In Manx waters the life span of *P. maximus* is 20 years or more, but the oldest specimens normally reach 10-11 years of age in exploited populations. The most abundant year classes in exploited populations are generally 4-6 years old.

The life cycle can be divided into the free swimming larval phase and the largely sedentary juvenile and adult phase. The scallop is a filter feeder, drawing in seawater, which is filtered through the gills. It is hermaphroditic, with the gonad divided into a proximal white testis and a distal deep orange-red ovary. In general the potential spawning season is long, from April to September or October, but its timing and duration vary geographically. During spawning gametes are released to the water column and fertilisation occurs externally. Fertilisation success is related to the density of scallop on the seabed as is the case with most species with external fertilisation.

The larval development period is 2-3 weeks. Larvae survival is promoted by good concentration and quality of food in the water column. This condition is dependent on physical conditions such as temperature, nutrient supply and light penetration.

Recruitment is usually unpredictable as it depends not only on successful spawning and larval production but also on retention of larvae or transport of larvae into the area suitable for settlement. Settlement in a particular area may be unpredictable leading to unstable age structure. As a consequence of this, scallop beds frequently show a regional separation of year classes and spatial variability in age structure.

Upon settlement, scallops secrete a byssus thread after metamorphosis for attachment to the substrate on the seabed. Recently settled scallops have been found on stones and empty shells, as well as being frequently

[3] *Potential capacity* is defined as the number of authorised vessels × the daily catch limit × the number of days a vessel may expect to fish when participating on a full-time basis.

observed on 3D biological structures such as bryozoans, hydroids and the algae *Laminaria saccharina* and *Desmarestia* spp.. Scallops generally lose the byssus soon after metamorphosis and few scallops larger than 15 mm shell length are found attached to substrate, either biological or inert.

After metamorphism, or detachment, scallops are usually recessed into the sediment so that the upper (left flat shell, the right shell is cupped) valve is level with or just below the surface of the sediment. The juvenile and adults are sedentary and they swim in response to simulation by light, water currents, vibration, fishing gears or predators. The general distribution of scallop 'beds' in the Isle of Man territorial sea and adjacent waters is shown below.

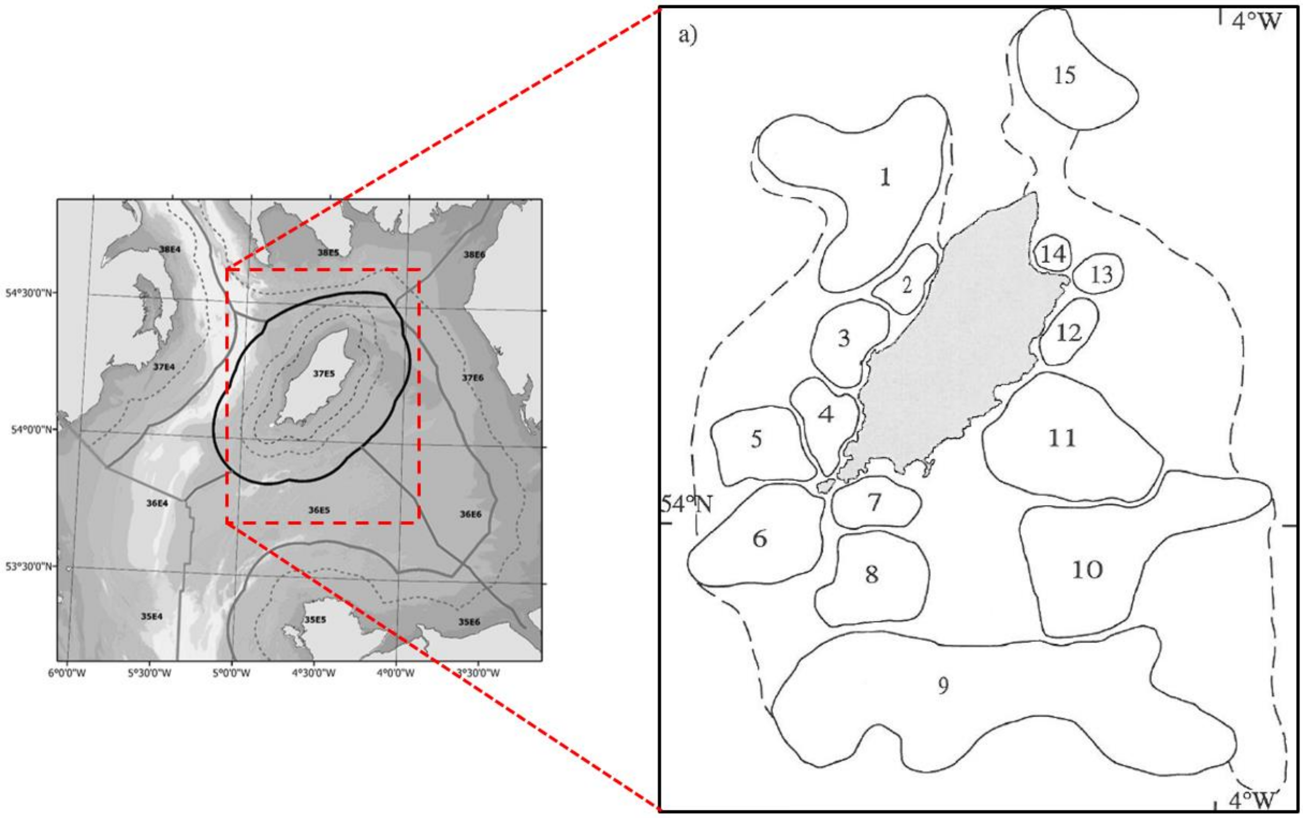

Figure 1. Left: The fishing authority boundaries of the North Irish Sea (Isle of Man 12 NM limit shown in bold). Right: North Irish Sea scallop (*Pecten maximus*) fishing grounds around the Isle of Man that are either currently or historically fished; 1) The Targets ('TAR'), 2) Kirkmichael bank, 3) Peel Head ('PEL'), 4) Bradda Inshore ('BRI'), 5) Bradda Offshore ('BRO'), 6) The Chickens ('CHI'), 7) Port St Mary ('PSM'), 8) Port St Mary Offshore ('PSM-O'), 9) Offshore South ('OS'), 10) Southeast Douglas ('SED'), 11) East Douglas ('EDG'), 12) Laxey ('LAX'), 13) Maughold Head ('MAG'), 14) Ramsey Bay ('RAM'), 15) Point of Ayre ('POA'). The dotted line represents the overall population boundary within where scallops may occur (adapted from Brand and Prudden, 1997).

1.2.3 Ecosystem interactions[4]

Scallop dredges are considered to be one of the most potentially damaging types of fishing gear to non-target benthic communities and seafloor habitats (e.g. Collie et al., 2000; Kaiser et al., 2006). Furthermore, the toothed dredges used in the Isle of Man fishery are likely to be the type of scallop dredge with the greatest potential impact due to the effect of their long teeth, which can penetrate 3-10 cm into the seabed (McLoughlin et al., 1991; Beukers-Stewart and Beukers-Stewart, 2009; Shephard et al., 2009; Hinz et al., 2012).

However, the effects of scallop dredging on marine ecosystems vary with different seabed types, levels of background disturbance, local hydrography, fishing intensity, and the characteristics of the ecological community (Kaiser et al., 1996; Auster et al., 1996; Bradshaw et al., 2001). The following sections address scallop dredging impacts that generally apply to any marine ecosystem.

[4] This section has been reproduced with permission for the authors, extracted from Stewart, B.D., and Howarth, L.M. (2016) Quantifying and Managing the Ecosystem Effects of Scallop Dredge Fisheries. Developments in Aquaculture and Fisheries Science 40:585-609

1.2.3.1 Physical Impacts

Dredges are specifically designed to penetrate and disrupt surface sediments in order to increase the catch rate of the scallops, which are typically recessed into the sediment. In doing so, scallop dredging can bring about a number of physical alterations to the seabed and surrounding environment.

Overall, the general effect is to cause homogenisation of substrates and topography through penetration, mixing, and flattening of sediments (Collie et al., 2000). Natural seabed features such as ripples, pits, and burrows can all be eliminated by scallop dredging (Currie and Parry, 1999). In their place, dredging can sculpt the sediment into 3 cm high ridges, which can persist for up to 3 years in low wave/tide energy environments (Hall-Spencer and Moore, 2000). Scallop dredging can also move and/or remove significant quantities of stones and boulders from fishing grounds (Eleftheriou and Robertson, 1992; Bradshaw et al., 2002), which has been reported to cause shifts in the granulometric structure of surface sediments (Hall-Spencer and Moore, 2000). Any changes in sediment topography will likely alter near bed hydrodynamics, which can result in the deposition of fine sediments (Probert, 1984; Dernie et al., 2003). In addition, the removal or disturbance of surface sediments can change patterns of nutrient cycling or carbon flux, e.g. by exposing underlying anaerobic sediments (Watling et al., 2001; Kaiser et al., 2002).

The disturbance caused by dredges can also re-suspend soft sediments, nutrients, eggs, algal cysts, and small organisms buried in the sediment (O'Neill et al., 2013). Particular concerns have been raised about this as high levels of suspended sediment can smother surrounding sessile marine life, burying important habitats such as maerl (see 'Biogenic Substrates' section), and clogging the feeding and respiratory organs of filter feeding organisms, such as mussels and scallops, thereby impacting on their reproduction (Brand, 2006b; Dale et al., 2011; Szostek et al., 2013).

1.2.3.2 Burrowing Infauna

As scallop dredges can penetrate anywhere between 3 and 10 cm into the seabed (Currie and Parry, 1996; Kaiser et al., 1996), they have a strong potential to disrupt the benthic infauna; the organisms that burrow and live within the sediment. Any impact scallop dredging has upon the infauna can percolate through the entire marine ecosystem as they constitute an important food resource to fish, invertebrates, and other higher trophic levels (Daan et al., 1990). The benthic infauna also play a significant role in linking benthic and pelagic processes by transferring energy to pelagic organisms derived from primary production and falling detritus (Newell et al., 1998), in addition to influencing the structure of planktonic food webs (ICES, 2001). Furthermore, burrowing species of infauna often play a key role in controlling the scale and direction of nitrogen flux in benthic communities (Leslie and Shelmerdine, 2007). By destroying the burrows of infaunal organisms and favouring the growth of small, highly abundant burrowing species over less common larger ones, fishing disturbance can alter the rate of nutrient flux (Kaiser et al., 2002; Leslie and Shelmerdine, 2007).

Compared to other taxa, less is known about the effects of scallop dredging on benthic infauna. Generally, it is thought a proportion of the benthic infauna will detect and react to an oncoming scallop dredge by entering the water column or burrowing deeper into the sediment; however, those that remain in the sediment will be subject to the same physical forces as the sediment they inhabit, meaning they may become crushed or suspended in the water along with the sediment (O'Neill et al., 2013). The fate of infaunal organisms will depend on the damage and stress they sustain, where they resettle and whether they are at an increased risk of predation. O'Neill et al. (2013) found no difference in the abundance and biodiversity of infauna between dredged and undredged sites on the west coast of Scotland, whereas a study off the Isle of Man found that dredging significantly reduced the biomass of infauna (Kaiser et al., 2000). Other studies have also reported inconsistent results of dredging on infaunal communities, with some observing no effect, but others reporting strong changes to infaunal abundance and biodiversity that can persist for 8-12 months (reviewed in Løkkeborg, 2005). In a large-scale experiment in Port Phillip Bay, Australia, dredging largely flattened the mounds made by burrowing callianassid ghost shrimps (Currie and Parry, 1996, 1999), but most of the shrimps appeared to survive and began rebuilding their mounds within 6 months.

1.2.3.3 Epifaunal and Sessile Organisms

In theory, some mobile organisms should be able to detect an oncoming scallop dredge and move out of its way, enter the water column, or burrow deep into the sediment, thereby avoiding damage and/or capture; however, this response is not possible for the benthic epifauna, the organisms attached to the seabed, making them particularly vulnerable to scallop dredging (Ramsay and Kaiser, 1998).

Organisms that attach to the seabed are functionally important to marine ecosystems as they provide an element of three-dimensional structure to often otherwise featureless seafloors (see section 1.2.2). In doing so, they supply important refuges for small/juvenile fish from predators and unfavourable environmental conditions (Monteiro et al., 2002; Ryer et al., 2004; Cacabelos et al., 2010), represent important feeding sites for fish and invertebrates (Bradshaw et al., 2003; Warren et al., 2010), and provide essential habitat for the settlement of scallop spat and a range of other organisms, including the settlement of further epifauna (Howarth et al., 2011, 2015a). Upright hydroids have been found to provide an attachment surface for scallops, nudibranchs, bryozoans, barnacles, sponges, tube-dwelling worms, and other hydroids (Bradshaw et al., 2001). Such locations are therefore often referred to as nursery areas, or essential fish (and scallop) habitat, as they tend to be highly productive, support high levels of juvenile density, growth and survival, and contribute disproportionally to the production of adult recruits (Beck et al., 2001; Gibb et al., 2007; Laurel et al., 2009).

Commonly cited nursery areas include maerl beds (see ‘Biogenic Substrates’ section; Kamenos et al., 2004a,b; Hall-Spencer et al., 2006), seagrass beds (Warren et al., 2010; Lilley and Unsworth, 2014), and areas of dense macrophytes/macroalgae (Christie et al., 2007; Cacabelos et al., 2010; Howarth et al., 2011, 2015a), all of which have been shown to harbour high densities of commercially exploited species such as spider crabs, *Maja squniado*, juvenile cod, *Gadus morhua*, edible crab, *Cancer pagurus*, and edible sea urchins, *Echinus esculentus*. In addition, many epifaunal species support unique micro-communities, e.g. caprellid amphipods on hydroids, the range of invertebrates associated with kelp forests, or the diversity of organisms associated with pomatocerid tube worm heads (Kaiser et al., 1999; Airoldi et al., 2008). Consequently, the removal/damage inflicted on nursery habitats from towed fishing gears can create a series of knock-on effects, reducing the capacity of an area to promote biodiversity and negatively impacting upon the recruitment of commercially important species (Collie et al., 1997; Bradshaw et al., 2001, 2003; Kaiser et al., 2005).

Long-lived, slow-growing, upright epifaunal species often have fragile body structures and are especially sensitive to encounters with fishing gear, whereas smaller taxa tend to be more resilient (Kaiser et al., 2000; Hall-Spencer and Moore, 2000). For example, slow-growing sponges and soft corals take much longer to recover (up to 8 years) from scallop dredging than organisms with shorter lifespans such as polychaete worms and encrusting bryozoans (less than 1 year; Kaiser et al., 2006). Hence, experimental dredging conducted in the Irish Sea was found to shift the benthic community from one state to another, going from a community dominated by upright species to one dominated by small, encrusting, opportunistic, fast growing species that offered much less three-dimensional structure (Bradshaw et al., 2001). Similarly, a later study on several fishing grounds in the Irish Sea found scallop dredging to reduce the overall biomass of the epifaunal community and for the community to become dominated by smaller-bodied organisms (Lambert et al., 2011). By impacting epifaunal assemblages, scallop dredging can cause a reduction in the range of ecological niches available for associated biodiversity that rely on epifaunal organisms for complex habitat, shelter, and food (Auster et al., 1996; Collie et al., 1997; Bradshaw et al., 2003; Lambert et al., 2011).

1.2.3.4 Mobile Species

In addition to capturing scallops, the dredges used in scallop fisheries capture a wide variety of non-target mobile megafauna, including some commercially important and endangered species. Examples include fish (flatfish, dogfish, skates, rays, monkfish, and dragonets), crustaceans (edible crabs, swimmer crabs, spider crabs, and hermit crabs), echinoderms (brittlestars, starfish, and sea urchins), molluscs (bivalves and gastropods), cephalopods (octopus and cuttlefish), and sea turtles (Bradshaw et al., 2001; Murray, 2004, 2011; Haas et al., 2008; Aldous et al., 2013; Craven et al., 2013). Although scallop dredges are often considered to be relatively ‘clean’ compared to other types of mobile fishing gear such as beam trawls (Kaiser, 2007), a study off the Isle of Man found that for every scallop captured by a Newhaven dredge, four individuals of by-catch were also caught (Hinz et al., 2012). Commercially valuable species are retained in some cases, particularly edible crabs and monkfish in the Isle of Man dredge fishery (Beukers-Stewart et al., 2001; Brown, 2013; Craven et al., 2013), cuttlefish in the English Channel dredge fishery (Enever et al., 2007) and yellowtail flounder in the US sea scallop fishery (Aldous et al., 2013), but the majority of by-catch is discarded damaged, dying, or dead (Beukers-Stewart et al., 2001; Jenkins et al., 2001; Aldous et al., 2013).

An assessment of the 10 most common by-catch species in the Irish Sea scallop fishery found that approximately 20-30% of individuals suffered fatal damage after dredge capture (Shephard et al., 2009); however, the proportion of individuals impacted by dredging varies greatly between species, even within the same family (e.g. starfish). The most sensitive species to dredge damage include the seven armed starfish (*Luidia ciliaris*), the edible sea urchin (*Echinus esculentus*), and the commercially important edible crab (*Cancer pagurus*) (Jenkins et al., 2001; Veale et al., 2001). In contrast, the pin cushion starfish (*Porania pulvillus*) rarely appears to suffer any damage from being captured in a scallop dredge (Beukers-Stewart et al., 2001; Jenkins et al., 2001). Initial contact with the dredge teeth appears to cause most of the fatal damage suffered by by-catch species, while non-fatal damage appears to occur in the mesh bag during the tow and landing of the catch (Shephard et al., 2009). Intensity of non-fatal damage may be related to the amount of stones in the catch and the fullness of dredges - suggesting shorter tow lengths could reduce this type of damage (Bradshaw et al., 2001).

Compared to numbers of crustaceans and starfish, a relatively small number of fish appear to be caught in European scallop dredge fisheries. A study in the Irish Sea recorded that 97.6% of tows of scallop gear generated fish by-catch belonging to 50 different species, of which the majority were monkfish (Figure 14.5; Craven et al., 2013); however, relative to the target species, fish by-catch was low; estimated at 1 fish per 103 scallops captured. Then again, when entire scallop fleets are considered, the number of fish removed can be quite substantial; estimated to be 3.3 million fish per year by the English Channel scallop fleet (Enever et al., 2007). There is also evidence that by-catch in the Isle of Man scallop dredge fleet was at least partially responsible for a dramatic decline in monkfish abundance over a 14-year period (Craven et al., 2013).

By-catch of Endangered, Threatened, and Protected species is generally very rare in scallop dredge fisheries, although catch of sea turtles in the US sea scallop fishery has proved to be an exception.

High levels of mortality may also occur in organisms that are impacted by the scallop dredge but not necessarily captured. Through the use of SCUBA surveys, Jenkins et al. (2001) found that over 75% of the megafauna which encountered scallop dredges remained on the seafloor. These organisms displayed surprisingly similar levels of damage and mortality as the by-catch landed on deck, which was caused by crushing as animals passed around, through, or under the heavy gear, or by the initial encounter with the tooth bar. They also found that damage to commercially valuable edible crabs (*C. pagurus*) was highest when they had been impacted by the dredge, but not caught. An associated study found that dredging resulted in the capture of approximately 25% of the edible crabs present in the dredge path, but that more than 40% of the remaining crabs were left dead or dying on the seabed (Beukers-Stewart et al., 2001). Scallop dredging is, therefore, a very inefficient way to catch crabs, and wastes a resource that would be otherwise available to fishermen employing static gears. Furthermore, towed fishing gears can cause entanglement and loss of crab pots when operating in the same area as crab fisheries. These patterns can give rise to considerable conflict between crab and scallop fisheries (Blyth et al., 2002). Management plans that spatially or temporally separate scallop and crab fisheries (e.g. the Devon Inshore Potting Agreement, the Mull Crab Box) should therefore be encouraged (Blyth et al., 2002; see 'Management' section).

Paradoxically, some organisms are attracted to areas that have been scallop dredged and consequently increase in abundance. A study in the Irish Sea found the densities of scavengers and predators, such as starfish, crabs, and dogfish, to increase by up to 200 times in the presence of scallop fishery discards (Veale et al., 2000a). Scavengers are also attracted to the disturbed sediment and to the damaged or dead organisms left behind by the wake of the dredge (ICES, 1992). High densities of scavengers can result in elevated predation pressure on some organisms (Ramsay and Kaiser, 1998), particularly where some individuals have already been damaged by fishing activity (Veale et al., 2000a; Jenkins et al., 2004). This may place added predation pressure on other organisms in the area, including scallops and other commercially targeted species (Beukers-Stewart and Beukers-Stewart, 2009). In addition, being lured to this 'honey pot' on the fishing grounds may place these species at increased risk of being caught or damaged during the next pass of the fishing gear (Bradshaw et al., 2000). Due to dispersion of odour plumes, sediment resettlement, and predation of damaged organisms, the high densities of scavengers gathering at dredged grounds is likely to be a short-lived event. Then again, a broad-scale study by Bradshaw et al. (2002) in the Irish Sea found that mobile, robust, and scavenging invertebrate species had increased in abundance over a 60-year time period while slow-moving or sessile, fragile taxa had decreased. Likewise, a study in the Isle of Man found that the density of scavenging dogfish significantly increased over a 14-year period, whereas the density of commercially important monkfish decreased (Craven et al., 2013). Both dogfish and monkfish were caught in substantial numbers, but differed in their post-discard survival. Dogfish have remarkably high post-discard survival rates of up to 98% (Rodrıquez-Cabello et al., 2005), which may be why they were not negatively affected by high levels of fishing disturbance, whereas monkfish routinely suffer serious damage when captured in scallop dredges, and grow and reproduce slowly, meaning they are much more vulnerable to depletion by scallop dredging (Craven et al., 2013).

Overall, most studies indicate that benthic communities in areas subject to a long history of scallop fishing will have become simplified to a suite of species that are relatively resistant to fishing disturbance (Currie and Parry, 1996; Bradshaw et al., 2002; Aldous et al., 2013; Brown, 2013). This can make it difficult to detect the effects of fishing within contemporary benthic communities. Within these altered ecosystems, normal levels of fishing may have relatively little effect on community structure. For example, an analysis of 15 years of data on mobile benthic invertebrate species around the Isle of Man found that fishing pressure only had a small negative effect on patterns of diversity (Brown, 2013). More detailed examination of individual species indicated that the abundance of the dredge resistant common starfish (*A. rubens*) and cushion stars (*P. pulvillus*) was more strongly influenced by environmental factors (chlorophyll-α and temperature) than fishing disturbance (Brown, 2013). Despite these observations, when the Port Erin Closed Area was established in the southwest Isle of Man and was protected from scallop fishing, the overall density of benthic species, especially king scallops and edible crabs, recovered dramatically and continued to increase, even after 17 years (Bradshaw et al., 2001; Beukers-Stewart et al., 2005; Brown, 2013). In contrast, the density of the scavenging common starfish declined significantly over time within the protected area (Brown, 2013); however, the way in which fishing affects benthic communities and how they recover from such impacts are not always consistent or predictable (Harris et al., 2014).

1.2.4 Habitat interactions[5]

As discussed earlier, the effects of scallop dredging vary with different seabed types, level of background disturbance, local hydrography, fishing intensity, and the characteristics of the ecological community (Auster et al., 1996; Kaiser et al., 1996; Bradshaw et al., 2001; Harris et al., 2014; LeBlanc et al., 2015). The following sections examine these differences in greater depth.

1.2.4.1 Biogenic Substrates

Biogenic substrates, such as seagrass, shellfish, and kelp beds or reefs, and their associated benthic communities, are the most sensitive to disturbance by scallop dredging; even a single pass of a dredge can cause substantial long-term damage (Hall-Spencer and Moore, 2000). The following discussion will now focus in detail on two good examples of such habitats, maerl, and Modiolus reefs, which have been well studied.

Maerl: Maerl (*Rhodophyta*: *Corallinaceae*) is a red algae that forms hard, brittle filaments made of calcium carbonate. It can accumulate to form deep, loose lying beds that can cover anywhere between 10 m^2 and several 1000 m^2 (Kamenos et al., 2004a,b; Newell and Woodcock, 2013). Maerl beds are structurally very complex, and as a result, often support tremendous levels of biodiversity (Birkett et al., 1998; Hall-Spencer and Moore, 2000; Kamenos et al., 2004b; Newell and Woodcock, 2013) as well as high densities of juvenile scallops, cod, and edible crab, all species of commercial interest in the United Kingdom (Hall-Spencer et al., 2008). They are, therefore, listed as a UK Biodiversity Action Plan (UKBAP) priority habitat, in Annex I of the EU Habitats Directive, as a threatened and/or declining species under the Oslo and Paris (OSPAR) Habitats Convention for the Protection of the Marine Environment of the North-East Atlantic, as well as being subject to a number international conservation legislation provisions.

Maerl beds are usually characterised by coarse sediment, clear water, and strong currents (to prevent smothering by silt), and thus often provide good scallop fishing grounds (ICES, 1992). Maerl beds are fragile and very slow growing, often taking thousands of years to build up, which means they are exceptionally vulnerable to damage by scallop dredging (Giraud and Cabioch, 1976; Foster, 2001; Grall and Hall-Spencer, 2003; Newell and Woodcock, 2013). A single impaction event with a scallop dredge can significantly reduce the structural complexity of a maerl bed by breakage and can kill the maerl by burying it under sediment (Hall-Spencer and Moore, 2000; Kamenos et al., 2003). For example, a study off the west coast of Scotland found that a single tow of three scallop dredges crushed and compacted maerl beds, and buried the maerl 8 cm below the sediment surface (Hall-Spencer and Moore, 2000). The passing of the dredge also caused re-suspension of sediments which blanketed an area at least 12 times the area that had experienced contact with the gear, reducing the maerl's ability to photosynthesise. These combined effects led to a 70-80% reduction in live maerl, which displayed no signs of recovery even after 4 years. It was concluded that the lack of recovery was related to the slow growth and poor recruitment of maerl. In reality, the effects of scallop dredging on maerl beds are likely to be even stronger as scallop dredgers often tow many more dredges than the three utilised in the above study, and fishers are likely to repeatedly dredge an area several times due to gear inefficiency (Beukers-Stewart et al., 2001). Losses to maerl beds in the United Kingdom will substantially reduce regional biodiversity and can impact commercial fisheries by diminishing nursery-area function (Kamenos et al., 2004b; Newell and Woodcock, 2013).

Horse Mussel (*Modiolus*) Reefs: Similar to maerl, horse mussels (*Modiolus modiolus*) can accumulate in large, dense aggregations, forming distinctive biogenic habitats rising up to 3 m above the surrounding seabed, known as Modiolus reefs (Wildish et al., 1998; Newell and Woodcock, 2013). Modiolus reefs are regarded as ecosystem engineers as the mussels that form the reef bind to each other, and to the seabed, with byssal threads, which has a stabilising effect on the seabed (Rees, 2009). In addition, through binding living mussels, dead shell, and fine sediments, they alter both the topography and the sediment composition of the seabed in and around the reef (DOE, 2005; Ragnarsson and Burgos, 2012). The biological activity of the mussels themselves also affects ecosystem functioning by filtering large volumes of seawater and altering nutrient fluxes (Hargrave et al., 2008; Callier et al., 2009; Dolmer and Stenalt, 2010). These reefs can support high levels of biodiversity as they provide a hard surface for the attachment of algae, kelp, sponges, hydroids, and soft corals (Rees, 2009). In addition, the mussel matrix itself can support a rich community of crevice-dwelling infauna of 200-300 species at densities exceeding 22,000 individuals per m2 (Ragnarsson and Raffaelli, 1999; Sanderson et al., 2008). *Modiolus* reefs have thus been identified as rare biodiversity hotspots and are listed in Annex I of the EU Habitats Directive, as a threatened and/or declining species by OSPAR, and a UKBAP priority habitat.

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Although a widespread and common species around the British Isles, true *Modiolus* reefs are restricted to small areas around the Isle of Man, Irish Sea, and Scotland (DOE, 2005). Due to their long lifespan (over 48 years), slow growth and poor recruitment, *Modiolus* reefs have been identified as particularly vulnerable to the physical impacts of fishing (Cook et al., 2013; Newell and Woodcock, 2013). For example, a substantial *Modiolus* reef was previously located south of the Isle of Man, but was eliminated by intensive scallop dredging in the 1970s and 1980s (Rees, 2009). Similarly, in Strangford Lough, Northern Ireland, *Modiolus* reefs that used to cover extensive areas were reduced to isolated small clumps by scallop fishing (Rees, 2009). In addition to flattening and killing *Modiolus* reefs and destabilising the seabed, a study by Cook et al., (2013) found that experimentally, scallop dredging *Modiolus* reefs off the Isle of Man and Wales reduced the biodiversity of the associated community by 59-90%. No signs of recovery were detected a year later, and given the life history recovery of horse mussels, recovery could take many decades.

Given the importance of biogenic reefs (such as maerl and *Modiolus* reefs) to both fisheries and biodiversity, along with their inherent vulnerability to disturbance, there is a strong argument for completely protecting biogenic reefs from all towed fishing gear.

1.2.4.2 Hard and Mixed Substrates

The rigid nature of scallop dredges means they are unlikely to perform well on hard and uneven grounds, and damage to fishing gear may render such grounds unprofitable. Consequently, maps of fishing effort indicate scallop dredgers generally tend to avoid areas of rocky reefs, boulders, and bedrock slabs (Boulcott and Howell, 2011). Nonetheless, it is a possibility that rocky-reef habitats suffer some damage from scallop dredging activity as they are often found in close proximity to commercially viable scallop grounds (Boulcott and Howell, 2011). For example, a study on rocky reefs in the sound of Jura, west Scotland, found dredging to damage bryozoans, hydroids, soft corals, and sponges, but that the damage was incremental, increasing with the number of dredge tows performed (Boulcott and Howell, 2011). This is in contrast to biogenic habitats where the majority of damage occurs on the first tow of fishing gear through a pristine site (see above). The authors therefore concluded that there is considerable value in protecting slow growing, rocky-reef communities even if they have experienced low to moderate fishing in the past. Likewise, a further study in Scotland on mixed substrates (Boulcott et al., 2014) found that the emergent fauna on hard substrates which are suited to dredging, such as pebbles and cobbles, are particularly vulnerable to dredging and should be protected.

Lyme Bay, in the south of England, provides a further example of a reef area, which is vulnerable to being both fished on and damaged by scallop dredging. The reefs here are made of a mosaic of mudstone, limestone, and chalk, which supports a diversity of attached fauna, flora, and associated marine life (Hinz et al., 2011; Sheehan et al., 2013a). The relatively soft nature of much of this substrate allows it to be fished and eventually broken down by scallop dredging (Sheehan et al., 2013a). Concerns over the impacts of towed fishing gears on these reefs initially resulted in several voluntary closed areas in 2006, which were eventually combined to produce a single large statutory marine protected area (MPA), which excluded towed gears, in 2008 (Hinz et al., 2011; Sheehan et al., 2013a). Hinz et al. (2011) surveyed areas both within and outside the voluntary closed areas soon after they were declared in 2007, some which had previously been fished and some which had not. They found that previous dredging had reduced the abundance and size of structurally complex bryozoans, soft coral and sponges by 54-73%, but that little recovery had occurred in first 12 months after voluntary protection. Wider monitoring soon after the statutory protected area had been designated also found that boulders and cobbles still only had limited sessile and epifaunal life growing on them (Sheehan et al., 2013a). In contrast, observations made 3 years later revealed structural complexity had substantially increased within the MPA through the recovery of pink sea fans (increase of 636%), ross coral (increase of 385%), branched sponges (increase of 414%) and hydroids (increase of 229%; Sheehan et al., 2013a,b). Furthermore, survey data also revealed that these reef-associated species had also colonised sedimentary habitat adjacent to what was originally perceived as reef (Sheehan et al., 2013a). In addition, the main target species of the excluded fishery, the commercially valuable king scallop (*P. maximus*), was also found to be in a state of recovery within the MPA (Sheehan et al., 2013a).

1.2.4.3 Soft Sediments

Although scallop dredge fisheries are known to have negative impacts in almost all habitat types, data have already shown that some are highly sensitive to disturbance while others are more resilient. In general, the more naturally stable an area of seabed is, the more sensitive the ecological community appears to be to disturbance (Eleftheriou and Robertson, 1992; Currie and Parry, 1999; Collie et al., 2000). It has therefore often been suggested that the effects of dredging will be relatively short-lived for ecological communities adapted to frequent natural disturbance by currents, tides, storms, and re-suspension of sediment, such as those inhabiting soft mud/sand/ sandy gravel sediments (ICES, 1992; Jennings and Kaiser, 1998; Collie et al., 2000; Dernie et al., 2003; Sciberras et al., 2013); however, these soft sediment areas often support diverse benthic communities of high biomass and tend to be the main focus of commercial scallop fisheries (Bradshaw et al., 2000; Kaiser et al., 2006; Stokesbury and Harris, 2006). Understanding how the fishing intensity of dredge fisheries can affect communities living in and on these sediments, and whether there are thresholds of disturbance arising from natural forces of energy (i.e. natural disturbance) levels, is therefore a priority.

1.2.5 Summary of key uncertainties and data needs

In the context of this LTMP for the Isle of Man king scallop fishery, there are some key uncertainties and data requirements in order successfully implement, review, and revise the LTMP. These uncertainties are briefly outlined below.

Fleet and Processor Economics

There is currently no fishery-specific assessment of fleet or processor economics. Understanding the economic aspects of the fishery is crucial, particularly where the LTMP aims to improve the overall economic context of the fishery and its stakeholders by increasing resilience and facilitating recovery. Whilst the UK Fleet Economic Survey undertaken by Seafish does provide a UK-wide overview of the economics of, for example, the under-15 m scallop fleet, an Isle of Man specific baseline and monitoring programme of data-collection is required.

Fleet Emissions (CO2e), and Climate Change impacts and mitigation

Net-zero emissions is an overarching Isle of Man Government policy objective. A better understanding of carbon emissions in respect of the fishing fleet is therefore required, as well as identifying opportunities for reducing carbon emissions and supporting the role of the fishing industry in wider carbon-related objectives. Connected to this is the consideration of the long-term implications of change climate and ocean chemistry on the king scallop stock, and therefore the fishery.

Biomass estimates and relative stock status

Determining the relative stock status based on a stock biomass is an important component of the LTMPs long-term and short-term objectives.

Cumulative benthic impacts of fishing activity, and impacts on stock status

The king scallop fishery does not exist in isolation, and the cumulative impacts of all anthropogenic activity is required, including but not limited to other fisheries, particularly where those cumulative impacts translate into the success (or limitation) of the LTMP.

Stock-recruitment relationship

The relationship between stock biomass and recruitment is not well understood, although what evidence does exist suggests that the Isle of Man king scallop fishery is dependent upon connectivity to the wider North Irish Sea, and therefore dependent upon good stock status within both Manx and UK waters.

Size- and age-structure of commercial catches and landings

Stock assessments often rely upon data collected from commercial catches and landings, including but not limited to the size- and age-structure of commercial catch (including landings and discards). Currently, this data is not routinely collected.

Isle of Man fisheries management in the context of the post-CFP UK Fisheries Framework

From a policy and regulatory perspective, there are uncertainties relating to the post-CFP UK Fisheries Framework, including the Fisheries Act 2020 (of Parliament), and the Joint Fisheries Statements and associated Fisheries Management Plans implemented by the UK Fisheries Authorities. Whilst it is clearly acknowledged that the UK Fisheries Framework does not apply directly to the Isle of Man owing to the Islands constitutional and jurisdictional independence and autonomy from the UK, it is possible that changes within the UK Fisheries Framework may have indirect impacts upon the Isle of Man king scallop fishery.

1.3 Relevant Policy Areas

1.3.1 Regional Scallop Fisheries Management (SICG / pan-Irish Sea approach)

The Isle of Man scallop fishery management unit is recognised as a sub-area to a larger Irish Sea scallop stock and fishery. However, until such a time that a pan-Irish Sea approach is appropriately developed, the Department and the SMB will continue to align the Isle of Man scallop HCS with a LTMP specifically for the local management unit. Further, whilst the biological basis for a pan-Irish Sea approach is clear, it is possible that the

Isle of Man scallop LTMP may aim to achieve a different set of socio-economic and biological objectives to a pan-Irish Sea approach.

As a potential precursor to a pan-Irish Sea management plan, The Marine stewardship Council, via its Project UK programme, has been facilitating the development of a stakeholder-based Fishery Improvement Plan (FIP) for UK scallops, including an Irish Sea Assessment Unit. Typically the production of a FIP via this process would identify specific areas for attention (ie. those failing an MSC sustainability assessment criteria), and which would specifically inform the development of a comprehensive Fisheries Management Plan.

A pan-Irish Sea approach to scallop management may be developed by the various UK DAs in conjunction with the UK Scallop Industry Consultation Group ('**SICG'**), which has been established as an industry advisory body to the Department of Environment, Food and Rural Affairs ('**Defra**'); however, the SICG may not be representative of all UK scallop sectors. Marine Scotland has recently established the Scottish Scallop Sector Working Group ('**SSSWG'**), which advises on management of scallop resources in Scottish waters. Both of these co-management bodies are tasked with the development of Fishery Management Plans ('**FMPs**') as required under the UK Fisheries Act 2020. The Department and Island-based stakeholder representatives will continue to attend and have input to the SICG process in addition to the development of this LTMP.

In addition, the ICES Working Group on Scallops has a specific objective in its Terms of Reference ('**ToR**') to collate all available data and attempt to conduct a stock assessment for the north Irish Sea. The Isle of Man IFSC, Bangor University, is leading on this specific ToR, which may ultimately assist in the delivery of this LTMP, and the development of a pan-Irish Sea approach to managing scallop resources.

1.3.2 Management within the 0-3 NM zone

The Isle of Man scallop management unit also contains distinct sub-areas that may have separate management approaches. For example, the 0-3 NM area and the Fisheries Zones ('**FZs**'; i.e. those parts of the 0-3 NM outside of MNRs), may have distinct management plans[6]; however, it is envisaged that this overarching LTMP shall complement, integrate, and build upon those existing management plan(s).

Access to the 0-3 NM FZs is already separated from the general (3-12 NM) scallop fishery. The dual-access approach is a legacy of the Island's territorial sea originally extended out to the three-mile limit only, until it was extended to the 12 NM limit (or the median point) in 1991. Vessels over 15.24 m (50 ft) registered length may not access the fishery resources (including but not limited to scallops) within the 0-3 NM zone. Access to the 0-3 NM was reduced significantly due to the application of a track-record of historic activity in 2016, which included consideration of a vessels economic-link to the Island, and remains a permit-only fishery.

The Department has existing policy aims and commitments to share management, survey, and decision-making responsibilities with those licence-holders with access to 0-3 NM FZs. The general ambition is for an 'Association' of stakeholders to lead in setting HCSs for 0-3 NM FZs using industry survey data. There is an obvious need and benefit to overall coherence between the 0-3 NM FZs HCSs and the LTMP.

1.3.3 Marine Nature Reserves

Marine Nature Reserves (MNRs) are a type of Marine Protected Area, statutorily designated under the Wildlife Act 1990, and with specifically-associated byelaws. They are an area of the sea protected from some potentially damaging activities and impacts, and usually intended to conserve particular species and habitats, or enable their recovery. Marine Protected Areas in general are a well-established tool for achieving these objectives and have been successfully used around the world to benefit marine conservation and fisheries.

The Isle of Man has had legislation for designating Marine Nature Reserves since 1990 (under Section 32 of the Wildlife Act 1990) and the first, Ramsey Marine Nature Reserve, was established in 2011 as an outcome of the Manx Marine Nature Reserve Project. The Isle of Man also had a network of Fisheries Closed and Restricted Areas, established since 1989 for fisheries management and research purposes, and which acted as marine protected areas to enable sustainable fisheries management. As such, marine spatial management, including the use of marine protected areas, was included as part of DEFA's Sea Fisheries Strategy ('Future Fisheries')[7]. In addition to their direct application in fisheries management, these marine protected areas also contained important marine species and habitats, whose protection is fundamental to achieving good environmental status, in support of fisheries and other marine-based interests.

[6] GD 2019/0098 A Management Plan For The 0-3 M Zone Of The Manx Territorial Sea
[7] GD 2015/0063 https://www.gov.im/media/1349731/sea-fisheries-strategy-300920.pdf

The Isle of Man is signatory to the Convention on Biological Diversity and, as a result, developed the Isle of Man's Biodiversity Strategy[8], which included a commitment to protect at least 10% of Manx waters by 2020.

The combination of these related considerations: the Manx Marine Nature Reserve Project, Sea Fisheries Strategy, Biodiversity strategy and international treaty objectives, resulted in two public consultations on an inshore marine zoning plan (2016) and marine nature reserve designations (2017). The outcome of these was that all of the Island's marine protected areas were re-designated from 1st September 2018 as Marine Nature Reserves. As such, the Manx MNR network now consists of ten individual designations, which cover around 430 km^2, 10.8% of the entire territorial sea and 51.8% of the 0-3 NM zone.

MNRs serve several purposes: providing consistency of designation across the Island's marine protected areas, specific protection of habitats and species under the Wildlife Act 1990 (whereas previously most were only related to fisheries management), meeting the Island's international commitments, and providing opportunities for future management within a statutory framework, e.g. specific zoning for conservation or other activities, including fishing.

Only one MNR currently allows fishing for king scallops using dredges, authorised by permits issued by the Department. This fishery occurs within the Ramsey Bay MNR Fisheries Management Zone (FMZ), and was integral to the original MNR designation as part of a co-management agreement with the Manx Fish Producers' Organisation. Currently the fishery is managed using a dedicated pre-fishery survey, an agreed Total Allowable Catch, Daily Catch Limits, and fishery access framework. Permits are issued with the condition that the ecological integrity of the FMZ is not affected by the fishing activity, and subject to a specific harvest control strategy that is based upon appropriate survey data.

1.3.4 Sea Fisheries Strategy

The Department has an overarching 5-year Sea Fisheries Strategy, which was endorsed by Tynwald in 2015, which is now due for review. The Sea Fisheries Strategy extends to all sea fisheries within the Isle of Man territorial sea, and has stated a vision to achieve:

A sustainable, thriving and well-managed fishing industry providing high-quality seafood products, supported by respect for the marine environment.

Although the Sea Fisheries Strategy (2015) may be amended or replaced in the future, its fundamental principles are unlikely to change, and so it is important that the king scallop LTMP maintains broad alignment with the existing and any future overarching Sea Fisheries Strategies objectives.

The 2015 strategy consultation identified ten key issues that need(ed) to be addressed to protect and develop the Isle of Man fishing industry sector, and the fisheries that occur within Manx waters. The resulting objectives were to:

1. Safeguard the long-term viability of the Manx sea fisheries industry with regionally relevant management
2. Develop sustainable fisheries to ensure reliable seafood production.
3. Obtain and apply basic fisheries science data to enable sustainable management
4. Apply an effective range of fisheries management measures within the territorial sea, supported by robust enforcement
5. Secure local industry viability and sustainability by appropriate management of fishing effort across all fishery sectors
6. Encourage and enable fishery diversification
7. By linking with the 'Food Matters' Strategy, Isle of Man Government can help grow industry value by maximizing product quality, value-adding and developing the Manx reputation through a coordinated marketing strategy
8. Encourage and enable greater stakeholder involvement
9. Facilitate Manx industry development by providing training, education and succession opportunities
10. Work with UK fisheries administrations and representatives to progress mutually-beneficial objectives.

1.3.5 Marine Monitoring Strategy

The Isle of Man government has developed the Marine Monitoring Strategy (**MMS**) to put in place monitoring measures to help achieve Good Environmental Status (**GES**) in Manx waters. Achieving GES is described by protecting the marine environment, preventing its deterioration, and restoring it where practical, while allowing the sustainable use of marine resources. The MMS aims to achieve clean, healthy, safe, productive, and biologically diverse waters surrounding the Isle of Man. The Islands Marine Monitoring Strategy is based off of

[8] GD 2015/0049 https://www.gov.im/media/1346374/biodiversity-strategy-2015-final-version.pdf

the UK's Marine Strategy and the EU's Marine Strategy Framework Directive. The strategy consists of 11 descriptors for achieving Good Environmental Status, with each descriptor having individual targets and indicators for achieving GES. The 11 descriptors are:

- Descriptor 1 - Biodiversity
- Descriptor 2 - Non-indigenous species
- Descriptor 3 – Commercial fish
- Descriptor 4 - Food webs
- Descriptor 5 - Eutrophication
- Descriptor 6 - Sea-floor integrity
- Descriptor 7 - Hydrographical conditions
- Descriptor 8 - Contaminants
- Descriptor 9 - Contaminants in seafood
- Descriptor 10 - Marine litter
- Descriptor 11 - Underwater noise

Additionally, the Isle of Man Marine Monitoring Strategy ensure that the Island meets its OSPAR monitoring requirements and delivers comparable data across the OSPAR maritime region. Collecting and analysing Manx data for local application and for data sharing in the greater context of global trends is crucial for the Isle of Man to react to challenges faced by climate change and provided adequate protection of the marine environment.

1.3.6 Isle of Man Government - Our Island Plan

The Isle of Man Government document 'Our Island Plan' (GD 2022/0004), approved by Tynwald in February 2022, provides the high level strategy for the Isle of Man Government's overarching aim to *build a secure, vibrant, and sustainable future for our Island.*

The Island Plan provides an ambitious vision for the Isle of Man, and sets out a firm direction of travel for the 5-year period 2022-2027. The Island Plan acknowledges that the island's economy, environment, and society is facing significant challenges, but also recognises that there are also significant opportunities. It notes that the island's "big policy issues all require in-depth thought and planning not only to resolve immediate issues, but to ensure that we have long term plans and associated structures that deliver sustainable policies for the future." In this way, the Isle of Man king scallop fishery long-term management plan is relevant in its strategic, long-term approach to ensuring that natural resources (scallops) are managed to secure biological and economic sustainability.

The Departments co-management approach to developing, implementing, and reviewing the LTMP is also aligned with the Island plan, which acknowledges that Isle of Man *Government alone cannot deliver all of the actions that will be needed, and we must increase our positive influence and collaborative working capabilities with key partners across the community if we are to achieve success*. DEFA will therefore set out a clear commitment to continue working with the fishing industry, via Isle of Man Scallop Management Board, during the development, implementation, and review of the LTMP.

The core strategic objectives of the Island Plan are:

> **Secure:** We have an Island where everyone feels safe, our economy is secure, our health and education systems support everyone, and we have housing, food, energy, and transport security.
>
> **Vibrant:** Our Island is vibrant, diverse and welcoming, providing excellent educational, recreational and economic opportunities for all, and our businesses are able to grow with confidence, accessing the skills and people required now and into the future.
>
> **Sustainable:** We look after and nurture our Island and our resources, driving forward our local agenda towards a fair, inclusive and sustainable society and environment

In order to deliver these high-level objectives, the Island Plan focuses on five interrelated priorities. Two of these priorities are, in particular, directly relevant to the scallop LTMP;

> **A Strong and Diverse Economy:** a strong and diverse economy which is sustainable, ambitious and built on firm foundations to provide economic success, rewarding career opportunities and prosperity which positively impacts all residents of the Isle of Man.

An Environment we can be proud of: an environment we can be proud of is an Island that provides for vibrant communities where people feel safe and is a rich and diverse biosphere that is being protected, nurtured and sustained and held in high regard here and around the world.

The Island plan also commits to a Food Security Plan by December 2023, which the king scallop LTMP shall feed into.

1.3.7 Climate Change Action Plan

As a responsible nation, and to protect our environment, our community and to safeguard our continued prosperity, the Isle of Man is committed to reaching carbon neutrality by 2050. The Net-zero programme consists of statutory Action Plans, the first of which was launched in September 2020 and consisted of 60 actions, including;

1. Setting up the Climate Change Programme
2. Government leading the way
3. Energy generation
4. Our homes
5. Carbon sequestration*
6. Transport
7. Business and industry
8. Public engagement and awareness
9. The Climate Change Bill
10. Financing the mitigation and ensuring a just transition.

In April 2022, the Isle of Man Government shall launch its first 5-year statutory Action Plan, which will build upon the Phase 1 Action Plan. The Phase 1 Action Plan included an Ocean-based Climate Solutions ("Blue Carbon") project, which aims to provide an empirical inventory of the carbon stores in the Islands territorial sea, in order to develop a comprehensive blue carbon management plan to maximise carbon sequestration and maintain and restore biodiversity and wider ecosystem services.

2.0 LTMP Aims and Objectives

2.1 Governance and Policy

The overall objective of the LTMP is to maximise the sustainable long-term benefits for the inshore sector and coastal communities resulting from the sustainable use of the Isle of Man scallop resource. In order to achieve this, the scallop LTMP must set out the long-term objectives from a governance and policy perspective.

2.1.1 Long-term High-level Policy Objectives

An LTMP built upon Co-management

Since 2017, decision-making in the king scallop fishery has been built upon **co-management**, delivered through the SMB. The SMB is constituted to advise the Department on the conservation and management of the scallop resources within the Islands territorial sea. Membership of the SMB consists of individuals with relevant scientific, commercial fishing, fish processing or public administration experience associated with the Isle of Man scallop industry. Members are tasked to reach management recommendation decisions by working towards consensus, setting aside all personal interests in the fishery, financial or otherwise. Co-management shall continue to be the keystone upon which the King scallop LTMP is delivered.

An LTMP built upon a Collaborative Science approach

The Department has appointed an Independent Fisheries Science Contractor (‘**IFSC**’) since the closure of the Liverpool University Port Erin Marine Laboratory. The IFSC is appointed with Treasury concurrence under section 5 of the Fisheries Act (2012), and is procured through the Attorney General’s Chambers (‘**AGCs**’). The IFSC contract requires the Contractor to work collaboratively with the fishing industry where necessary and appropriate. The current contractor, Bangor University, has fostered an especially productive and effective relationship with the fishing industry. An important objective of this LTMP shall be to promote and sustain the **Collaborative Science** approach that combines the analytical and modelling expertise of fisheries scientists with the knowledge and understanding of the resource-users. It is recognised that the best-available evidence is attained through cooperation, collaboration, openness, and transparency. The principle of collaborative science must necessarily be supported by robust data-sharing agreements that is compliant with the Data Protection Act (2018).

An LTMP that ensures Effective Compliance and Enforcement

The aims and objectives of the LTMP may only be achieved if there is **effective compliance and enforcement** of the rules applied to resource-users. Effective compliance necessitates that the Department is equipped with the appropriate tools, technologies, and resources to monitor fishing activity both at sea, on the quayside, and throughout the processing sector. This requirement extends to vessels fishing within the management unit but landing scallops off-Island, and therefore requires collaborative working with fisheries enforcement agencies throughout the UK DAs.

Effective enforcement requires that the regulations and conditions applied to the fishery are enforceable with the tools, technologies, and resources available to the Department. The industry, through co-management, must work with the Department to ensure that the HCRs applied to the fishery are robust, reasonable, and responsive from the perspective of the Department, whilst ensuring that the industry can have a high degree of confidence in demonstrating compliance.

An LTMP that promotes Credible Fisheries Management and Best-Practice

Fisheries management decisions are often afflicted by controversy, misrepresentation, or misinterpretation. The LTMP must ensure that the governance of the Islands scallop resources is recognised as a **credible fisheries management** system. This will be delivered through effective communication and delivering against the principles of co-management, collaborative science, and effective compliance and enforcement, and by drawing upon examples of best-practice throughout the world.

An LTMP that is supported by an Efficient Regulatory and Policy Framework

The Department is ultimately responsible for the regulation of the Isle of Man inshore king scallop fishery under the vires of the Fisheries Act 2012. It is recognised that the pre-existing regulatory framework requires a review and may be improved through consolidation, and a focus on clear and concise regulation that is easily attainable for resource-users.

2.2 Fisheries-specific Management Objectives

2.2.1 Long-term Objectives (‘**LTOs**’)

In order to be sustainable, resource-use must be undertaken within a HCS framework that applies biologically sustainable limits whilst considering wider ecological and environmental impacts based on the best-available evidence, and effectively balances those limits with an economically-viable approach for industry. Central to this is the recognition that the Isle of Man king scallop fishery is an inshore fishery, and that the LTMP should aim to deliver long-term rewards for the inshore sector. The HCS is discussed in greater detail in Section 4.0.

The Department and the SMB formally recognise and endorse the following long-term High-level objectives for the Isle of Man king scallop fishery:

LTO 1 – Primary Objective: Good Environmental Status and UNESCO Biosphere principles

To achieve Good Environmental Status in the king scallop fishery, using an approach that reflects the principles of the Island’s UNESCO Biosphere status.

Good Environmental Status means that the harvest of king scallops is within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. This generally means that king scallops will be exploited sustainably (consistent with the highest sustainable long term yield), have adequate reproductive capacity for replacement (able on average to reproduce at least once before being caught) and that stocks will have an age and size distribution that avoids impaired recruitment. The GES target is based on stock assessment and require fishing rates to be at levels which can produce Maximum Sustainable Yield or a suitable proxy.

The UNESCO Biosphere promotes three global functions: 1) sustainable development, 2) conservation, and 3) learning. UNESCO defines sustainability as *meeting the needs of today without compromising our ability to meet the needs of tomorrow*.

LTO 2 – Management is based on an optimised Harvest Control Strategy (HCS)

To establish an annual HCS that is optimised via a robust co-management decision-making processes in pursuit and continuation of the primary objective; to restore and maintain good stock status and achieve long-term stability in line with the sustainability principle of the Island’s UNESCO Biosphere status.

LTO 2.1 – HCS: Biologically Sustainable Limits

To adopt a Harvest Control Strategy that sets biologically sustainable limits on fishing activity, informed by robust/best available scientific stock data linked to biological reference points (limit and target reference points).

LTO 2.2 – Bio-economic capacity management

To adopt a Harvest Control Strategy that manages vessel numbers, access, and fishing effort so that fleet capacity is economically viable within the limits set (i.e. a bio-economic approach), and with consideration of;

A. the ‘inshore’ definition of the fishery;
B. environmental impacts of resource-use;
C. socio-economic requirements of the industry; and,
D. monitoring-control-surveillance (‘**MCS**’) requirements.

LTO 2.3 – Harvest Control Rules

To adopt a HCS that utilises Harvest Control Rules with defined limits that are **effective** (deliver the aims and intent of the measure), **responsive** (able to adjust in a dynamic context), and **enforceable** (non-compliance is able to be objectively determined).

LTO 2.4 – Considerations of Recruitment

To adopt a Harvest Control Strategy that avoids and/or mitigates, where possible, poor recruitment and recruit overfishing.

LTO 2.5 – Spatial Management

To adopt a Harvest Control Strategy that incorporates spatial management at an appropriate spatial scale and duration to protect juvenile populations and control the exploitation in high-density areas, safeguard critical scallop brood-stocks, and protect sensitive marine habitats/species, with consideration of other marine users.

LTO 3 – The Ecosystem Approach

To deliver an inshore fishery that acknowledges, monitors, and mitigates where possible environmental impacts of the fishery, following an ecosystem-based approach.

LTO 4 – Quality Seafood

To work with stakeholders to deliver a high-quality seafood product, produced sustainably, that delivers market access and maximises stakeholder economic return, and GDP contributions to the Islands economy.

LTO 5 – Safety, Wellbeing and Succession

To work with stakeholders to deliver a high level of safety and wellbeing for those people working in the industry. Further, to work with industry to develop a new entrant programme that allows for succession in the industry, integrating into long-term management plans for other fisheries in the Island.

LTO 6 – Energy Efficiency and Climate Change

To work with stakeholders to achieve an energy efficient and climate-friendly inshore fishery, and to enable a Just Transition in reducing carbon emissions and/or contributing towards Ocean-based climate solutions with targeted Isle of Man Government initiatives.

LTO 7 – Other Marine Users

To work with regional stakeholders, particularly in relation to Marine Spatial Planning and other marine-users (including other sectors of the fishing industry), to ensure that the Isle of Man king scallop fishery (and stock) is appropriately considered in relation to proposals and developments, and adapt, mitigate, and/or offset impacts to safeguard the future of the fishery.

2.2.2 Short-term Objectives (‘**STO’**) - key objectives to deliver prior to a 2027 review of LTMP

In pursuit of the above LTOs, the Department and the SMB commit to the following short-term objectives (STOs) during the first 5-year period of the LTMP (01st June 2022 – 01st June 2027), after which the LTMP will be reviewed.

STO 1: Implement new/amended technical restrictions and specifications relating to dredge-gear

In recognition of the ‘Inshore’ characterisation of the territorial sea (0-12 NM) fishery the Department shall introduce new (and amended existing) technical measures to improve the regulation and enforcement of dredge (technical) restrictions, whereby:

- The total number of dredges that a vessel may use shall be specified as twelve in the 3-12, and ten in the 0-3 NM;
- The number of dredges-a-side shall be specified as six in the 3-12 NM;
- A maximum tow bar length of 5.5 m shall be introduced for the entire territorial sea;
- The maximum number of teeth that may be used on each dredge shall be reduced from nine to eight;
- The minimum spacing between teeth shall be increased from 75 mm to 85 mm to reflect the above.

The LTMP acknowledges the overarching UK-wide policy aim to harmonise inshore technical conservation measures.

Addresses LTO 2.3; LTO 2.4

STO 2: Implement a Capacity Reduction Programme

In recognition that the catching requirement for the current number of *potential* full-time vessels being several times in excess of the possible TAC at economically viable DCLs, the Department shall reduce the number of authorisations to fish for king scallops by applying the qualifying criteria recommended by the SMB in the 2021 consultation.

The eligibility criteria for scallop authorisations requires that;

1. an authorisation must not currently be “latent”, i.e. includes only those authorisations that are *active* or *dormant*, for details see Specific Fishery Authorisation policy;

2. the authorisation must meet **either** one of the following track-record requirements;

   - At least 54 days fishing king scallops in the territorial sea during the period 01st November 2017 to 31st March 2020; **or**

   - At least 27 days fishing king scallops in the territorial sea in any one season during the period 01st November 2017 to 31st March 2020 (i.e. the 2017/18, 2018/19, and (part of) the 2019/20 season).

Where an authorisation is already “latent” but meets one or both of the above criteria, they will be retained by the Department in line with the Specific Fishery Authorisation policy.

A review process will be administered by the Department following initial notification of the outcome of the above criteria. Details of the review process will be explained in the notification letter sent to licence-holders whose eligibility may be impacted by the above criteria. The SMB will advise the Department on what criteria should be included for consideration within the review process.

Whilst it is accepted that this measure will not deliver Objective 2.2 in full (matching fleet capacity to fishing opportunities), it will reduce potential capacity significantly by determining that only those vessels with a consistent and minimum participation are eligible for future access.

As such, and in pursuit of Objective 2.2, additional HCRs that aim to manage fleet capacity in line with fishing opportunities may be considered, and may be introduced via amendments to this document. Additional HCRs may incorporate effort controls to enhance the effectiveness of the current access framework, for example a ‘days-at-sea’ HCR.

In addition to the above eligibility criteria, the Department will consider the general requirement to reduce fleet capacity when determining whether, if an *active* or *dormant* scallop authorisation becomes latent in line with the Specific Fishery Authorisation Policy (e.g. when a vessel is sold, scrapped, or not licenced), those authorisations should be made available for application and re-allocation.

Where further reductions in capacity is considered necessary or appropriate in the context of the LTMP, and with advice from the IFSC and/or the SMB, the Department may withhold authorisations that become latent (i.e. they are not made available for application and reallocation to new owners), or may only reallocate authorisations dependent upon applications presenting a strong case for doing so and subject to conditions or limitations deemed necessary, by taking the following into consideration;

- continuity of local employment;
- a strong economic-link to the Islands economy through landings; and
- the individual track-record of activity associated with that authorisation.

In light of the above, the Department shall introduce an economic-link requirement in respect of authorisations applications, which may be re-allocated on the basis that the application was approved subject to an economic-link being demonstrated.

Linked to LTO 2.2

<u>STO 3: Termination of Grandfather Rights (GFRs)</u>

In recognition of the inshore nature of the territorial sea fishery (Objective 2.2), access to the fishery will be limited to vessels that have a registered engine capacity of 221 kW or less. In effect, this will eliminate any remaining GFRs first introduced in 2010. With recognition of the immediate impacts that this may have on a number of vessels eligible for future access, GFRs shall be phased-out completely by no later than the 31st October 2024, i.e. a 2-year period from the initiation of the LTMP, and a 14-year period since GFRs were first introduced. The existing phase-out policy, which stipulates that all replacement vessels must be 221 kW or less, will be maintained in the interim period.

Addresses LTO 2.2

STO 4: Implement a voluntary Research Contribution Scheme

Further to Objective 2.1, the LTMP recognises the role and requirement for industry to maintain a research fund, which can be utilised to deliver against research priorities set by the SMB.

The Department will develop a voluntary scheme whereby vessels may retain and land scallops that would otherwise be discarded in order to comply with the DCL ('excess scallops'), subject to conditions. The scheme shall be authorised by the Department by way of 'Fishery Improvement Permits' issued under Section 75 of Fisheries Act. The permits shall grant the master of a vessel permission to retain and land excess scallop to a nominated processor, and the processor must make payments for excess scallops to the 'Scheme-recipient'. The Scheme-recipient, with confirmation and oversight of the Department, must make reasonable and relevant expenditures to deliver the Research priorities established by the SMB. The Scheme-recipient must produce a financial report to the SMB detailing the income and expenditure under the scheme.

The Scheme shall be conducted on a trial-basis, subject to review following the closure of the season, and shall be initially conducted on a limited trial-basis.

Addresses LTO 2.1 and principle of Collaborative Science

STO 5: Internal Review of the Scallop Management Board (membership and processes)

A review of the SMB, in terms of its membership and its processes, is appropriate and timely as the LTMP sets out a long-term strategic approach to scallop fishery management in the Isle of Man territorial sea.

The Department shall work with existing members to ensure that the review does not negatively affect the short-term decision-making role and requirements of the Board. The Department shall aim to complete the review in advance of the 2023/24 fishing season, and implement the recommendations of the review thereafter. A review is in-line with the long-term policy objectives of effective co-management and credible fisheries management, and does not reflect the performance and commitment of existing membership. The review of the SMB will consider establishing the Board as a statutory body under Section 36(9) of the Fisheries Act 2012.

Addresses LTO 2 and principle of Co-management

STO 6: Establish decision-making guidelines for spatial management

Further to Objective 2.5 of the LTMP, the SMB shall establish guidelines that enables appropriate application of spatial management to the fishery. This shall, in particular, aim to set out:

- how closed areas should be introduced when surveys detect an abundance of juvenile scallops that are unlikely to recruit into the immediate fishery (i.e. through voluntary or statutory means, and/or whether further evidence is required);
- how closed areas should be re-opened to the scallop fishery following recruitment of previously protected juvenile populations, with consideration of necessary management measures to avoid overfishing and a 'race-to-fish', such that benthic (seabed) impacts are effectively managed and harvests may be sustained for reasonable periods of fishing; and,
- how closed area decisions may receive input from other sectors of the fishing industry that might seek to exploit closed areas, with the overall aim of reducing gear-conflict and maximising the economic value of sea fisheries.
- how to consider spatial management decisions that may have unforeseen or indirect effects, such as displacement and/or socio-economic.

Addresses LTO 2.5 and principle of Best-practice

STO 7: Adopt a quantitative stock assessment that produces biomass-linked advice

The Scallop Assessment Working Group of ICES WGSCALLOP seeks to develop and improve stock assessment methods for scallops and increase understanding of scallop populations and fisheries. The working group shares and combines expertise on survey methodologies, advances in technology and recent studies on various scallop species. This includes work on dredge efficiency, incidental and discard mortality, growth, and population genetics.

Work has been undertaken to examine the potential stock assessment options for data limited stocks (cohort analysis and SPiCT) and the group has recently improved the performance of three different models applied both to the Isle of Man survey time-series.

A list of available data (landings, effort, survey, observer, catch sampling, VMS, habitat data) for scallop fisheries in the Irish Sea region has been produced and the extent of the initial stock assessment area has been agreed.

Bangor University scientists contracted to the Department currently conducts stock assessments at the level of the Isle of Man's territorial sea, but the aim of ICES WGSCALLOP is to assess the scallop stock as the wider stock level (i.e. North Irish Sea). The project will run for three years with the expected deliverable at the end of this period of a Stock Assessment for the North Irish Sea. The Department's IFSC provider will continue to lead in the stock assessment research for the region, and will aim to produce a robust and reliable biomass estimate for the scallop resources in the territorial sea.

The development of a quantitative stock assessment that produces biomass-linked advice will be part of defining and achieving Good Environmental Status.

Biomass-linked stock assessments ordinarily incorporate 'confidence intervals'. Management of the fishery using a TAC should consider these confidence intervals, for example, setting a soft-TAC at the lower-estimates, with consideration of an in-season TAC uplift to the median estimate using fisheries-dependent data, and further uplifts not exceeding the upper-estimate.

Addresses LTO 1, 2.1 and principle of Credible Fisheries Management

STO 8: Develop and test Target Reference Points (TRPs) and Limit Reference Points (LRPs) to guide in-season adjustment of Harvest Control Rules

Real-time fisheries-dependent data can be modelled to produce activity-parameters important for controlling fishing activity in order to prevent overfishing and/or direct impacts on ecosystem and benthic habitats. The use of 'thresholds', which are set against historic baseline data, can be helpful for decision-makers. These thresholds are often called 'reference points', and the Isle of Man king scallop fishery has been monitored against LPUE (kg/dredge/hr) and Fishing Intensity (swept area) reference points.

When a particular parameter reaches a reference point, it can 'trigger' pre-arrange interventions or adjustments to HCRs, known as 'trigger reference points' ('**TRPs**'). For example, if LPUE declines to a historic reference point in a particular area, the SMB will be requested to discuss the likely causes of this, and consider whether intervention is required, including additional monitoring and/or management measures.

Similarly, decision-makers can adopt 'limits' for particular parameter, known as 'limit reference points' ('**LRPs**'). For example, the TAC is a form of LRP, whereby the fishery would close once landings reach the TAC. LRPs can also be applied to different parameters, and can be applied to specific areas / fishing activities.

The LTMP shall aim to incorporate a series of robust, evidence-based and agreed TRPs and LRPs. This shall necessarily need to balance the data-availability with the regulatory ability to implement changes to HCRs. The SMB shall work with Bangor University to develop formal advice on the scope and application of TRPs and LRPs for the LTMP.

Addresses LTO 2

STO 9: Develop and test a decision-making framework for area-based catch thresholds

Exploration of geo-statistical methods to analyse the current short-term, fine-scale industry survey data at an area (fishing ground) level will be completed. This will include trials of the use of statistical methods to standardise the survey indices and to assess biomass predictions within discrete fishing grounds.

Other geo-statistical methods using both surveys will also be investigated. Once area-based biomass estimates are available, then TRPs and LRPs for landings and LPUE can be explored to develop and test a decision-making framework for area-based catch/landings thresholds (similar to the way Ramsey Bay is currently managed).

STO 10: Develop and test a decision-making framework for Relative Benthic Status / Fishing Intensity thresholds

Quantifying the impact of fishing activity in benthic habitats is an important metric for monitoring the fishery to ensure sustainability of scallop recruitment, as well as maintaining the overall condition of the habitats and benthic communities. Essentially it provides a seabed condition indicator for a fishing ground, and a baseline from which to monitor change.

Fishing intensity is defined as the fishing effort per unit area per unit time. Consideration needs to be given to the potential for cumulative impacts of queen scallop trawling and queen and king scallop dredging within each fishing ground which may have disproportionally damaging effects compared to each in isolation. This could provide a metric that is usable, in real time, through the season to monitor cumulative impacts during the king scallop fishery in relation to the specific benthic substrate-types that are typical of the various fishing areas.

Relative Benthic Status (RBS) is a metric that should also be further developed and assessed for monitoring scallop fisheries. The status of mobile-gear fished habitats and hence their RBS value depends on impact rate (depletion per tow), recovery rate and exposure to fishing. This enables a quantitative estimate of status relative to an un-impacted baseline and could provide a useful metric for monitoring of scallop fisheries. This approach would allow an assessment of each habitat type within the territorial waters, or within a fishing ground, to indicate which areas are more at risk from higher fishing intensities, and whether levels of fishing intensity would have a negative impact on habitat status (using pre-defined management criteria).

Addresses LTO 3.0

STO 11: Develop and test a decision-making framework for adjusting TAC between seasons

The Harvest Control Strategy for the management unit must adjust to inter-annual variation in biomass estimates of the resource, reflected in the overall TAC for the fishery. However, it is recognised that significant variations in TAC from year-to-year can have economic implications for resource-users, particularly where there are significant adjustments (e.g. in excess of ± 20%). The LTMP must therefore adopt a decision-making framework that allows for proportionate and reasonable TAC adjustments.

The SMB and Bangor University shall be tasked to construct a decision-making framework that allows for year-to-year TAC adjustments that balances biological sustainability and economic implications. This is one aspect of the bio-economic approach to a sustainable inshore (territorial sea) king scallop fishery.

STO 12: Develop and test a decision-making framework for adjusting TAC in-season

In-season adjustments of the TAC should not ordinarily occur, particularly when the TAC is based upon a biomass-linked assessment of the stock biomass. However, the Department, Bangor University, and the SMB recognise the potential opportunity for flexible adjustments of catching opportunities in some circumstances, where such changes are supported by the robust data, and dependent upon good stock status.

Therefore, subject to a biomass-link stock assessment being available in the future, the LTMP will seek to develop and test a 'flex' TAC policy, which may allow for catching opportunities to be 'banked' to, or 'borrowed' from, the subsequent king scallop season. This will be conditional upon improvements in modelling and predicting recruitment, and a sound rationale that justifies such measures.

Addresses LTO 2.1

STO 13: Adopt a decision-making framework for a bio-economic approach to setting Daily Catch Limits (DCLs)

It is recognised by the Department and the Scallop Management Board that DCLs have been used as an effective management measure to control or limit overfishing in the inshore (territorial sea) king scallop fisheries and, in particular, eliminate the *race-to-fish* phenomenon. The DCL is also used to ensure that the overall TAC is not depleted before the end of the season, and that fishing opportunities, supply to processors, market demand and cash flows were sustained throughout the season. The DCL approach has been supported by the SMB, which together, have recommended that the TAC should be sustained throughout the season.

However, Daily Catch Limits have a fundamental economic impact on both the catching sector as well as the processing sector by limiting daily earning potential across the range of vessel sizes, as well as daily supply of scallops into the factories. Supply constraints can have downstream effects on market access and the labour market for processors. Equally, a capped earning potential can have severe impacts on the catching sector if it is below the level required for minimum economic viability, for example it has become challenging to retain crew as prices have decreased as profit margins have been constrained or eliminated.

The Daily Catch Limit should be fundamentally based in a bio-economic approach, which ensures that the daily earning capacity of vessels (i.e. volume of scallops) is at, or above, the minimum economically viable level for the vessel characteristics, and that supply-chain considerations (supply and demand) are considered. The minimum economically viable DCL should be informed by market price, product yield, operating costs (crew, fuel, gear), and capital re-investment costs (boat-shares). Of course, a well-regulated fishery with attractive (if limited) catch limits may attract uptake of capacity, and progress towards a bio-economic DCL should be considered in-line with progress towards Objective 2.

The LTMP therefore sets out to establish a DCL within each annual HCS that is set at, or at least moves towards, a bio-economically moderated level.

Addresses LTO 2.2

<u>STO 14: Assess and determine the feasibility and opportunity of a sustainable dive-caught scallop fishery</u>

The inshore (territorial sea) Isle of Man king scallop fishery is currently a dredge-fishery; however, there is interest from some stakeholders to develop a dive-caught product using resources in the 0-3 NM area, potentially within existing MNRs, and subject to an appropriate HCS and regulatory framework being established and aligned to the LTMP for king scallops as it applies to the mobile-gear sector, and in particular, consider the impacts on existing resource-users.

Further to LTO 14, the Department shall work with 0-3 NM stakeholders (‘the Association’) to assess and determine the regulatory feasibility and economic opportunity of a limited and managed dive-caught fishery, which creates catching opportunities specifically for diver-caught exploitation. Consideration should be given to develop a ‘user-pays’ development strategy, including contribution to future management of the 0-3 NM area. The dive-caught fishery must be managed using an appropriate set of HCRs and technical-conservation measures to ensure that it is moderated within sustainable limits, as well as being low-impact, and should be based upon a high evidence-threshold that acknowledges localised density depletion and/or size structure impacts.

Addresses LTO 4 and LTO 7

<u>STO 15: Assess the efficacy of resource-implications for the introduction of Remote Electronic Monitoring (REM)</u>

REM, which includes existing technologies such as VMS, is being expanded elsewhere to include onboard camera and winch-sensor technologies. Onboard cameras are focused on the fishing equipment, and provide a bird’s eye view of where the dredges are stowed, emptied and launched from (i.e. there is no intention that they may be used to identify crew). This technology may provide for significant improvement in the provision of desk-based MCS capabilities, as well as ensuring coherence with emerging requirements elsewhere in British fishery limits.

Addresses LTO 2.3 and the principle of an LTMP that ensures Effective Compliance and Enforcement

<u>STO 16: Fleet Economics data-collection</u>

A better understanding of fleet economics will be essential in assessing the delivery of the LTMP. The Department and SMB will work with stakeholders to assess how baseline fleet economic data-collection, analysis and reporting should be undertaken.

Addresses Objective 2.2 (Bioeconomic approach)

<u>STO 17: Fleet emissions & climate-change impacts</u>

A better understanding of energy efficiency, carbon emissions, and opportunities to promote ocean-based climate solutions will be essential in assessing the delivery of the LTMP. The Department will work with stakeholders to undertake a fleet ‘emissions-audit’ and explore mechanisms to enable and support a Just Transition.

Addresses Objective 6

3.0 Fisheries Management Structure

3.1 Legal Framework

Management of the fishery within the Isle of Man territorial sea is the statutory responsibility of the Department under Section 5 of the Fisheries Act (2012) (of Tynwald) (‘**the Act**’).

Part 5 of the Act provides legal *vires* for the Department to regulate (section 36), and licence (section 37-38) commercial fishing activity in the Isle of Man territorial sea. In relation to Part 5, section 83 of the Act requires the Department to consult with stakeholders, scientific authorities and the UK Secretary of State before introducing any new regulations, and also to ensure that any agreements between the Isle of Man Government and the sea-fisheries administrations of the UK are not contravened.

In addition to section 83 of the Act, the current Fisheries Management Agreement (2012) (‘**FMA**’) between the UK DAs and the Isle of Man remains in effect. Whilst the FMAs primary purpose was to ensure that regulation of sea fisheries in the Isle of Man’s territorial sea complied with the UK’s previous obligations under the EU CFP, the agreement also sets out the system by which the Department introduces fisheries management measures in the extended territorial sea (3-12 NM, i.e. that area of the territorial sea outside of the dashed black line in Figure 2). It is recognised that the FMA requires a complete review in the context of the UKs exit from the CFP.

Under the legal framework described above, commercial fishing for king scallops within the Isle of Man territorial sea is prohibited to all commercial fishing vessels except those that hold both a valid UK Fishing Licence with a scallop entitlement, a general Isle of Man Sea Fisheries Licence, which has specific authorisation to fish for king scallops in the 0-3 NM zone and the 3-12 NM zone, via a ‘Specific Fishery Authorisations’ (‘SFAs’). SFAs are issued under the Specific Fishery Authorisation Policy.

The king scallop fishing HCS is currently regulated directly by a number of pieces of Manx legislation[9], including (but not limited to):

The Fisheries Act (2012) – Enabling (primary) legislation, under which;

- Sea Fisheries (Vessel Monitoring System) Regulations 2015
- Sea Fisheries (Closed and Restricted Areas) Regulations 2015
- Sea Fisheries (Baie ny Carrickey Closed Area) Regulations 2013
- Sea Fisheries (Ramsey Bay Closed Area) Regulations 2010
- Sea Fisheries (Technical Measures) Bye-laws 2000 (as amended)
- Sea Fisheries (Consolidation) Bye-laws 1984

The Wildlife Act (1990) provides for designation and regulation of marine nature reserves (several of which relate to former fisheries closed and restricted areas)(see above);

- Manx Marine Nature Reserves (Designation) Order 2018
- Manx Marine Nature Reserves Byelaws 2018

In addition, king scallop fishing activity is also regulated by way of licence conditions association with the general Isle of Man Sea Fisheries Licence, which may be varied from time to time, and which specifies a range of harvest control rules (HCRs) in the licence conditions (section G), licence schedule (section H), and the licence annex (section I). In recent seasons, HCRs have included:

- Permanent closed areas within the 0-3 NM
- Temporary closed areas within the 3-12 NM
- Curfew (prohibition on fishing between 1800 – 0600)
- Mid-season temporal closures (2 weeks over Christmas)
- Daily Catch Limit (DCL)
- Total Allowable Catch (TAC)
- Limits on aggregate dredge width (a form of ‘dredges-a-side’ restriction)
- Requirements to report bycatch
- Requirements to report catch and effort data for scientific and fisheries management purposes
- Requirements to land biological/scientific samples if requested by the Department
- Prohibits access to the fishery to vessels in excess of 221 kW engine power, unless they are a ‘qualifying vessel’ (i.e. with Grandfather Rights ‘GFRs’ introduced in 2010).

The Isle of Man also maintains alignment with the WWER, which establishes DAS limits on vessels over-15 m throughout ‘Western Waters’, although is considered to have been overall non-limiting in recent seasons. A full

[9] All licence-holders should be familiar with, and comply with all relevant Sea Fisheries legislation.

description of the Isle of Man inshore king scallop fishery is described in section 4.0.

3.2 Institutional Arrangements

The Department is a separate legal entity to the other Departments of the Isle of Man Government; however there are clearly significant overlapping areas of responsibility and obligation with respect to the marine environment and exploitation of marine resources (living, and non-living).

Within DEFA, there are a number of Directorates. The Fisheries Division is within the Environment Directorate, and has a small team with a limited resource, which includes all aspects of sea fisheries management, from administration, policy development, compliance, and enforcement.

The DEFA Political Structure (being separate to the Operational structure) is primarily the Minister for the Department, who is ultimately responsible for the functions of the Department, and is legally responsible for making legislation, or approving policies. Legislation (Primary and secondary) and policies are approved at the DEFA Policy and Strategy Committee, which meets monthly. The Minister is often supported in their role through the appointment of Political Members of the Department (Members of the Tynwald House of Keys). Departmental Members may be given delegated responsibilities for specific Directorates of the Department.

3.3 Consultation and Co-management Arrangements

When introducing new fisheries management measures, whether by regulation or licence condition, the Department has agreed to adhere to the current Fisheries Management Agreement 2012 (‘**FMA 2012’**). The FMA 2012 Section 9(6) requires that, before implementing new management measures in the extended territorial sea (3-12 NM), the Department must:

- Consult, and take account of the views of, the other relevant UK Fisheries Administrations and provide them with any revisions prior to consulting more widely with industry and other interested parties on new fishery measures (‘prior consultations’);
- Ensure that new measures are justifiable, evidence based and non-discriminatory by reason of nationality;
- Follow UK Government best practice guidance when consulting with stakeholders;
- Ensure that fair access continues to apply for UK and Island vessels in each other’s waters.

The FMA 2012 is not a legally-binding document in itself; however, the Department must satisfy itself that regulation of the fishery is not in its contravention when making regulations under the Act further to Section 83(5)(3). The FMA 2012s primary function was to ensure alignment between the Isle of Man, being outside of the European Union (‘**EU**’), and the UKs obligations under the EU Common Fisheries Policy (‘**CFP**’). It is recognised, therefore, that the FMA 2012 requires revision, and subsequent removal, replacement, or amendment.

The Isle of Man Scallop Management Board (SMB) is a non-statutory advisory body formed by the Department, and has a constitution which is downloadable from a dedicated Isle of Man Government webpage, along with minutes and explanatory documents. The Scallop Management Board is structured as follows:

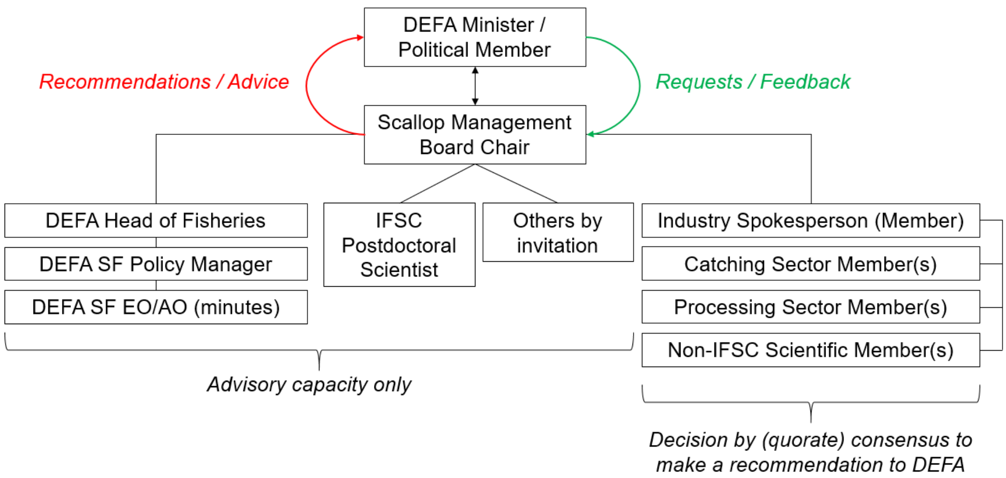


Figure 2. The organizational structure of the Isle of Man Scallop Management Board.

The remit of the SMB includes:

- consideration of scientific advice presented by Bangor University and any other relevant, qualified scientific establishment;
- consideration of best practice fisheries management practices;
- to support the priority aims and objectives of the Isle of Man Future Fisheries Strategy;
- consideration of socio-economic impacts that may affect each of the fisheries;
- to advise DEFA on the introduction of management measures to ensure the protection of scallop fisheries, including spatial and temporal management and technical measures as appropriate;
- to make recommendations to DEFA on further scientific research required in order to better understand and manage scallop fisheries;
- to act as an independent fisheries advisory board to respond on such matters that may impact or have influence on Isle of Man scallop fisheries.

The SMB typically meets at least biannually in between the queen scallop and king scallop fishing seasons (see below). In addition, the SMB may meet quarterly to conduct in-season reviews, depending upon issues for consideration, industry member availability during the fishing seasons and Departmental priorities. In addition, a subgroup of the SMB typically meets more regularly throughout a season, which consists of DEFA officers, IFSC scientists, SMB Chair and the Industry Spokesperson. The SMB Subgroup, which reports back to SMB, monitors fisheries-dependent data and is tasked to highlight emerging concerns in the fishery that may trigger management interventions.

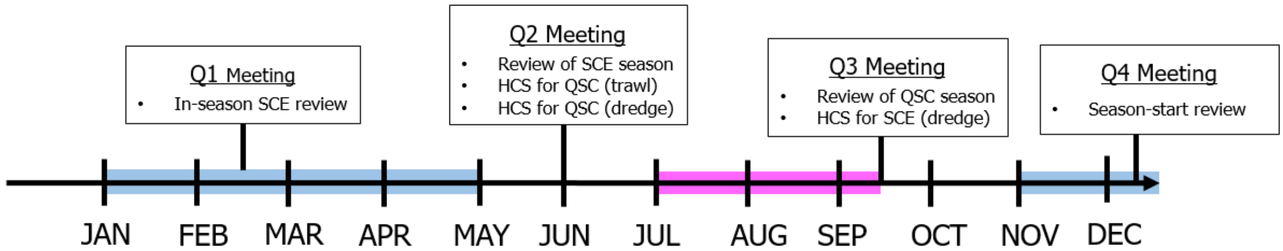


Figure 3. A typical Isle of Man Scallop Management Board calendar. Blue = king scallop fishing season (defined by regulation) and Pink = the typical Queen scallop fishing season (not defined by regulation).

With respect to the king scallop fishery, the SMB is expected to develop an annual HCS for the upcoming fishery in the Q3 meeting (ordinarily in September). The details of the HCS are shared with DEFA by way of a formal recommendation via the SMB Chair. DEFA Officers then present the HCS recommendation to the Minister during October, in advance of the start of the season on 01st November. Additional technical or other measures may also form part of formal recommendations and Ministerial decision making processes.

4.0 Harvest Control Strategy (HCS) and Harvest Control Rules (HCRs)

A Harvest Control Strategy (HCS) is the strategy by which the fishery will be harvested. The Harvest Control Rules (HCRs) are specified in order to implement and achieve the strategy. In essence, the HCS is a framework that combines the HCRs into a specific set of conditions, limitations, restrictions, obligations and opportunities that should control fishing activity such that the desired outcomes (economic, environmental, or social) are achieved.

It is important to recognise that a HCS may have a range of objectives, which may be relatively prioritised, depending on different considerations (economic, environmental, socio-political, etc.) relevant at the time. As such, the overall strategy must be both comprehensive and flexible, whilst also meeting its overall purpose. For example, a HCS may have an objective to increase carbon efficiencies during resource harvesting, but may also aim to maintain (or increase) local employment. Whilst both of these HCS objectives are entirely valid from a policy-context (environmental and socio-political respectively), they may come into conflict with one another.

There is a potential tradeoff between each pair or set of HCS objectives - carbon efficiency and local employment is just one example. It is the task of fisheries managers to set out a HCS in such a way to achieve a balanced and *optimised outcome*. The optimised outcome is unlikely to suit all stakeholders, which is why consultation and co-management is important. By developing a HCS through co-management, with clearly prioritised LTOs and STOs, fisheries managers hope to deliver, as close as possible, an optimised outcome.

> It should be clearly noted that objective prioritisation is a dynamic process, and the circumstances and context of each decision may impact how objectives are prioritised and/or delivered.

4.1 Harvest Strategy

4.1.1 Description

Under the *vires* of the Fisheries Act 2012, the Department has the powers to regulate commercial fishing activity for any fish or shellfish species within the island's territorial sea using a combination of both secondary legislation and limited (conditional) licensing (the Isle of Man sea fishing licence '**IOMSFL**').

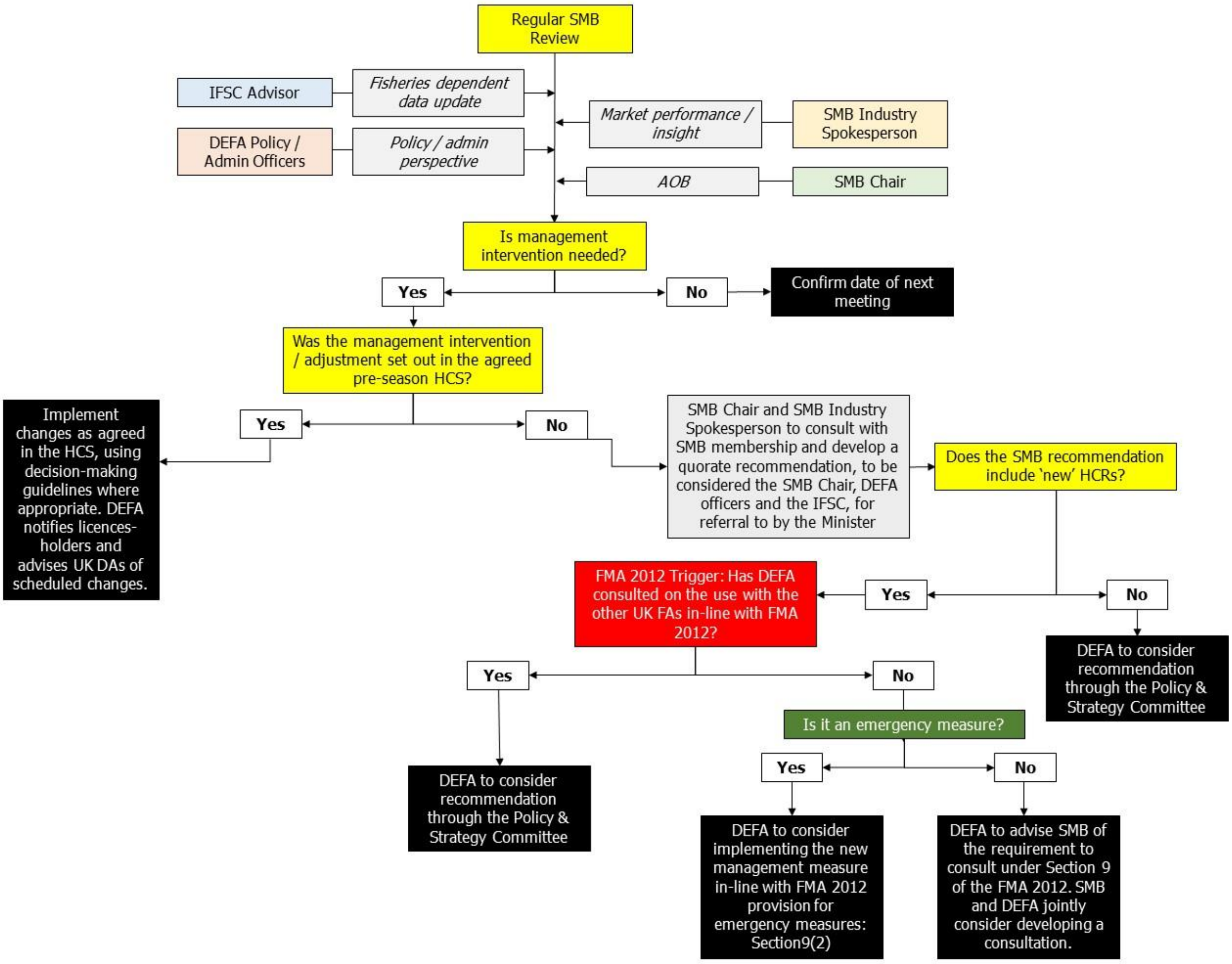
Using the above powers, and through a process of adaptive and reactive co-management through the Isle of Man Scallop Management Board, the Department shall implement a HCS for the Isle of Man king scallop fishery in pursuit of the LTMP LTOs (Section 2.2.1). The HCS specification shall be determined with input and advice from the IFSC and the SMB during the Q3 SMB meeting.

4.1.2 Monitoring, Review and Evaluation of the Harvest Strategy

The king scallop fishery is monitored, reviewed, and evaluated fortnightly by DEFA Fisheries Officers, IFSC scientists, SMB Chair and the SMB Industry Spokesperson via the SMB-subgroup. Typically, the IFSC produces a weekly report that presents fisheries-dependent data summaries and trends (see 6.2), which tracks fishery performance (e.g. landings, effort, LPUE, Fishing Intensity, etc.) against TRPs (e.g. LPUE thresholds) and LRPs (e.g. Landings vs TAC). The SMB Industry Spokesperson typically provides the Department with market performance and insight reports, for example; updates on price and yield data provided by processors.

Based on discussions arising from the SMB subgroup meetings, the SMB Chair and SMB Industry Spokesperson may liaise with the wider SMB membership to discuss any desired or necessary management interventions, and the SMB may make appropriate recommendations. The decision-making framework for certain management interventions may be pre-arranged in the HCS prior to the season start (for example determining the timing of the Christmas fishery closure) and may therefore be implemented without further recommendations from the SMB membership.

In some circumstances, unforeseen decision-making requirements to amend existing management measures may require consultation with SMB members, who may be asked to make a formal quorate recommendations to the Department for consideration via the SMB Chair. Should the recommendation incorporate the use of a 'new management measure', the Department may be required to consult more widely under the obligations of the FMA 2012. A flow chart of the general sub-group HCS evaluation process is presented below; noting that some circumstances and decision-processes may not be comprehensively captured by the graphic.



The annual HCS is also reflectively reviewed during the Q2 'full' SMB meeting, following the end of the fishing season. The HCS for the subsequent season is discussed during the Q3 meeting, which has an initial standing agenda item to review the minutes of the Q2 meeting.

4.2 Harvest Control Rules (HCRs) and technical-conservation measures

4.2.1 Harvest Control Rules and technical-conservation measures

For the purpose of this document, HCRs are considered to include fisheries management measures that are subject to frequent (annual, or in-season) change in response to the stock or fishery dynamics. Technical-conservation measures are considered to include aspects of regulatory requirements and restrictions that are not subject to frequent change. In reality, the distinction between a HCR and a technical-conservation measure is sometimes less distinctive; however, it is useful to consider the 'permanent' and 'flexible' regulatory requirements and restrictions that underpin a HCS.

4.2.2 Description of the Harvest Control Rules/ technical-conservation measure

The HCRs and technical-conservations measures, which together deliver the HCS, may be subject to change when they are specified in the context of TRPs and LRPs, which are monitored against fishing activity using a set of pre-determined reference points and thresholds. The HCS may be set out in such a way that when fisheries-dependent data are observed to meet or exceed these pre-determined thresholds, the initial specification of HCRs may be adjusted, revoked, or replaced by new HCRs.

HCRs and technical-conservation measures are generally catagorised as 'input' (methods of limiting fishing effort) or 'output' (methods of limiting fishing mortality) controls. In the Isle of Man king scallop fishery, the fishery has operated using a hybrid model that combines both input and output controls in order to establish the HCS.

Table 3. HCRs applied to the Isle of Man inshore king scallop fishery

Input HCRs	Output HCRs
Days at Sea (DAS) for >15 m vessels – *WWER*	Total Allowable Catch (TAC)
Days at Sea (DAS) within 'Restricted Areas' (RAs)	Daily Catch Limit (DCL)

Closed Areas (CAs) – 'temporary' no access	

Table 4. Technical-conservation (TC) measures applied to the Isle of Man inshore king scallop fishery	
Input TC Measures	**Output TC Measures**
Curfew (no fishing 1800-0600)	Technical Specifications (Minimum Landing Size)
Technical Specifications (Gear)	
Capped Access / Authorisations	
221 kW Capacity-cap + Grandfather Rights (GFRs)	
Closed Areas (long-term / permanent)	

4.2.3 Review of the Harvest Control Rules / Technical-conservation measures

This section describes the HCRs current in effect in the Isle of Man inshore king scallop fishery. Where there is a clear requirement to amend or adjust the application of existing HCRs, this document links those requirements to the Short-Term objectives outlined in 2.2.2.

WWER DAS

The Western Waters Effort Regime ('**WWER**') sets out the maximum levels of annual fishing based on kW days-at-sea ('**DAS**') for vessels fishing for scallops (and, also separately, *C. pagurus*). The WWER was designed to cap fleet activity by EU Member States in certain seas and certain métiers, based on a track-record of fishing effort during the late-90s. It was not designed to control effort in relation to stock status in any of the fisheries so regulated.

The 2018 Poseidon report for the UK SICG concluded that WWER is not fit for purpose as a stock management tool in the scallop, or any other fishery, as it does not respond to the status of stocks. Significant sectors of the EU Member State fleets (including the UK) are not included, such as the 10-15 m scallop sector. Nonetheless, the Department is obliged to maintain alignment with the WWER through the requirements of FMA 2012.

Since 2003, in ICES Area VII the United Kingdom has been allocated a total of 3,315,619 kW days, and in ICES Area 6, the UK has been allocated 1,974,425 kW days. Effort allocation is fixed and does not change year to year. Only vessels greater than 15m in length are curtailed by the WWER (apart from in the Irish Biologically Sensitive Area). Days are allocated to individual vessels on a quarterly basis.

Table 1. The WWER DAS allocation 2016-2020. The Isle of Man king scallop seasons are shown in colour (orange = 16/17, yellow = 17/18, green = 18/19, blue = 19/20, purple = 20/21).

	2017	**2018**	**2019**	**2020**
Q1	50	80	50	50
Q2	60	70	40	35
Q3	75	30	50	55
Q4	80	80	80	80

The number of WWER DAS during the three fishing season 2017/18 – 2019/20 varied between 165 and 230 DAS. The duration of the Isle of Man scallop season is typically 200 DAS after taking account of the Christmas closure. Further, when the number of days during which severe weather forces even over-15 m vessels to tie-up, and no fishing occurs, the number of Beaufort-*viable* days in the Isle of Man king scallop fishery is typically between 170 and 190 days. Therefore, in the context of the Isle of Man inshore (territorial sea) king scallop fishery, the WWER DAS allocations is considered to have had no limiting effect on fishing effort during recent seasons. This is also the conclusion of the Poseidon 2018 report for SICG, which summarised that the WWER was designed to control fleet access, and it is not an effective effort management tool in its current form.

STO 2 commits to developing a capacity and effort management framework that is linked to stock, whilst also taking into consideration bio-economics.

DAS within Restricted Access Areas ('RAs')

Ahead of the 2020/21 fishing season, Bangor University advised that the stock survey had identified a number of high-density scallop beds that had recently recruited into the fishery. These beds were spatially discrete, and it was advised that they may require fine-scale spatial management in order to avoid high fishing intensity (race-to-fish scenario). The SMB discussed the various options in detail, drawing upon lessons-learned from the queen scallop fishery, and advised that the Department should implement a restricted effort regime within those areas, limiting vessels to only a specific number of days per week. This is unlike the general scallop fishery, which allows for fishing 7 days-a-week.

The RA framework was implemented by the Department for the start of the 2020/21 fishing season through licence condition, with details of the restrictions set out in the Schedule (Section H) of the IOMSFL.

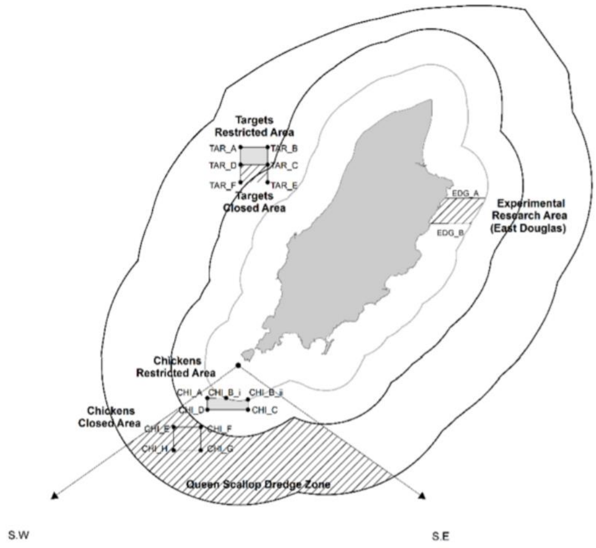


Figure 4. The spatial designations in the 2020/21 Isle of Man inshore king scallop fishery HCS.

The RA approach has been effective in controlling fishing effort in high-density scallop beds, thereby reducing the race-to-fish, and helping to ensure that economically-viable catch rates persist for a longer period of the fishing season. It is, ultimately, a solution to the issues that were made evident in the initial weeks of the 2015 and 2016 fishing seasons.

However, there are concerns in the fishing industry, particularly within the catching sector, that the RA approach may impact competitiveness in the absence of a dynamic and robust decision-making framework. At present there are no guidelines or decision-making rules regarding RAs, notably;

- What density of scallops, observed in the stock surveys, should trigger the consideration of RAs;
- How spatially extensive RAs ought to be designated compared to survey observations;
- How many DAS may be accessible during a week within each RA, and what should determine this;
- Whether the ‘restrictions’ in RAs should be limited to just DAS (per week), or whether other HCRs may be adjusted for these areas (for example, an adjusted curfew period if undertaking fishing activity within an RA).

STO 6 commits to developing spatial management decision-making guidelines, which takes account of survey data.

Closed areas – temporary no-access designations

The Department has, with advice from the SMB, incorporated the designation of temporary scallop closed areas (‘CAs’) in order to protect juvenile scallop populations from fishing mortality, with the aim of therefore encouraging a greater recruitment success-rate and greater subsequent abundance of exploitable biomass.

It is acknowledged that CA designation can frequently represent opportunity costs to the catching sector in the form of prohibited catching opportunities, and may result in displacement as those catching opportunities must be achieved elsewhere. A high degree of accuracy and precision is therefore vitally important in determining the extent of CAs, and consequently a spatially high-resolution stock survey is a pre-requisite to effective spatial management.

There are concerns within the fishing industry, particularly within the catching sector, that whilst the designation of temporary scallop CAs based on best-available data is appropriate and effective for the protection of juvenile scallops, CAs must not be considered in isolation to other components of the king scallop HCS (particularly spatial components), and there must also be a strategy for assessing whether, when, and how temporary CAs may be later re-opened at the time of designation. The SMB and the Department would usefully benefit from guidelines or decision-making rules regarding temporary CAs, notably;

- What density of juvenile scallops, observed in the stock surveys, should trigger the consideration of CAs;
- How spatially extensive CAs ought to be designated compared to survey observations;
- Consideration of unforeseen or indirect effects such as displacement;
- How to re-open CAs following the recruitment of scallops that were being protected (i.e. what HCRs may be necessary);
- How to consider and potentially alleviate the opportunity cost inherent in temporary CAs;
- How to consider existing CAs during decision-making for new / additional CAs.

STO 6 commits to developing spatial management decision-making guidelines, which takes account of survey data.

Curfew

Currently, the fishing may not take place between the hours of 1800 and 0600. This input control is a form of effort management, and a measure that increases the Department's capability to monitor compliance with, and enforce the HCRs in the fishery.

To date, there has not been much discussion around future adjustments of the curfew; however, a separate curfew in relation to RAs has been discussed on a number of occasions by the SMB, particularly at the start of a fishing season when densities are high and the DCL can be achieved in a fraction of a day.

Technical Specification (Gear)

The Isle of Man king scallop fishery is prosecuted by vessels using spring-loaded toothed dredges. One of the most fundamental aspects of effort (input) control in scallop fisheries is effective and appropriate technical regulations of the type (design) and capacity (footprint) of fishing gear.

Since 2010, the technical regulations have been drafted as below:

> No person shall fish for, take or kill scallops, by means of a scallop dredge, or system of scallop dredges, if the width of the scallop dredges, or in the case of a system of scallop dredges, the aggregate of the widths of the dredges exceeds:
>
> (a) in the three mile area, 762 centimeters; or
> (b) in the territorial sea other than in the three mile area, 1067 centimeters.
>
> No person shall fish for, take or kill scallops, in the territorial sea by means of:
>
> (a) a scallop dredge with more than 9 teeth per dredge or tooth bar;
> (b) a scallop dredge with a tooth spacing between the internal edges of less than 75 mm internal diameter;
> (c) a scallop dredge with a mesh size of less than 100 mm in the netting cover;
> (d) a French dredge;
> (e) a scallop dredge with belly rings having a clear opening of less than 75 mm internal diameter;
> (f) a tow bar that exceeds 185 mm in diameter

Although not explicitly specified in terms of number of dredges, the restrictions aim to limit the number of dredges that may be operated by a vessel to 5 dredges-a-side in the 0-3 NM zone, and 7 dredges-a-side in the 3-12 NM zone.

From an enforcement perspective, the absence of a specified tow-bar length, and a specified number of dredges presents a serious issue; a vessel can only be proven to be committing an offence if Fisheries Officers can demonstrate the aggregate dredge width in operation is in excess of a measured distance (i.e. requires precise measurements, onboard the vessel, of each dredge). Therefore, even if Fisheries Officers *observe* from a distance that a vessel is operating excessive numbers of dredges (e.g. 8+ dredges-a-side), it is unlikely to be prosecuted unless the aggregate width of those dredges are accurately measured.

In the absence of a specified tow-bar length, some larger vessels operate gear from tow-bars that can potentially carry up to 12 dredges-a-side (24 in total), i.e. fishing gear capable of deploying over 40% more 'effort' than is permitted in the fishery.

The use of up to 7 dredges-a-side is currently permitted (as standard) in English territorial waters, and 8 dredges-a-side in Scottish territorial waters, notwithstanding some unique approaches in the 0-6 NM zone around the Shetland Isles and in some English Inshore Fisheries Conservation Authorities ('**IFCAs**'). The other Crown Dependencies ('**CDs**') also restrict the use of dredges within the territorial waters of the Bailiwicks of Jersey and Guernsey to 6 dredges-a-side.

With the recognition that the Isle of Man king scallop fishery is an **inshore** fishery (0-12 NM), the 2021 consultation highlighted that most stakeholders consider the use of up to 14 dredges in the Isle of Man inshore king scallop fishery to be excessive.

Therefore, the Department shall implement new and amended technical measures relating for dredges-a-side, which better reflect the inshore nature of the Isle of Man king scallop fishery and aligns with the Conservation of Scallop Regulations (Northern Ireland) 2008. The measures shall reduce the maximum number of dredges in the 3-12 NM from 14 to 12 ('7 dredges-a-side' to '6 dredges-a-side'). The maximum number of dredges permitted in the 0-3 NM will remain at 10 in total. The new measures will close the enforcement 'gaps' in relation to tow bar length and specific dredge numbers, and will also reduce the maximum number of 'teeth' from 9 to 8 to improve size-selectivity of scallops at the 110 MLS. The restrictions shall be:

A person on a fishing boat in the territorial waters of the Isle of Man must not fish for, take, or kill king scallops, using scallop dredges by means of:

(a) a tow bar that exceeds 5.5 metres in length
(b) a tow bar 5.5 metres or less in length which is constructed in such a way as to enable more than 6 scallop dredges to be attached to it at the same time
(c) a scallop dredge with more than 8 teeth per dredge
(d) a tow bar that exceeds 185 mm in diameter
(e) a scallop dredge with a tooth spacing between the internal edges of less than 85 mm on the dredge or tooth bar
(f) a scallop dredge with belly rings having a clear opening of less than 75 mm internal diameter
(g) a scallop dredge with a mesh size of less than 100 mm in the netting cover and
(h) a French dredge.

A person on a fishing boat in the three mile area of the Isle of Man (0-3 NM zone) must not fish for, take, or kill king scallops, using scallop dredges by means of:

(a) a system of scallop dredges with an aggregate width of more than 762 cms;
(b) more than 10 dredges in total.

A person on a fishing boat in the extended territorial sea of the Isle of Man (3-12 NM zone) must not fish for, take, or kill king scallops, using scallop dredges by means of:

(a) a system of scallop dredges with an aggregate width of more than 915 cms
(b) more than 6 scallop dredges from any side of the vessel and
(c) more than 12 scallop dredges in total

No person shall carry onboard any fishing boat within the territorial sea (0-12 NM zone) scallop fishing gear designed for king scallop fishing other than in accordance with the above conditions, or any tow bar extensions, except where:

(a) the vessel is transiting the territorial sea at a speed of no less than 4.0 knots (speed over ground) and
(b) the gear is lashed and stowed so that it is not readily available for use whilst the vessel is in the territorial sea

STO 1 commits to implementing the above restrictions and conditions relating to technical (gear) measures.

Capped/Restricted Access

Currently, the number of scallop authorisations (3-12 NM) is capped based on the 2016 track-record requirement for licensed vessels to have demonstrated a minimum number of DAS (equal to 6% participation) during the four Isle of Man king scallop fishing seasons 2011/12 to 2014/15 inclusive, whereby;

- Licensed vessels under-15 m (LOA) were required to demonstrate 50 DAS fishing for scallops in ICES Statistical Rectangles 36E5, 37E5, 38E5.
- Licensed vessels over-15 m (LOA) were required to demonstrate 26 DAS fishing for scallops in ICES Statistical Rectangles 36E5, 37E5, 38E5.

The above policy reduced the number of eligible licences in the 3-12 NM to 94. During the subsequent 5-year period (to 2021), the number of authorisations declined to 83 due to *natural wastage*. However, the Department and the SMB recognise that whilst the authorisation-system is a fundamental management tool for controlling effort in the Isle of Man king scallop fishery, and the number of authorisations in circulation has declined over time, the existing number authorisations is nonetheless misaligned with the available (or reasonably expected) fishing opportunities, given that licences are identical in terms of the allocation of fishing opportunities.

2021/22 King Scallop Fishery | Capacity vs Opportunity (simple model):

Input Allocation: 83 *potentially* ‘full-time’ authorisations, achieving ~100 DAS per season
→ effectively 8,300 DAS (input) allocated to fishery

Output Allocation: 700 kg DCL

Allocated Catching Capacity:
→ (8,300 x 700 =) 5,810,000 kg catching capacity, or
→ 5,800 tonne catching capacity

Catching Opportunities: 2,049 t TAC
→ catching capacity = 183% greater than catching opportunities.

The Department and the SMB accept the problem that the current access framework presents, and that intervention is required to reduce the overcapacity of the fleet in line with LTO 2.2.

There are three regulatory solutions to the overcapacity problem, so that bioeconomic allocations (of input and output) are equal (or approximate) to the catching opportunities:
1. Maintain the access framework and reduce the number of ‘full-time’ authorisations on licences;
2. Maintain the number of authorisations and adjust the access framework (variable permits); or
3. A hybrid of the above two options.

The Department and the SMB acknowledge that addressing fleet capacity is of fundamental importance in the LTMP; however, also that the steps taken to address overcapacity should be carefully undertaken, ideally phased over a period of time that allows for reflection of previous interventions, and consideration of the requirement for further interventions following each of strategic step.

In addition to the aforementioned cap on access to the 3-12 NM in 2016, access to the 0-3 NM area was based on a track-record methodology that incorporated VMS data and electronic log-book data over the period 2010–2016, applying combined criteria of;

- number of years fishing in 0-3 NM,
- number of days fishing in 0-3 NM,
- economic-link to the Island, i.e. fishery landings attributed to 0-3 NM and landed to Manx ports versus non-Manx ports.

The vision for the 0-3 M zone of the Isle of Man territorial sea encompasses sustainable use within a high-quality marine environment, aligned with the principles and objectives of Biosphere Isle of Man, and contributing to the island’s net-zero carbon objective. This vision includes concepts outlined in the Fisheries Strategy, Biodiversity Strategy and related Isle of Man Government policy objectives. The 0-3 NM zone is to be a test-bed for greater co-management through a 0-3 NM zonal management plans for iFMZs.

STO 2 commits to developing a capacity and effort management framework that is linked to stock, whilst also taking into consideration bioeconomics.

STO 14: Implement the pilot policy for 0-3 NM zonal management of i-FMZs (‘the Association’)

221 kW capacity-cap and Grandfather Rights (GFRs)

The term inshore is often ambiguous. The Department's interpretation of inshore fisheries going forward will be where fishing activity takes place exclusively within 12 nautical miles of the shore, and therefore **the Isle of Man king scallop fishery is considered an inshore fishery**. Clarification of this definition is important when identifying structures for stakeholder engagement and LTMP development. Broadly speaking, the Department shall aim to align LTMP objectives, and fishery HCSs, to promote a more sustainable, profitable, and well-managed inshore fisheries sector by securing long-term sustainable rewards for the inshore sector. The 221-kW rule is applied elsewhere in the UK in respect of determining inshore access, and for differentiating between 'inshore/coastal' and 'large-scale/offshore' fleets (Davies, et al., 2018; Rijnsdorp, et al., 2021).

The Department set out to secure the Isle of Man king scallop fishery for the inshore sector during the 2010 consultation, which proposed a prohibition on vessels with an engine power in excess of 221 kW; however, some UK stakeholders voiced strong opposition to the proposal, which was supported by opposition from the Scottish Government's fisheries authority (Marine Scotland). Therefore, in 2010, the Department implemented the 221 kW rule alongside 'Grandfather Rights' ('**GFRs**'), i.e. exemptions, for those vessels able to demonstrate a track-record (50 days) in the fishery during the 2008/09 and 2009/10 seasons. GFRs extinguish when the vessel is replaced or changes ownership. Whilst the number of GFRs has declined over time, GFRs were not envisaged to be a permanent component of the access framework for the Isle of Man inshore king scallop fishery.

Stakeholders with vessels operating under GFRs typically adopt opposing positions to the HCS and fishery objectives of the Department and the wider (inshore) industry, fundamentally because the Department has, over time, sought to promote the above vision for an economically sustainable and profitable inshore fisheries sector in-line with a biologically sustainable and stable inshore scallop resource.

These aims and objectives are often misaligned with the requirements and preferred harvest strategy of the offshore scallop sector, which tend to be nomadic and rely upon high-volume landings in a short period of time, and thus a rapid depletion of biomass. Nomadic vessels subsequently abandon depleted grounds in favour of opportunities elsewhere, and travel throughout the UK EEZ in order to prosecute those opportunities, i.e. sequential localised rapid stock-depletion. Clearly, this harvest strategy is misaligned with the aims and objectives of the Isle of Man inshore king scallop fishery LTMP.

Whilst unanimous stakeholder consensus is not required in order to implement a successful LTMP and associated HCSs for the fishery, there is a clear and fundamental disagreement between the vision of an optimum harvest strategy for inshore and offshore fleets. As such, the Department will remove all remaining GFR exemptions with effect no later than 31st October 2024. This final phase-out period will allow eligible licence-holders to;

1. re-engine the vessel to conform with the 221 kW requirement, if practicable;
2. Replace the vessel with an appropriate inshore vessel (i.e. under 221 kW) in line with the Specific Fishery Authorisation policy; or,
3. Retire from the fishery.

STO 3 commits to a final phase-out of GFRs by 2024/25

Total Allowable Catch (TAC)

The TAC for the Isle of Man king scallop fishery has been applied since 2017, and is essentially a Limit Reference Point for total landings. The TAC is currently set (and adjusted) based on an abundance index calculated by the long-term Bangor University time series data, in-line with the ICES Category 3 'data-limited' approach. To date, the fishery has yet to close as a result of TAC-exhaustion, instead closing on the 31st May with TAC remaining.

The TAC is nonetheless recognised as a fundamental management measure in order to achieve LTO 1.0 and 2.1. There is consensus within the SMB membership and the Department (including IFSC) that there is a need to move away from the ICES Category 3 approach, and towards a biomass-linked assessment of total allowable catch in the scallop fishery.

Currently, the TAC is monitored using estimates of landings submitted by vessels on the day of capture (the 'NESTFORMS' reporting system). The vessel is not required to estimate scallop 'discards' that occurred during the same trip. The TAC may therefore be more accurately described as 'total allowable landings', as the term *catch* is usually interpreted to include discards (with an associated discard mortality estimate included in stock modelling).

The Departments IFSC, in collaboration with other scientific experts at the ICES Working Group on Scallops, is investigating statistical and quantitative techniques that may be used to determine an estimate of spawning-stock biomass, which may then be used for developing biomass-linked TAC advice. A summary of TAC and landings to date is presented below:

Table 5. The Total Allowable Catch (TAC), Landings, and % of TAC realised 2016/17 – 2020/21

Season	TAC	Landings	%	Notes
2016/17	NO TAC	4,150 t	-	-
2017/18	3,203 t	3,009 t	94 %	-
2018/19	2,562 t	1,832 t	72 %	-
2019/20	2,049 t	1,186 t	58 %	Covid19 affected during 2020 Q2
2020/21	2,049 t	1,727 t	85 %	Covid19 & Brexit affected. No survey data.
2021/22	2,049 t	-	-	-

STO 7 commits to working towards a quantitative stock assessment that produces biomass-linked advice, which may set biomass-linked TAC.

Daily Catch Limit (DCL)

The DCL was introduced on the 15th November 2016 following two weeks of intense fishing effort and unprecedented landings in a geographically concentrated area of the territorial sea. The Department had previously consulted on the application of DCLs during the 2010 consultation, and sought feedback on the use of output-limits in the 2016 consultation. Nonetheless, the use of the DCL was initially introduced as an urgent response to an intense period of unprecedented fishing effort, whereby over 100,000 kW days of effort were exerted in a small area (2 NM x 2 NM area).

The introduction of the measure attracted criticism from some stakeholders, particularly from the Scottish Government and Scottish licence-holders, who cited a perception of disproportionate impact and loss of potential earnings to larger vessels. Criticism also came from other licence-holders, typically smaller vessels and their representatives, who had raised concerns from the outset of the season and felt the measure was introduced too late to mitigate most of the negative impacts and long-term risks to the stock and ecosystem integrity of the benthos.

The DCL was subsequently removed on the 10th January as, by that time, it had become ineffective as an output control because i) scallop densities had been depleted, and ii) vessels with greater catching capacity had abandoned the fishery in favour of unregulated fishing elsewhere in the UK.

Table 6. The Daily Catch Limit (DCL) set for the Isle of Man king scallop fishery 2016/17 – 2020/21

Season	DCL	Notes
2016/17	1,400 kg	15 Nov 2016 – 10 Jan 2017 only
2017/18	1,050 kg	01 Nov 2017 – 27 Nov 2017 initially, reducing to 700 kg thereafter
2018/19	700 kg	-
2019/20	560 kg	Increased to 630 kg for the period 05 Dec 2019 - 22 Dec 2019 only.
2020/21	700 kg	-
2021/22	700 kg	-

A DCL has remained in place for the Isle of Man king scallop fishery since the 2017/18 fishing season, and is adjusted both between and within seasons based on recommendations from the SMB having considered the best available scientific and socio-economic data. It is an essential component of the current management framework. The overall aim of the DCL is to indirectly manage fishing effort (by controlling landings) using a risk-based, precautionary approach based on the best available data. The overarching principles of the DCL are to:

- avoid complete economic depletion of fishing grounds;
- to ensure the TAC is not exceeded, and that fishing opportunities are available until the end of the season;
- maintain ecosystem integrity by controlling effort, and to
- ensure that the DCL acknowledges socio-economic requirements of the fleet, and market demand.

However, the SMBs efforts (to date) to control and manage over-capacity and fishing effort in the Manx fishery through the DCL has rendered the majority of vessels uneconomic in the longer term.

The SMB has also highlighted that any potential dividends (i.e. an increased DCL) following stock recovery and/or enhanced management of the fishery would be quickly exhausted due to the scale of fleet capacity currently existing, and particularly among those vessels that have not been active in the fishery during recent seasons with a limited DCL aimed at promoting stock recovery. From a multi-decadal perspective, this phenomenon has occurred several times in the Isle of Man territorial sea, where recruitment pulses and subsequent ‘super-abundances’ are rapidly depleted during the first weeks of the fishery due to the absolute capacity of the licenced fleet (e.g. 2008/2009 fishery, TAR November 2016) and the inadequate effort controls currently in place.

Reducing DCLs, and/or maintaining them at low (and unprofitable) low levels in order to manage fishing capacity and effort is not economically strategic. The SMB considers the DCL, as a HCR, to be reduced to the greatest extent possible without undermining the economics of much of the scallop catching sector.

The SMB and the Department nonetheless recognise that the DCL is an important and appropriate HCR if it is applied using a bioeconomic approach that allows for target daily fishing income to be achieved, and controlled supplies of product to processors. This LTMP aims to utilise the DCL HCR, or a variation thereof, using a bioeconomic approach, subject to and conditional upon capacity and access being adequately controlled such that overexploitation cannot occur (‘race-to-fish’ and/or ‘boom-to-bust’ exploitation), i.e. LTO 2.2.

STO 13 commits to adopting a decision-making framework for a bioeconomic approach to setting DCLs

4.3 Decision-making Frameworks

The Isle of Man king scallop fishery management system requires effective decision making processes that result in measures and strategies to achieve the LTMP objectives. This document contains a clear description of the decision-making and consultation processes (section 3.2 and 3.3), and how the SMB quorate recommendation process provides advice to the Department in relation to HCS-setting and adjustment of HCRs both in-season and between seasons.

It is acknowledged that a review of the SMB is timely, both in terms of its membership and processes. This LTMP commits to a review of the SMB subsequent to the adoption of this LTMP.

The Department recognises that decision-making rules and/or guidelines will be useful for considering the application of HCRs that respond to scallop stock and/or economic factors, for example guidelines on how to adjust the DCL or implement spatial management. These decision-making rules / guidelines should be developed, considered, and ultimately adopted by the SMB. Note that decision-making guidelines/rules may include provision for the SMB to not apply the recommended HCRs in certain contexts. Fundamentally, decision-making guidelines should be used to be used to inform rather than dictate management, and allow for a flexible and considered approach by the SMB and the Department. For example, in the wake of the CV-19 pandemic and the associated impacts on market demand and prices, the SMB may necessarily consider the guidelines relating to economics and DCL differently compared to a ‘normal’ economic climate.

STO 6, 9, 10-13 commits to developing, considering, and adopting decision-making guidelines/rule for existing and/or potential HCRs in the context of agreed Trigger Reference Points and Limit Reference Points.

5.0 Ecosystem Management Strategies

The Isle of Man inshore king scallop fishery LTMP recognises that fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent ecologically related species) on which the fishery depends.

5.1 Bycatch and Discards

5.1.1 Non-commercial species bycatch

Jenkins et al. (2001) researched the impact of scallop dredging on benthic megafauna including crabs, starfish, urchins, whelks and bivalves in Manx waters. Capture efficiency for the megafauna was found to be low, ranging from 2 to 25% among species, thus the majority of megafauna which encounter scallop dredges remain on the seafloor. The report investigated fishing-induced damage to species taken as bycatch and left on the seafloor. In total 53% of the sea urchins encountering scallop dredging were found to be left in good condition and 46% with spine loss, minor cracks or crushed/dead. Based on the area targeted by scallop dredgers together with the fact that urchins prefer rocky boulder substrata (where dredges cannot access); have a high fecundity, early maturation and; a 53% survival rate when encountering scallop dredges, it is considered highly likely that sea urchins are within biologically based limits. However, given that there may be local-level impacts on non-target species, an LTMP should remain open to incorporating strategies to reduce non-target bycatch, should there be a population-level impact resulting from fishing.

A long term survey data time-series (1992 – 2021) which includes bycatch data has been collected since 1992 at 12 historical scallop survey stations around the Isle of Man. At each station in each year the bycatch is retained and sorted from all survey dredges (2 x king scallop dredges and 2 x queen scallop dredges). Bycatch is sorted to species level, counted and weighed. Various studies have used the bycatch data (at various time scales) to assess the bycatch assemblages from king scallop dredges at the main king scallop fishing grounds in the Isle of Man (e.g. Veale et al., 2001, Craven et al., 2012).

Veale et al., 2001 undertook an analysis of the bycatch species retained during twice-yearly research vessel dredge surveys of king scallops in the Isle of Man to explore the distribution and abundance of major species retained from 1992 – 1996 and assessed the damage sustained by these species during the surveys in 1994 and 1995. Spatially the distribution of the major by-catch species broadly fit into one of two assemblages: e.g. goose foot starfish (*Anseropoda placenta*), red cushion star (*Porania pulvillus*) are abundant off the south-west coast of the island, whilst hermit crabs (*Pagurus* spp.) and purple heart urchin (*Spatangus purpureus*) are more abundant around the rest of the coast (Veale et al., 2001).

Major non-commercial bycatch species recorded from king scallop dredges in king scallop grounds in the Isle of Man during the 1994-1995 fishing season included:

- Goose foot starfish (*Anseropoda placenta*)
- Common starfish (*Asterias rubens*)
- Sand sea star (*Astropecten irregularis*)
- Sea snail (*Colus gracilis*)
- Common sunstar (*Crossaster papposus*)
- Edible sea urchin (*Echinus esculentus*)
- Curled octopus (*Eledone cirrhosa*)
- Red whelk (*Neptunea antiqua*)
- Hermit crabs (*Pagarus spp*)
- Red cushion star (*Porania pulvillus*)
- Purple heart urchin (*Spatangus purpureus*)

As expected Veale et al., 2001 found a hierarchy of sensitivity to dredge capture amongst the different bycatch species recorded. For example, *S. purpureus* and *A. placenta* were both particularly susceptible to damage due to the fragile and thin nature of their test and body with virtually all individuals caught expected to die within 72 hrs. In contrast, *Asterias rubens* and *P. pulvillus* both appeared to suffer very limited damage with less than 10% dying on discard (Veale et al., 2001).

In the context of an ecosystem-based approach to fisheries management it appears important to consider whether there are secondary effects on non-target species, at least on a local level, and that may have implications for the ecosystem that ultimately supports the scallop fishery.

As such, consideration should be given, and opportunities for further research taken, in relation to non-target, non-commercial species; including precautionary gear development to reduce benthic impacts

5.1.2 Commercial species bycatch (Non-Quota Species)

The main non-quota species ('**NQS**') that are caught as bycatch in the Isle of Man king scallop fishery is brown crab (*C. pagurus*), and Queen scallop (*Aequipecten opercularis*).

Crustaceans are known to be sensitive to direct physical contact with scallop dredges and bottom-fishing trawls (Eleftheriou and Robertson, 1992; Kaiser and Spencer, 1995; Bradshaw et al., 2000; Veale et al., 2000) such that the survival rate of crabs with even limited damage can be quite low (Stoner, 2012). Although crustaceans can repair limited amounts of damage to their carapace and can regenerate damaged or lost limbs, this requires investment of the crabs energy resources. This diversion of energy into tissue repair may reduce growth by increasing intermoult duration, reduce foraging ability, and protection from predators.

Several studies have investigated the damage level and mortality of crabs in scallop dredges (e.g. Hill et al., 1996; Jenkins et al., 2001; Veale et al., 2001; Öndes et al., 2016). These studies reported that damage to crabs included limb loss, carapace and abdominal cracks and crushed body-parts. There may be other (internal) forms of physical damage and physiological stress that cannot be ascertained from visual assessment in the field.

Brown crab is an important fishery in the Isle of Man, with between 460 t – 630 t landed annually, worth an approximate £0.7 m - £1.2 m at first sale. Brown crabs co-occur in the same habitat as scallops and consume scallops damaged as a result of dredge fisheries (Jenkins et al., 2004). Therefore, it is not surprising that brown crabs have been recorded as a by-catch species in scallop dredges (Bradshaw et al., 2000; Veale et al., 2000; Beukers-Stewart et al., 2001; Jenkins et al., 2001; Veale et al., 2001; Öndes et al., 2016).

Observations of brown crab elsewhere in the UK indicate that there is a directional reproductive migration of brown crab between offshore soft-sediment habitats and inshore hard-substrate areas. As a result, scallop fisheries could be an important source of mortality for crabs at a critical time in their reproductive cycle if there is overlap between fishing activity and the distribution of crabs at that time. Therefore, in the context of an ecosystem-based approach to fisheries management it is important to consider not only the effect of scallop dredging on the scallop population, but also to consider whether there are secondary effects on non-target species that may have implications for the fisheries they support.

Whereas previously the female brown crab migration fishery showed a peak in landings-per-unit-effort through September and October, the timing of the fishery in recent years has tended to be seen in mid-October and, in some instances, not until November. There is evidence to support the view that a shift in thermal-time may result in changed migratory patterns (Bakke et al., 2019). Such a biological shift is now reportedly putting the autumn crab 'pot' fishery in conflict with the king scallop fishery in certain areas, and concerns about gear-conflict have been noted in consultations held by the Department on the management of brown crab fisheries.

As noted above, long term bycatch survey data has been collected around the Isle of Man, and has provided the following data.

Queen scallops, common whelk and brown crab were identified as major by-catch species by king scallop dredges on king scallop grounds around the Isle of Man during the 1994-1995 fishing season (Veale et al., 2012). Brown crab were found to exhibit a seasonal variation in abundance in the bycatch with mean numbers, per 2 nautical miles towed, averaging 11.7 (± 1.3 SE) crabs in October and 3.5 ± 0.4 SE in June (Veale et al., 2001).

Work by Craven et al., 2012 analysed patterns and impacts of fish bycatch (quota and non-quota species) retained from twice-yearly research vessel dredge surveys of king scallops in the Isle of Man between 1992 and 2005. This study focused on eight study sites to the west, south and east of the Isle of Man and included catch from king and queen scallop dredges and all fish species. In general, all fish bycatch rates appeared low (~ 1.37 individuals per tow or 0.297 (+/- 0.063 SE) fish per 1000m^2 swept area, however, almost all tows (97.6%) of the survey gear generated fish bycatch with a total of ~ 50 species recorded. The most common non-commercial species included lemon sole (*Microstomus kitt*) and lesser spotted dogfish (*Scyliorhinus caniculus*) which made up a further 16.91 % of all fish bycatch. There was considerable spatial and temporal variation in fish bycatch around the island, a finding also confirmed for bycatch in the Isle of Man queen scallop trawl fishery (Boyle et al 2016). From a spatial context East Douglas (east coast) recorded the highest density of fish bycatch with an average of 0.655 (+/- 0.067 SE) fish per 1000 m^2 swept area, whilst Bradda Inshore (south-west coast) recorded lower than average densities with an average of 0.169 (+/- 0.021 SE) fish per 1000 m^2. Temporal variation was also evident with for example the density of lesser spotted dogfish bycatch increasing significantly over the 14 year of the study (Craven et al., 2012).

The major commercial non-quota bycatch species recorded by Craven et al., (2012) from scallop dredges in king scallop grounds in the Isle of Man during from 1992-2005 included:

- Common dragonet (*Callionymus lyra*)
- Lemon sole (*Microstomus kitt*)
- Lesser spotted dogfish (*S. caniculus*)
- Dab (*Limanda limanda*)
- Blenny (*Blenniidae*)
- Red gurnard (*Aspitrigla cuculus*)

5.1.3 Commercial species bycatch (Quota-species)

In addition, the MFPO collected bycatch data for a number of years (2015-2018) using a sentinel fleet that reported daily bycatch observation forms for the purpose of demonstrating the extent and nature of ‘quota-species’ bycatch in respect of the EU Landings Obligation. The bycatch data shows that for the king scallop dredge fishery, there are some ‘quota-species’ that may be caught in the scallop fishery and, as a result of the Landings Obligation (‘LO’), cannot be discarded. The estimated quantities of bycatch are shown below in table 7.

Table 7. Bycatch of ‘quota-species’ per tonne of retained scallops

Species	**Stock**	**Bycatch Rate (kg per 1,000 kg of retained scallops)**
Anglerfish (Monk)	ANF/07	2.79
Hake	HKE/571214	0.00
Haddock	HAD/07A	0.00
Plaice	PLE/07A	1.24
Sole	SOL/07A	0.09
Whiting	WHG/07A	0.00
Skates/Rays	SRX/67AKXD	2.93
Cod	COD/07A	0.00
Megrim	LEZ/07	0.00
Total	**TOTAL**	**7.05 kg per 1,000 kg of retained king scallop (0.7%)**

Scallops below the MLS of 110 mm shell-width must not be retained onboard by vessels, and are therefore discarded. Stakeholders and conservationists are broadly in favour of measures that reduce the incidental capture of sub-MLS scallops, for example decreasing the number of teeth on each dredge (i.e. increasing the 'spacing' between the teeth) and thereby selecting scallops with a greater shell-width on the seabed. Additional gear-technology trials may improve the selectivity-at-size of scallops, and should be encouraged and incorporated where possible within the LTMP.

A consequence of the DCL management measure is the discarding of *excess scallops* that have commercial value and of legal-size, but must be discarded as a result of the DCL before arrival in port. This type of discards is recognised as an economically and biologically wasteful consequence of the HCS, in addition to creating compliance and enforcement concerns (see section 7.0), and should be mitigated if possible.

A long term survey data time-series (1992 – 2021) which includes bycatch data has been collected since 1992 at 12 historical scallop survey stations around the Isle of Man. At each station in each year the bycatch is retained and sorted from all survey dredges (2 x king scallop dredges and 2 x queen scallop dredges). Bycatch is sorted to species level, counted and weighed. Various studies have used the bycatch data (at various time scales) to assess the bycatch assemblages from king scallop dredges at the main king scallop fishing grounds in the Isle of Man (e.g. Veale et al., 2001, Craven et al., 2012, Brown 2013).

5.1.1 Management Strategy

In Scotland, a pilot-project has been established whereby the West Coast Regional Inshore Fisheries Group ('SCRIFG') proposed that a ~65 km^2 area west of Mull is temporarily designated as a no-mobile gear zone between 01st October and 31st January each year. Access to the 'Mull box' by vessels targeting crab is limited in terms of pot-allocations per vessel. The original project proposal by WCRIFG also suggested that access should be limited in terms of vessels; however, this aspect of the proposal was not supported by Marine Scotland. Following the closure, the Mull box is opened to mobile-gear vessels with 'uninhibited access' (i.e. no static-gear allowed). This spatial separation is reportedly improving and resolving gear-conflict in the area.

5.1.2 Other considerations

Queen scallop bycatch is also common in the king scallop fishery, and is often seen as an opportunity for the industry to maintain a supply of 'fresh' queen scallop product during the Queen scallop 'off-season'. The king scallop LTMP may reasonably consider integrating a permissible level of Queen scallop bycatch as a retained non-target species component of the king scallop fishery; however, such a measure must necessarily integrate with a Queen scallop Harvest Control Strategy and be included in the Total Allowable Catch and stock assessment of that fishery.

5.2 Endangered, Threatened and Protected Species (ETP)

Endangered, Threatened and Protected species, collectively ETP, is somewhat self-explanatory, but specific consideration is likely to be locally defined dependent on occurrence, conservation status and ecological value. As such, for the Isle of Man, the Wildlife Act (1990), the OSPAR Convention's list of threatened and/or Declining Species and Habitats, and the IUCN Redlist are indicative.

The ETP species that have the potential to be incidentally caught in the Isle of Man king scallop dredge fishery can be determined based using three factors: temporal range of the species; spatial range of the species and; evidence of interaction with the fishing gear. Concerning marine mammals and birds it is considered highly unlikely that any interactions with the fishing gear could occur.

ETP species that have the potential to be incidentally captured or damaged by scallop dredgers are typically demersal elasmobranch species and several sessile in-faunal invertebrates. The Elasmobranch species; common (flapper) skate (*Dipturus batis*), starry ray (*Amblyraja radiata*) (not yet recorded from Manx waters) and angel shark (*Squatina squatina*) are mentioned under EU regulations 104/2015, which has been retained by the UK following its withdrawal from the EU (and the CFP) through the *Commission Delegated Regulation (EU) 2019/2239 of 1 October 2019 specifying details of the landing obligation for certain demersal fisheries in North-Western waters for the period 2020-2021*. This regulation is carried into effect in the Isle of Man territorial waters as a requirement of the FMA 2012. Under this regulation a vessel is prohibited to fish for, retain on board, tranship, or land these species. Therefore the species mentioned in this regulation are considered ETP species in the context of the LTMP. Other elasmobranch species classified as near-threatened under the IUCN Redlist include thornback ray (*Raja clavata*) and blonde ray (*Raja brachyura*), both regional quota species and therefore subject to fisheries reporting requirements.

In order to identify whether any interactions of the scallop fishery with Elasmobranch ETP species, information is available from fisheries-independent stock surveys that collect bycatch data (the Bangor University long-term time series, currently collected using the RV Prince Madog), and logbook reports on ETP interactions in the fishery.

A long term survey data time-series (1992 – 2021) which includes bycatch data has been collected since 1992 at 12 historical scallop survey stations around the Isle of Man. At each station in each year the bycatch is retained and sorted from all survey dredges (2 x king scallop dredges and 2 x queen scallop dredges). Bycatch is sorted to species level, counted and weighed. Various studies have used the bycatch data (at various time scales) to assess the bycatch assemblages from king scallop dredges at the main king scallop fishing grounds in the Isle of Man (e.g. Veale et al., 2001, Craven et al., 2012, Brown 2013).

In relation to scallop fishery interactions with ETP sessile invertebrates, the following species are relevant; Iceland clam (Arctica islandica), fan mussel (*Atrina fragilis*), non reef-forming horse mussel (*Modiolus modiolus*), and potentially file-shell beds (*Limaria hians*)(and/or as a habitat type) and the re-establishment and recovery potential of European flat oyster (*Ostrea edulis*).

Assessment of potential interactions with these species would require consideration of spatial distribution of fishing activity data in relation to habitat/species distribution, and potentially specific survey to determine ETP distributions.

5.2.1 Management and Conservation Strategy

Elasmobranchs

A number of strategies exist to manage fisheries interactions with elasmobranchs at the UK level. As discussed, UK retained CFP regulations prohibit vessels to fish for, to retain on board, to tranship and to land the basking shark, angel shark, common (flapper) skate, starry ray and porbeagle. The regulation requires prompt release of these species unharmed to the extent practicable and encourages fisheries to develop and use techniques and equipment to facilitate the rapid and safe release of the species. The regulations also require the following five species of ray to be recorded separately when landed: Cuckoo ray (*Leucoraja naevus*), Thornback ray (*Raja clavata*), Blonde ray (*Raja brachyura*), Spotted ray (*Raja montagui*) and Starry ray (*Amblyraja radiata*) in order to allow a better understanding of stock status at a species level.

The future management of vulnerable elasmobranchs will require strategic consideration within the LTMP in order to find an appropriate local balance between economic value, quota and other statutory landing obligation considerations, and local marine conservation objectives.

Sessile Invertebrates

Any strategic approach to management and conservation of relevant invertebrates in relation to scallop fishing activity will relate to similar considerations of economic benefit, versus marine conservation obligations and objectives, and will likely have a spatial management basis.

5.2.2 Other Considerations

In addition to fisheries management measures, it is likely to be appropriate that ETP marine species should be specifically protected under Manx law via the Wildlife Act 1990. As such several marine species, including common (flapper) skate and angel shark, are to be considered for Schedule 5 listing (Animals Which Are Protected) under that Act.

5.3 Habitats

The habitat impacts of scallop dredge fisheries are described in detail in section 1.2.4, and includes impacts on biogenic substrate, hard and mixed sediments, and soft sediments. This section will outline how the Isle of Man king scallop fishery LTMP will address those impacts, including monitoring, management and mitigation.

5.3.1 Management Strategy

Scallop dredges, which have teeth specifically designed to penetrate the seabed, are widely known to have a negative impact on benthic habitats and marine invertebrate organisms as well as causing long-term changes in benthic community structure. This impact should be considered in the broader ecosystem context as part of fisheries management and as part of the LTMP an assessment of the interaction of scallop dredging on sensitive habitats and species within the Isle of Man territorial waters will be undertaken.

The current status of each of the main habitat types found within the Isle of Man territorial waters will be quantified using the Relative Benthic Status (RBS) approach. RBS provides a method to measure the impact of fishing on the benthic community or individual species. RBS combines information on the fishing intensity across the area of interest (*f*), the depletion rate per pass of gear (specific to gear type) (*d*), on the type of habitat within the area of interest and the recovery rate of the benthic community (*r*). RBS is then estimated using the following equation and refers to the proportion of biomass remaining relative to an unimpacted site. The values for RBS range between 1 and 0 with 1 indicating no depletion of biomass as a result of fishing and 0 indicating complete depletion of the seabed habitat as a result of fishing:

$$RBS = 1 - \frac{Fishing\ Effort\ (f)\ x\ Depletion\ Rate\ (d)}{Recovery\ Rate\ (r)}$$

As part of the LTMP RBS will be applied to assess the status of habitats in Isle of Man territorial waters, which are fished for scallop by scallop dredgers. As specified in the above equation the status of dredged habitats, and hence their RBS score, will depend on their depletion rate, recovery rate and exposure to dredging. This can be done for general habitat types or to look at the vulnerability and recovery of specific benthic species. For example, the presence of benthic emergent fauna, such as hydroids and bryozoans which tend to be most abundant in gravelly sand (Kaiser et al., 1998), is important for scallop recruitment as they provide suitable structures for larval settlement of scallops. Emergent fauna are vulnerable to removal by scallop dredges (e.g. Kaiser and Spencer, 1996) and so these type of species may be assessed (using species distribution modelling to map areas of presence/absence)

This assessment will include producing maps of dredge effort (from combining fisheries dependent VMS and logbook data), as annual swept-area ratio (SAR) per grid-cell from 2011 to 2021 for the Isle of Man territorial waters (including a mean SAR for 2011 – 2021).

5.3.2 Other considerations

The king scallop fishery should be considered as one of several anthropogenic impacts in Manx territorial waters, and in some instances where habitat impacts are cumulative, monitoring and mitigation of this impact should be undertaken holistically.

Increasingly, marine habitats are being considered as part of the Islands store of ‘blue’ carbon, and it is possible that habitat impacts may have geochemical impacts as well as biological and ecological impacts. The king scallop LTMP should commit to remaining relevant and coherent with this emerging discipline of marine conservation, which may have a fundamental role in the Isle of Man Government’s wider commitment to achieving net-zero emissions by 2050.

5.4 Ecosystems

The ecosystem impacts of scallop dredge fisheries are described in detail in section 1.2.3, and includes direct physical impacts on the seabed substrate (ie. turbation), as well as impacts on burrowing infauna, epifaunal, sessile organisms and mobile species. Consequences of these impacts may include biological simplification, food-chain disruption, predator-prey imbalance and loss of recruitment surfaces. This section will outline how the Isle of Man king scallop fishery LTMP will address those impacts, including monitoring, management and mitigation.

5.4.1 Management Strategy

ICES uses several key phrases to define what an ecosystem-based approach to fisheries management looks like, these are: "*management of human activities, consideration of collective pressures, achievement of good environmental status, sustainable use, optimisation of benefits among diverse societal goals, regionalisation, trade-offs, and stewardship for future generations*".

This LTMP recognises these descriptors and will use them to shape the ecosystem-based approach to managing the Isle of Man king scallop fishery, taking a holistic and inclusive approach wherever possible, and having environmental sustainability as a key tenet and achieving this through inclusive engagement and avoiding taking decisions in isolation.

In relation to the management of ecosystems, defined as the living organisms and the physical (non-living) environment with which they interact, the island has specific legislation for their protection. This is primarily the Wildlife Act 1990 and its secondary legislation (including marine nature reserves), but other relevant provisions may be included in the Fisheries Act 2012 and the Endangered Species (Import and Export) Act 2010.

In addition to statutory requirements, the Isle of Man is a signatory (via the UK) to the Convention on Biological Diversity (CBD)[10], an international treaty under the United Nations.

The CBD has three main goals:

- the conservation of biological diversity (or biodiversity)
- the sustainable use of the components of biological diversity
- the fair and equitable sharing of the benefits arising out of the utilisation genetic resources.

Signatories to the convention, of which there are 196 states, are required to develop national strategies for the conservation and sustainable use of biological diversity, and the Isle of Man's Biodiversity Strategy[11] outlines these principles and objectives for the island. The island's Sea Fisheries Strategy (Section 1.3.4) is also closely integrated with the Biodiversity Strategy, to provide policy continuity across DEFA business areas.

The CBD is often seen as a key document in relation to sustainable development, and is therefore consistent with the UN Sustainable Development Goals (SDGs), which are central to the principles and objectives of Biosphere Isle of Man[12]. Specifically, SDG 14 ('Life Below Water')[13] provides a useful reference point and link between CBD, high-level Isle of Man Government Policy strategies and more specific environmentally-based management plans, such as the LTMP.

In contrast to agriculture, where there is requirement for production inputs, typically hydrocarbon based fertilizer and pesticide, in order to deliver harvests, fisheries depend on no additional inputs, but is dependent upon a self-producing healthy marine ecosystem. Therefore, there is a requirement to maintain, restore or improve (as appropriate) the supporting environment. As such, the Ecosystem (sometimes Ecosystem-based) Approach is considered to be one of the principal strategies for sustainable fisheries management strategies.

[10] UN Environment Programme – Convention on Biological Diversity
[11] GD 2015/0049
[12] UNESCO Biosphere Isle of Man – Working together for a sustainable future
[13] Life Below Water (SDG 14) – Conserve and sustainably use the oceans, sea and marine resources for sustainable development

The CBD defines the ecosystem approach as; a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. As such, it also relates to the goals of the CBD, see above.

In addition to the CBD, the Isle of Man is also signatory to OSPAR, which is a regional marine protection convention for the north-east Atlantic and, provides a more specific definition of the ecosystem approach, defined as;

"the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity".

As such, and taking into account the objectives of the LTMP, the plan will take an ecosystem-based management approach including consideration of;

- relevant Isle of Man environmental legislation
- relevant international agreements and obligations[14]
- relevant department-adopted strategies, policies and principles (eg. precautionary principle (CBD and the IoM Biodiversity Strategy (Appendix E[15])))
- environmental monitoring, survey and research programmes (e.g. DEFA marine monitoring strategy, territorial sea surveys, blue carbon project, Bangor University research).

5.4.2 Other considerations

As noted above, and in the context of an ecosystem-based management approach, developing issues such as climate change, and its mitigation, eg. carbon-emissions management, blue carbon, are also likely to be relevant to the long-term management of Manx scallop fisheries.

As with other such indirect considerations, these will be addressed and included in the LTMP according to the governance policies of the Isle of Man Government, and include principles such as stakeholder engagement, formal and informal consultation and, as appropriate, co-management arrangements and agreements.

[14] A complete list of relevant Multilateral Environmental Agreements which have been extended to the Isle of Man (i.e. is effectively signatory to) to can be found at https://www.gov.im/about-the-government/departments/environment-food-and-agriculture/environment-directorate/ecosystem-policy/wildlife-biodiversity-and-protected-sites/international-conventions/

[15] Appendix E: Precautionary Principle: the CBD defines this as "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat." Planning conditions are set to safeguard wildlife through controlling the timing of development to avoid disturbance to nesting birds or roosting bats. Marine habitat mapping has advanced greatly in recent years but it would require more survey to be able to give definitive areas for priority marine habitats such as horse mussel reefs, maerl beds and eelgrass meadows. However, Ramsey Marine Nature Reserve was established in 2011 to protect good examples of horse mussel reef and eelgrass and to allow maerl habitats to recover. When there is a possibility of significant reduction or loss of biodiversity but there is insufficient scientific evidence to prove it the Precautionary Principle should be applied.

6.0 Stock Assessment, Fishery Monitoring, and Research

6.1 Current status of target stock(s)

The current status of the target stock cannot be assessed quantitatively as there is currently no quantitative stock assessment in place and there are no reference points by which to assess current stock status. The results of the latest survey data are presented below to give a general overview of stock trends.

Many scallop species, including king scallops, typically exhibit large fluctuations in recruitment over time which appear to be independent of stock biomass. Overall stock trends for recruits (scallops < 95 mm) can be observed using the recruit abundance index calculated using the geometric mean from the long-term scientific survey time series (Figure 5). Which shows a general increasing trend in the mean abundance of recruits from 1992 to 2007 and a general decreasing trend from 2007 to 2018. The recruit index peaked in 2014 with subsequent year on year reductions until 2018. However, the most recent years (2019 and 2021) both show increased in the abundance of recruits for the first time since 2014 (Figure 5).

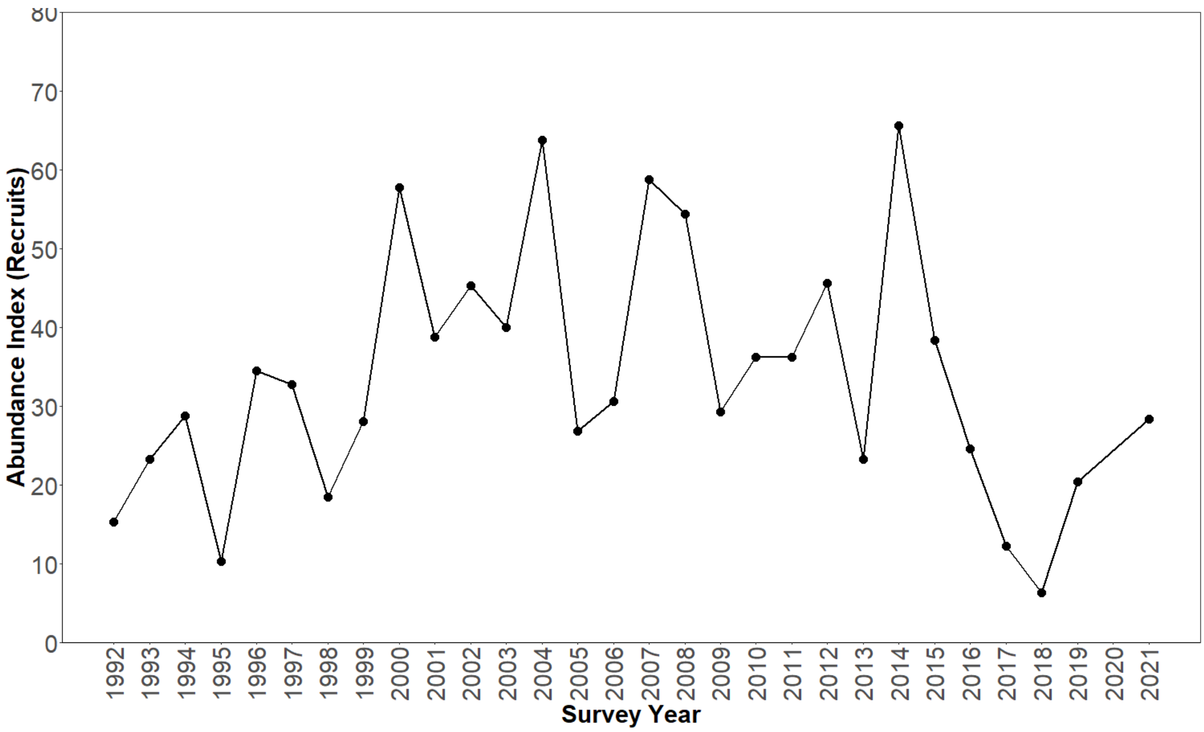


Figure 5: Recruit abundance index (scallops < 95 mm). Calculated based on length-based data where recruits were categorised as scallops under 95 mm at the time of the spring survey (generally April) which would typically be considered too small to grow into the fishery by 31st May (i.e. final day of the following season). The data is sourced from the April scallop survey using data from queen scallop dredges only. No data for 2020 due to coronavirus restrictions.

Overall stock trends for post recruits (i.e. scallops ≥ 95 mm) can be observed using the abundance index calculated using the geometric mean from the long-term scientific survey time series (Figure 6). This shows a general increasing trend in the mean abundance of post recruits from 1992 to 2015 (reaching the highest level on record in 2015), followed by four years of decreasing values before an increase in the most recent survey year (2021).

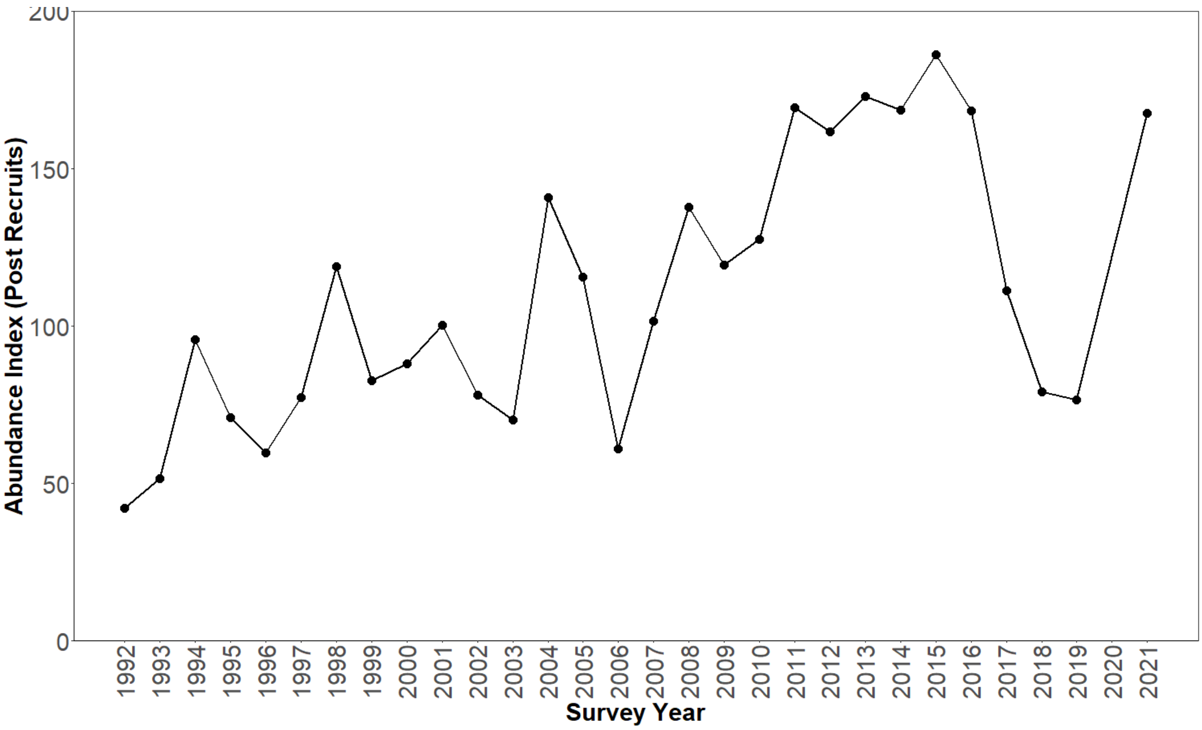


Figure 6: Post recruit abundance index (scallops ≥ 95 mm). Calculated based on length-based data where post recruits were categorised as scallops 95 mm or above at the time of the spring survey (generally April) which would typically be considered of size to grow into the fishery by 31st May (i.e. final day of the current season). The index is displayed here using calculation of the Geometric mean (solid line) for general stock trends only. The data is sourced from the April scallop survey using data from queen scallop dredges only. No data for 2020 due to coronavirus restrictions.

Frequency-density plots of king scallop size data are presented for 2019 and 2021 (no survey in 2020) in Figure 7 from samples measured at ten historical stock assessment stations (POA, LAX, EDG, SED, PSM, CHI, BRI, BRO, PEL and TAR; data from all dredges combined). In 2019, two main cohorts can be seen in the size data: Cohort 1 with a peak at 40-60 mm and Cohort 2 with a peak at 110-130 mm. Cohort 1 indicates pre-recruits i.e. scallops that will be recruiting into the fishery two to three years, whilst Cohort 2 represents post-recruits, i.e. king scallops that are typically already at minimum landing size (MLS). There are also additional cohorts mixed into the population but for which a peak can't be seen, scallops in these cohorts (i.e. 70 -100 mm) will either grow into the fishery during the following fishing season or the season after (for king scallops in the Isle of Man waters it is estimated that on average scallops of 95 mm or above at the time of the survey in April year^{0} will typically have reached 110 mm by 31st May Year^{+1} i.e. the end of the following fishing season).

In 2021 the main peak of scallops is at 100 – 110 mm, which may grow into the fishery during the upcoming fishing season. Whilst there is an absence of a peak for Cohort 1 at 40-60 mm, indicating limited pre-recruitment, there is another peak around 80-100 mm which may represent growth progression of the peak in Cohort 1 from 2019 (Figure 7). This population size structure for 2021, where the majority of the sampled population are just below or just above the MLS is of concern as this indicates a recruit-driven fishery, where the majority of harvested scallops are fished as they grow into the fishery (i.e. at 110mm) which leaves little buffer of older age classes (or larger scallops) within the population and makes the fishery heavily dependent on annual recruitment success. A healthy fished population would have a better spread of scallops throughout the size frequency range, i.e. from 40-200 mm.

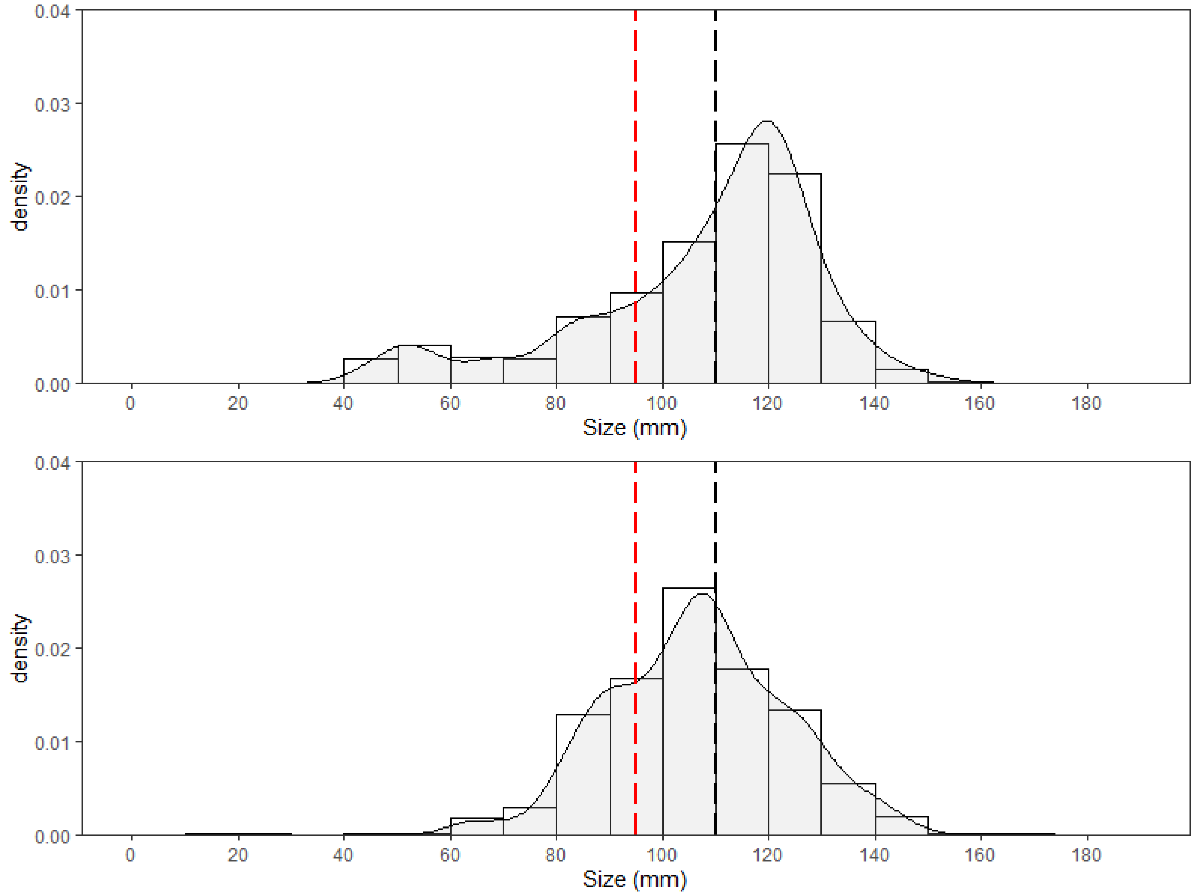


Figure 7: King scallop size frequency-density plot for 2019 (top) and 2021 (bottom). Black dashed line indicates MLS (110 mm) and the red dashed line indicates the estimated MLS cut-off width (95 mm) for the territorial sea (i.e. the size at which scallops sampled in April Year^{0} will typically have reached MLS by 31$_{st}$ May Year^{+1}). Data from historical stations (no RAM) and includes data from both king and queen scallop dredges.

The industry survey, which is fine-scale but currently only has a short-time series (2019-2021) is useful to assess the spatial and temporal patterns of stock status within individual fishing grounds during the last three years (Figure 8).

Within the territorial sea there has been an overall increase in the abundance index (geometric mean) from 2020 to 2021 from the industry survey for both post-recruits and recruits when combining the three grounds surveyed in all three years, EDG, TAR and CHI (from 0.689 in 2020 to 0.830 in 2021 for post recruits and from 0.162 to 0.203 for recruits). The same increasing pattern is evident in the scientific survey for both recruit and post-recruit abundance indices from 2019 to 2021 (missing year of data in 2020).

Improvements in stock status are evident in both surveys in recent years. This follows disrupted fishing activity due to the coronavirus 19 pandemic and a depressed market in 2019/20 that supported just 1,223 t, and an in-season management approach that controlled landings below the TAC in 2020/21 (i.e. only 1,727 t), resulting in an underutilization of fishing opportunities. Stock status should also be considered in the wider context of the long-term time series and the structure of the fished population (Figure 7).

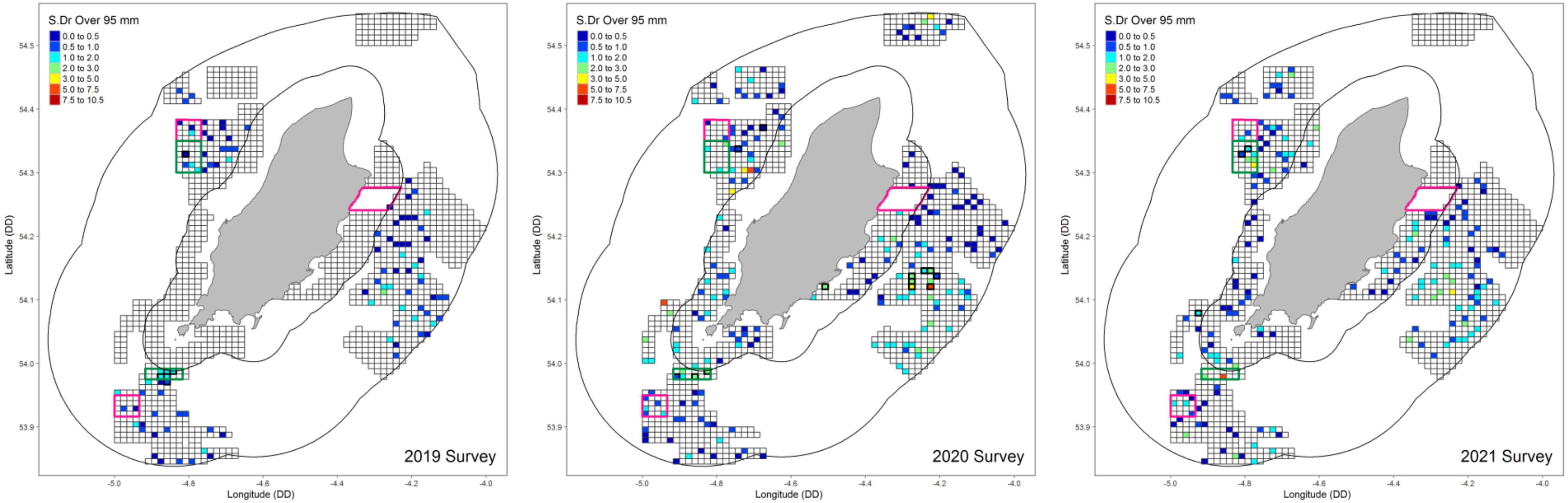


Figure 8: Maps illustrating the survey densities (scallops per 100 m2) for king scallops over 95 mm from standard king and standard queen scallop dredges for 2019 (left), 2020 (middle) and 2021 (right). In the 3-12 nm Point of Ayre in the north of the TS and in the 0-3 nm Bradda, East Coast and Maughold in the south-west, east and north-east of the TS were all surveyed for the first time in 2020. In the 3-12 nm Point of Ayre in the north of the TS and in the 0-3 nm Maughold in the north-east of the TS were not surveyed in 2021 due to lack of financial resources. The green boxes indicate restricted access areas during the current queen scallop fishing season (i.e. 2021) and the pink boxes indicate areas currently closed for queen scallop fishing in 2021. Black borders indicate cells that were part of an additional targeted survey and are not included in the main analysis for the TS, or for individual fishing areas (although for some grounds analysis of targeted cells is presented).

6.2 Stock assessment methodologies

At present a quantitative stock assessment for king scallops is still under development with trials of multiple methodologies undertaken and evaluated:

In September 2017 working with scientists from the European Commission Joint Research Centre (JRC) to an initial quantitative statistical catch-at-age stock assessment model was developed, which was specific to the Isle of Man king scallop stock and used an 'R' based statistical packages called 'a4a' (assessment for all).

Collaboration in 2019 with Dr Adam Delargy of (then) Bangor University led to substantial advances in developing Bayesian stock assessment models for king scallops. Through comparative assessment of the model outputs based on the long-term data from the Isle of Man king scallop fishery with that from a short-term dataset from the Welsh king scallop fishery it was possible to critically assess three different stock assessment models that have been adapted specifically for use with this species and these stocks. The models were compared based on the data available, the population characteristics and the model fit. All three models were integrated analysis (multiple observed datasets) stock assessment models based on different characteristics of stock structure (length-, age- and un-structured respectively). Unstructured models are also known as surplus production or biomass dynamic models. All models were designed to operate with aggregated catch data (single sum of annual catch) as well as survey data as either length- or age-frequencies or total index. The models were also designed to account for the seasonal patterns in scallop life history and fishing activities. All models required basic data on the total landings and discards from the stock assessment area and a survey dataset for the same time period. The unstructured model has the least data requirements and has a very short run time (i.e. 5– 10 mins). The structured models (age or length) are more complicated in both their data input requirements (requiring survey data to be structured by age or length categories) and in their run times. The age model is structured by 1 year time steps in age which increases the model run time to around 4-5 hours. The length model is structured by 1 mm length steps and is thus very data intensive, increasing the model run time to 2-3 days. At present these models continue to be refined and tested.

In 2019 collaboration with the International Council for Exploration of the Seas (ICES) Working Group on Scallop Stock Assessment (WGSCALLOP) also started, with the development of a 3 year term of reference (ToR) with the aim of developing a standardized approach to stock assessment for king scallops that could be trialled for the north Irish Sea stock. A description of the group's work, which remains ongoing as a ToR for the sub-group (chaired by Isle of Man fisheries scientist) for a further 3-year period (2021 – 2024), can be found within the working group report (ICES 2021). A brief summary is also give here:

The surplus Production Model in Continuous Time (SPiCT) is a stochastic state-space model evolved from traditional biomass dynamic models and is one of several assessment methodologies approved by ICES to estimate MSY reference points for Category 3 stocks like the Isle of Man king scallop fishery. SPiCT, which has been the initial focus of the WG, uses observed data on landings and catches along with catch or landings-per-unit-effort indices from either survey data or commercial data and multiple CPUE or LPUE time series datasets can be incorporated into the model. The indices of abundance used within SPiCT need to reflect changes in stock abundance over time and standardization prior to inclusion in the model are thus required in order to remove or standardize for factors other than abundance. The Vector Autoregressive Spatio-temporal Model (VAST) has been used here for this purpose as along with standardizing indices of abundance it can also provide useful insights into the spatial and spatio-temporal patterns of scallop stocks. Initial standardization of indices have now been completed using VAST for both the Isle of Man scallop survey data from 2009 – 2019 and for joined VMS and logbook data from 2011 – 2021 from Isle of Man vessels within the Isle of Man territorial waters. Next steps for the group involve the incorporation of these two standardized indices into a SPiCT model (work progressing in Phase II from 2021 – 2024) (see ICES 2021 for more detail).

In the interim, the SMB has adopted the ICES framework for Category 3 data-limited stocks (ICES, 2012) to calculate annual changes to the total allowable catch (TAC). This approach uses the scientific survey abundance index as an index of stock development to tune the TAC for each year. This method compares a ratio of the latest two index values (Index A: i.e. average of 2021 and 2020) to the three preceding years of index values (Index B: i.e. average of 2019, 2018 and 2017). This ratio is then multiplied by the TAC from the previous year to provide an adjusted TAC for the current year (i.e. a ratio of 0.85 would see the 2020/2021 TAC reduced by 15% for the 2021/2022 fishing season; whilst a ratio of 1.15 would see the 2020/2021 TAC increased by 15% for the 2021/2022 fishing season). Survey indices are assumed to contain noise and so inter-annual changes of the TAC using the ratio are capped by ± 20% between years.

6.3 Fisheries-dependent monitoring and reporting

Three main sources of fisheries-dependent data are collected as part of the fishery:

All British fishing vessels, regardless of port of origin, must submit a logbook recording their fishing activity. However, the specific requirement and process depends on the size of the fishing vessel. When fishing in territorial waters the master of a fishing vessel which has an overall length of less than 10 m and fishing vessels with an overall length equal to or greater than 10 m but less than 12 m which are fishing for king scallops are required to have on board, complete and submit, a paper logbook, not later than 48 hrs after landing (Sea Fisheries (Logbook) Regulations 2015). The master of a fishing Vessel of 12 m or more must operate an electronic means for recording and sending fishing logbook data at least once a day and no later than 23:59 UTC and in accordance with the instructions set out in Part 1 of Schedule 1 (Sea Fisheries (Logbook) Regulations 2015). In addition, licence conditions require the mast of the vessel to complete and submit a new Fishing Activity Report (FAR) for e-logs, or a new line entry if using paper logbooks, upon each transit of the limit of the territorial sea.

All British fishing vessels, regardless of size or port of origin, fishing for king scallops in the Isle of Man's territorial waters, must have on board an approved operational Vessel Monitoring System (VMS) which can relay information to a Fisheries Monitoring Centre (FMC). A VMS installed on a British fishing vessel must automatically send to an FMC information on the fishing vessel's identification; the most recent geographical position of the fishing vessel; the date and time of transmission and the fishing vessel's course and speed at the time of the transmission (Sea Fisheries (Vessel Monitoring System) Regulations 2015). Since 1st November 2016 king scallop vessels fishing within the Isle of Man territorial waters have been required to operate their VMS at a 15 minute polling interval (increased from standard 2 hr polling frequency required by EU).

Since the start of the 2017/2018 king scallop fishing season an online data collection service (www.nestforms.com) which allows fishers to submit fisheries dependent data via an app on their phone/tablet/pc has been used for fishing trips within the Isle of Man territorial waters. All British fishing vessels, regardless of size or port of origin, fishing for king scallop sin the Isle of Man's territorial waters are required to submit information on each fishing trip by midnight of that day and the information must include details on the fishing vessel's identification, the number of dredges operated, bag weight of scallops landed, fishing ground, whether or not a restricted area has been fished, the number of tows (split inside and outside the 0-3 nm) and the number of bags of scallops landed (split inside and outside the 0-3 nm) via NestForms.

During the fishing season, weekly monitoring reports are provided to DEFA and the SMB summarizing the fisheries dependent data. As the data is submitted via Nestforms on a daily basis then this data is near-real time. Analyses include the uptake of the TAC, the number of unique vessels fishing, LPUE trends at each fishing ground, monitoring of daily catch limits and the spatial distribution of fishing effort and landings. An example report from the 2020/2021 fishing season can be found in Appendix 1.

6.4 Bycatch, ETP species and other surveys

A long term survey data time-series (1992 – 2021) which includes bycatch data has been collected since 1992 at 11 historical scallop survey stations around the Isle of Man. At each station in each year the bycatch is retained and sorted from all survey dredges (2 x king scallop dredges and 2 x queen scallop dredges). Bycatch is sorted to species level, counted and weighed. Various studies have used the bycatch data (at various time scales) to assess the bycatch assemblages from king scallop dredges at the main king scallop fishing grounds in the Isle of Man (e.g. Veale et al., 2001, Craven et al., 2012, Brown 2013).

A total of 91 unique bycatch species were collected from king scallop dredges at historical stations during the 2021 scientific scallop survey. The top ten bycatch species by abundance (numbers of individuals) are presented in Figure 9 and consist of six starfish species (*Asterias rubens, Henricia* *oculata, Luidia ciliaris, Crossaster papposus, Ophiura ophiura* and *Porania pluvillus*), two sea urchin species (*Echinus esculentus* and *Spatangus purpureus*), one whelk species (*Buccinum undatum*) and one hermit crab species (*Pagurus bernhardus*).

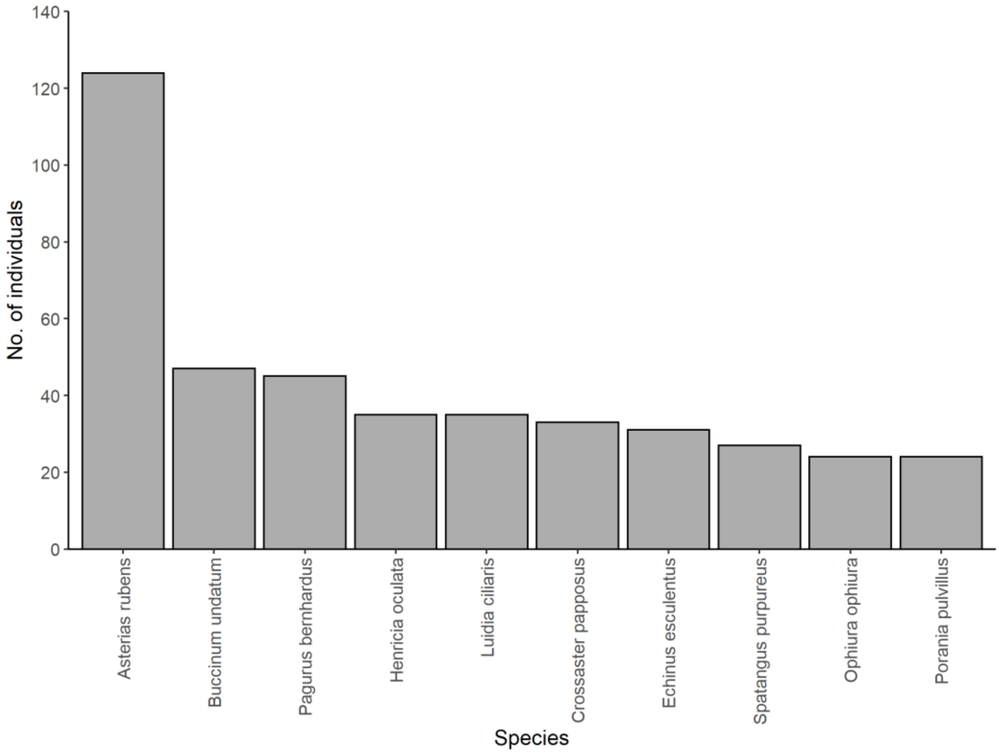


Figure 9: Top ten most abundant bycatch species (number of individuals) recorded during the 2021 scallop survey (data filtered to king scallop dredges).

The top ten bycatch species by weight (kg) are presented in Figure 10 and consist of four starfish species (*Asterias rubens, Luidia ciliaris, Marthasterias glacialis and Crossaster papposus*), two whelk species (*Buccinum undatum* and *Neptunea antiqua*), two sea urchin species (*Echinus esculentus* and *Psammechinus miliaris*), one soft coral species (*Alcyonium digitatum*) and one hermit crab species (*Pagurus bernhardus*).

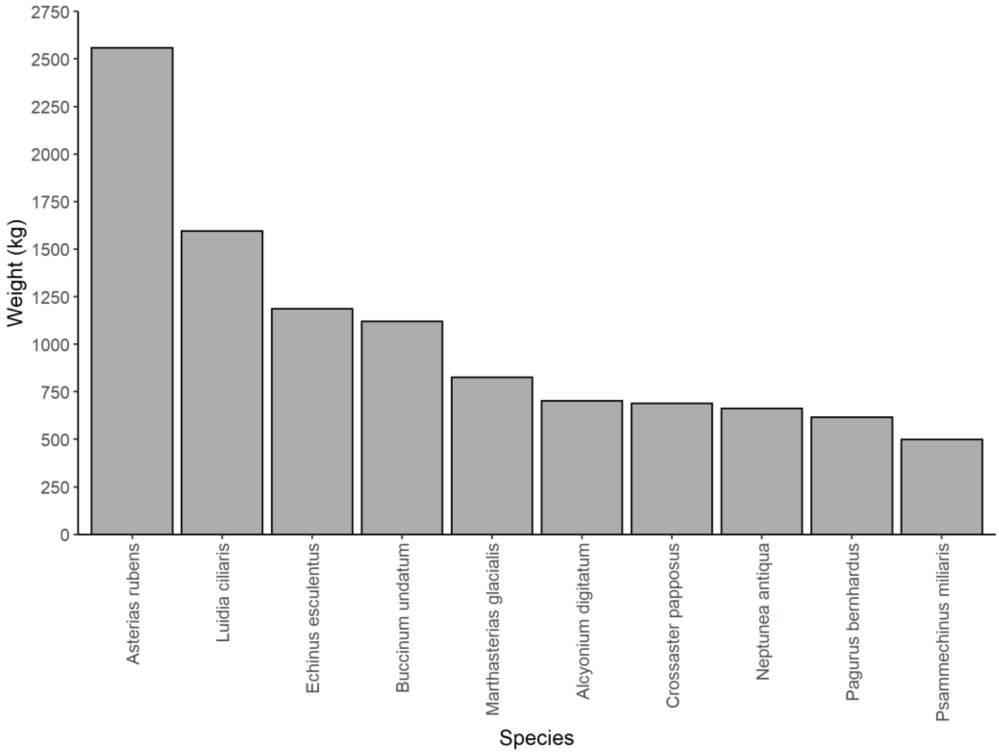


Figure 10: Top ten most abundant bycatch species (weight in kg) recorded during the 2021 scallop survey (data filtered to king scallop dredges).

At the 11 historical stations there was one fish species (common dab, *Limanda limanda*, *n* = 1), two species of rays (Cuckoo ray, *Leucoraja naevus, n*=1; spotted ray, *raja* montagui, *n* = 1) and two dogfish species (lesser spotted dogfish, *Scyliorhinus canicula*, *n* = 5; spiny dogfish, *Squalas acanthias*, *n* = 1) caught as bycatch.

Of the 91 species recorded as bycatch only two species are commercial species with fisheries occurring within Isle of Man territorial waters: common whelk (*B. undatum*), *n* = 47 and brown crab (*Cancer pagurus*), *n* = 1.

6.5 Other relevant research

Relative benthic status and fishing intensity: Bottom-trawling, using gears such as benthic otter trawls, beam trawls and scallop dredges, is thought to be one of the greatest causes of disturbance to marine benthic communities. As well as having direct effects on target species through a reduction in abundances, trawling has wider biogeochemical impacts on the environment. Scallops typically form aggregations and so fishing activity is often focused within spatially discrete areas with high queen scallop density. A quantification of the impact of fishing activity in benthic habitats is therefore an important metric for monitoring the fishery to ensure sustainability of scallop recruitment as well as the overall condition of the habitats and benthic communities. Fishing intensity is defined as the fishing effort per unit area per unit time. Consideration needs to be given to the potential for cumulative impacts of queen scallop trawling and queen and king scallop dredging within each fishing ground which may have disproportionally damaging effects compared to one or the other in isolation. So as to provide a metric that is usable in real time through the season fishing intensity data could be incorporated from King season y^{-1} and queen season y^{1} (i.e. fishing intensity from the 2021 queen scallop fishery and the 2021/2022 king scallop fishery could be combined to monitor cumulative impacts during the 2021/2022 king scallop fishery).

Relative Benthic Status is a metric that should also be further developed and assessed for monitoring scallop fisheries. The status of trawled habitats and hence their RBS value depends on impact rate (depletion per trawl), recovery rate and exposure to trawling. This enables a quantitative estimate of status relative to an unimpacted baseline and could provide a useful metric for monitoring of scallop fisheries. This approach would allow an assessment of each habitat type within the territorial waters or within a fishing ground to indicate which areas are more at risk from higher fishing intensities and whether levels of fishing intensity would have a negative impact on habitat status (using pre-defined management criteria).

Recruitment: The high resolution industry survey has allowed greater insight into the patterns of recruitment across the three major fishing grounds of the territorial sea. The differences in general oceanography and frontal systems across the territorial sea might lead to long-term recruitment patterns varying considerably among individual fishing grounds. At present we only have three years of data for three of the main king scallop fishing grounds within the 3-12 nm. As the time series continues to extend then the survey data will provide a better insight into what is average, good and poor in terms of recruitment densities for individual grounds. Historical analysis of the scientific survey data would for example indicate that larger recruitment events typically occur at CHI and TAR compared to EDG or POA. A longer term data set will therefore provide more information on what is normal in terms of recruitment at the fishing ground level. This in turn will assist with a longer-term management approach and knowing when to expect above average fisheries within each ground in the coming year(s).

Irish Sea Management: The Irish Sea king scallop fishery should be managed at the appropriate spatial scale, which would ideally relate to the function unit (FU) of the stock. Unpublished genetic and oceanographic research indicates that northern Irish Sea populations of king scallops may be considered a singular, connected functional unit of many sub-populations. The most appropriate unit for managing the fishery in Isle of Man territorial waters may therefore be the Northern Irish Sea FU. It is vital that work continues towards achieving a collaborative management approach for king scallop stocks within the different regions of the Irish Sea.

Oceanographic and Environmental Data: Scallop stocks and recruitment success are both highly influenced by environmental and oceanographic variables. As such, work towards including relevant data sets (i.e. temperature, bed sheer stress, currents and habitats) into stock assessment models for these sedentary, spatially aggregating species should be developed

7.0 Enforcement: Monitoring, Control and Surveillance (MCS)

7.1 Objectives and approach

The Departments Fisheries Enforcement Policy (Policy No.: SF/01/2022) outlines the general objectives and approach to compliance, monitoring and surveillance objectives in relation to both Inland and Sea Fisheries.

Fundamentally, under the Fisheries Act 2012, the Department has a statutory duty for the "supervision and protection of inland and sea fisheries" and for "fostering the establishment and development of such fisheries". The Fisheries Act 2012 allows the Department to appoint warranted officers in order to enforce regulations made under the Fisheries Act 2012 and the Wildlife Act 1990.

The aim of SF/01/2022 is: *through the effective enforcement of the Fisheries Act 2012 and related secondary legislation, the Fisheries Division of the Environment Directorate, DEFA will conserve the marine and freshwater fish and shellfish populations of the Isle of Man. SF/01/2022 outlines the general principles and processes that the Department shall follow with respect to enforcement of the Fisheries Act and secondary legislation, including conditions of licence granted under those statutory powers.*

The principal regulations that apply MCS requirements to the Isle of Man king scallop fishery are:

- Sea Fisheries (Vessel Monitoring System) Regulations 2015
- Sea Fisheries (Logbook) Regulations 2015
- Sea-Fisheries (Registration of Buyers and Sellers) (Isle of Man) Regulations 2012
- The Sea-Fisheries (Licensing, etc.) Bye-laws 2004
- Sea-Fisheries (Control of Importation) Bye-laws 1990
- Sea Fisheries (Consolidation) Bye-laws 1984
- Sea Fisheries (Trans-Shipment) Order 1987

In addition, MCS requirements are also implemented by condition of the IOMSFL. It is an offence under the Sea Fisheries (Licensing) (Fishing Vessels) Regulations to undertake any commercial fishing activity other than in accordance with the licence (including conditions of licence).

In relation to MCS, the following are exiting requirements in the Isle of Man king scallop fishery:

- All vessels engaged in king scallop fishing must have a compliant VMS+ device that is operating at a 15 minute ping-rate.
- All vessels must accurately report fishing activity using the statutory logbook (electronic, or otherwise).
- All vessels must accurately report using a scientific electronic logbook (app) in order for the Department and the IFSC to monitor aspects of activity omitted from the statutory logbook.
- All commercial operators (Buyers and Sellers) associated with the production and purchase of king scallops must be registered and compliant with the requirements of the 'RBS' regulations, which apply the EU chain-of-custody requirements to the Isle of Man.
- The above regulations require accurate sales notes, including landed weight, of all king scallops to be verified at the point of first sale.
- All commercial operators (Buyers and Sellers) are required to admit unobstructed inspection by warranted officers in order so that they may enforce any regulations under the Fisheries Act 2012.

MCS activities are undertaken either office-based or desk-based. The two are undertaken strategically, where office-based MCS provides for an overview and assessment of risks and issues in the fishery, and field-based MCS is used to address those risks and provide a deterrent for any possible infringements.

There is no stand-alone "control plan" or strategy document for each fishery, rather the MCS plan is set out through the general SF/01/2022 policy.

7.2 DEFA Roles and MCS Responsibilities

DEFA has a small Sea Fisheries Enforcement & Compliance team, which is responsible for the monitoring, detection, investigation, and, if appropriate, implementation of enforcement action in relation to offences under the Fisheries Act 2012, and marine offences under the Wildlife Act 1991. Where court proceedings are required, the Enforcement and Compliance team work with the Isle of Man Government Attorney General's Chambers.

7.3 MCS Process and Outcomes

7.3.1 Office-based MCS

Office-based MCS activities are based upon the routine monitoring and processing of logbook/sales-notes and VMS data, ensuring that accurate and timely reports are undertaken in-line with regulatory requirements. Activities are undertaken from DEFA HQ in St Johns and using remote access systems.

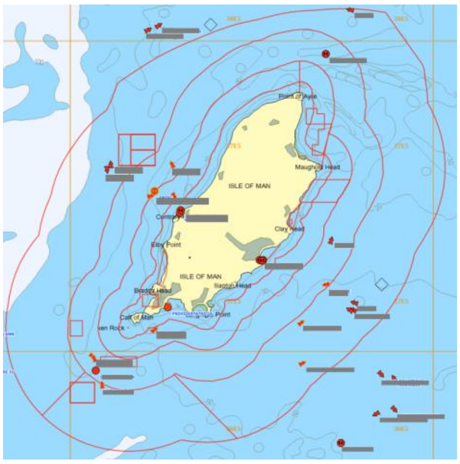



Figure 11. Left: DEFA HQ. Right: Screen-shot of office-based surveillance of vessel activity in the context of spatial restrictions in the Isle of Man territorial sea.

VMS monitoring is applied to all vessels engaged in king scallop fishing activity, irrespective of vessel size, at a 15 minute ping-rate. VMS reports are checked routinely by officers in both real-time and retrospectively, and geo-fencing technology is used to monitor vessel activity in relation to spatially restricted zones. Geofences are updated as and when spatial restrictions are varied. Geofence alerts are used by Fisheries officers to interrogate activity that may potentially have been undertaken in restricted areas.

7.3.2 Field-based MCS

Field-based inspections are typically undertaken at sea (from the Departments sea-going assets and/or through observer trips on commercial vessels), on the quayside, in processing facilities, and shops/restaurants. In order to carry out at sea operations the Department operates the FPV Barrule along with its boarding RIB 'Delta' and an independent RIB 'Enbarr' that is able to operate out to the 12 NM territorial limit.

Following the extension of the Isle of Man territorial sea from in 1991, the Fisheries Directorate of the then Department of Agriculture Fisheries and Forestry commissioned the design and build of a vessel that would economically best achieve its fisheries enforcement duties within the demanding environment of the Irish Sea. The FPV Barrule was delivered in January 2000 (cost £680,000) and has been used successfully for fisheries protection and enforcement since that time. The FPV is used in conjunction with the RIB Enbarr and RIB Delta.


Figure 12. Left: FPV Barrule leaving Port St Mary with the RIB Enbarr onboard. Right: a Fisheries officer inspecting the catch onboard a king scallop fishing vessel.

Fisheries Officers undertake regular and routine inspections to monitor Fisheries regulatory compliance throughout the Isle of Man king scallop catching and processing sectors, including sea patrols, catch inspections, factory inspections, quayside inspections, and logbook inspections. Together, these MCS activities are considered to be an effective deterrent against the majority of likely offences; however, there is scope to improve the MCS by utilising new tools and technologies available to the fishery, discussed further in section 7.4.

7.3.3 Enforcement actions

The aim of the department is to achieve the highest degree of legislation compliance possible through the provision of education, advice and guidance, including:

- Production of advisory literature and dissemination of information, advice and guidance via conventional and social media
- Distribution of information specifically targeted to the relevant user group, e.g. FISHTXT (SMS) alerts to commercial skippers
- Ongoing direct and interactive stakeholder engagement e.g. meetings of the the Manx Fish Producers Organisation (MFPO) and the Isle of Man Scallop management Board.
- Prompt and comprehensive responses to individual enquiries.

Where this is not successful, appropriate and proportionate action will be taken by utilising one of the following enforcement and administrative tools:-

1. *Oral advice/warning*

Where it is considered that a minor infringement may have been inadvertently been committed, oral advice may be given to the transgressor, and a written record of the incident and action taken will be made by the officer and used as a reference should a further offence be committed. Whenever possible, this record will be produced in the presence of, and endorsed by the transgressor.

2. *Advisory letter*

Where it is believed that breaches of the law may have been committed and it is appropriate to do so, an advisory letter may be sent as a reminder of the law and the need for compliance.

3. *Official written warning*

Where there is evidence that an offence has been committed but it is not appropriate to implement formal prosecution proceedings, an official written warning may be issued outlining the date, time and nature of the alleged offence, and stating that a prosecution may be perused should a repeat of the behaviour occur.

4. *Official caution*

This is similar to an official written warning except that the person concerned is formally interviewed under caution. An official caution should only be issued when there is sufficient evidence to bring a prosecution but it is considered appropriate to caution rather than prosecute. The offender must admit their guilt and formally acknowledge that they will accept the caution as an alternative to being prosecuted.

Official cautions are kept on record and would be brought to the courts attention should future transgressions lead to a prosecution.

5. *Prosecution*

The powers afforded to the department to pursue a criminal prosecution are essential to discourage non-compliance, particularly where it is considered that the above options would not deliver the desired outcomes and/or that a conviction would provide a strong deterrent for other would-be offenders.

Prosecution cases will be referred to the Isle of Man Government's Attorney General's Chambers ('**AGCs**') when the Department is satisfied that there is sufficient evidence to support a prosecution taking into consideration:-

- The impact, or potential impact, of the offence on people, the environment, or animals having regard, in particular to the strategic priorities of DEFA;
- The impact of the offences upon the regulatory regime e.g. a failure to obtain a required licence for a regulated activity undermines the integrity of the regime and may deprive DEFA of revenue;
- The financial aspects of an offence such as the benefit accrued and or profit made as a result of breaking any regulation;
- Whether the offence was committed deliberately;
- Whether officials were obstructed;

- The previous enforcement record of the offender;
- The attitude of the offender, including behaviour towards officials, and whether corrective measures to remedy the offence or prevent reoccurrence have been put in place;
- Where offences are prevalent or difficult to detect and a prosecution would constitute a general deterrent for others as a result of making an example of the offender; and,
- If the offence arose from unusual circumstances where the situation could not have been foreseen or reasonable precautions would not have avoided the situation, or reasonable steps were taken to mitigate the matter and the appropriate authorities were notified.

6. Licence suspension

In addition to the above measures the Department may under section 38 of the Fisheries Act 2012 cancel or suspend an IOMSFL if necessary or expedient for the regulation of sea fishing.

7.4 MCS and the LTMP

This document also explicitly states a governance and policy objective to implement an LTMP that ensures Effective Compliance and Enforcement. It is recognised that the aims and objectives of the LTMP may only be achieved if there is effective compliance and enforcement of the rules applied to resource-users. Effective compliance necessitates that the Department is equipped with the appropriate tools, technologies, and resources to monitor fishing activity both at sea, on the quayside, and throughout the processing sector. This requirement extends to vessels fishing within the management unit but landing scallops off-Island, and therefore requires collaborative working with fisheries enforcement agencies throughout the UK DAs.

In terms of specific fisheries-management objectives, this LTMP document makes specific reference to MCS requirements in the LTO 2.2, whereby the long-term objective shall be to introduce the HCS with consideration of MCS requirements, which is interpreted to include considerations of efficiency and efficacy of new MCS tools and obligations in relation to both cost and risk from the perspective of both the industry and the Department. LTO 2.3 also commits to adopting a HCS that utilises HCRs with defined limits that are effective, responsive, and enforceable.

In relation to fishery-specific STOs, this LTMP commits to a number of MCS aims:

1) to improve the enforceability of input controls, specifically dredges-a-side restrictions (STO 1); and,
2) to assess the efficacy of resource-implications for the introduction of Remote Electronic Monitoring (REM) – STO 15.

8.0 Fishery Performance Evaluation

As shown in Appendix 1, the Isle of Man king scallop fishery performance is routinely reviewed within each season within the SMB regular fishery review, and each seasons' fishery performance is reviewed holistically by the SMB during the Quarterly SMB meetings.

Following the approval of the LTMP, the performance evaluation of the fishery will necessarily refer to the LTMPs long-term and short-term objectives, and shall seek to incorporate, where appropriate, measurable performance indicators in addition to those already incorporated into the existing reviews. Several of the objectives are a task-and-finish type objective, and do not lend themselves to 'measurable performance indicators' ('**MPIs**'); however, some of the objectives may relate to MPIs.

8.1 Measurable Performance Indicators

Many MPIs are subject to an improved or new evidence base, and their future consideration shall be subject to that evidence base being developed. MPIs that may be potentially included as the LTMP is implemented, reviewed, and revised include –

- King scallop stock status (biomass) and other considerations of Good Environmental Status;
- Relative Benthic Status;
- Landings (total) relative to appropriate TRPs and LRPs;
- Landings (per-unit-effort, overall and ground-by-ground);
- Economic-performance indicators (revenue, operating profit, operating costs); and,
- Fleet CO_2e emissions (total, and in terms of Energy-return-on-investment).

8.2 Review Process, LTMP Revision and Update

The LTMP will be kept under both constant (i.e. as and when required) and periodic (as scheduled) review. The periodic review shall occur every 5 years, and shall primarily focus on reviewing, and revising or replacing the plans short-term objectives, which shall aimed to be delivered within each 5-year implementation period. It is anticipated that the long-term and high-level objectives of the plan shall remain relatively consistent over the 25-year LTMP period; however, those objectives too may be subject to change.

As part of the periodic review, the extent to which the LTMPs short term objectives have been delivered will be set out in a LTMP 'phase report', for example a "LTMP Phase 1 report". This report shall also include, where possible, a review of the MPIs, and a holistic consideration of the overall performance of the fishery, the scientific evidence base, and a general conclusion of LTMP efficacy. The phase reports will also note any relevant FMPs being developed by the UK Fisheries Authorities that may have indirect implications on the Isle of Man king scallop LTMP, as well as any other Departmental and National (Isle of Man) policies, and international obligations of relevance that may have implications on the LTMP.

The LTMP shall be jointly reviewed every 5-years by the Department, the IFSC, and the SMB, and the next review shall be undertaken in June 2027. Where significant changes and adjustments are proposed following the review, the Department and the SMB may undertake a period of consultation, either publicly or directly with relevant stakeholders, on either a formal or informal basis, as appropriate, with a view to adopting and implementing a revised LTMP following feedback and consideration of consultee feedback.

9.0 Resources required to implement the LTMP

9.1 Approach

9.1.1 Human Resources

The successful delivery of the king scallop LTMP, including its periodic review and amendment, will require existing human resources, including staff within the Fisheries Division and the procurement of experts through the Independent Fisheries Science Contract. Further, it will require the same level of human resources voluntarily dedicated by the industry to maintain the co-management and co-science approach to date.

9.1.2 Financial Resources

Additional financial resources are likely required for specific components of the LTMP aims and short term objectives, which may be achieved by either a task-and-finish type project approach, or will require ongoing budgetary commitments.

For example, delivery of objectives STO14 (*Assess and determine the feasibility and opportunity of a sustainable dive-caught scallop fishery*), STO 13 (*Adopt a decision-making framework for a bio-economic approach to setting Daily Catch Limits*), and STO 17 (*Fleet emissions & climate-change impacts*) may be comprehensively mapped, or delivered, through procurement of external (expert) consultants to undertake discrete projects, who are tasked with reporting and advising the Department and SMB on their findings and recommendations on how to achieve those objectives. It would then be the responsibility of the Department and the SMB to consider, integrate, and implement those recommendations.

Other components of the LTMP, for example STO16 (*Fleet Economics data-collection*) may be efficiently and effectively delivered by dedicating additional financial resources to appoint external (expert) consultants that routinely do this type of data collection and analysis elsewhere.

The benefits of procuring external (expert) consultants for specific projects would be that 1) existing resources, which are fully-utilised, are not overextended to an extent that undermines other operational aspects of fisheries management, 2) the objectivity and impartiality of expert independent analysis and advice, and 3) cost-efficiencies of procuring specific expertise for specific purposes.

9.1.3 Data resources

Data resources shall continue to be managed in line with existing arrangements, and in compliance with the Isle of Man Data Protection and GDPR requirements.

9.2 Cost sharing and recovery

The Department currently charges an administrative fee for all Isle of Man sea fishing licences, which recovers approximately 8% of the Divisions total costs associated with the management, development, and enforcement of fishing activity within the territorial sea, a proportion of which may be directly associated with the king scallop fishery.

The Department previously consulted on proposals to change the licence fee in order to increase cost recovery; however, no adjustments, except for nominal CPI increases, have since been implemented. Consideration of amending the licence fee framework is outside the scope of this document.

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11.0 Glossary of Terms and Abbreviations

AGC	Attorney General's Chambers (Isle of Man)
BEM	Bioeconomic Model
BRI	Bradda Inshore (fishing ground)
BRO	Bradda Offshore (fishing ground)
CA	Closed Area
CBD	Convention on Biodiversity (United Nations)
CHI	Chickens (fishing ground)
CO2	Carbon-dioxide
CPI	Consumer Price Index
CV-19	Coronavirus-19 (virus)
DAS	Days-at-sea
DCL	Daily Catch Limit
DEFA	Isle of Man Government Department of Environment, Food and Agriculture
Defra	UK Government Department of Environment, Food and Rural Affairs
EBM	Ecosystem-based Management
EDG	East Douglas (fishing ground)
ETP	Endangered, Threatened and Protected Species
EU CFP	European Union Common Fisheries Policy (EU)
FMP	Fisheries Management Plan (UK)
FMZ	Fisheries Management Zone
FU	Functional Unit (of a stock)
FZ	Fisheries Zones
FZMP	Fisheries Zone Management Plan
GDPR	General Data Protection Regulations
GES	Good Environmental Status
GFR	Grandfather Rights
HCR	Harvest Control Rule
HCS	Harvest Control Strategy
ICES	International Council for the Exploration of the Seas
IFSC	Independent Fisheries Science Contractor
IoM	Isle of Man
IOMSFL	Isle of Man sea fishing licence
JRC	European Commission Joint Research Centre
kW	Kilo-watt
LAX	Laxey (fishing ground)
LOA	Overall Length (of a vessel)
LRP	Limit Reference Point
LTMP	Long Term Management Plan
LTO	Long-term Objective
MAG	Maughold Head (fishing ground)
MCS	Monitoring, Control and Surveillance
MLS	Minimum Landing Size
MMS	Marine Monitoring Strategy
MNR	Marine Nature Reserve
MPI	Measurable Performance Indicator
MS	Marine Scotland Directorate of the Scottish Government
NM	Nautical Mile
NQS	Non-quota Species
OS	Offshore South (fishing ground)
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PEL	Peel Head (fishing ground)
POA	Point of Ayre (fishing ground)
PSM	Port St Mary (fishing ground)
PSM-O	Port St Mary - offshore (fishing ground)
RA	Restricted Area
RAM	Ramsey Bay (fishing ground)
RBS	Relative Benthic Status
SED	Southeast Douglas (fishing ground)
SFA	Specific Fishery Authorisation
SMB	Isle of Man Scallop Management Board
SPiCT	State-space production Model
SSSWG	Scottish Scallop Sector Working Group
STO	Short-term Objective
TAC	Total Allowable Catch
TAR	Targets (fishing ground)
ToR	Terms of Reference
TRP	Trigger Reference Point
UK DAs	Devolved Administrations of the United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
VAST	Vector Autoregressive Spatio-Temporal Model
WGSCALLOP	ICES Scallop Assessment Working Group
WWER	Western Waters Effort Regime

Appendix 1 – Fisheries-dependent reporting of the Isle of Man king scallop fishery

Below is the 'End of Season' report for the Isle of Man king scallop 2020/21 season. This report is developed and published on a weekly basis during the king scallop season. Please note that the analysis within this report excludes any data from Ramsey Bay which is a permit only fishery and operates under a separate quota and management framework.

Total and Cumulative landings

The fishery opened on Sunday 1st November. As of March 01 2022 (end of Week 32), landings for the king scallop dredge fishery are 1726.61 t with 64 unique active vessels and 3084 fishing trips undertaken to date from the main fishery.

The graph below shows the cumulative landings (t) for the king scallop dredge fishery by month (totals for individual months are displayed as numbers above the points). The TAC for the 2020/2021 fishing season is 2049 t.

Please note the fishery closed for the Christmas break on 22nd December 2020 and opened again on 4th January 2021 (i.e. closure for most of Week 9 and all of Week 10).

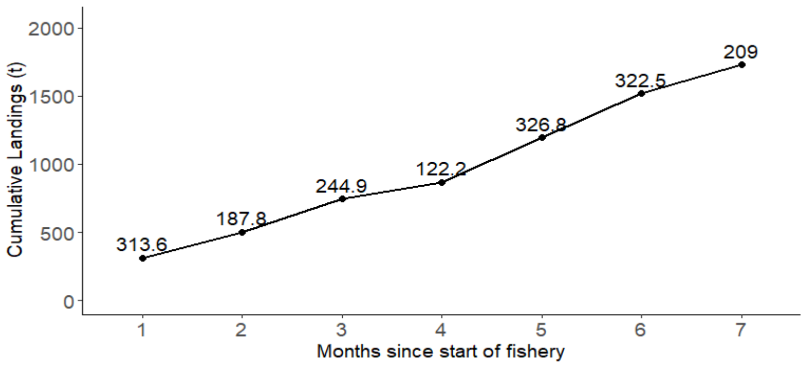

Figure 13. Cumulative Landings (t) by Fished Month.

Figure 15 shows landings in tonnes by fished week grouped by calendar year of season (i.e. 2020 or 2021).

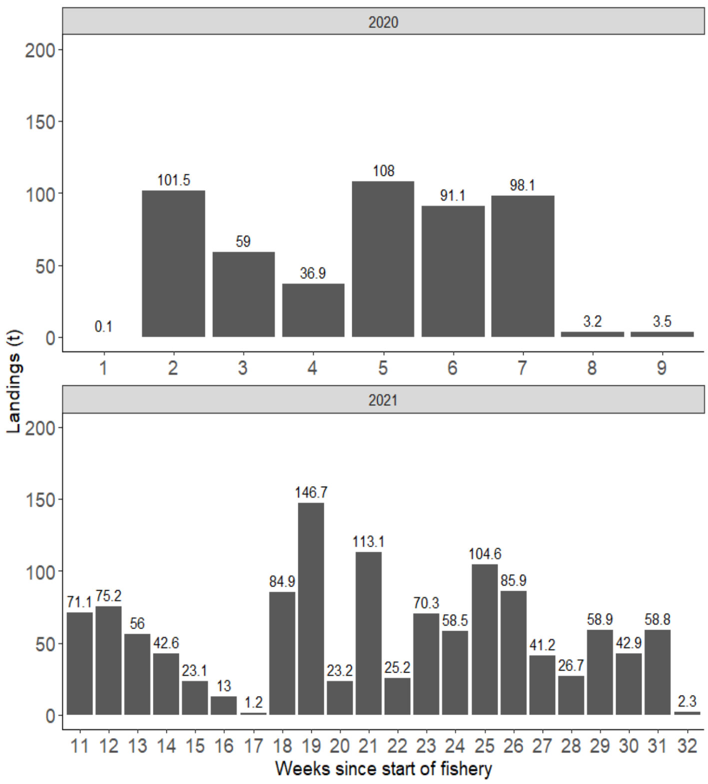

Figure 14. Weekly Landings (t) grouped by Calendar Year of season.

Quota Allocation and soft monthly targets

The quota for the 2020/2021 Isle of Man king scallop fishery is 2049 t. Soft targets were calculated by apportioning the TAC by month based on the average proportion of total seasonal landings landed monthly from the 2012/2013 season to 2015/2016 seasons. The purpose of these soft targets is to aid management and monitor progress of the TAC over the season. The **remaining** column indicates the **%** of soft TAC left for the month (i.e. a positive value indicates an undershoot and a negative value indicates an overshoot).Cumulative values for the season are also provided in the table this is to provide overall context (i.e. 1 month may have overshot the soft target but the fishery may still be under the total cumulative for the season to date).

Month	Soft Target (t)	Landings (t)	Remaining (%)	Soft Target Cumulative (t)	Landings Cumulative (t)	Remaining Cumulative (%)
Nov	479	313.56	34.54	479	313.56	34.54
Dec	198	187.78	5.16	677	501.34	25.95
Jan	210	244.86	-16.60	888	746.20	15.97
Feb	336	122.16	63.64	1223	868.36	29.00
March	348	326.76	6.10	1571	1195.12	23.93
April	284	322.51	-13.56	1855	1517.63	18.19
May	194	208.99	-7.73	2049	1726.62	15.73
Total	2049	1726.62	15.73	2049	1726.62	15.73

Weekly vessels fishing and vessel trips

The number of unique active vessels fishing are displayed in Figure 16 below for each week of the fishery.

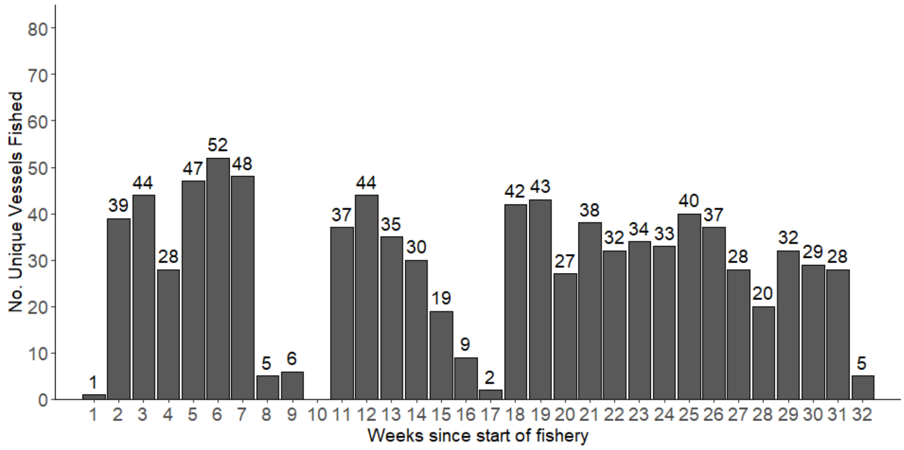

Figure 15. Number of unique vessels fishing by Fished Week

The total number of vessels trips are displayed in the Figure 17 for each week of the fishery. A unique vessel trip is registered each day that a vessel fishes (i.e. 2 vessels fishing 3 days at sea = 6 vessel trips).

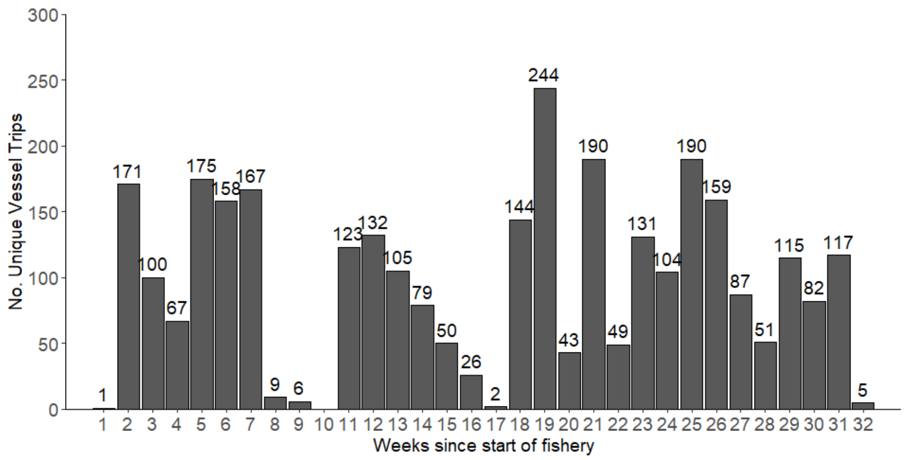

Figure 16. Total number of unique vessel trips by Fished Week

The average number of trips per week per active vessel are displayed in Figure 18 for each week of the fishery (i.e. 6 would indicate that on average every vessel fishing that week achieved 6 days of fishing).

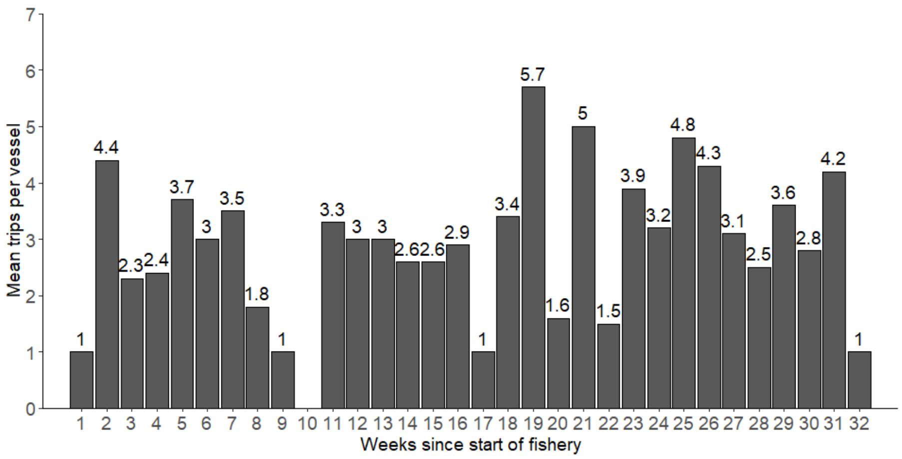

Figure 17. Average number of vessel trips per active vessel by Fished Week

Daily Catch Limits (DCL)

The Daily catch limit for the start of the 2020/2021 Isle of Man king scallop dredge fishing season within the 0-12 nm limit is **700 kg** per vessel. Data from each active vessel was analysed to assess whether the daily catch limit was achieved at the end of each fished day. A 10% buffer (70 kg or ~2 bags) was used to verify whether vessels had achieved their daily catch (i.e. vessels achieving 630 kg or above were considered to have met their DCL). Met: Green >= 90%, Not Met: blue = 75-90%, yellow = 50-75% and red <= 50% of DCL achieved.

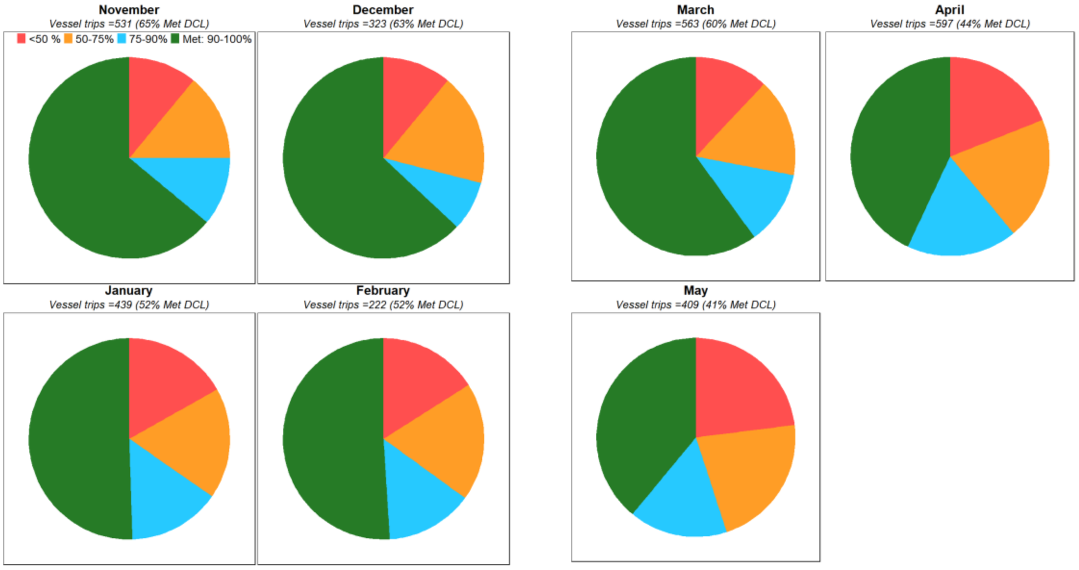

Figure 18. Daily catch limit achieved

Spatial Distribution of Landings

Landings are reported below by IS Box which represents the Main Fished Ground. Figure 20 shows the location of each IS Box within the Isle of Man territorial sea. The main fishing grounds are Targets in IS9, Chickens in IS21, Bradda/Port St Mary in IS14, East Douglas in IS15, Maghould in IS10 and Point of Ayre in IS6. Landings are also reported from other partial ISBoxes within the territorial sea including IS22: South-East corner, IS20: South-West corner, and IS13: South-West side.

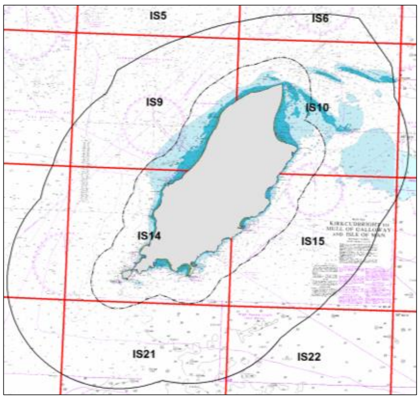

Figure 19. A map showing the location of IS Boxes for reported landings

Figure 21 displays the landings for each Main Fished Ground. The fill colour of each bar shows which month landings are from. This enables temporal changes in the spatial distribution of landings through the season to be detected.

IS10:MGH does not include any landings from Ramsey Bay which is also in IS10 but operates as a permit only fishery with its own TAC.

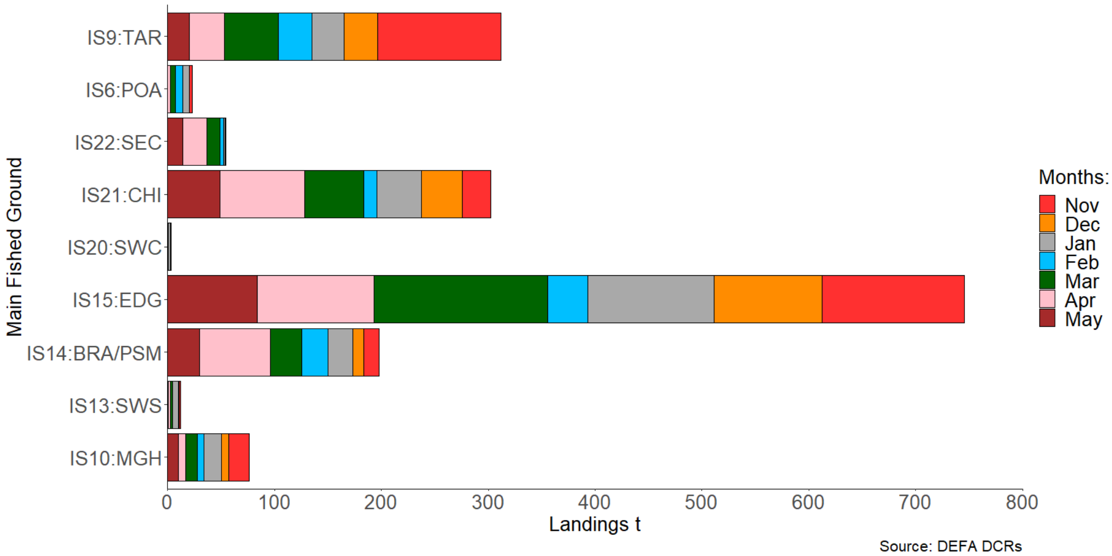

Figure 20. Landings from main fished ground by month

Figure 22 shows the split in landings for IS21:CHI and IS9:TAR among three reported options: the general fished ground (General Ground; khaki), the Restricted Area (RA Only; blue) and vessels fishing both areas (Both; grey). TAR RA Closed from 23:59 on 4/12/2020.

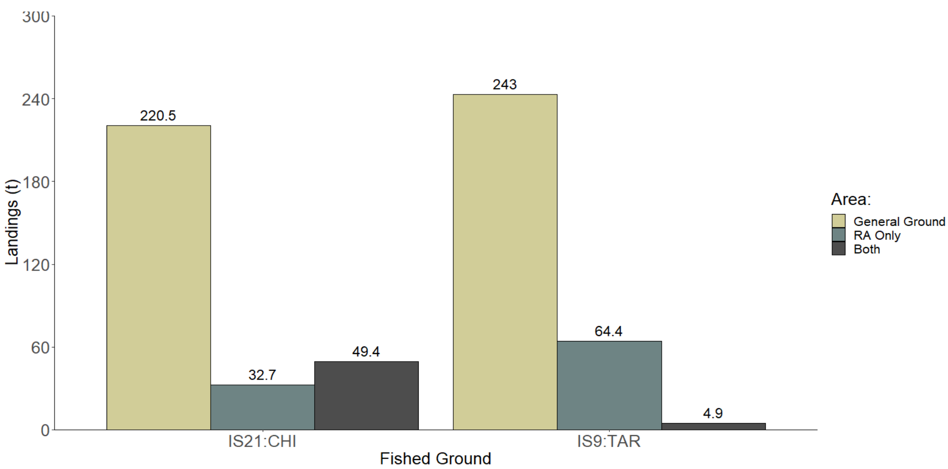

Figure 21. Landings from IS21:CHI and IS9:TAR split by area

Landings per unit effort (LPUE) by ground for 2020/2021

The landings per unit effort (LPUE) has been standardised to **kg per hour fished per dredge**. The boxplot in Figure 23 illustrates the LPUE by week at each of the main fished grounds.

Box plot explained:

- The horizontal line within the box indicates the median (or middle number, so half the data is above and half the data is below),
- The box itself represents the interquartile range (or the middle 50% of the data).
- The box and vertical lines together indicate the full range of the data.

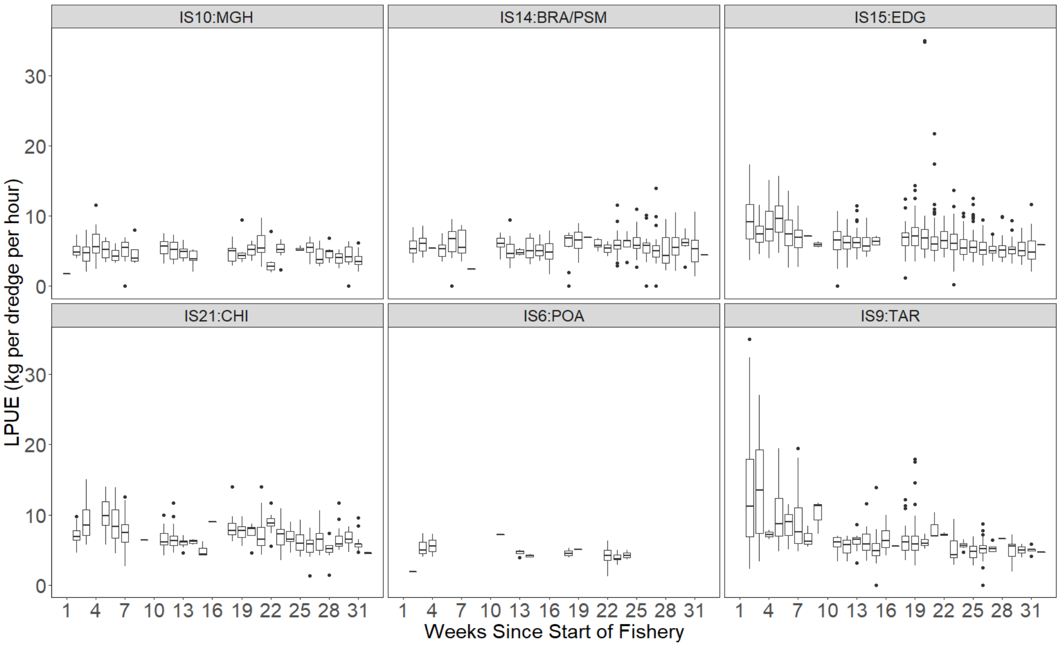

Figure 22. LPUE by week and main fished ground

The boxplot in Figure 24 shows the LPUE data for IS21:CHI and IS9:TAR split by area i.e. General Ground (left; 0 in RA column in table), Restricted Area (middle; 1 in RA column in table), or Both (right; 2 in RA column in table)) by week. This enables comparison of the LPUE within the open and restricted areas of these two grounds.

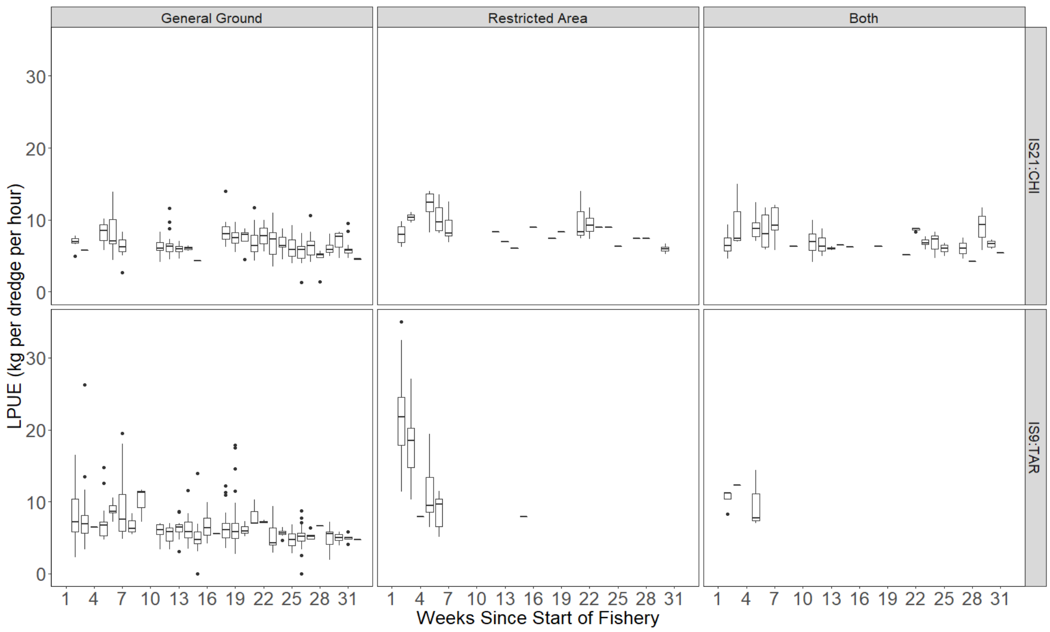

Figure 23. LPUE for Restricted Areas at TAR and CHI vs main fishing area

LPUE comparison of the current season LPUE to 2017/18, 2018/19 and 2019/20 by fished ground

A comparison of the current seasons average LPUE (**kg per hour fished per dredge**) at each of the main fished grounds is displayed below with comparisons for 2017/18, 2018/19 and 2019/20 by fished week.

- Note: the different scales on the Y-axes,
- Note: In all seasons the fishery closed for Christmas during Week 9,
- Note: MFPO Survey trips will also be removed from this dataset.

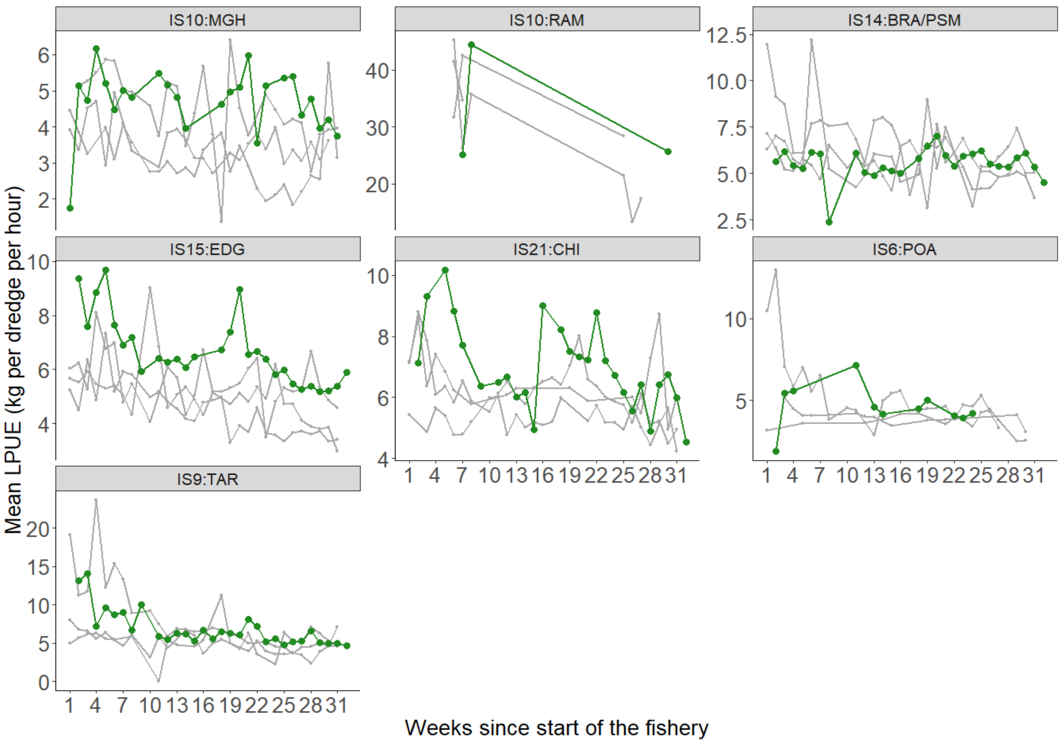

Figure 24. LPUE for current (green) and historic (grey) fishing seasons.