ICES WGSCALLOP REPORT 2017

SCICOM Steering Group on Ecosystem Processes and Dynamics

ICES CM 2017/SSGEPD:25

Ref. ACOM, SCICOM

Interim Report of the Scallop Assessment Working Group (WGSCALLOP)

10–12 October 2017

Belfast, Northern Ireland, UK

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2017. Interim Report of the Scallop Assessment Working Group (WGSCALLOP), 10–12 October 2017, Belfast, Northern Ireland, UK. ICES CM 2017/SSGEPD:25. 18 pp.

Contents

Executive summary

The Scallop Assessment Working Group (WGScallop) has assembled the present information on the location of fishing effort, methods of surveying, population dynamics, biological parameters, fishery reference points and habitat impacts for the King, Queen and Icelandic scallops in ICES areas: 2a, 4a, 4b, 5, 6a, 6b, 7a, 7d, 7e/h, 7g, and 8, as outlined by the ToRs, based on the research of individual groups and organizations. This year WGScallop was transferred from the Advisory Committee to the Science Committee under Ecosystem Processes and Dynamics Steering Group (EPDSG).

The fifth meeting of the ICES scallop working group in Belfast, Northern Ireland, was productive; consisting of summary presentations addressing the terms of reference and a review of the sampling design of the newly developed English Channel cooperative dredge survey conducted by CEFAS and the fishing Industry. The data presented suggest that several stocks are in good shape, with indices either holding steady or increasing from the previous 3 years; a few seem to be in decline such as the Celtic stock. These patterns seem to be continuing from last year.

The large King scallop recruitment in the Baie des Seine observed in 2016 has moved into the year 2 suggesting extremely good landings in the upcoming year. Further, a second large recruitment of scallops has been observed in the French surveys. The tension continues to build with the fishing fleets from different nations focusing on harvests in the English Channel, particularly the Baie des Seine waters. This reflects the need for a global plan to avoid "the tragedy of the commons" scenario; without it sustainable management decisions will be difficult.

The workshop began with review of the ToRs. Discussions focused on: 6) Review the scallop stock assessment approach and methodologies developed for stock in English waters; followed by 3, 2, 4, 5 and 1, Review of current research underway on scallops including updates on surveys results. For the first time all areas will have independent fisheries surveys, as Ireland is now doing a survey with the Isle of Man/Welsh researchers. New information on the Norwegian King and Icelandic stocks was also presented.

Examining VMS data by ICES rectangle or on finer scale (kilowatt days, VMS hours) has been compiled by WGSFD, we will examine this data set ensuring it meets the needs of the effort maps we are trying to compile, and compare it to other researchers work completed by York University and Marine Scotland. This will enable us to map effort/weight/fishing time, and maybe nominal LPUE (everybody will try to do it). Further each group will produce relative abundance maps for their survey area and we will create a data table with tow, scallops m2, efficiency, scallops m2 * efficiency coefficient, midpoint latitude and longitude of tow. Finally we will compile data on google earth and GIS (type structure). We are also conducting King scallop aging calibrations between laboratories.

1 Administrative details

Working Group name

Scallop Assessment Working Group (WGScallop)

Year of Appointment within current cycle

2016

Reporting year within current cycle (1, 2 or 3)

2

Chair(s)

Kevin Stokesbury, USA

Meeting dates

10–12 October 2017

Meeting venue

Belfast, Nothern Ireland, UK

2 Terms of Reference

1. Compile and present data on landings and fishing effort that enables the following data products to be produced at as high a spatial resolution as the available data allows in ICES areas IV, VI and VII. Refer to WGScallop 2015 for methodologies
    a. maps of fishing pressure, fishing effort and landings
    b. GLM/GAM standardised LPUE indicators of stock status
    c. maps of relative abundance of scallop
    d. best estimates of absolute abundance using available habitat specific gear efficiency estimates
    e. estimates of area of stock distribution exposed to fishing each year
2. Identify studies of larval source sink patterns of scallops throughout their distributional range in the NE and NW Atlantic to
    a. evaluate the potential value of protected areas as sources of scallop recruitment
    b. Identify populations that are important sources of larval supply
3. A) Review of current research underway on scallops throughout their distributional range in the NE and NW Atlantic, focusing on population dynamics, stock structure, life history and habitat impact of fisheries. B) Compare basic models

derived from landings and effort to more complex models where they are available. (link to WKLife)

4. Estimate scallop discard mortality for all regions.
5. By-catch information, compile and report on the different survey/ICES rectangle.
    1. Table and maps will be compiled prior to the meeting of landings, effort (kilowatts days) by ICES rectangle.
    2. Shell exchange – aging examination.
    3. Use this data to define boundaries comparing/contrasting the ICES rectangle to the biological and fishing effort distributions.
    4. Examine the connectivity between these rectangles.
6. Review the scallop stock assessment approach and methodologies developed for stock in English waters and comment on the appropriateness of the approaches to deliver metrics of stock biomass and exploitation rate suitable for use in a management context.

3 Summary of Work plan

To complete compilation of landings, effort, fishing distribution data and to derive basic indicators of stock status. Evaluate how stock assessment methods proposed by WKLife can be applied to scallop stocks. Evaluate the potential benefit of MPAs and European marine sites as sources of scallop recruitment. Evaluate and report on by-catch species composition and also on discard mortality rates of underside scallops with reference to the EU landings obligation.

4 List of Outcomes and Achievements in this delivery period

Stokesbury, K.D.E. ICES Scallop Working Group Overview. International Pectinid Workshop, Portland, Maine April 2017.

5 Progress report on ToRs and workplan

The fifth meeting of the ICES scallop working group in Belfast, Northern Ireland, was very productive and consisting of summary presentations addressing all the terms of reference. Each group compiled a summary paragraph of each presentation which are included in Annex 2 of this report. The presentations are loaded on the SCALLOP WG ICES work site.

The WG had a discussion on the role of observers at the meeting and how best to communicate information to the larger community, specifically fishing Industry partners that participate in cooperative research. Presenting summary work from the group at an open forum or having one of the meeting days as open were both suggested. Concern was raised over confidentiality of preliminary research and equal transfer of information to all parties.

A table detailing the design of scallop surveys presented at this meeting was compiled and loaded on the SharePoint.

The protocols for the group scallop aging experiment were reviewed, an agenda of shell exchange was designed and a uniform spreadsheet for the observer information was created and loaded on the share point.

A review of the sampling design of the newly developed English Channel cooperative dredge survey conducted by CEFAS and the fishing Industry was completed (ToR 6). This survey came together very quickly resulting from a great deal of work and coordination between the scientific agency and the industry. Surveys began in May and were conducted into September 2017. Data from the summer's surveys were not available yet but the sampling design, assumptions and possible statistical procedures were presented and discussed.

The beds in the English Channel were defined by examining 8 years of VMS data. A 15km by 15km grid with each grid divided into 60 cells was laid over the VMS data. One cell was randomly selected within each block but this number was reduced by 25%. The 25% was given to the fishing industry partners to choice a tow location. If an Industry tow was located in a cell it was used to raise the density within that cell only. The randomly selected tows were averaged and used to estimate the density/abundance of the bed (arithmetic means method). This process was necessary as the industry tow was not a randomly assigned tow and its influence therefore had to be restricted to a local effect only.

Efficiency was previously estimated by depletion tow experiments (5). There were variation between substrates but these did not seem to follow particle size. Estimates suggested higher efficiency for this gear compared to other studies. We suggested that continuing and expanding these efficiency experiments, maybe add a camera to dredge (useful in other areas i.e. Isle of Man). The researchers are proposing to release RFID tagged scallops and subsequently try and recapture these and detect these with RFID readers on the dredge to estimate efficiency.

Drop camera surveys are being conducted in non-fished areas; these worked well but covered only small area given the low scallop density (1 scallop to $10m^2$). We suggest conducting some drop camera samples in the fished areas where dredge survey tows are taken, could add to the estimates of dredge efficiency.

There is a need to assess the western English Channel and the Eastern Channel as 2 stocks. Permission was not obtained to sample in French waters for the 2017 sampling year. Addressing the 3 primary questions on design put forward by the research scientists conducting the survey the WG suggested:

1) The definitions of the beds using the VMS and a polygon tool

This is a sound approach that clearly defines the beds based on the fishing effort.

2) The stratification on rectangles characterizing the bed

Habitat map might improve precision and accuracy by enabling stratification by substrate type. The basis for stratification could be further developed.

Re-randomize stations annually? Examine the data collected in 2017 by post-stratifying by habitat to see if re-stratification is required.

3) The inclusion of the industry survey stations in the sampling design.

The inclusion of the industry tows complicates the estimate of the variance associated with the survey design, probably a bootstrap technique will be required.

Need to conduct analysis of the industry vs random tows on actual data. Does the reduction of 25% of the random tows result in a significant increase in variance? The survey could be improved possibly by randomly assigning (within strata) 100% of the tows. Industry LPUE data in the previous year could be used to assign industry tows.

Explore different interpolations, different smoothers, geostatistical procedures etc.

Although there seems to be a great deal of LPUE data it was unclear how to use it, plus these data suggest dredge efficiency is low while the depletion experiment suggested it was high. The patterns depend on how the LPUE are reported and how they are aggregated in time and space. Sequential fishing of different areas, relative to the spatial resolution of reporting, could mask depletion.

Action list:

1) Examine variations in ageing techniques: Variations in growth rate
2) Compile Fishing effort data (VMS data by ICES rectangle and /or kilowatt days): Stock boundaries

6 Revision to the work plan and justification

None. The group is continuing to address the current 3-year ToRs and preparing for the final report due after the next meeting.

7 Next meetings

WGScallop will meet on 10–12 October 2018 in York, UK, hosted by Bryce Beukers-Steward.

Annex 1: List of participants

Name	Country	Email
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Annex 2: Summary presentations

Marine Scotland Science Scallop Dredge Survey 2017 overview

Lynda Blackadder

The marine laboratory has carried out dredge surveys for king scallops for at least 36 years, formerly using commercial boats, but more recently its own research vessel which since 2008 has been the MRV Alba na Mara. The survey aim is to collect catch rate data for the stock assessment process. MSS conducts three scallop surveys per year; the east coast of Scotland, the west coast and Shetland, with 332 fixed stations. Station positions are based on historical fishing patterns and areas of suitable sediment from British Geological Survey sediment maps. In 2017, six new stations were added to provide better coverage of commercial fishing grounds as indicated by VMS.

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 belly rings, similar to commercial King scallop dredges and the port side has sampling gear made up of 6 x 11 toothbar and 60 mm belly rings, 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 2.5 knots for ~30 minutes and all King scallops are aged and measured. Other objectives include: assessing shell damage, identification of bycatch and collection of samples for genetic research. Camera work has started but time restraints put a limit on progression. Further trials should hopefully be carried out in 2018.

In 2017, a total of 221 stations were sampled and 26801 scallops caught. Some stations, located in newly designated Marine Protected Areas (MPA) where commercial dredging is banned, were not completed (although the impact of this on the survey index appeared to be relatively minor). Vessel time has been requested, as usual, for three surveys in 2018 and the main objective will be the same.

Marine Scotland Science scallop stock assessment overview

Lynda Blackadder

Scottish regional scallop stock assessments carried out by Marine Scotland Science (MSS) based on commercial catch-at-age data up to 2015 and survey data up to and including 2016 were presented at WGScallop 2017. Full analytical assessments (Time Series Analysis) were presented for the East Coast, North East, North West, Shetland and West of Kintyre scallop stocks. Full details will be available in the report, due to be published shortly. There are insufficient data from the Clyde, the Irish Sea and Orkney assessment areas to perform analytical assessments or evaluate stock trends

The most important areas, in terms of recent landings, are the Irish Sea, West of Kintyre, the North West, North East and East Coast. In 2015, over 75% of landings into Scotland were taken in these areas.

In the East Coast assessment area, relatively high recruitment appears to have maintained spawning stock biomass (SSB) and landings above average between 2005 and

2014. Current estimates of recruitment for 2015 and 2016 are, however, particularly low and SSB has declined since 2014. The decreasing stock size coupled with the relatively high landings results in a generally increasing trend in fishing mortality (F) since 2011.

In the North East assessment area, SSB has declined sharply in recent years. Recruitment has declined over the last five years and estimates for 2015 and 2016 are particularly low. F has fluctuated without trend over the last ten years.

At Shetland, following a number of very strong year classes during the mid-2000s, recruitment is estimated to be more moderate in recent years. The SSB increased during the 2000s to a maximum in 2010, but has been declining since 2012. Fishing mortality has increased since 2009, in line with the increase in landings, but is still at around the long term average.

In the North West assessment area, following a period of lower recruitment in the mid-2000s, estimated recruitment has increased and has been above the long term average since 2010. As a result of this and moderate landings, estimated SSB has increased steadily over this period. Recent estimates of fishing mortality are fairly stable at around the long term average.

In the West of Kintyre assessment area, recruitment is estimated to have increased substantially since 2000 resulting in the highest estimated SSB of the time series in 2012. Since then the stock has remained relatively stable at a high level. This increase in stock size means that despite an increase in landings since 2011, fishing mortality remains relatively low.

There are no agreed biomass or fishing mortality reference points for Scottish scallop stocks. MSS' advice for assessed stocks is provided on the basis of estimates of recent fishing mortality, recruitment and biomass in relation to historical values.

Northern Ireland scallop and queenie surveys

Carrie McMinn

In 2016, 1300 tonnes of king scallops were landed in to Northern Ireland ports by 59 vessels. 53% of these vessels were less than 12m in overall length and so will not have VMS available. ICES rectangles 37E4 and 37E5 show the highest landings which are landed into Northern Ireland. Landings per Unit Effort (LPUE) shows an upward trend in tonnes/day between 2000 and 2016.

AFBI carry out an annual scallop survey. Random stations are selected from a stratified grid of 1.5nm2. Four dredges are towed for 30 minutes at a speed of 2.5nm. All scallops which are caught are aged, length recorded and total weight, muscle weight and gonad weight taken. In addition all bycatch species are identified, weighed and counted. Genetic samples are also collected. Approximately 40 stations are surveyed annually.

The 2017 survey showed highest scallop abundance along the North Coast of Northern Ireland. Fifteen of the 2017 randomly selected stations were the same stations as in 2016. One of these sites, on the North Coast, the catches recorded in the 2 years shows less than a 3% variation. Seven of the stations showed a decrease in catches from 2016 to 2017, whilst the remaining 7 showed an increase in catches largest reduction in catch.

Analysis of the survey data from 1992–2016 (for the East Antrim and County Down) shows an increase in abundance of scallops in terms of numbers/m2 and biomass g/m2. In terms of juvenile scallops (<105mm length) there is a slight increase in numbers over the survey period but a larger increase in biomass of juveniles.

Bycatch Analysis from 2001–2016 shows 10 Phyla, 22 classes, 51 orders and 111 families have been reported from the survey Areas. Seven species have been reported from every Area; plaice, Norway pout, brown crab, hermit crab, common starfish, common sun star, edible urchin. Along the North coast the number one characterising species is the queen scallop. In all other Areas the common starfish is the most abundant bycatch species.

AFBI also carry out an annual queen scallop survey in the Irish Sea and Northern Ireland North Coast. Stations are selected at random from a fixed grid. At all stations the camera (sledge) is deployed and towed for 15 minutes. 10 minutes of the video footage is then counted. Based on these counts stations selected to fish. In the 2017 survey the fishing gear which was deployed was a tow bar with 2 scallop dredges and 2 queenie dredges, a queenie net and a beam trawl. After final analysis of the data collected during the UWTV survey, queen scallop density estimates will contribute to the provision of fisheries management advice.

Work is ongoing to produce an assessment for both king and queen scallops with the aim to have this completed by early 2018.

Fisheries UK Fisheries Improvements – The English Channel Scallop Fishery

Michel J. Kaiser, School of Ocean Sciences, Bangor University, UK

Bryce D. Stewart, Environment Department, University of York, UK

Project UK (www.seafish.org/pukfi) represents a four year collaboration between the Marine Stewardship Council (MSC), Seafish, WWF & various retailers & processors that started in 2016. The project will focus on six fisheries, including the dredge fishery for king scallops in the English Channel. The aim is to identify, improve and ultimately MSC certify market-relevant fisheries in the UK. By using the MSC Pre-Assessment process as a gap analysis, the project aims to determine current status, identify improvements and inform the development of an appropriate Action Plan for each fishery. The MSC pre-assessment of the Channel scallop fishery identified particular shortcomings / data gaps around stock status, harvest rate regulations (Principle 1) and the effects of the fishery on benthic habitats (Principle 2). The issues around Principle 1 are being addressed through a programme of work by Cefas, while the MSC, Bangor and York Universities successfully secured European Maritime and Fisheries Funds to address concerns around Principle 2. This funding will employ a 2-year post-doc, supervised by the two Universities, who will use the modelling approach from the recent 'Finding common ground: best practices for trawling' project (led by Michel Kaiser). This quantifies the instantaneous effect of specific fisheries (including scallop dredging) on different habitat types. Data requirements include: VMS outputs on fishing activity, maps of vulnerable marine ecosystems (VMEs), habitat maps with sedimentological information, penetration depth of the fishing gear and environmental data to assess recoverability of benthic communities. This research will be designed to inform spatial management of the fishery as gear modifications are unlikely to achieve the desired aims. The practical component of the project will

use overhead cameras on board approximately five commercial vessels to assess catch and bycatch on conveyor belts. These cameras are turned on and off by the crew, making them more acceptable. The cameras are also GPS and laser enabled to gather position data and provide a constant reference scale which will allow measurement of both by-catch and scallop quantities and size classes within commercial catches. This will provide information on the effect of the fishery on non-target species, and further inform habitat maps through the composition of species present in different areas. Outputs from this project will be reported to further ICES Scallop Working Group meetings as the research evolves.

Improving sustainability and reducing conflict in the Yorkshire, UK scallop fishery

Katharine Woods and Bryce D. Stewart, Environment Department, University of York, UK

Commercial fisheries within the coastal zone often target multiple different species, using various different gear types, in the same areas. This can result in conflict, particularly between those using static (e.g. crustacean pots and fixed nets) and towed fishing gear (dredges and trawls). Fisheries within 0-6 nm of the Yorkshire, UK coast are managed by the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA). In recent years, scallop dredging in this area has expanded dramatically, causing conflicts with crab and lobster fisheries and raising concerns over the sustainability of the scallop fishery. In response to this situation the NEIFCA introduced a temporary ban on all scallop dredging within six miles of the coast in February 2015, before opening two small boxes to scallop fishing for five months in December 2016. The location and size of these boxes was selected through a process of consultation to minimise conflicts with crustacean fishing activity and to reduce conservation concerns. Fishing effort was strictly limited in these areas and permitted vessels were subject to a range of conditions. This study analysed population dynamics of the king scallop, *Pecten maximus,* within these fished and unfished areas off the Yorkshire coast between 2014 and 2017. Analysis incorporated data from both annual fisheries-independent dredge surveys and quayside sampling of commercial scallop catches. Scallop densities were low in 2014 and increased up to 2017 in both fished and unfished areas; most notably for scallops above Minimum Legal Landing Size (MLLS) of 100 mm shell length. There were no significant differences between the densities in fished and unfished areas. Comparing size and age distributions, and their associated means, also showed general increases since 2014, but no differences between areas. Quayside sampling and surveys showed similar age and size distributions, indicating the surveys were relatively representative of commercial catches. In summary, the management strategy adopted by the NEIFCA appears to have reduced conflicts between sectors and to have generally improved the state of the scallop stock. Given the limited differences between the fished and unfished areas, we suggest that a cautious increase in fishing effort in the next season should be acceptable. Designating specific fishing areas for potentially damaging fishing methods, such as scallop dredging, appears to be a promising avenue for reducing conflicts in coastal fisheries and reducing their environmental impact.

Queen scallops (*Aequipecten opercularis*) Faroe Islands

Luis Ridao Cruz

Within the Faroe Islands territorial waters (ICES Vb) queen scallops (*Aequipecten opercularis*) are commercially fished. The main fishing grounds are located in the east and north of the islands. The fishery was initiated in the early 1970s in the eastern coast and early 1990s in the northern coast. In recent years the fishing activity has also extended to a fjord (Djúpini) situated in the north-east. The bulk of landings (>85%) is comprised of catches from the eastern area. Fishing for scallops is conducted by one single domestic vessel (30 m in length) using a double 12-feet dredge.

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

Since 1991 landings have fluctuated between 2300 and 6700 metric tonnes. Landing in both 2015 and 2016 remained unchanged (3000 t). Average tonnage from 1991 to 2016 is around 4100 t. Catch rates (CPUE, catch per hour) 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. No catch rates data for 2016 were available at the time of the meeting.

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-east ford (Djúpini) respectively.

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 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.

US scallop survey update 2017

Kevin Stokesbury

In the US there has been a great deal of research on the stock assessment of sea scallops. Scallops are assessed through a catch-at-size analysis (CASA) model (NEFSC, 2010; Hart *et al.*, 2013). Information used in the CASA model include Stratified Random scientific dredge conducted by the National Marine Fisheries Service and The Virginia Institute of Marine Science (VIMS), an independent cooperative drop camera survey sampling a grid pattern (School for Marine Science and Technology (SMAST) survey; Stokesbury *et al.* 2016) and a Habitat Camera survey (Habcam) using a "belt transect" design the Woods Hole Oceanographic Institute/National Marine Fisheries Service Habitat Camera survey (Chang *et al.* 2017). The US scallop abundance has been driving by several very large recruitment events (Bethoney *et al.* 2016). In 2017 all surveys provided similar estimates of the scallop resource minas the extreme recruitment areas, dredge = 136 000 mt, Drop camera = 132 000 mt and Habcam = 137 000 mt. However, when the recruitment areas were included for an estimate of the whole resource the dredge at 183 011 mt fell far below the two optical surveys, Drop camera = 309 000 mt and Habcam = 317 000 mt. Prelim-

inary observations suggest that at these high abundances the dredge is filling up completely before the 10 min tow is finished. Overall the stock is at very high abundance but such high densities raise concerns of increase natural mortality and limited new recruitment.

Bethoney N.D., S.C. Asci, and K.D.E. Stokesbury. 2016. Implications of extremely high recruitment events into the US sea scallop fishery. Mar. Ecol. Prog. Ser. 547:137-147.

Chang, J-H., B.V. Shank, and D. R. Hart. 2017 A comparison of methods to estimate abundance and biomass from belt transect surveys. Limnology and Oceanography: Methods. 15: 480-494.

English stock assessment program

Ewen Bell and Andy Lawler (Cefas)

The proposed program for stock assessment within English waters was presented to the group for review, discussion and, if appropriate, endorsement.

There are no long-time series of data considered appropriate for the assessment of scallop stocks in English waters and therefore a new data collection program has been devised. This comprises surveys (dredge and UWTV) and biological sampling of the landings and has been designed in a collaborative framework with industry through a Project Steering Board (PSB).

Survey design and rationale was presented to the group and was largely approved of, although there was considerable discussion around the use of both randomly allocated and industry selected stations in the survey design. This approach was requested by the PSB (to ensure incorporation of fisher experience into the process), however in order to maintain the statistical integrity of the survey design, the industry selected stations are considered representative of the position selected, whilst the randomly allocated stations are considered representative of the whole strata. Sensitivity testing of this design was conducted using historic data derived from VMS data linked to landings as proxies for survey catch data, with an assumption that industry selected stations would represent the highest catch rate areas (and therefore representing a "worst-case" scenario of potential bias). If industry selected stations were not treated with the appropriate statistical design then abundance could be significantly over-estimated. Due to the low spatial density of randomly allocated stations (each random station representing ~225km^2), with each industry selected station representing the immediate vicinity (~5km^2) they have less power to reduce uncertainty than had they been randomly allocated. The group agreed that given the combination of both scientific and industry-selected stations, that the planned data-raising process was the most appropriate. There was general agreement that it would be better to randomly allocate all stations in order to maximise the power of the survey in terms of reducing the uncertainty estimation. The group discussed historic values of gear efficiency which are required to convert survey derived relative abundance estimates to absolute abundance, and the importance of proposed future work designed to provide more accurate substrate and gear specific estimates.

The biological sampling program requires more spatially explicit data than could necessarily be obtained through standard market sampling techniques and primarily involves obtaining targeted samples from vessels identified using VMS data. At present there is a nominal target of 5 samples per ICES rectangle per quarter, however the group suggested

that changing the sampling target to reflect effort expenditure or landings might be more statistically appropriate.

Welsh Survey and Research

Adam James Delargy

Further research surveys have been undertaken throughout Welsh waters, with two major surveys within the last year sampling scallops using both dredges and a camera sledge. To date there have been five years of survey data collected for scallops in Welsh waters. Another survey is expected for 2018. The data gathered from these surveys will be used to help implement stock assessment of scallops, initially for a small-scale fishery which may open in part of Cardigan Bay. Currently the early stage stock assessment is conducted as a delay-difference model, but it is hoped to be able to incorporate age data to implement an age-structed cohort-based model. The advice provided from this stock assessment will take in to account environmental damage, by incorporating an environmental limit which will be based on research indicating the maximum amount of dredging that could be tolerated by a particular area.

Other pieces of research that are ongoing or have been completed recently include a study of spatial differences in life history traits in scallops throughout Welsh waters and further efforts to conduct camera sampling in a hope to improve this methodology. Research has also focussed on identifying and quantifying errors from the scallop surveys, with a view towards correcting for these in the stock assessment model. Efforts are being made to map commercial fishing patterns and there remains the longer-term view of conducting an economic analysis of the Welsh scallop fishery.

Norway (*Chlamys islandica*) – an historical overview

Ellen Sofie Grefsrud

Iceland scallops were found in substantial quantities in some fjords in northern Norway already about a century ago. The scallop was used as bait for local fisheries, but no data are available on the size of this fishery. A small fishery for human consumption existed near Kvænangen in the early 1960s and was estimated to be of approximately 500 t. The fishery did not persist due to a poor market and underdeveloped fishing and processing technologies, but the scallop beds at depths of 15 to 60 m in Balsfjord, Kvænangen and Porsanger were considered to have fishing grounds of commercial potential.

In the early 1970s it was discovered larger beds in the Bear Island, Spitsbergen and Jan Mayen areas in depths of 40 to 100 m. However, cost-efficient gear for harvesting scallops in offshore areas did not exist at the time. In 1985, the large-scale commercial harvest of scallops began with 1192 t whole weight being harvested that year and it increased rapidly, to more than 44 000 t in 1987. The gear and techniques were borrowed from Canada, USA, Iceland, and the Faroes. A total of 11 vessels, 10–14 m in length, were licensed for fishing in the coastal areas of northern Norway, while 34 vessels participated in the offshore fishery between 1985 and 1992. The numbers of fishermen varied from about 10–12 on the smaller vessels to 36 on the larger ones. The daily catch often exceeded 600 t for the most efficient vessels.

Ocean-going vessels, ranging in length from 29 to 69 m, were mostly modified factory trawlers, fresh fish and shrimp trawlers, purse seiners, longline vessels and supply ships from the oil industry. When the fishery began, the boats used a single-side action dredge (2.5 m wide) from Iceland that was towed at two knots. Afterward, catch efficiency was increased through use of a double-action dredge and higher towing speed. The dredge was a modification of US and Canadian dredge types and was towed at four to five knots with equal efficiency on both sides. The larger of the specially designed ships typically operated three dredges simultaneously, and sophisticated instrumentation to optimise fishing effort. The boats had up to three mechanised production lines for onboard processing and freezing of scallops. Crews onboard these boats could fish for 24 hours a day. The heavy fouling on the shells caused problems in the mechanised processing of the scallops and resulted in large amounts of discard in the early days of the fishery. Norway exported most of their scallops, as a frozen product to French and U.S. markets.

During the offshore fishery for Iceland scallops few regulations existed to protect the stock from over-exploitation. Outside the protection zone extending 4 nm from the coastline of Spitsbergen, no regulations were in effect for registered vessels participating in the Barents Sea scallop fishery in 1985. In 1986 restrictions preventing new boats from entering the fishery were implemented. The same year the University of Tromsø (UiT) conducted a two-month survey of the stocks at Svalbard, and Jan Mayen. The results showed that the size and depth distribution and scallop abundance varied between the areas. In 1987 a lower size limit of 60 mm was introduced for all areas, and, because stocks were depleted, scallop beds were closed at Jan Mayen. The 1987 UiT survey aimed to gain more knowledge on the scallop biomass but the main stocks were already highly affected by the heavy fishery. In 1989, a limited area of the Jan Mayen beds was reopened for fishing, while the scallop beds at Bear Island and Moffen (Spitsbergen) were closed. Subsequent catches have been from reopened areas regulated by a limited fishing period and a total catch quota. In 1989, Fevolden cautioned that a conservative approach to management of the Iceland scallop should be taken by considering each of the main areas (Jan Mayen, Spitsbergen, Bear Island, and northern Norway) as if they were separate genetic units.

In 1996 and more recently in 2006, some 20 years after this fishery started in Norwegian waters, surveys showed that two of the main scallop beds in the Svalbard area, one close to Bear Island and one at Moffen (Island), north of Svalbard, have recovered both in terms of scallop density and recruitment. However, the catch rates (CPUE) was 5–7 times lower when the scallop fishery stopped at the beginning of the 1990s than when the scallop fishery originally started. Shell height distributions show that the recruitment situation has improved at both beds, particularly at Bear Island. The relative number of legal scallops (shell height > 65 mm) is at the same level as at the end of fishery at Bear Island, while it has increased at Moffen. The 2006 survey showed that recovery of the scallop beds back to the pre-fishery status will still take many years, probably due to slow individual growth rates and rarely abundant recruitment events.

For the coastal stocks fishing was restricted to August 1st – March 1st. For 1985–1994, the total catch quota was 500–700 t round weight. In 1987, the first coastal scallop bed, south of Tromsø, was closed. Since 1995 the catch quota has been 250 t round weight, but the catch has been minimal. In 1986, bounded catch reporting by logbooks was implemented. The coastal stocks have been monitored on a regular basis from 1991 to 2008. In 2007 a

national program for mapping marine habitats along the Norwegian coast was initiated and since 2009 Iceland scallop has been mapped using an underwater towed video sledge. In this project, not only the commercial potentially stocks are mapped but also low-density occurrences based on historical data and/or using sea maps to choose areas that may be suitable for Iceland scallops. So far, the mapping project has shown that in Troms County few new occurrences have been found, while further north in the western part of Finnmark County, low densities of Iceland scallops were found several places. The mapping of Finnmark will continue throughout 2018 and will show if the eastern part of Finnmark (stretching from North Cape to the Russian border) shows the same pattern. Based on the previous monitoring and the ongoing mapping a new plan for monitoring the coastal stocks will be set.

(For a summary on the King scallop fishery in Norway please refer to last year's report).

Iceland (*Chlamys islandica*)

Jónas Jónasson

Moratorium was put in place in 2003 on the scallops 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. During the last years of the dredge survey there was a reduction in number of days at sea and in 2012 and 2013 only southern and northern part of Breiðafjörður were surveyed respectively. The full dredge survey index between 2006 and 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 and recruitment was evident in several areas.

In 2014 a cooperation 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. Two drop frame surveys were conducted in 2014, 146 camera stations were conducted in April and 43 stations in December after a spell of experimental fishing. In 2015, 80 drop frame stations were carried out, 150 in 2016 and 241 in the fall of 2017 (still being analyzed). 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 the known beds (Figure 1). Few new beds and scallops in fishable densities in the inner part of the old grounds have been detected in the drop frame surveys. A link to the drop frame surveys can be found here: http://www.hafro.is/~jonasp/

In the experimental fishing of 2014, 280 tonnes were fished in an area in southern part of the fjord. During the winter of 2015/2016, 630 tonnes were fished on four distinct areas. During the winter of 2016/2017, 575 tonnes were fished on five distinct areas, but due to a fisherman strike that lasted 8 weeks, the season was cut short. Each experimental area was split up further into roughly 1 km^2 rectangles. The fishing effort varied between areas and on the most heavily fished rectangles a decline in LPUE was observed during the fishing season.

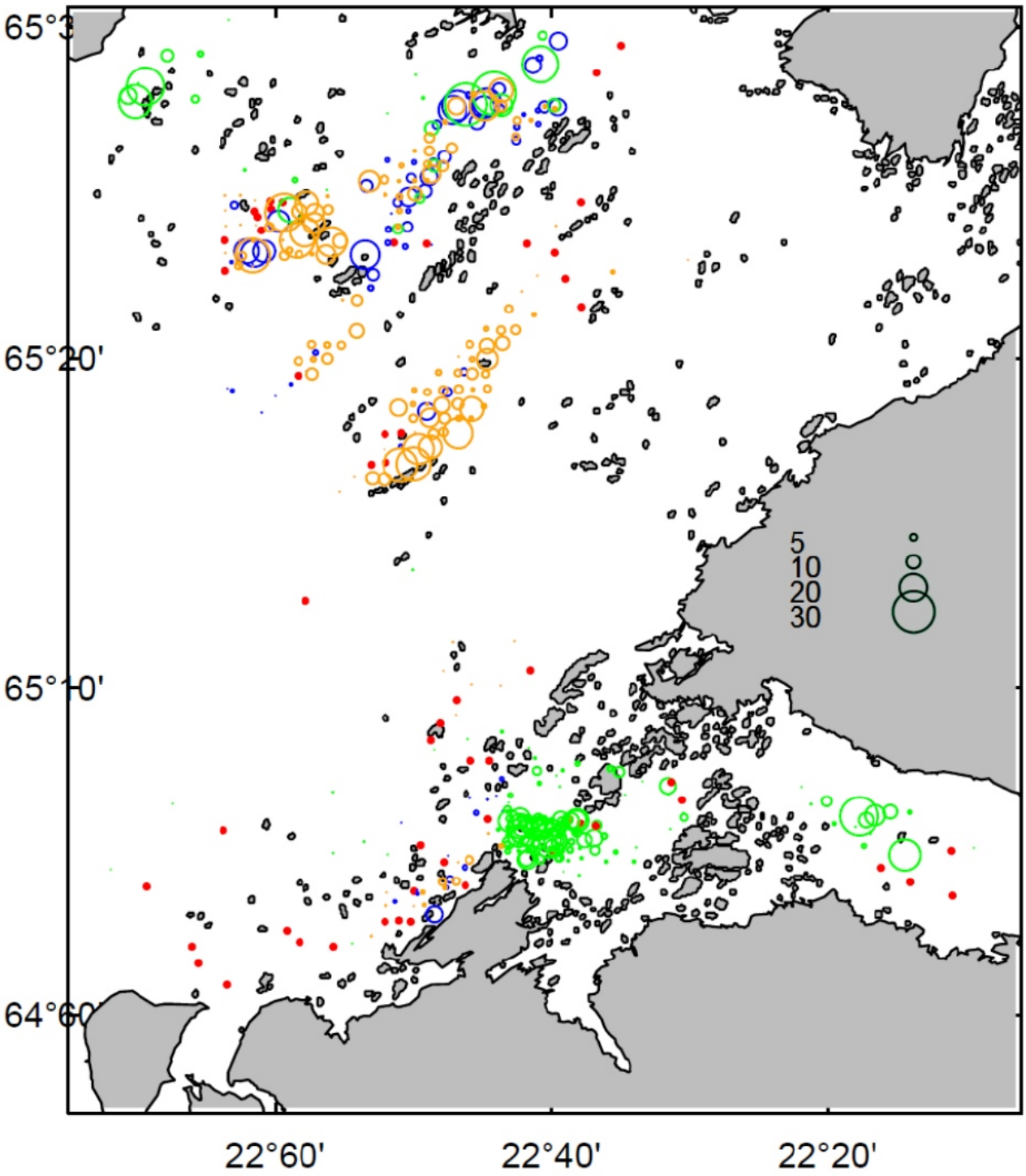

Figure 1. Camera survey stations in Breiðafjörður, during 2014 (green), 2015 (blue) and 2016 (orange). The size of circles represents the number of scallops (m^2). Red dots are stations with no scallops.

Annual assessment of King Scallop stock in the bay of Seine (France)

Eric Foucher

Each year, Ifremer assess the Bay of Seine stock of King scallop *Pecten maximus*, using data collected during a summer scientific survey. The survey COMOR47 took place from 30th of June to 17th of July 2017, during which 171 dredge hauls were made in the classified ground of Bay of Seine (located in French territorial waters) and the "Near Outside" (Figure 2), area located further north, between the 12-mile limit and the parallel 49°48N.

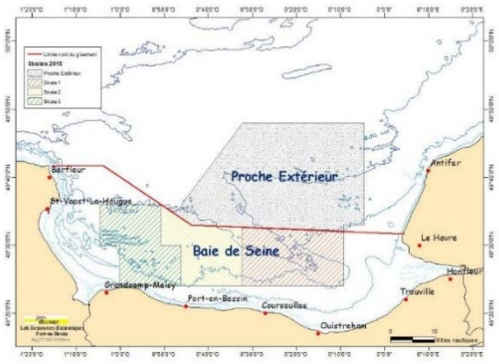

Figure 2. Area assessed by the French survey. The red line is the limit of the Bay of Seine fishing ground, corresponding approximatively to the 12 miles limit. The area called "near Outside" ("Proche Extérieur" in French) is located in international waters, and exploited by UK, Irish and French fleets.

The results of the assessment show, for all the areas surveyed, the best recruitment (2 years old individuals, cohort 2015) ever seen in the historical dataset, a better amount of adults (3 years old and more King scallop) than previous years, and a big difference for numbers of 1 year old juveniles scallops (pre-recruitment) between offshore and inshore areas, low level outside the French territorial waters, and massive amount inside. The exploitable biomass is estimated at 48572 and 18783 tons (Figure 3), respectively to the Bay of Seine and the "Near Outside".

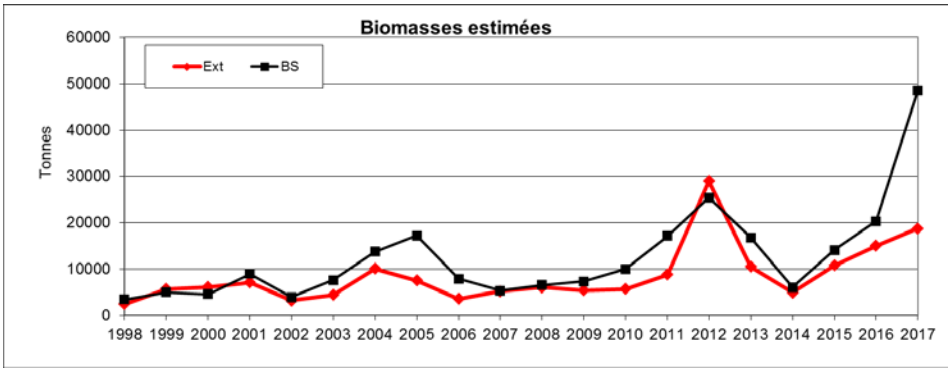

Figure 3. Trends of exploitable biomass in the bay of Seine, France (red line: international waters, black line: French territorial waters).