SCALLOP ASSESSMENT WORKING GROUP (WGSCALLOP)

VOLUME 1 | ISSUE 90

ICES SCIENTIFIC REPORTS

RAPPORTS
SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

ISSN number: 2618-1371 I

ICES Scientific Reports

Volume 1 | Issue 90

SCALLOP ASSESSMENT WORKING GROUP (WGSCALLOP)

Recommended format for purpose of citation:

ICES. 2019. Scallop Assessment Working Group (WGSCALLOP).
ICES Scientific Reports. 1:90. 31 pp. http://doi.org/10.17895/ices.pub.5743

Editor

Lynda Blackadder

Authors

Lynda Blackadder • Isobel Bloor • Andy Brand • Adam Delargy • Spyros Fifas • Eric Foucher • Ellen Sofie Grefsrud • Stuart Jenkins • Jonas Jonasson • Shona Kinnear • Claire Lambden • Andy Lawler • Carrie McMinn • David Rudders • Michael Sheridan • Bryce Stewart • Kevin Stokesbury • Claire Szostek

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

Contents

i Executive summary

The Scallop Assessment Working Group (WGScallop) seeks to develop and improve stock assessment methods for scallops and increase understanding of scallop populations and fisheries. The working group shared 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 genetics.

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

A list of available data (landings, effort, survey, observer, catch sampling, VMS, habitat data) for scallop fisheries in the Irish Sea region was produced and the extent of the initial stock assessment area has been agreed. The group will now progress with checking the format of the data sources and collating the data.

Significant progress has been made in the collation of landings and effort data and the group now have access to data currently held in the Regional Database (RDB). Data checking will be attempted using the app developed by the Working Group on Mixed Fisheries Advice (WGMIXFISH). A sub- group will lead this work and provide a summary of the data currently available and highlight any issues. This will inform the requirements for the data call next year.

Preliminary analysis results from an exchange of scallops for age determination showed inconsistencies within and among exchange participants and institutes. For this reason the group will support a Workshop on Scallop Aging (WKSA) in 2020 to identify ways to improve accuracy and consistency. SmartDots (an age reading platform developed within ICES) was recently introduced to the group and a sub-group will now progress with exploring possibilities for hosting an event at WKSA in collaboration with the Working Group on Biological Parameters (WGBIOP). The aim of the workshop is to produce a standard methodology for aging king scallops. WGScallop will look to adopt this standard procedure for all future scallop exchanges and will recommend that all institutes are aware of the outputs from this workshop.

In future, WGScallop will evaluate the potential benefits of marine protected and closed areas for management and will produce a review paper to bring together information on dredge efficiency, as it would be useful to have this information available in one place.

ii Expert group information

Expert group name	Scallop Assessment Working Group (WGSCALLOP)
Expert group cycle	multiannual
Year cycle started	2019
Reporting year in cycle	1/3
Chair	Lynda Blackadder, Scotland, UK
Meeting venue(s) and dates	8–11 October 2019, Douglas, Isle of Man (18 participants)

1 Progress on ToR a)

ToR a) Compile and present data on scallop fisheries in ICES areas IV, VI and VII by collating available fishery statistics

The group had intended to issue an official data call for scallop landings and effort data with the aim to have these uploaded to InterCatch. The group have now been informed that data are available through a Regional Database (RDB) extraction. The group were made aware of the rules of use of data from the RDB and pointed to the relevant policies available on the ICES website. A subgroup has been established and will begin quality checks; attempting to make use of the app developed by the Working Group on Mixed Fisheries Advice (WGMIXFISH). The subgroup will report back on any problems and decide on next steps. Note that members have agreed that this ToR should be amended, and that ICES areas II and V should be included to cover Iceland, Faroe Islands and Norway as these stock areas are represented within the WG.

The WG had a discussion on stock assessment areas and as a group we reviewed the list that was first produced in 2012. An updated table is now available in Annex 3. The group also prepared a separate table, which lists the ICES statistical rectangles that correspond to each assessment area. These are the scallop assessment areas that are currently being used by institutes and the group agreed that we will keep these under review as further information becomes available. See below for further discussion on the Irish Sea and English Channel region.

Irish Sea

The group discussed the assessment area for the Irish Sea region and agreed that the statistical rectangles agreed last year were still the most suitable. Further details are listed under ToR c) which covers this region in particular.

English Channel (and Celtic and North Sea)

Identification of assessment areas (AAs) is a prerequisite for the determination of stock status. Cefas presented a description of proposed AAs (Figure 1) already defined and used for those assessments currently carried out adjacent to English coasts. They are defined by ICES Rectangle, the spatial resolution of available fishing activity data, but take into consideration known differences in population structure and exploitation patterns (Table 1). However, some of the AAs are harvested internationally and Cefas sought validation of those definitions from WGScallop members to ensure agreement and that scientific evidence held by other agencies had not been overlooked. Although determination of assessment areas is rarely straightforward, and compromises are often required there was no disagreement with those currently defined (Douglas, 2019) and Cefas intends to use these going forward unless further information becomes available.

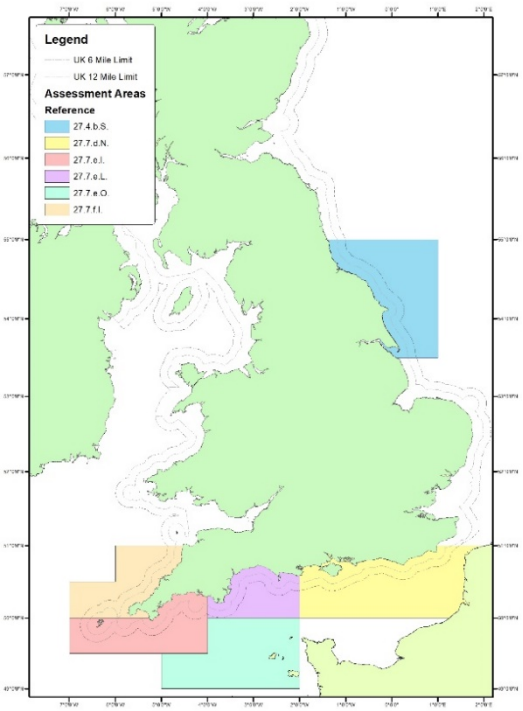

Figure 1. Stock unit assessment areas defined in the English Channel, Celtic and North Sea as part of the determination of stock status by Cefas and collaborators.

Table 1. Assessment areas by ICES rectangle.

27.7.d.N	29E8	29E9	29F0	29F1	30E8	30E9	30F0	30F1
27.7.e.I	28E3	28E4	28E5	29E5	29E4*			
27.7.e.L	29E6	29E7	30E6	30E7				
27.7.e.O	27E5	27E6	27E7	28E6	28E7			
27.7.f.I	29E3	29E4⁺	30E4	30E5				
27.4.b.S	36F0	37E9	37F0	38E8	38E9	38F0		

*** area within boundaries of division 27.7.e, ⁺ area within boundaries of division 27.7.f**

2 Progress on ToR b)

ToR b) Review recent/current stock assessment methods of the main scallop species and explore other methodologies; including comparisons with fishery de-pendant indicators

Work has been undertaken to examine the potential options for data limited stocks (cohort analysis and SPiCT) and Marine Scotland Science (MSS) reported that many king scallop stocks around the UK are considered data-limited, with no survey or commercial sampling until recent years. For the Scottish scallop fishery however, five of eight assessment areas are considered data-rich, and are currently assessed using an analytical Time Series Analysis (TSA). For the other three areas, data-limited approaches to stock assessment are needed. In this study, we carried out assessments for the Scottish data-rich areas using two data-limited approaches, an age-structured Cohort analysis and a Stochastic Surplus Production Model in Continuous Time (SPiCT). Our aim was to determine whether these approaches can produce the same results as the TSA, and if they can be used in future assessment. In both cases, the estimates from the data-limited models showed similar trends to the TSA estimates, but retrospective analysis suggested they were not robust to the removal of the final year's data. The estimates in the Cohort analysis diverged from the TSA in the latter half of the time series and were found to be highly sensitive to assumptions placed on fishing mortality. For SPiCT, the model was only able to converge for three areas, and the uncertainty surrounding the estimates were extremely large in comparison to the TSA.

Substantial advances have been made with the comparison of the performance of three biologically different models in relation to both a temporally data-limited scallop stock (Wales) and scallop stock with a longer data time series (Isle of Man) as presented by Adam Delargy (Bangor University). The biological detail incorporated into historical reconstruction stock assessment models can affect model outputs and the effects are typically case-specific. The models were compared based on the data available, population characteristics and 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 designed to account for the seasonal patterns in scallop life history and fishing activities. The model outputs were highly different and generally performed poorly for the Welsh data, but the outputs were similar, and the models performed better for the Isle of Man data, presumably due to the longer time series. The differences in estimates highlights the importance of carefully considering biological detail in stock assessment models.

3 Progress on ToR c)

ToR c) Collate all available data and attempt to conduct a stock assessment for the north east Irish Sea

The Isle of Man currently conducts stock assessments at the level of the Isle of Man's territorial sea, but the aim of this ToR is to assess the scallop stock as the wider stock level (i.e. North Irish Sea). The ToR will run for three years with the expected deliverable at the end of this period of a Stock Assessment for the North Irish Sea.

To support this ToR a data call was sent around the group to ask for an inventory of data sources from each organisation at the level of ICES Statistical Rectangle. A list of data sources was then collated from Northern Ireland (AFBI), Isle of Man (Bangor University), Wales (Bangor University), Ireland (Marine Institute) and Scotland (Marine Scotland). These data sources included commercial landings, effort and VMS data; scientific survey data; observer and port data; habitat data and bycatch data. Additional data sources were discussed with reference to linking up with other ICES WGs etc.

At the meeting the agreed area for the initial data collation and stock assessment was the North Irish Sea or ICES Area 27.7a (see map below). Next steps are to start collating the available data in a standardised format and then discuss options for data and stock assessment for presentation at the 2020 meeting.

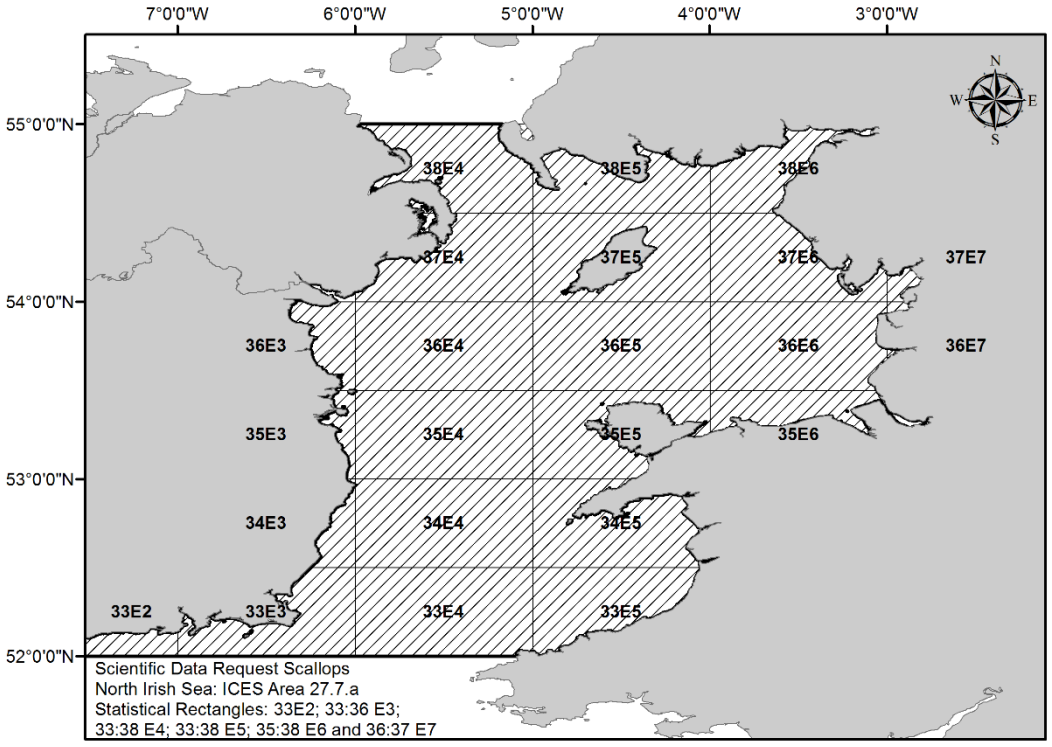

Figure 2. ICES Area 27.7a

4 Progress on ToR d)

ToR d) Review and report on current scallop surveys and share expertise, knowledge and technical advances

The first two days of the meeting focussed on updates of recent surveys, assessments and any advances in field studies (see report for presentation abstracts). This included work on dredge efficiency, incidental and discard mortality, growth, and genetics. The group proposes to produce a review paper on dredge efficiency, as it would be useful to have this information available in one place. Brief summaries of the work presented can be found below.

Dredge efficiency

The US sea scallop resource is assessed by several optical (video and drop down camera) and dredge surveys on an annual basis. Coverage between the different survey methods overlaps across the resource, and this results in multiple annual spatially-explicit biomass estimates. Since 2015, several of the spatially explicit biomass estimates from the dredge survey have diverged significantly from optical survey estimates. Absolute biomass estimates for the dredge survey are estimated with dredge efficiency values derived from a paired dredge optical field study conducted in 2008/2009. Since that time, several high-density aggregations of scallops have been observed in the resource. The working hypothesis to explain the divergent biomass estimates is that dredge performance and thus efficiency is reduced in high density areas, as a result of gear saturation that may be occurring early during a tow. Applying the stationary efficiency value to scale relative biomass is leading to an underestimation in these areas.

Several field studies have been conducted by the Virginia Institute of Marine Science, Northeast Fisheries Science Centre, and the University of Delaware to address the dredge performance and efficiency issue. A tow duration study was conducted across the resource area over two years to test for an effect of a reduced tow time of 10-minutes versus the standard 15-minute tow on the catch of scallops. There have also been several years of paired dredge optical tows to re-assess dredge efficiency, especially in high-density areas. The current approach to correct biomass estimates for the survey dredge has been to use a reduced efficiency value in high-density areas.

Bay of Seine Ring Size Results

The SELEDRAG project was conducted in French territorial waters in May 2019. It was a short project, leaded by the CNPM (French National Committee for Marine Fisheries), with Ifremer as scientific partner, and funded by "France Filière Pêche". The context of the project is the French King Scallop fishery in the Eastern Channel, including 720 fishing boats directly concerned by this species. Despite its importance, there is very little management for this species at the European level, but binding rules for French fishermen in order to protect the stock, not applicable to other countries. One of the differences is the ring size used, 92 mm for all Scallop fisheries in France, 85 mm (or less) for UK fisheries. Another sharp difference is the summer closure in France (from 15 May to 30 September) when there is no seasonal closure in the same area for UK boats which are allowed to fish all year long. Consequently, French fishermen would like to see these protective and effective stock management measures applied by all other fleets the Channel, beginning with a harmonization of the size ring to 92 mm. On the other hand, French fishermen organizations are in the process of increasing the ring size of the dredges, from 92 mm to 97 mm by October 2020.

The aim of SELEDRAG project was to establish the correlation between the increase of the diameter of King scallop dredge ring size and the improvement of gear selectivity, and also to quantify the sorting gain in time and handling on board associated with the increase of the diameter of the dredge rings.

Three days of trials were done onboard "Le Tourville" fishing boat beginning of May 2019.

The study showed that the selectivity of King scallop dredges increased with the diameter of the rings used (85, 92 and 97 mm). Selection was not so much on commercial size scallops (> 110 mm), but rather on undersized scallops which are better filtered by a larger ring size. This increase makes it possible to reduce the catches of under size scallops and waste (pebbles, rocks, dead shells, debris, brittle stars, etc.), in favor of commercial size scallops, in addition to a larger average shell size, and resulting reduction of sorting time on the deck and hard labor for the crew. The ring size of 97mm slightly reduced catches of scallop between 102–110mm. This could be considered as a yield loss for the scallops beds in Western English Channel where the minimal catch size is 100 mm, but it should be noted that the use of this mesh will allow to keep a surplus of scallops which will continue to grow and will be captured at the next fishing season.

As part of this ToR the group provides **updates on recent surveys, assessments or relevant scallop work**. Brief summaries are provided below.

Iceland update. Icelandic scallop (*Chlamys islandica*)

A moratorium was put in place in 2003 for the scallop grounds in Iceland. Since 2014 the annual dredge survey targeting Iceland scallops (*Chlamys islandica*) on the main beds in Breiðafjöður was substituted by a drop frame camera survey/mapping. The full dredge survey index between 2006–2011 had dropped down to between 11–14 % of the average index of the years 1993–2000, prior to collapse of the stock. In the last two dredge surveys, old scallops (~10 year) were dominant in the catches but recruitment was also evident in several areas. In 2014 a co-operation was established between the stakeholders and the Marine and Freshwater Research Institute in regards to increase the research activities (partly funded by the industry in form of vessel time) and conduct experimental fishing. Prior to the experimental fishing, a survey is conducted on proposed and other scallop beds. The scope of the drop frame survey was to get an absolute abundance estimate on the common grounds and also to search for new beds and get a better coverage of known scallop beds. Few new beds and scallops in fishable densities at the inner part of the old common grounds have been detected in the drop frame surveys. As such between 80 (2015) and 245 (2019) drop frame camera stations have been carried out annually, with an additional dredge stations for biological samples.

In 2014, the advice was no fishery on conventional grounds, but small-scale fishing experiment were allowed in areas outside the limits of the dredge survey. The same advice has been given in 2015–2018 and fishing trials continued, mainly on new grounds, but later also on traditional grounds were scallops are found in fishable quantities. As such, 280 tonnes were harvested in the southern part of the fjord during 2014. The number of areas and catches increased in the following years and reached 945 tonnes in 2017 which were fished on six areas. The fishing effort varied between areas, but proposed exploitation rate was between 4–12%. On almost all rectangles within an area a decline in LPUE was observed during the fishing season and reduction in abundance estimates between years. It is proposed to catch roughly 500 tonnes in seven areas in the fishing year 2019/2020.

Faroe islands update. Queen scallops (*Aequipecten opercularis*)

The commercial dredge fishery for queen scallops (*Aequipecten operculari*) within the Faroe islands territorial waters (ICES 5b) began in the early 1970s in the eastern area (E) relatively close

to shore, about 1–15 nm from the coast on sandy, rocky or soft bottom habitats The fishery expanded to the northern coast (N) in the 1990s but pressure from the traditional longline fishing for gadoids resulted in the interruption of further exploitation of the resource in this area.

The fleet consists of a domestic vessel of around 30 m long using a double 12-feet dredge. There are indications of increases in gear efficiency but evidence is poorly documented.

The fishing grounds cover around 400 km^2 and 100 km^2 in the east and north respectively.

Though in recent years the northern fishing grounds have been exploited along a narrow fjord situated in the north-west (DJ) of the islands with limited success. The fishery operates at depths ranging from 60 m to 110 m in the east and 90 m to 110 m in the north whereas the north-west fjord is slightly deeper than the latter. Initially the scallop fishery was highly seasonal (August till January) but at present it has extended until the beginning of the summer season. Marine specimens such as whelks, mussels, starfishes, brittle stars, sea urchins, and crabs co-exist in the main habitats of scallops.

No assessments for scallops are carried out and therefore estimates of recruitment and fishing pressure are not available. The historical fishing grounds (E) are managed through licenses issued annually whereas both the north (N) and north-east (DJ) are managed with TACs allocations which have not been reached. A swept area survey was carried out in 1991 in the east and north coast. In 2012 and 2013, similar surveys were conducted in the northern area as well as in the north-west ford respectively. Size and age samples were taken to investigate growth patterns. Results suggest differences in the size composition of scallops between the N and DJ grounds. Average heights of 1-year old scallop (recruits) in the DJ and N areas are estimated at around 50 mm and 40 mm respectively. No significant differences in size were found for older age groups between the two areas. Growth rate is size-dependant with younger individuals growing 10–20 mm per year. Larger scallops tend to grow slowly at rates of 0–5 mm per year.

Landings and effort data are available from official statistical sources and logbooks respectively.

Since 1991, landings have fluctuated between 2300 and 6700 metric tonnes. Landings in 2018 are estimated at 3174 t. Standardized catch rates (GLM model) suggests no long-term decline of the scallop fishery. The index fluctuates around 1500 kg/hour with no clear trend while fishing effort has decreased which may indicate an increase in dredge efficiency.

Although age disaggregated data is sparse it suggests that growth is spatially dependant within and among the north and eastern areas. In 2016, an experiment with an underwater camera was performed in fished and relatively un-fished grounds to assess the effect of dredging on the sea floor. Unfortunately, the results of the experiment cannot be used quantitatively but rather as a visual indicator of effects of dredging in both historical and contemporary fishing grounds.

Norway update. King scallop (*Pecten maximus*)

The great scallop *Pecten maximus* a fishery resource on the move northwards?

The great scallop *Pecten maximus* is distributed along the European Atlantic coasts, reported north to Lofoten Islands in Norway (69 ^{o}N). The commercial diver-fishery developed in mid-Norway during the early 1990s, overlap the major populations in the county of Trøndelag (64 ^{o}N). Since 1999 the catch has been 400–800 tonnes with a value of 2–3 million Euro. During the recent 3–4 years catches in the county of Nordland, north from Trøndelag has increased.

The northernmost find has been reported from Andøy, about 68–69 ^{o}N, but this was a fresh-looking valve and not a living specimen (Soot-Ryen, 1951). About 20 years ago the northernmost recording of a living specimen was at Grønholmen, west off Bodø (67^{o} 16′ N; 14^{o} 09′ E); (Strand, personal observation). Based on knowledge from monitoring and recreational diving at that time the northernmost viable populations were assumed to be located south of Bodø.

As a part of the "National marine habitat mapping program" areas of high abundance of the great scallop *P. maximus* and Iceland scallop *Chlamys* islandica have been mapped in Norwegian coastal areas. The combination of a long coast line (100 000 km including the mainland coast and islands) with high variability in bottom topography and sediment types over short distances, makes scallop mapping a challenge. The scallop beds were mapped using a vessel-towed camera platform collecting real-time video along survey lines. These lines are chosen combining topographic information from sea maps with anecdotal knowledge about scallop distribution pattern. In 2012, *P. maximus* populations were found north of Bodø at Helligvær (67° 26′ N; 14° 3′ E). In 2013, the Lofoten area was mapped and live *P. maximus* were found at low densities at Sund and Skjellfjorden (68° 01′ N; 13° 13′ E) and a small but dense population was found in Nusfjord (68° 02′ N; 13° 21′ E). This was reported as the northernmost verified live *P. maximus*, further northward than previously registered (Grefsrud *et al.* 2015).

In 2018, the locations in Lofoten (Sund and Nusfjord) and coastal locations further south towards Bodø were revisited using scuba diving, in order to confirm the registrations from 2013 and to allow for samples of the scallops. This survey confirmed the distribution pattern from 2013. Surprisingly, all locations where scallops could be found showed an age distribution indicating that recruitment to these populations have been relatively stable during the recent 4-5 years. This included the northernmost locations Sund and Nusfjord. The data suggest that the conditions for recruitment of the great scallop *P. maximus* has improved in the coastal areas from Bodø to the outer part of Lofoten islands.

References

Grefsrud ES, Jenssen M. Strand Ø. 2015. Northern distribution of *Pecten maximus* and *Aequipecten opercularis* populations in Norway. The 20th International Pectinid Workshop, 22nd-28th April 2015, Galway, Ireland

Soot-Ryen T, 1951. New records on the distribution of marine mollusca in Northern Norway. Astarte, 1: 1-11.

Scotland update. King scallop (*Pecten maximus*)

Marine Scotland Science (MSS) has been carrying out dredge surveys for king scallops (*Pectin Maximus*) since the late 1980s, formerly using commercial boats, but more recently its own research vessel which since 2008 has been the MRV *Alba na Mara*. The aim of these surveys is to collect catch rate data for use in the stock assessment process. MSS currently conducts three scallop stock assessment surveys per year, covering the east coast of Scotland, the west coast and Shetland with 332 historical fixed stations. The station positions are based on historical fishing patterns and areas of suitable sediment from British Geological Survey sediment maps. Additional stations have been recently surveyed using Vessel Monitoring Systems (VMS) data from the commercial fishing fleet to ensure coverage representative of industry fishing areas. Accessibility of other stations are also being reviewed due to offshore renewables, pipelines and Marine Protected Areas (MPAs).

Spring loaded Newhaven type dredges are used on the surveys, with a total fishing width of 9 m. The starboard side has 6 x 9 toothbar and 80 mm bellyrings, similar to commercial king scallop dredges and the port side has sampling gear made up of 6 x 11 toothbar and 60 mm bellyrings, similar to that used for Queen scallop fishing. The latter sampling gear is utilised to catch undersized scallops and smaller bycatch.

At each station, the dredges are towed at a speed of about 2.5 knots for approximately 30 minutes, and all king scallops caught are aged and measured. Other objectives for the surveys

have included: assessing scallop shell damage, identification and length measurements of by-catch, underwater filming of dredges using a Go-pro camera, record and retain marine litter (monitoring as part of the Marine Strategy Framework Directive), the collection of frozen scallops for heavy metal testing as part of the OSPAR assessment of hazardous substances in the marine environment and the collection of DNA samples from common skate.

In 2019, all three surveys were completed successfully. Fifty-four days were spent at sea covering 22 ICES statistical rectangles. A total of 248 stations were sampled with 34 548 king scallops aged and measured, 9375 bycatch and 10 784 starfish were also sampled. Camera trials have progressed slowly over the last year because of the limited time available on the surveys, but further advances in the design of the housing and lighting have been made.

MSS also completed a preliminary scallop survey of the Clyde area. The survey was planned at last minute because ship time became available. The survey was successfully completed (30 Sep – 18 October), with only one day lost to adverse weather conditions. This was a preliminary dredge survey to collect catch rate data in an area that has not been recently surveyed for king scallops. A number of hauls were relocated because the ground was unsuitable for scallops or because there were creels in the area. A total of 58 hauls were completed successfully with only one foul haul. A total of 5292 king scallops were caught, measured aged and damage indexed. Sub samples of king scallops were kept for ring measurements and dissected to collect biological data. A total of 6758 bycatch individuals were also noted. The data will now be uploaded to our survey database and a full report will be available shortly. The scientists involved would like to express their thanks to the Clyde Fishermen's Association and all of the industry members who were involved in planning this survey.

In 2019, Orkney Sustainable Fisheries ltd.'s completed its first *Pecten maximus* dredge survey around Orkney. Carried out on board two commercial fishing vessels, a total of 20 1-hour tows were completed at 20 different sites across 4 regions. Growth curves were produced to examine potential differences in growth rates between the 4 regions. The growth curves highlighted a lack of data for two of the 4 regions and the potential for some revising. During the survey abnormal gonads were discovered across all the dredged regions, samples were sent to MSS for further analysis and degradation of the gonad is apparent, although it is not yet clear what is causing it. Changes to the gonad guide are discussed, with Orkney scallops showing large amounts of variation between stage 5 samples. New substages 5(a) and 5(b) are proposed to better pinpoint when stage 6 occurs (there was a lack of stage 6's found in the samples). Recent effort to collect monthly dive fishery samples is described, this sampling is in its early stages and as of yet there is not enough data to present. Preliminary analysis between the use and selectivity of the N-Virodredge and the Newhaven dredge was briefly highlighted.

Northern Ireland update. King and queen scallop (*Pecten maximus* and *Aequipecten opercularis*)

King Scallops

In 2018, 827 tonnes of scallops were landed from ICES rectangles that fall within Northern Ireland territorial sea (ICES rectangles 36E4, 37E4, 38E4, 39E3 and 39E4). This is a decrease from 1075 tonnes in 2017. The fishery was targeted by vessels from Northern Ireland, Scotland, Isle of Man and England. In terms of what was landed into Northern Ireland ports, this also showed a decrease from 1028 tonnes in 2017 to 769 tonnes in 2018. Of the total landings into Northern Ireland, 58% were from within the ICES rectangles bordering Northern Ireland.

AFBI carry out an annual scallop survey, which has a time series extending from 1985, and collects data on scallops length, breadth, total weight, muscle and gonad weight, scallop ages and

bycatch number and weight. Genetic samples are also collected for future analysis. In 2019, 39 stations were surveyed. The highest catches tended to be along the North Coast (ICES 39E3). Examination of survey CPUE (Figure 3) between 1992 and 2019 shows that in recent years, whilst there has been a small upward turn in the 2019 survey, CPUE is decreasing from a peak in 2012-14 (this peak is perhaps due to the extension of the survey to the North Coast).

During the survey, all bycatch species are counted and weighed. In the 2019 survey, 75 taxa were recorded.

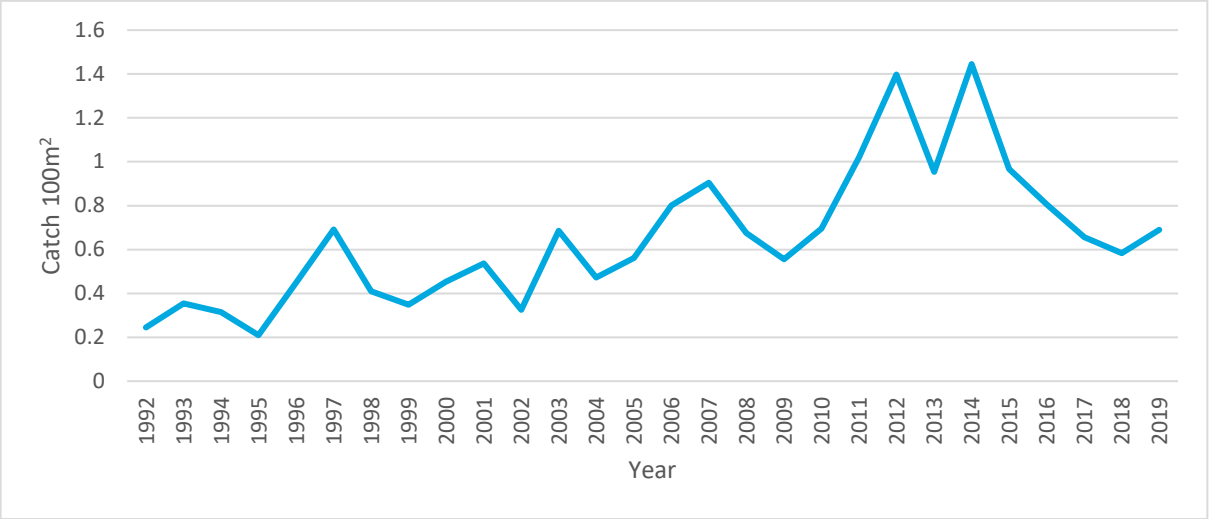

Figure 3. Catches of scallops per 100m² reported from the AFBI scallop survey between 1992 and 2019 (the blue line represents the year at which the survey was extended from the County Down area only, to the full Northern Ireland territorial seas).

Queen Scallops

In 2018, whilst 82 tonnes of queenies were landed from ICES rectangles that fall within the Northern Ireland territorial sea (ICES rectangles 36E4, 37E4, 38E4, 39E3 and 39E4), a total of 196 tonnes of queenies were landed into Northern Ireland ports. There has been a dramatic decrease in landings of queenies into Northern Ireland from peak landings in 2011 (Figure 4).

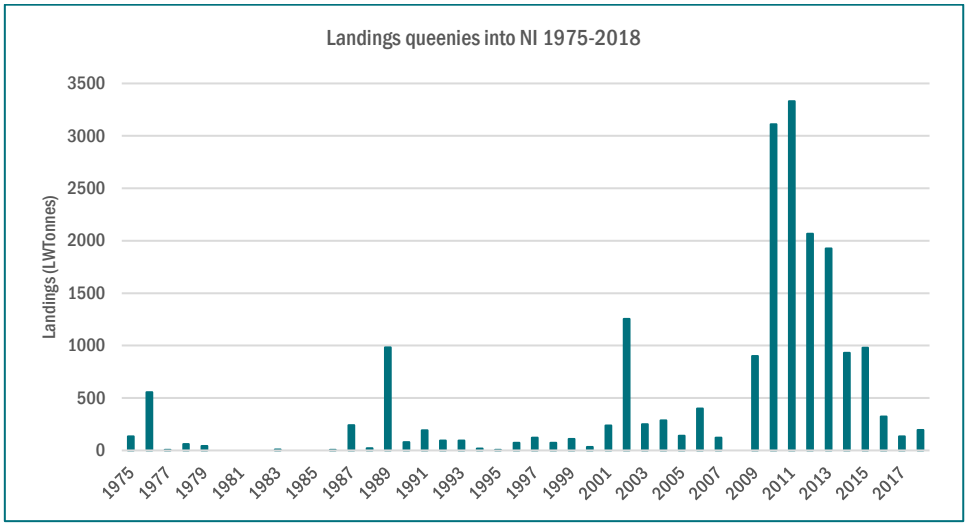

Figure 4. Landings of queenies into Northern Ireland between 1973 and 2018.

AFBI have been carrying out an annual queen scallop survey since 2013. The survey covers areas VIa and VIIa. Stations are selected randomly from a fixed survey grid. At each selected station a camera sled is deployed and towed for 15 minutes. The camera footage is analysed and all queenies are counted each minute by two separate readers (if counts are outwith a determined range then a third counter analyses the footage and so on). This provides information on the density of queenies. Based on the counts, stations are selected for fishing (to collect biological information on the queenies). Fishing is by a queen scallop net or a dredge bar, which is fitted with two king scallop dredges, one of which is fitted with a fine mesh liner, and two queen scallop dredges.

In July 2019, 31 camera stations were carried out within the Irish Sea (area VIIa). For fishing purposes, eight dredge tows were carried out. Results from the VIIa survey showed a further decrease in estimated abundance compared to previous years (Figure 5).

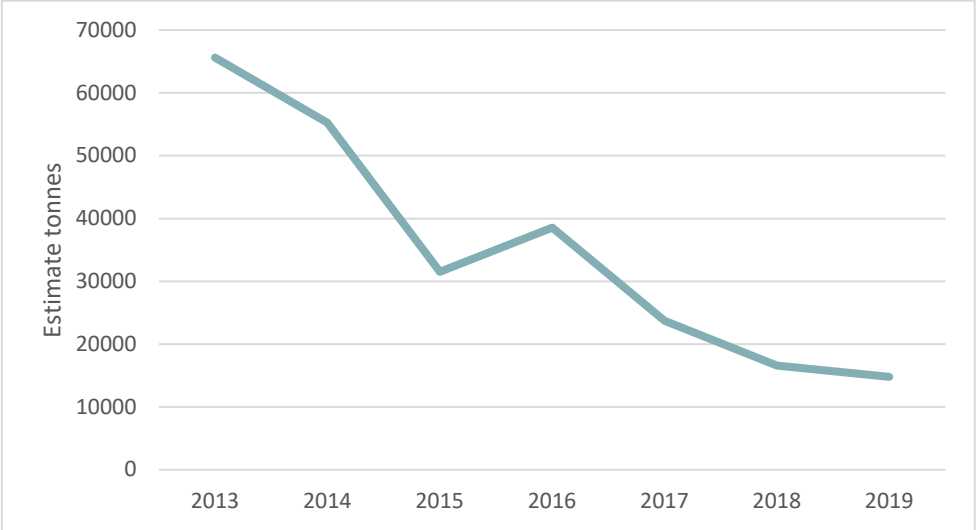

Figure 5. Estimated Irish Sea queenie biomass from the AFBI survey between 2013 and 2019.

Along the North Coast (area VIa) 28 camera stations were completed before the survey had to be terminated due to becoming entangled in a discarded fishing net.

Isle of Man. Queen scallop (*Aequipecten opercularis)*

A quantitative stock assessment has been undertaken for queen scallops in the Isle of Man's territorial sea since 2013. The Isle of Man has a robust time series of data for stock assessment of queen scallops that includes landings data and scientific survey data from 1992 to 2019. The current stock assessment station for queen scallops comprise a fixed grid of stations at approximately 3nm spacing across the extent of the main queen scallop fishing grounds (delineated from VMS). The outputs from the stock assessment model indicate decreasing biomass of queen scallops within the territorial sea from 2011–2019, a trend which is mirrored by commercial landings as well. The estimated biomass from the stock assessment for 2019 is now at the lowest level since the time series began in 1993.

Following scientific advice and anecdotal evidence from the fishing industry of high densities of queen scallops off the east coast of the Isle of Man the Scallop Management Board (SMB) commissioned an industry led juvenile scallop survey in three of the four main queen scallop fishing grounds during June 2019. This survey was undertaken using industry vessels and crew with scientific support. The survey used standard scallop and queen scallop dredges as well as queen scallop dredges with 17 teeth, which are designed to target smaller queen scallops. The survey design uses a fine scale survey grid (resolution of 1 min longitude by 0.5 min latitude) across the

extent of the queen scallop VMS. Survey cells within the grid are then selected using a randomised stratified survey design. At two of the three main fishing grounds (Targets and Chickens) the April and June survey show very similar results despite the difference in scales with generally low densities across the grounds. Although areas of high-density queen scallop juveniles were identified in both surveys at Chickens and subsequently closed. At the third fishing ground (East Douglas), although the two surveys showed similar results across the main extent of the survey area the finer scale June survey identified a localised hotspot of queen scallops which falls between the coarser scale April survey stations. Localised high-density areas are common in queen scallop fisheries, however, in periods of lower stock density these localised areas may become more important for fisheries management and less identifiable in fixed surveys. Whilst the current coarser scale stock survey and assessment robustly assess larger scale trends for the whole territorial sea the need for fisheries management to react at a finer scale may make increase the requirement for data from additional finer scale industry surveys.

England update. King scallop (*Pecten maximus*)

Assessment plans for an assessment of scallop stocks in the English Channel were presented for review to the WG (Belfast, 2017) and the first and second assessments were presented at York, 2018 and Douglas, 2019 respectively. Partial presentation of the executive summary from the latest report (2019) is included below.

The report describes the assessment of the status of some of those stocks undertaken in 2017 and 2018 by the Centre for the Environment, Fisheries and Aquaculture Science (Cefas) during a collaborative project with the UK fishing industry, Defra (Department for Environment, Farming and Rural affairs) and Seafish. The results from the 2017 surveys are included for context and have been updated for this report to account for improvements in the methods used to analyse the data. This includes the correction of an error in the code covering the stocks in 27.7.e which over-estimated the stock area by approximately 30%. The estimates of harvest rates in the 2017 assessment used the 2017 surveys and the fishery data from the previous 12 months as a proxy for what might be taken from the stock in the 12 months subsequent to the survey. Full international landings data for 2017 have not been collated by the International Council for the Exploration of the sea (ICES) or the Scientific, Technical and Economic Committee for Fisheries (STECF), so landings for the 12 months after the 2017 survey have been estimated by taking the UK landings for that period and adjusting by the historic ratio of UK to International landings. The 2017 harvest rates are presented as the realised harvest rates, i.e. the landings in the 12 months following the survey. These changes (improvements, error correction and the realised landings) combine to give harvest rates that are substantially different to those estimated in 2017.

In 2017 five stock assessment areas were identified as being of importance to UK fisheries, three in ICES subdivision 27.7.e (Inshore Cornwall, I; Offshore, O; Lyme Bay, L) and two in 27.7.d (North, N; South, S). In 2018 two additional areas were defined, one in the approaches to the Bristol Channel (27.7.f.I) and another in 27.4.b (North Sea South, S). These assignments are based on regional differences in growth and fishery exploitation patterns. Commercial landings data are available at the spatial resolution of ICES Rectangle and their boundaries are used to describe the extent of the assessment areas.

This report assesses the status of the dredged portion of stocks in 27.7.d.N, 27.7.e.I, 27.7.e.L, 27.7.e.O, 27.7.f.I and 27.4.b.S using dredge surveys and with additional estimates of unfished biomass in some parts of 27.7.e.L and 27.7.e.I. There is likely to be biomass of scallops outside those areas surveyed but for which there are no data to make any estimates. The biomass and exploitation rate of the fished portion of stock in the Bay de Seine part of 27.d.S is routinely estimated by scientists from The French Research Institute for the Exploration of the Sea (IFREMER) in a robust process. In 2018 we surveyed a small bed in 27.7.d.S that is not covered

by the IFREMER assessment, the results of which are presented, however there is no further analysis of 27.7.d.S in this report

Three data streams were used for the assessments described in this report; dredge surveys, underwater TV surveys and a biological sampling programme. Dredge surveys in the main fished beds of 27.7.d.N, 27.7.e.I, 27.7.e.L, 27.7.e.O, 27.7.f.I and 27.4.b.S were used to estimate harvestable biomass available to the dredge fishery (converting survey catch rates to absolute biomass via a gear-efficiency coefficient). The scallop biomass in some un-dredged regions of assessment areas 27.7.e.I and 27.7.e.L was estimated from underwater TV surveys in the first year (2017); no underwater TV survey was undertaken in 27.7.d.N, 27.7.e.O, 27.7.f.I or 27.4.b.S.

A biological sampling programme will provide a time series of age structure of the removals, but these data are under review and only size distributions are presented. Estimates of harvestable biomass (i.e. biomass above minimum size and in areas in which dredgers can operate) and the exploitation rate experienced by those scallops are covered by this assessment, however the assessments presented here are not able to fully estimate the impact of the fishery on the wider stock as we were unable to estimate the scallop biomass in all un-dredged areas. Dredge surveys and catch sampling only cover the portions of stock found on the main fished grounds, as identified by density of Vessel Monitoring System data (VMS). Harvest rate estimates from dredge surveys or commercial sampling therefore only apply to the fished portion of the stock. In situations where there are significant portions of un-dredged stock that are contributing offspring to the fished areas, any estimates of MSY harvest rates will, in future, need to be adjusted to compensate for this.

The potential harvest rates experienced by the surveyed portion of stocks were estimated by comparing a proxy for international landings to the available biomass estimates, either dredged area only or including the biomass from un-dredged areas from the available UWTV surveys.

The estimates of harvest rate from dredge survey and UWTV are given below, note that the 2018 harvest rate estimates use some landing data prior to the survey being undertaken and will be updated when the full landings from the 12-month period after the survey are known.

	Provisional harvest rate on dredged portion of stock (dredge survey only, %)		**Provisional harvest rate for wider stock where UWTV available*** (not 100% coverage, %)**		**MSY Candidate (%)**
	2017*	2018**	2017*	2018**	
27.7.d.N	74.3	62.4	NA	NA	21
27.7.e.I	38.0	24.7	24.0	16.7	25
27.7.e.L	55.2	67.4	33.2	41.7	21
27.7.e.O	11.2	18.3	NA	NA	24
27.7.f.I	NA	10.2	NA	NA	NA
27.4.b.S	NA	42.2	NA	NA	NA

*** assumes historic International landing ratio applied in 2017 ** to be revised in 2019 once the true 2018 landings are known *** assumes stock in UWTV areas is contributing a proportionate level of recruits to dredged portion of stock.**

This is the second attempt at stock assessments undertaken for scallops in this region. A few points of data are always more uncertain than when a time series are available, so the results of this assessment should be viewed with some caution. These results represent the start of a long-term monitoring and assessment programme and there is likely to be some evolution of processes and methodologies. As the time series of data develops and increases in comprehensiveness, this will in turn contribute to a more robust determination of stock status of King Scallop in this region.

Ireland update. King scallop (*Pecten maximus*)

Geostatistical assessment of Celtic Sea *Pecten maximus* survey data

VMS data from the Irish fleet targeting king scallop (*Pecten maximus*) was used to define the spatial extent of the commercial scallop grounds in the Celtic Sea off the south-east coast of Ireland. Acoustic backscatter data, that provides information about the hardness and texture of the seabed in the Celtic Sea, was available from multibeam acoustic surveys carried out by the Marine Institute. Ground truthing has allowed the range of acoustic backscatter values in this area to be classified into two principal ground types dominated by either coarse sediment or sand.

Dredge surveys carried out in 2018 and 2019 in the Celtic Sea scallop grounds, on board commercial fishing vessels, have indicated the persistence of a strong relationship between scallop density and ground type in these areas. Densities were similar to previous surveys last carried out between 2001 and 2005 in this area, with the highest densities recorded on coarse sediments, and very low densities on sand. Survey results suggest that *P. maximus* discriminate not only between sand and coarse sediments, but also between different grades of these sediments; there is a positive correlation between backscatter and catch rates within the range of backscatter values in the survey area. Acoustic backscatter data (where available) should therefore be used as a co-variable to inform the interpolation of survey data.

Universal kriging uses co-variables that are universally sampled (e.g. both raw and classified acoustic backscatter datasets and bathymetric data) to inform the interpolation of the poorly sampled variable (i.e. survey data). This method provides estimates at chosen locations of mean prediction and variability based on the spatial covariance structure of the data, as described by the semi-variogram, which is used for weighting the influence of neighbouring observations in the prediction. This, together with improved estimates of dredge efficiency (catchability), which varies according to ground type, can be used to derive absolute estimates of biomass for surveyed areas.

Wales update. King scallop (*Pecten maximus*)

Scallop landings into Wales by UK vessels have continued to decrease since landings peaked in 2012, when they were the most valuable wild fishery in Wales. Scallops are now the third most valuable fishery in Wales with a first-sale value of £1.4 million in 2017, which was approximately 2% of the value of the greater UK scallop fishery in that year. Bangor University conducted their eighth king scallop research survey in April 2019. The survey results indicated that there is limited evidence for improvement of mean king scallop densities in any of the areas open to commercial scallop dredging in Welsh waters. However, mean densities in an important closed area have improved since 2017 and there is also evidence that this may have led to an increase in pre-recruits in a neighbouring area open to commercial scallop dredging. Management may wish to consider opening this high density closed area and closing one of the low density commercially dredged areas.

France update. King scallop (*Pecten maximus*)

Bay of Seine Assessment Survey

The assessment of the King scallop stock of the Bay of Seine (*Pecten maximus*) was carried out in July 2019, in the Bay of Seine *sensu stricto*, located in French territorial waters (from the Normandy coast to the south to the limit of 12 nautical miles to the North), as well as the bordering zone lying north of this 12-mile limit and up to a latitude of 49°48N to the North, called "Extérieur Baie de Seine". For this, a scientific survey, based on a stratified random sampling plan, was conducted aboard the F/R Thalia, a coastal research vessel of the French Oceanographic Fleet.

Nearly 170 sampling points were completed in the whole area. Analysis of these data leads to an overall increase in exploitable biomass over the entire area.

Outside the Bay of Seine, the estimated biomass (8873 tons) is slightly up than the estimated biomass in 2018. Most of this biomass is located south of the Barfleur-Antifer line (49 ° 42N), close to French territorial waters. In the Bay of Seine, the estimated biomass is sharply down compared to the previous year (23 634 tons, against 63 581 tons in 2018), but which was the absolute record of the historical series, but it is nevertheless in 4th place in the historical series. This biomass is made up of almost equal parts of 2-year-old adult scallops arriving for the first time in the fishery and an abundant number of remaining scallops after the last fishing season (56% and 44% of the biomass, respectively). It is equitably distributed in the different areas of the Bay of Seine, although more abundant in its eastern part. A new generation of juvenile King scallops born in 2018, again relatively abundant, has been identified and is expected to arrive in the fishery in 2020.

WGScallop group members would like to take this opportunity to spare a thought and thank our colleague Jérôme Quinquis for all of his involvement in scallop work. He left us too soon and we express our deepest condolences to his family and friends.

Bay of Saint-Brieuc (VIIe, 26e7). Survey results and management projections.

Ifremer carried out the yearly directed stock assessment for the inshore King Scallop fishery of the Saint-Brieuc Bay (VIIe, 26e7) extended to 634 km² of total surface divided in six spatial strata (survey COSB2019; French R/V "Thalia").

The onboard operations usually undertaken in the late summer involve in sampling 115 stations by dredging on constant distances of 200 m using an experimental dredge of 2 m width equipped with a pressure plate (Breton dredge), teeth of 8.5 cm length and belly and back ring diameter of 50 mm. The dredge efficiency is calibrated owing to previous references (Fifas and Berthou, 1999; Fifas *et al.*, 2004). Caught individuals are exhaustively aged and a LFD by age group and by tow is obtained.

The inshore King Scallop fishery of the Saint-Brieuc Bay is probably represented by the highest density levels in European scale. For the period 1962–2019, landings usually oscillated in a range of 4000–6000 t with some extreme values as 12 500 t (season 1972/73) and 1300 t (season 1989/90). In recent years, the exploitation has been undertaken by 220–230 vessels (99% dredgers, 1% divers). Many historical stages throughout more than a half century of exploitation (from the early 60s onwards) show the vanguard position of this stock for the scallop French fisheries: licence system by pair skipper/vessel, global quota/TAC, obligation of landings at auction, improvement of selectivity pattern.

The adult biomass includes all age groups 2 and +, it provides an index of the potential fecundity of the stock. The exploitable biomass corresponds to individuals larger than 102 mm (MLS in VIIe French waters), thus it is a fraction of the adult one. Those indices show cyclical pattern with

a downwards trend in the period 2006–2013 (respectively -53% and -57% for adult and exploitable biomass). Afterward, an increasing phase is obvious. In 2018, the historically highest level was reached, but a reduction occurred in 2019 for adult biomass (-13%) whereas the exploitable one remains almost stable (+2%).

The recruiting class abundance is estimated at 81 million (7750 t, among them 1310 t immediately exploitable). This value is above the average level of the historical series although accordingly to the last year's survey it was expected that the abundance of this class should be much higher (135 million, 12 960 t; based on relationship abundance GR2 *vs.* GR1 for a same cohort between subsequent years: see below). The reasons for this deficiency were debated: probable ageing errors, excessive direct (illicit catches) or indirect (damaged scallops) fishing pressure, predation (octopus), but no explanation seems to be solely a key factor.

The management policy consists to preserve more than one significantly abundant age groups at the aim of reducing fluctuations between yearly total abundance as more as possible independently of the annual recruitment variability. Four age groups are significantly abundant in the fishery: 3-6 years (respectively 8720 t, 5760 t, 6810 t, 5640 t). The total remaining biomass was estimated at 26 930 t (28 130 t in 2018). The cohort 2016 (fig. 4b) is represented by a total abundance of 68 million, among them 76% reached the MLS=102 mm (7100 t on a total biomass of 8720 t).

In September 2019, the age group 1 was estimated equal to 175 million individuals (this abundance should provide a total one of 101 in the next year's survey; see below). This value is above the historical average level whereas below the majority of recent years: it is noticeable that the majority of historically high reproductions (cohorts 1973, 1999, 2005, 2016, 2017) occurred during the last two decades of the stock history. The mean size of this year class was 66 mm (length) against 61 mm a year ago for the cohort 2017.The year class abundances (2019–2021) are not currently known. The 2019's cohort abundance will be reliably estimated not before the late summer 2020 as the spat collectors used in summer 2019 provide a minor part of explanation for the future class strength. The input values for those three classes will be simulated. The simulation takes into account that a Ricker S/R model explains a very low ($\varrho^2 \approx .115$) part of the predicted cohort abundance. The uncertainty in this relationship can be expressed by a log-normal probability. On this basis, recruitments for cohorts 1989–2018 (surveys 1990–2019) are assigned to probability levels against the spawning biomass[1] of the birth year.

There is no other surveyed species or stocks in French fisheries with possibility of reliable projections on three years. The partnership scientists/fishing industry (project FEAMP 28 on years 2017–2019 with possibility of extension for 2020–2022) consists to guarantee the durability of the whole study. In this partnership, the survey at sea provides accurate estimates for GR1+ whereas the age-size structured stratified biological sampling on landings allows to calculate all fishing mortality components for GR2+ and the spat collectors for GR0 gives the first semi-quantitative estimate by cohort.

The management regulations allow to smooth decreasing patterns when the unavoidable weak cohorts arrive although the cannot completely change neither cyclical phenomena nor the global warming trend.

[1] The spawing biomass differs from the adult one because it is calculated by weighing accordingly to the number of eggs potentially produced which is a function of the scallop size.

Table 2. Numerical application for the 2019/20 season's proposed quota. 1st column: proposed quota(t); 2nd column: actual nominal landings (t); 3rd column: Δf=% variation for fishing effort between 2017/18 and 2018/19; 4th to 6th columns: ΔY1, ΔY2, ΔY3=% variation of landings between subsequent fishing seasons; 7th to 9th columns: ΔBf1, ΔBf2, ΔBf3=% variation of spawning biomasses between springs/summers of subsequent years.

							Log-normal p=0.5			Cyclical log-normal p			
Option	Quota	Landings	Δf	ΔY1	ΔY2	ΔY3	ΔBf1	ΔBf2	ΔBf3	ΔY3	ΔBf1	ΔBf2	ΔBf3
1	4706	5616	2.2%	0.0%	5.6%	2.1%	-1.5%	-1.6%	-9.7%	3.0%	-1.5%	12.6%	17.2%
2	4604	5514	0.0%	-1.8%	6.2%	2.5%	-1.1%	-1.3%	-9.5%	3.3%	-1.0%	12.8%	17.2%
3	4350	5256	-5.4%	-6.4%	7.7%	3.3%	0.0%	-0.6%	-8.9%	4.2%	0.0%	13.4%	17.2%

References

Fifas S., Berthou P., 1999. An efficiency model of a scallop (*Pecten maximus*, L.) experimental dredge: Sensitivity study. *ICES Journal of Marine Science, 56*: 489-499.

Fifas S., Vigneau J., Lart W., 2004. Some aspects of modelling scallop (*Pecten maximus*, L.) dredge efficiency and special reference to dredges with depressor plate (English Channel, France). *J. Shell. Res., Aug. 2004; 23 (2)*: 611-620.

New England update. Atlantic sea scallop (*Placopecten magellanicus*)

The scallop stocks of New England are a fisheries success story. The 2019 estimated stock is 184 000 mt for US waters. For 2018, the stock was estimated at 218 000 mt (scallop meat weight). For the last 10 years the average landings were about 23 000 mt (values at $460 million, for the last 20 years the average landings were 20 000 mt valued at $345 million, and from 1970 to 1996 the average landings were 9000 mt valued at $81 million (NOAA data). This success is the result of nature providing the right conditions for the scallops to produce large numbers of offspring, scientists and the fishing industry working together to develop new ways to document the numbers of scallops, their distribution, size and biomass, and agencies being open to new ideas on rotational management and flexible enough to act on the new scientific data. The scallop industry set aside a portion of their quota, which the National Marine Fisheries Service now distributes through the RSA program (Research Set-Aside), funding much of the 3 surveys used to assess this stock; 2 optical surveys (SMAST drop camera and Habcam -NEFSC-CFF) and one dredge survey (NEFSC and VIMS). In 2019, a large amount of effort was focused on the Nantucket Lightship West area resulting in a 14 000 mt harvest, however the resource dropped from 86 000 mt in 2018 to 13 000 mt in 2019. It appears that about 40 000 mt were lost to discard; examination of predator species and clapper distribution suggests that the last was not the result of natural mortality. The fishing effort in this area was highly concentrated, 350 vessels making 3 trips each of 8.2 mt and fishers noted a great deal of discard due to processing conditions. The sustainable fishery reduces environmental impact and increased economic prosperity, but to ensure this success continues requires a better understanding of fishing practices and new ways of allocating harvest.

The US sea scallop resource is assessed by several optical and dredge surveys by multiple research groups on an annual basis. The individual research group surveys are conducted at varying spatial scales, with a goal of assessing the entire resource. An additional objective is to conduct fine scale surveys of scallop rotational access areas to support management of the resource in the next fishing year. Survey data are used to set annual specifications for the fishery,

as well as for assessment purposes. Optical surveys collect information on the distribution, number, and length distribution of scallops. Dredge surveys collect the same information and also collect biological sample data including meat and gonad weight, meat quality information, disease information, and reproductive stage.

The Northeast Fisheries Science Center (NEFSC) conducts the US federal survey through a combination of an optical survey called HabCam, a towed camera system, and a dredge survey. The NEFSC dredge survey time series extends back to 1979. The Virginia Institute of Marine Science has conducted a survey dredge of the Mid-Atlantic portion of the resource since 2014, as well as several rotational access areas since 2000. The University of Massachusetts, School for Marine Science and Technology has been conducting a drop camera survey of the resource at varying spatial scales since 1999. This survey has covered both the Mid-Atlantic and Georges Bank areas, as well as the majority of rotational access areas. Other research groups have conducted optical surveys using a Habcam system in more recent years include the Woods Hole Oceanographic Institution and the Coonamessett Farm Foundation.

Various members of the WG are also involved in the Project UK Fisheries Improvements (PUKFI) project. The group received a presentation to provide an overview and the aim of the project which is summarised below.

Project UK Fisheries Improvements (PUKFI)

Project UK Fisheries Improvements (PUKFI) is a collaborative stakeholder partnership project working towards an environmentally sustainable future for UK fisheries, using MSC FIP tools and facilitated by MSC. The project uses the MSC pre-assessment process as a gap analysis to determine a fishery's current status in relation to the MSC standard so that areas of improvement can be identified, and Action Plans developed to deliver those improvements through credible Fishery Improvement Projects or FIPs. Clear milestones for each action within the fishery's Action Plan are set by Steering Groups made up of representatives from the fishing industry, scientists, NGOs, retailers and the supply chain, and the progress of these actions and improvements is tracked and reviewed annually through the MSC's Bench-Marking and Tracking tool.

Fisheries in PUKFI were selected by the UK supply chain as commercially important species that they wanted to see progress towards MSC certification. Currently these FIPs include:

- North Sea plaice & lemon sole, demersal trawl, beam trawl & seine
- Channel scallops, dredge
- Western & Channel monkfish, demersal trawl, beam trawl & gill net
- Southwest crab & lobster, pots
- King Scallop – North Sea, West of Scotland and Irish Sea, dredge
- Nephrops – North Sea, West of Scotland and Irish Sea, demersal trawl and creel/pot

PUKFI actions specifically related to UK scallop fisheries include:

Stock status: Review and define appropriate stock boundaries, including review of VMS data and biological data. Consideration of extent requirement for further data/survey to support stock definition, and consideration of appropriate reference points based on:

- Stock surveys and TSA in Scotland where analytical stock assessment available
- Fishery-independent surveys and yield-per-recruit modelling in English stocks
- AFBI and Isle of Man surveys in Irish Sea
- Welsh surveys in Cardigan Bay

Consultation on proposed reference points with ICES Scallop Working Group and agreement of reference points in all scallop fishing areas, including understanding larval distribution between dredged and undredged areas, and stock assessment calculations on exploitation rates.

Harvest strategy: Investigate approaches for assessing both the discard rate and the survival rate of discarded unwanted small scallops. There is a need more data on stocks in in Orkney, Clyde, English North Sea and Irish Sea (where not already subject to scallop stock survey).

Harvest Control Rules: ICES have already established candidate values for Bmsy but we need to establish trigger points.

Habitats: Improving the understanding of scallop fisheries on different habitats at different intensities, particularly vulnerable marine ecosystems.

Bycatch: More inclusive bycatch recording program is required to improve the robustness of the data set, including the need for a short term more detailed quarterly observer program (including no. of skate and ray interactions).

The WG also discussed ways to improve sharing our knowledge and technical expertise with a wider audience including the fishing industry. We considered the possibility of a workshop and discussed the International Pectinid Workshop. It was agreed that this may be a useful forum to present the work of the group.

International Pectinid Workshop

The 23rd International Pectinid Workshop will be hosted on the Isle of Man in April 2021. This bi-annual gathering of world-wide scallop people (scientists, students, fishermen, fishery managers, seafood businesses etc.) has been running since 1976, and makes a welcome return to the island, having last hosted in 1980.

This fairly informal, 5-day workshop, provides plenty of opportunity to discuss scallops via presentations, poster displays, social events and relevant local trips. Topics covered typically range from fisheries and aquaculture, stock assessment to genetics, physiology to disease, taxonomy to gastronomy, ecology and economics – and everything in between.

The Isle of Man has two important regional scallop fisheries, and has implemented a comprehensive range of management measures for both king and queen scallops, including stock assessments, quota management and marine protected areas. The conference will include these topics, and also encourage students, early-career scientists and industry members to participate.

Details of the last event, held in Spain, can be found here; https://pectinidworkshop.com/index.html

For further details please contact Peter.Duncan@gov.im

5 Progress on ToR e)

ToR e) Continue to refine stock structure using best available information on genetics and larval dispersal and look to improve current mapping of scallop stocks

The king scallop (*Pecten maximus*) is a commercially important bivalve in Europe and particularly in the English Channel, whose fisheries are managed at regional and local scales through regulation of fishing effort. In the long term, knowledge about larval dispersal and gene flow between populations is essential to ensure proper stock management based on population biology. Yet, previous population genetic studies reported contradictory results.

The group received an interesting presentation on work on the spatial genetic structure of king scallop in the English Channel.

New insight on the population genetics and genomics structure of *Pecten maximus* among the main fishing grounds in the English Channel, the Ushant Sea and the Bay of Brest

William HANDAL[1], Grégory CHARRIER[1] and Pierre BOUDRY[2]

1. LEMAR/IUEM, Université de Bretagne Occidentale, Technopôle Brest-Iroise, Rue Dumont d'Urville - 29280 Plouzané – France. Contact : william.handal@univ-brest.fr et gregory.charrier@univ-brest.fr
2. Ifremer, Unité Physiologie Fonctionnelle des Organismes Marins, Centre Bretagne - ZI de la Pointe du Diable - CS 10070 - 29280 Plouzané – France. Contact : pierre.boudry@ifremer.fr

The main objective of this study was to improve knowledge about connectivity and local adaptation among great scallop fishing grounds located in the English Channel, the Ushant Sea and the Bay of Brest, in order to provide concrete information to fisheries managers regarding great scallop population biology. This work was divided in three part. (i) Firstly, population genetic structure of *Pecten maximu*s among the main fishing grounds of the English Channel was analyzed through a multidisciplinary seascape genetics approach coupling microsatellite data and demo-genetic modelling. The main results underlined genetic differentiation between western Start Point population and the rest of the fishing grounds of the English Channel, suggesting reproductive independency. (ii) Secondly, the genetic structure between the Western English Channel, the Ushant Sea, the Bay of Douarnenez and the Bay of Brest was investigated using 'Genotype by Sequencing' (GBS) coupled to a hydrodynamic modelling approach, in order to understand connectivity between Bay of Brest and neighboring populations in a context intensive enhancement of this Bay. Results emphasize (1) the importance of the Ushant Front as barrier to larval dispersal between the Western English Channel and the Ushant Sea/The Bay of Brest and (2) larval flux from the Bay of Douarnenez to the Bay of Brest. (iii) Finally, adaptative genetic structure was explored using GBS, between the Bay of Brest, the Bay of Morlaix and the Normano-Breton Gulf. For the first time, fine scale adaptative processes were observed among main Brittany fishing grounds, for which reproductive differentiation were previously noticed.

This body of research showed demographic and genetic isolation between fishing grounds of *P. maximus* of the Western English Channel, the Ushant Sea and the Bay of Brest and suggested for the first time fine scale signals of selection between enhanced fishing grounds. This thesis aims to contribute to decision processes regarding management strategies of *P. maximus* stocks in the English Channel and in Brittany.

The present study provides a step forward in the understanding of great scallop population biology in the English Channel, underlining the fact that even in a context of potentially high gene flow and recent divergence time (since the end of last glacial maximum) at a regional scale, weak but significant spatial genetic structure can be identified. The group are aware of results available from a number of other studies in the Irish Sea and WG members are involved in trying to establish PhD projects to further consider the topics of genetics and larval dispersal.

6 Progress on ToR f)

ToR f) Keep current biological parameters under review and update when more information becomes available and report on all relevant aspects of: biology, ecology, physiology and behaviour, in field and laboratory studies

A number of biological parameters were reviewed in the various models that have been highlighted as part of ToR b. There was also an interesting discussion on predation because a high number of octopus have been present in areas around France. Starfish are also a known predator of scallops and the group discussed the possibilities of collaborating on a future project.

The group were also presented with a number of studies that the Virginia Institute of Marine Science have been involved in.

Age and growth

Age and growth data of sea scallops is routinely collected from fishery-dependent data sources for use in assessment and management of the stock. Growth or length data are used to provide length frequency distributions for relevant management areas and to determine when protection should be provided from fishing effort for juvenile scallops within the context of rotational area management. Growth data in conjunction with meat weight data are used to estimate length-weight relationships for relevant management areas and for both sub-units of the stock. Age data is estimated from external growth signatures from the top value of shells by the Northeast Fisheries Science and the Virginia Institute of Marine Science (VIMS). VIMS is also developing an age technique based on reading of annual growth signatures in the resilium.

Understanding growth is an important component of the assessment for sea scallops because the assessment is forward projecting length-based model. Examining external growth signatures across time and space has found growth to vary spatially and temporally. Also, in recent years, slow growth has been observed in several areas of the resource. This slow growth may be attributed to high scallop density and has had to be accounted for in the assessment model, projection model for the annual specific process, and management. There is also an effort underway to develop an age-structured model.

Incidental scallop mortality

Estimates of incidental mortality of sea scallops in the US sea scallop fishery were considered uncertain and based on studies conducted in the 1970s and 1980s, until the 2018 benchmark assessment. Incidental mortality is assessed separately for stock areas characterized by differences in dominant substrate types; there are area specific estimates for the Mid-Atlantic and Georges Bank. This type of mortality is accounted for in the annual specifications process. Incidental mortality of sea scallops is subtracted from the acceptable biological catch prior to the fishery receiving its annual catch limit.

Previous study estimates ranged from 15–20 percent for hard bottom to 5 percent for sandy bottom. Based on these studies, the 2014 assessment used estimates of 0.2 for Georges Bank and 0.1 for the Mid-Atlantic. The most recent study conducted in 2014 and 2015 utilizing an autonomous underwater vehicle provided updated estimates for both resource sub-units. The Mid-Atlantic estimate was 2.5 percent and the Georges Bank estimate was 8 percent and both were lower than published in previous studies. These updated values were used in the 2018 benchmark assessment. Assessments also adjust incidental mortality to account for the selective nature of commercial scallop dredges.

Discard mortality

Discard mortality in the US sea scallop fishery has been estimated for several bycatch species and sea scallops in recent years. Sea scallops are discarded in the fishery as a result of market conditions, product quality, high grading, and regulatory requirements. Other bycatch species including skates, monkfish, and several flatfish species are discarded for a variety of reasons ranging from no possession regulations to market conditions. The main method for estimating discard mortality across the majority of species has been the use of health indicators that assess reflex impairment, vitality, and injury condition in combination with survival mixture models to assess the relationship between the capture/handling process and delayed mortality associated with fishing. This method allows for field study results to be scaled to the fishery, while providing robust discard mortality estimates for management and assessment use.

Results from the different studies varied and indicated the approach for estimating discard mortality is species-specific. For some species (scallops and skates), the use of on-board holding tanks to assess delayed mortality was successful, but for other species like monkfish, the use of pop-satellite tags was a more effective approach. Also, for some species the incorporation of additional covariates like exposure time and tow duration into the survival model improved discard estimation. The majority of discard estimates from these studies indicated discard mortality is below 100 percent. The 20 percent discard mortality of sea scallops estimated from the field study was similar to the assumed value used for assessment purposes. For skates, discard mortality was species-specific and ranged from 90 to 35 percent. The monkfish discard mortality rate was estimated at 27 percent and found to vary by month.

Recovery of commercially valuable scallop (*Pecten maximus*) populations under different forms of protection around the Isle of Arran, Scotland

This study assessed the effects of a Marine Protected Area (MPA) and No-Take Zone (NTZ) around the Isle of Arran, Scotland, on the recovery of commercially valuable king scallop (*Pecten maximus*) populations. Changes in density, size, age, biomass and reproductive potential in king scallops were assessed over time. This research built on previous data collected by annual dive surveys from 2010–2015. Now, after over ten years of the NTZ being in place (2008), and three years since the MPA was designated (2016), new data were collected in 2019 to compare the differences in densities and population structure. Fifty-five underwater SCUBA survey transects were completed within the NTZ, the MPA and in a fished areas open to scallop dredging. All scallops were counted on each transect, the first ten were aged and measured, and a subsample were collected for dissection to assess exploitable and reproductive biomass. King scallop density was 2.7x greater in the NTZ (~23 scallops/100m^2) than in the Fished area (~8.6/100m^2) and 1.4x greater than at the Far-Control sites in the south of the MPA (~16.5/100m2). Densities of king scallops above the Minimum Legal Landing Size (MLLS) within the NTZ were significantly higher than those in the Fished area. A dramatic increase of king scallops over time was found in the NTZ (~3.4 fold from 2013–2019), in the MPA Near-Control site (~4.4 fold from 2013–2019); and within the Far-Control sites in the MPA (~6.2 fold from 2014–2019). A generalised linear model showed that juvenile scallop abundances in the protected areas were affiliated with the presence of bryozoans and macroalgae. With increasing level of protection, scallops were older and larger; there was ~8x more gonad biomass per unit area in the NTZ than the Fished sites in 2019. With a reduction in fishing pressure in the MPA and NTZ, scallop populations have been able to recover and grow to larger sizes. With increased size, scallops have larger gonads, thus more gametes are released in spawning seasons. Given scallops are broadcast spawners, high densities are also likely to increase fertilisation success. This suggests protected areas can be a key tool for implementing ecosystem-based management, which is important for the recovery of benthic species. If properly monitored and managed, this method can also provide a contribution to fishery landings from larvae exports to surrounding areas.

7 Progress on ToR g)

ToR g) Compare age reading methodologies and attempt to develop common practices and determine precision and bias of scallop age reading data derived from different readers

Being able to accurately estimate the age of a population is an essential component to the majority of fisheries stock assessments and contributes significantly to sound fisheries management. Due to serious repercussions that age errors can potentially have upon the management of stock, standardised methodologies and quality control measures are vital in order to produce validated age and growth estimates. This study aimed to examine the precision of age estimates for king scallops, *Pecten maximus*, from readers within and between scientific institutes across the NE Atlantic and suggest ways in which any variability could be reduced. A total of 133 scallops from 7 institutes across 7 countries (England, Scotland, Northern Ireland, Isle of Man, Ireland, France and Norway) were exchanged during 2018 and 2019, with each set of samples (~20 scallops) being aged by up to 19 scientists. Two key statistics were calculated from the resultant age estimates, percentage agreement and coefficient of variation. Results showed high variability between readers from different institutes, with low percentage agreement (~50 %) and high coefficients of variation (~17%). Percentage agreement between readers from the same institutes was similarly poor (~50%) but coefficient of variation was much better (<5 %) suggesting readers only differed by a small amount. Fish ageing studies using otoliths indicate that a coefficient of variation > 10 % is a concern, suggesting a need to improve consistency between different scientific institutes in the NE Atlantic. We recommend an in person workshop where key scientists from each institute can share their interpretations of shells from different areas. The adoption of image analysis software such as 'Smart Dots' for recording and sharing samples between scientists would also enhance future age validation exercises.

The group were informed that the resolution for the Workshop on Scallop Aging (WKSA) had been accepted and this meeting will be held in Aberdeen (9–13 March 2020). A presentation from the Working Group on Biological Parameters (WGBIOP) provided an introduction to SmartDots and a sub group will now progress with possibilities for hosting an event at WKSA.

Use of cameras/photos/images

Image based age reading is used in otolith age assessments and exchanges. Marine Scotland Science (MSS) are currently trialling the efficacy of using this technique for scallop age assessments/exchanges. Image based age reading is quick and may reduce time and costs associated with exchanging scallop shells with various institutes. MSS have trialled different methods of imaging the scallops using various camera and tripod set ups. Different lighting, camera settings and scallop states were tested, and the next stage is to ask readers to age the scallop images. The age readings between scallops in real life and images of the scallops will be compared. The aim is to develop a reference set of scallop images and develop a standardised protocol for imaging scallops. Once the images are finalised and analysed they will be uploaded to the online portal SmartDots that allows readers to take part in exchanges by reading the images online. We hope that this image-based age reading will allow a quicker and more effective method of exchanging scallop age readings.

Annex 1: List of participants

Name	Institute	Country (of institute)	Email
Lynda Blackadder	Marine Scotland Science	Scotland, UK	Lynda.Blackadder@gov.scot
Shona Kinnear	Marine Scotland Science	Scotland, UK	Shona. Kinnear@gov.scot
Isobel Bloor	Bangor University	Isle of Man/Wales	i.bloor@bangor.ac.uk
Kevin Stokesbury	University of Massechussets	USA	kstokesbury@umassd.edu
Adam Delargy	Bangor University	Wales, UK	adam.delargy@bangor.ac.uk
Claire Szostek	Bangor University	Wales, UK	c.szostek@bangor.ac.uk
Carrie McMinn	AFBI	Northern Ireland, UK	Carrie.McMinn@afbini.gov.uk
Eric Foucher	IFREMER	France	Eric.Foucher@ifremer.fr
Michael Sheridan	Marine Institute	Ireland	Michael.Sheridan@Marine.ie
Andy Lawler	CEFAS	England, UK	andy.lawler@cefas.co.uk
Spyros Fifas	IFREMER	France	spyros.fifas@ifremer.fr
Bryce Stewart	University of York	York, UK	bryce.beukers-stewart@york.ac.uk
Jonas Jonasson	Marine & Freshwater Resarch Institute	Iceland	jonas.jonasson@hafogvatn.is
Ellen Sofie Grefsrud	IMR	Norway	ellen.sofie.grefsrud@imr.no
Claire Lambden	Orkney Sustainable Fisheries	Scotland, UK.	c.lambden@orkneysustainablefisheries.co.uk
David Rudders	Virginia Institute of Marine Science	USA	rudders@vims.edu
Stuart Jenkins	Bangor University	Isle of Man/Wales	s.jenkins@bangor.ac.uk
Andy Brand	Retired	Isle of Man	arbrand@liverpool.ac.uk

Annex 2: Resolutions

The **Scallop Assessment Working Group** (WGScallop), chaired by Lynda Blackadder, Scotland, UK, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2019	7–11 October	Isle of Man	Interim report by 1 December	
Year 2020			Interim report by Date	
Year 2021			Final report by Date to SCICOM	

ToR descriptors

ToR	Description	Background	Science plan codes	Duration	Expected Deliverables
a	Compile and present data on scallop fisheries in ICES areas IV, VI and VII by collating available fishery statistics.	The fisheries are socio-economically important and there is a need to collate these data at a national level to ensure assessments can proceed.	5.1	Years 1,2,3	Landings, effort and commercial sampling data on listed species, from each country.
b	Review recent/current stock assessment methods of the main scallop species and explore other methodologies; including comparisons with fishery dependant indicators.	The aim is to assess the status of scallop stocks and contribute to Integrated Ecosystem Assessment and Management and descriptor 3 of the MSFD.	5.1, 6.3	Years 1,2,3	Report on alternative assessment methods. Link with WKLIFE.
c	Collate all available data and attempt to conduct a stock assessment for the north east Irish Sea.	The Isle of Man currently conducts stock assessments on their territorial seas. The aim is to assess the wider area.	5.1, 6.2	Years 1,2,3	Stock assessment for north east Irish Sea.
d	Review and report on current scallop surveys and share expertise, knowledge and technical advances.	Focus will be on reporting recent updates with regards to surveys and sampling, use of cameras, gear efficiency and selectivity, impact of scallop dredging, discard mortality, MPA's and closed areas, bycatch.	1.4, 1.5, 4.4, 5.2, 5.4	Years 1,2,3	WG report chapters. Exchange of scientific staff on surveys. Database to collate bycatch data.

e	Continue to refine stock structure using best available information on genetics and larval dispersal and look to improve current mapping of scallop stocks.	Knowledge on the genetic stock structure and extent of larval dispersal is still weak but a number of projects are underway.	1.4, 1.8	Years 1,2,3	WG report chapters and relevant maps. Link with WGSFD.
f	Keep current biological parameters under review and update when more information becomes available and report on all relevant aspects of: biology, ecology, physiology and behaviour, in field and laboratory studies.	Several biological parameters are important for analytical assessments and parameters may vary depending on the stock area.	5.1, 5.2	Years 1,2,3	Update knowledge on crucial stock parameters.
g	Compare age reading methodologies and attempt to develop common practices and determine precision and bias of scallop age reading data derived from different readers and methods.	Many institutes rely heavily on aging methods but there are no common methodologies or protocols.	4.4, 5.1	Years 1,2,3	Produce guidelines on agreed methodologies.

Summary of the Work Plan

Year 1	Annual standard outputs for ToR a,d,e, f. Collate lists of available data for Irish Sea (c). Age reading workshop (g), arrange scientific staff exchange on surveys (d) and knowledge exchange on current scallop stock assessment methods (b).
Year 2	Annual standard outputs for ToR a,d, f. Collate available data for Irish Sea (c). Age reading guidelines further discussed (g). Update and report on genetic and larval dispersal models and attempt to colloborate on further work (e). Review scallop stock assessments caried out by national institutess (b).
Year 3	Annual standard outputs for ToR a,d, f. Stock assessmnet for Irish Sea (c). Age reading guidelines produced (g). Produce maps on genetic stock structure and larval dispersal (e) Further develop scallop stock assessment methods (b).

Supporting information

Priority	The fisheries for scallops are socio-economically important and trans-national in Europe and North America. Management of stocks in Europe is primarily by technical measures and in most countries there are generally little or no management instruments to control fishing effort. This is currently the only scientific assessment forum for discussion and

	development of common assessment methods for scallops. Consequently, these activities are considered to have a very high priority.
Resource requirements	The research programmes, which provide the main input to this group, are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by 16 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages as the WG does not currently provide advice.
Linkages to other committees or groups	There are currently no direct linkages but the WG has made recommendations for WGSFD and WKLIFE.
Linkages to other organizations	None.

Annex 3: Assessment areas

ICES subareas	ICES divisions	Assessment area	Species	Data support	Assessments	Latest Assessment
2	IIa	Frøya, Trøndelag	King	Logbooks; effort	Landing size	
4	IVa	Shetland	King	Landings (sq), VIMS, 2 surveys, C at Age,	C at Age TSA, VPA, LPUE	TSA 2016
	IVa	North east	King	Landings (sq), VIMS, 1 surveys, C at Age,	C at Age TSA	TSA 2016
	IVb	East coast	King	Landings (sq), VIMS, 1 surveys, C at Age (limited)	C at Age TSA	TSA 2016
4 and 6	VIa and IVa	Orkney	King	Landings; VMS; C at Age (limited)	None	None
	IVb	27.4.b.S (Cefas)	King	Swept area dredge survey, biological sampling	Biomass estimates	2018
5	V	Iceland	Icelandic	survey; landings; logbooks;	Data limited approaches	2019
	Vb	Feroes	Queen	Landings; logbooks	None	None
6	VIa	Clyde	King	Landings, VMS, C at Age, annual dive surveys around Arran (since 2010), dredge survey 2019	None	None
	VIa	West of Kintyre (including NI)	King/Queen	Survey 3 yr (K), 1 yr (Q); VMS; landing; logbooks; Scottish survey, C at Age	C at Age TSA (King)	TSA 2016 (King)
	VIa	North west	King	Survey; landings, VMS; C at Age	C at Age TSA	TSA 2016
7	VIId	Bay of Seine	King	Survey; logbooks; effort; landings; VMS	Biomass estimates, population structure, TAC	2019
		Greenwich Buoy	King	Logbooks;effort; landings;VMS	Effort	
		Sussex	King	Logbooks;effort; landings;VMS	None	
		Bassurelles	King	Logbooks;effort; landings;VMS	Effort	
	VIId	27.7.d.N (Cefas)	King	Swept area dredge, biological sampling	Biomass estimates	2018
	VIIe/h	Cornwall	King	VMS, historical survey	None	
	VIIe	27.7.e.I, O, L (Cefas)	King	Swept area dredge and UWTV survey, biological sampling	Biomass estimates	2018

VIIf	27.7.f.I (Cefas)	King	Swept area dredge survey, biological sampling	Biomass estimates	2018
VIIg	Celtic Sea	King	Logbooks; VMS; historic survey; size data; 2018/19 survey	Trend, biomass estimates	2019
VIIa	Tuskar	King	Logbooks; VMS; size data; 2019 survey	Trend, biomass estimates	2019
VIIa	Cardigan Bay/Liverpool Bay	King	Landings; logbooks; VMS; 7 years survey	Landing size, engine power, # of dredges, gear specs, closed areas. Three stock assessment models	2019
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	Queen	28 yrs surveys(I of M); logbooks; VMS; landings	Landing size, # of dredges, gear specs, closed areas	2019
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	King	28 yrs surveys(I of M); logbooks; VMS; landings	Landing size, # of dredges, gear specs, closed areas	2019
	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	28 yrs surveys(I of M); logbooks; VMS; landings	CSA -queen, none for King	2019
(Ireland)	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	15 yrs surveys(I of M); logbooks; VMS; landings	CSA -queen, none for King	
	Liverpool Bay (separate survey from IOM until 2013)	King/Queens	Landings; logbooks; VMS; 2 years survey	Landing size, engine power, # of dredges, gear specs, closed areas	
	Northern Irish Coast	King	20 yrs of survey, VMS, logbooks	Survey based	
26e7, VIIe	Greater Baie de St Brieuc	King	Survey;logbooks; effort; landings	TAC	2019
	West Brittany	King	Survey; logbooks; effort; landings	Effort	
	Lyme Bay	King	Logbooks; effort; landings	Effort	
	Baie de Brest	King	Logbooks; effort; landings	Effort	
	Casquets	Queen	Logbooks; landings	None	
VIII	Glenan	King	Logbooks; effort; landings	Effort	

Pertuis/Charentais	King	Logbooks;effort; landings; historical surveys	Effort
Belle ile en Mer	King	Logbooks; effort; landings	Effort