ICES WGScallop REPORT 2015

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Report of the Scallop Assessment Working Group (WGScallop)

5-9 October 2015

Trinity, Jersey, UK

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

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Contents

Executive summary

WGScallop met at Galway (2013), Nantes (2014) and Jersey (2015) to evaluate data availability, data provision and methods for stock assessment of scallop

The data available for scallop assessment varies by region and includes survey time-series, port sampling data on size and age, at sea observer schemes of catch rate, size distribution and bycatch, commercial vessel logbook and VMS data which report spatially explicit landings and effort data. Surveys use dredge (Europe) or dredge and underwater visual (video, stills) (USA) methodology. Surveys report absolute biomass (where sampler efficiency and selectivity is known) or relative abundance indices (by size or age). New developments include acquisition of high frequency VMS for the inshore fleet in some areas.

Stock boundaries are not well defined although larval dispersal modelling combined with genetic data provide information on connectivity between beds and the likely meta-population structure in some areas.

Stock assessment methods include Time-series Analysis (TSA) (Scotland), direct estimates from survey (France) and indicators (Ireland, UK). Potential per recruit reference points were evaluated.

Dredge efficiency and selectivity varies by seabed type and dredge design. These and other properties and design of the dredge are important in standardizing catch effort indices, for producing biomass estimates from surveys and in determining seabed impacts.

Scallop fisheries may overlap with Marine Protected Areas (including European Marine Sites). Impacts of scallop fishing on seabed integrity and biodiversity are reasonably well known and significant. Areas within MPAs/EMS which harbour scallop could be valuable as spawning areas and sources of larval supply.

Scallop biological parameters (growth, mortality, recruitment) vary spatially and are regulated by various environmental variables. Assessments including reference points therefore need to be spatially explicit.

Bycatch in the scallop fishery includes undersized scallop, crustaceans and demersal fish including elasmobranchs.

To improve future assessments and management advice, additional work to define the practical assessment units is needed. Future approaches to assessment should be spatially explicit because of environmental effects on scallop biology. Fishery-independent surveys will not be available for all stocks. However, logbook, VMS and high frequency VMS (inshore) data from the commercial fleet together with independently collated data on dredge numbers, seabed habitat and shear stress could be used to provide standardized indicators of stock status. These data also provide information on fishing pressures from which likely impacts on seabed integrity can be assessed for MSFD. Other stock assessment methods in review by WKLife will need to be evaluated. The value of MPAs as sources of scallop recruitment should be evaluated using larval dispersal simulation methods. More data on bycatch and discard mortality (of scallops and bycatch) are needed in relation to TAC species, the landings obligation and to evaluate the efficacy of management measures such as minimum landing sizes. These issues will be addressed in the period 2016–2018 by the Working Group.

1 Terms of Reference and Administrative details

Working Group name

Working Group on the Assessment of Scallop fisheries (WGScallop)

Year of Appointment within the current three-year cycle

Third year within the three year cycle

Reporting year concluding the current three-year cycle

2015

Chair(s)

Kevin Stokesbury, USA

Meeting venue(s) and dates

2–5 September 2013, Galway, Ireland, (15 participants)

6–10 October 2014, Nantes, France, (13 participants)

5–9 October 2015, St Helier, Jersey, UK, (10 participants)

Terms of Reference

The focus of the three year working group is to providing scientific advice on scallops, defining a common approach to the assessment of scallop stocks. The workshop focused ICES areas: IIa, IVa, IVb, V, VIa, VIa and IVb, VIIa, VIId, VIIe/h, VIIg, and VIII. Scallop species and biological stocks were identified in each of the ICES areas.

The original ToR's for this working group were:

1) Compile data on distribution of fishing effort and landings for scallop inshore and offshore waters, and explore the development of a common database.
2) Identify stock assessment and management units
3) Review biological parameters
4) Explore stock assessment methods and evaluation of indicators of stock status and identification of reference points
5) Review data provision and feasibility of obtaining data
6) Assess the efficacy of scallop fisheries management measures
7) Assess the impact of scallop harvesting on habitat and habitat recovery rates

In the first meeting in Galway 2–5 September 2013, we:

a) Compiled and reviewed available fisheries data for scallops
b) Reviewed data on stock boundaries to identify stock assessment units
c) Compiled and reviewed available data on biological parameters for scallops including

i) Size at age and ageing methods

ii) Size at maturity including seasonality

a) Discussed development of a common stock assessment methodology(ies) for scallops:

i) The use of RV surveys

ii) Catch and effort indices (including VMS data)

iii) Age based methods

iv) Depletion methods

b) Data provision for stock assessment

c) Assessing the efficacy of scallop fisheries management measures

d) Quantifying ecosystem effects

In the second meeting held from the 6–10 October 2014 at the Ifremer Center, Nantes, France, we continued to:

a) Build on the 2013 working group meeting and report and reviewed the information for the seven ToRs.

b) Look at the feasibility of assessment of all stocks. There are difficulties here; VIIA is a complex mix of 'stocks' with Irish, Northern Irish, Scottish, Isle of Man and English vessels and there are numerous different sources of data for parts of this stock complex.

c) Continued the discussion on standardizing between surveys, age methods, and life history/reference points.

d) Scallop stock structure is not well understood and the assessment areas were defined to reflect the characteristics of the fisheries in the past rather than on the basis of evidence to support discreete populations. It is fundamental to the assessments and subsequent management of scallop stocks that the connectivity's between adult scallop beds is better understood.

e) Different management alternatives including spatial management and the increasing use of closed areas and their effect on scallop stock and habitats were examined.

In the third meeting held from the 5–9 October 2015, in St Helier, Jersey, UK, we finalized our analysis by:

a) Reviewing whether we have sufficient data and appropriate methods for defined assessment areas to produce stock assessments.

b) Recommendation for stock assessment methodologies for data limited and data rich situations.

c) Further investigate and quantify benefits of MPA's and/or rotational areas from the perspective of the scallop fishery.

d) Have a recommendation to examine a global project at the European level.

e) Complete and finalize the three year report, self-evaluation.

1.1 Summary of Work plan

The work plan of the group is to begin a review of data available for scallop fisheries, to look at the feasibility of acquiring certain types of data such as surveys, to use existing information to define preliminary stock boundaries and to compare approaches to assessment and management in different jurisdictions.

1.2 Summary of Achievements of the WG during three-year term

- Reviewed the availability of data for stock assessment
- Compiled fishing distribution data as a proxy for identifying potential stock boundaries
- Compiled available information on biological parameters including an age reading calibration exercise
- Presented stock assessments for stocks with survey time-series (Scotland, northern France)
- Presented information on scallop fisheries – seabed interactions / impacts for a number of case studies
- Reviewed information on gear efficiency and selectivity

1.3 Final report on ToRs, Workplan and Science Implementation Plan

Terms of Reference:

1) Distribution of fishing effort and landings for scallop inshore and offshore waters, and explore the development of a common database.
2) Identification of stock assessment and management units
3) Biological parameters
4) Stock assessment methods and evaluation of indicators of stock status and identification of reference points
5) Data provision and feasibility of obtaining data
6) Efficacy of scallop fisheries management measures
7) Impact of scallop harvesting on habitat and habitat recovery rates

2 First and second meetings

In the first two meetings we compiled the existing information on surveys, available data and stock assessment approaches; several key factors emerged. Some groups rely heavily on aging methods and proportion of landings by year class is a fundamental dataset. Many of the other data varied between research groups. A summaries focusing on ToRs are presented in Tables 1, 2, 3 and 4.

Addressing the "common approach to stock assessment," all groups represented at the meeting had:

- VPA – the ability to calculate a virtual population analysis or cohort analysis or pseudo-cohort analysis using age information and a representative shell height frequency of the stock. In some cases this shell height frequency relies on samples collected from the commercial fishery and there were some concerns about spatial coverage, representative sampling and cooperation.
- CPUE – the ability to calculate a catch per unit of effort analysis, these were divided into two groups, ones from commercial catch data which is perceived to be of poor quality in some cases; and ones from independent survey data which have high quality data, these include the North Irish surveys, the Scottish surveys and the French surveys. There is a trade-off that needs to be considered between high quality but low frequency data on relative abundance from surveys and lower quality but higher frequency and larger quantities of data that can be obtained from the commercial fleet
- Landing data – there may be issues with underreporting in some cases. Landings by vessels under 10m in length may be poor.
- Effort data – all had this but in some cases the quality was of concern. It may exist at different resolutions and described by different indicators
- ICES Rectangles - this is the finest spatial scallop all groups had; individual datasets from some areas were of much higher resolution.
- UWTV: Access to visual underwater equipment – discussion on the feasibility of developing an underwater visual survey as a common sampling tool was discussed. Presentations of effort in the Northeast United States, Alaska US, Iceland, Cardigan Bay Wales, Iceland, and several Bay along the French coast were considered. Every research group has access to visual underwater equipment but the spatial distribution, cryptic nature of the species and funding are challenges that require further research.
- YPR –yield-per-recruit analysis using growth rate data (von Bertalanffy), and shell height/meat weight relationships are possible for most areas. However, growth rate is highly variable over small spatial scales and it is difficult to age scallops in some areas.
- Stock-Recruitment Relationship – This is an unknown for all groups.
- Bycatch issues – all research groups felt that bycatch either was or will be a critical issue but the bycatch levels differ between inshore and offshore; the present information on bycatch is patchy.
- Statistical Catch-at-age analysis – some groups could calculate this but most did not have the level of information to calculate a model similar to the Scottish TSA. Some have adequate data that has not been assessed and assessment capacity varies by area.

- Productions Models – some groups can calculate production models based on landings and effort data, however in many cases the high quality data extends back only a few years. These will improve in the near future. Some have adequate data that has not been assessed and assessment capacity varies by area.
- Natural Mortality – all groups had an estimate of natural mortality but further research is need as the estimates are currently based on historic literature or clapper ratios. Research with closed areas shows strong potential for this.

There were a number of differences as well:

- Selectivity and Efficiency –the French researchers had experimental estimates of dredge selectivity and efficiency, allowing them to convert their survey data into absolute values. However, all felt this research in each stock area was important.
- Different fishing and scientific sampling dredges – the French dredge differs from the New Haven dredge and their efficiencies differ with substratum type. Information from multibeam sonar reviewed far greater abundance of scallops on gravel than on sand in the Celtic Sea.
- Information on discard mortality, and incidental mortality, these are poorly understood.
- Early recruitment information (age two) is available from independent surveys; age one in French surveys.

Merits of independent surveys (dredge and image), port-sampling, observers, commercial fisheries sampling:

- Survey time-series are available for a limited number of stocks. The future of some of these time-series may be at risk because of reduced resources for surveys
- More recently 'survey grade' catch and effort data from commercial vessels has become available based on high frequency inshore VMS data and logbook reports (e.g. Isle of Man).
- Port sampling and at sea observer schemes are implemented in most areas but at different levels

Estimates of F, F_{max}, von Bertalanffy growth parameters by stock/ICES rectangle:

- F_{max} is not a good proxy for F_{MSY} for King or Queen Scallops due to flat topped YPR curves, at current selection patterns.
- There is no evidence of a stock recruitment relationship.
- There is evidence of connectivity between beds and work is underway on examining these processes through the study of environmental conditions and genetics.

MPAs and fisheries-environment interactions

- MPA's appear to be a useful tool for improving overall scallop productivity, reducing fishing effort, negative impact on the seabed and improving habitat condition. However, MPA's need to be carefully chosen considering adult population densities, current structure, presences of predators and/or competitors. Rapid declines may occur within protected populations; possibly due to environmental/climatic conditions.

- Recent declines in scallop recruitment in the Eastern English Channel have occurred and appear to be linked to environmental conditions, particularly average SST between May and July and the Atlantic low.
- Habitat studies on the effects of dredging are underway and suggest recovery from impact in 0.5 to 5 years depending on the dynamic environmental condition of the area. However, this is very dependent on what the habitat is, i.e. if it is ground that has been historically fished. In addition, some particularly sensitive seabed habitats such biogenic reefs (maerl, horse mussel beds etc.) are likely to take much longer to recover (10+ years).

Table 1. Summary table identifying the stocks within each of the ICES areas and addressing the ToR; distribution of fishing effort and landings for scallop inshore and offshore waters (ToR 1), identification of stock assessment and management units (ToR 2) and data provision and feasibility of obtaining data (ToR 5).

			ToR 1, 2, and 5	
ICES	**Stocks**	**Species**	**Data support**	**Assessments**
IVa	Shetland	King	Landings (sq), VIMS, 2 surveys, C at Age,	C at Age TSA, VPA, LPUE
	Moray Firth	King	Landings (sq), VIMS, 1 surveys, C at Age,	C at Age
IVb	East coast Scotland/England	King	Landings (sq), VIMS, 1 surveys, C at Age (limited)	Survey based
VIId	Bay of Seine	King	Survey; logbooks; effort; landings; VMS	TAC
	Greenwich Buoy	King	logbooks;effort; landings;VMS	Effort
	Sussex	King	logbooks;effort; landings;VMS	None
	Bassurelles	King	logbooks;effort; landings;VMS	Effort
VIIe/h	Cornwall	King	VMS, historical survey	None
	Greater Baie de St Brieuc	King	Survey;logbooks; effort; landings	TAC
	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
VIIg	Celtic Sea	King	logbooks, VMS; historic survey, size data	Trend
VIIa	Tuskar	King	logbooks, VMS; historic survey, size data	Trend
VIIa	Cardigan Bay/Liverpool Bay	King	landings; logbooks; VMS; 2 years survey	landing size, engine power, # of dredges, gear specs, closed areas
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	Queen	21 yrs surveys(I of M); logbooks; VMS; landings	landing size, # of dredges, gear specs, closed areas
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	King	21 yrs surveys(I of M); logbooks; VMS; landings	landing size, # of dredges, gear specs, closed areas
	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	15 yrs surveys(I of M); logbooks; VMS; landings	CSA -queen, none for King
(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
VIa	Clyde	King	landings, VMS, C at Age, annual dive surveys around Arran (since 2010)	None
	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
	North west	King	survey; landings, VMS; C at Age	C at Age
VIa and IVa	Orkney	King	landings; VMS; C at Age (limited)	None
V	Iceland	Icelandic	survey; landings; logbooks;	TAC
IIa	Frøya, Trøndelag	King	logbooks; effort	landing size

Table 1b. Summary of Biological parameters (ToR 3)

ICES	Stocks	life span	growth rate	Size at age	aging method	maturity
IVa	Shetland	Age to 10+, live up to 20 years	data available	data available	Count growth rings on shell	Scotland aged 2 onwards
	Moray Firth	Age to 10+, live up to 20 years	data available	data available	Count growth rings on shell	Scotland aged 2 onwards
IVb	East coast Scotland/England	Age to 10+, live up to 20 years	data available	data available	Count growth rings on shell	Scotland aged 2 onwards
VIId	Bay of Seine					
	Greenwich Buoy					
	Sussex		Height_inf=119.2, k=0.516, T0=0.692			
	Bassurelles					
VIIe/h	Cornwall	Age to 8+	Height_inf=110.2, k=0.44, T0=0.68			
	Greater Baie de St Brieuc	12-15	Linf=99; K=0.86 on 2000's (historical Linf=110; K=.7)	Y (years 1974-2012 ; with survey: years 1991-2012)	winter rings+validation daily rings (Univ of Brest)	2 years (H=64 mm)
	West Brittany	12-15	not well estimated (Linf higher than SB; K lower than SB)	Y (only exploitable fraction; data of fishery industry since 1990)	winter rings	2 years H=? close to SB)
	Lyme Bay		Height_inf=113, K=0.56, T0=0.69	data available		
	Baie de Brest	12-15	Linf=105; K=.7	Y (not yearly but sparse information)	winter rings+validation daily rings (Univ of Brest)	2 years H=? close to SB)
	Casquets					
VIII	Glenan					
	Pertuis/Charentais					
	Belle ile en Mer					
VIIg	Celtic Sea		Have data from 2001-2005 surveys & 2012-2013 landings data	Have data from 2001-2004 surveys & 2012-2013 landings data	Limited data, based on rings on shell (Allison *et al*., 1994)	None
VIIa	Tuskar		Have data from 2001-2005 surveys & 2012-2013 landings data	Have data from 2001-2004 surveys & 2012-2013 landings data	Limited data, based on rings on shell (Allison *et al*., 1994)	None
VIIa	Cardigan Bay/Liverpool Bay	None		12+ (2013 survey)	Linf =128; K=0.34 (2013 survey)	Yes
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	CSA		Up to 8 (Allison. 1993)	Linf=75.91, k=0.59 (Murray, 2013), Linf=83; K=0.564 (Allison, 1993)	No
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	None		Age to 10+, live up to 20 years	Linf=137; K=0.43 (Allison, 1993)	Yes
	Liverpool Bay/Isle of Man/Scot coast inshore	see Lee Murray for data	see Lee Murray for data	see Lee Murray for data	counting rings for kings - none for queens	age 3 for kings
(Ireland)	Liverpool Bay/Isle of Man/Scot coast inshore		Have data from 2001-2005 surveys & 2012-2013 landings data	Have data from 2001-2004 surveys & 2012-2013 landings data	Limited data, based on rings on shell (Allison *et al*., 1994)	None
	Liverpool Bay (separate survey from IOM until 2013)	*None*		12+ (2013 survey)	*Linf=140; K=0.26 (2013 survey)*	*Yes*
	Northern Irish Coast	evidence of 15+	data available	data available	shell/hinge	samples collected from 2013
VIa	Clyde	Age to 10+, live up to 20 years	Shell length: k=0.38, L_{inf}=153.18, T_0=0.13	data available	Count growth rings on shell	Scotland aged 2 onwards
	West of Kintyre (including NI)	NI survey evidence of 15+; Scottish age to 10+ (live up to 20 years)	data available	data available	Scottish count growth rings on shell; NI shell and hinge	Scotland aged 2 onwards; NI samples collected from 2013
	North west	Age to 10+, live up to 20 years	data available	data available	Count growth rings on shell	Scotland aged 2 onwards
VIa and IVa	Orkney	Age to 10+, live up to 20 years	data available	data available	Count growth rings on shell	Scotland aged 2 onwards
V	Iceland	20	8-10 mm a year	-	Shell growth ring counts	40-50mm
IIa	Frøya, Trøndelag	None		Age to 10+, live up to 20 years	data available	data available

Table 1b continued.

		ToR 3 parameters			
ICES	Stocks	Recruit est	M	F	Carrying Cap
IVa	Shetland	Recruit at age 3 (from assessment)	0.15	Calculated from stock assessment	NA
	Moray Firth	Recruit at age 3 (from assessment)	0.15	Calculated from stock assessment	NA
IVb	East coast Scotland/England	Estimate from survey	0.15	Proxy calculated as ratio of catch to survey SSB index	NA
VIId	Bay of Seine				
	Greenwich Buoy				
	Sussex				
	Bassurelles				
VIIe/h	Cornwall				
	Greater Baie de St Brieuc	VPA (classes 1964-2005); survey(classes 1984-2011)	0.15	0.40 (historical higher values up to 0.7-0.8)	unknown upper limit:beds already occupied by high densities of American slipper limpet
	West Brittany	not yet (but possible for 2 coastal beds for period 1990-2010)	0.15	NA	NA (anyway lower observed densities than for SB)
	Lyme Bay				
	Baie de Brest	NA (although historical information for years 1949-1963)	0.15	NA	unknown upper limit:beds already occupied by high densities of American slipper limpet
	Casquets				
VIII	Glenan				
	Pertuis/Charentais				
	Belle ile en Mer				
VIIg	Celtic Sea	None	None	Based on data from 2001-2005	Based on data from 2001-2005
VIIa	Tuskar	None	None	Based on data from 2001-2005	Based on data from 2001-2005
VIIa	Cardigan Bay/Liverpool Bay	counting rings	A50 = Age 2; L50=75mm (height)	Yes - from undersize scallops in queen dredges	maximum 0.4
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	None	None	Yes- from undersize scallops in queen dredges	0.2-0.5 (Allison, 1993)
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	counting rings	age 3 for kings	Yes- from undersize scallops in queen dredges	0.22 (Beukers-Stewart et al. 2005)
	Liverpool Bay/Isle of Man/Scot coast inshore	Yes- from undersize scallops in queen dredges	estimated in stock assessment for queens?	estimated in stock assessment for queens?	No estimate?
(Ireland)	Liverpool Bay/Isle of Man/Scot coast inshore	None	None	None	None
	Liverpool Bay (separate survey from IOM until 2013)	*counting rings*	A50 = Age 2; L50=75mm (height)	Yes - from undersize scallops in queen dredges	*maximum 0.25*
	Northern Irish Coast	data available	not currently available	not currently available	none
VIa	Clyde	Recruit at age 2 in dive surveys	0.15	0.74 (based on catch curve analysis & M=0.15)	NA
	West of Kintyre (including NI)	Scotland at age 3 from assessment, NI data available	Scotland 0.15; NI not available	Scotland calculated from stock assessment	NA
	North west	Recruit at age 3 (from assessment)	0.15	Calculated from stock assessment	NA
VIa and IVa	Orkney	NA	0.15	NA	NA
V	Iceland	NA	0,05 – 0,40	NA	NA
IIa	Frøya, Trøndelag	winter rings	aged 2 onwards	NA	NA

Table 1c. Summary of stock assessment methods (ToR 4)

					ToR 4 stock assessment				
ICES	Stocks	Gear	sampling design	Rel/abs	efficency	selectivity	uncertainties	CPUE	LPUE
IVa	Shetland	6 dredges per side; one side of commercial dredges (9 teeth and 80mm standard belly rings) second side of scientific dredges (11 teeth and 60mm belly rings)	Fixed stations	Relative index of abundance	Unknown	Juvenile scallops (<3 years) not retained by dredge	Fixed stations are based on historical information on the fishery. May not cover complete stock area.	Data available	Effort data not available
	Moray Firth	6 dredges per side; one side of commercial dredges (9 teeth and 80mm standard belly rings), second side of scientific dredges (11 teeth and 60mm belly rings)	Fixed stations	Relative index of abundance	Unknown	Juvenile scallops (<3 years) not retained by dredge	Fixed stations are based on historical information on the fishery. May not cover complete stock area.	Data available	Effort data not available
IVb	East coast Scotland/England	6 dredges per side; one side of commercial dredges (9 teeth and 80mm standard belly rings), second side of scientific dredges (11 teeth and 60mm belly rings)	Fixed stations	Relative index of abundance	Unknown	Juvenile scallops (<3 years) not retained by dredge	Fixed stations are based on historical information on the fishery. May not cover complete stock area.	Data available	Effort data not available
VIId	Bay of Seine								
	Greenwich Buoy								
	Sussex								
	Bassurelles								
VIIe/h	Cornwall								
	Greater Baie de St Brieuc	dredges (2 types: diving plate+spring loaded)+diving (Jersey)	survey: stratified sampling plan; sampling of landings (auction): subsampling plan; C at age and size)	abs (restrictive SB)	asymptotical value for diving plate up to 0.75-0.8;spring loaded:???)	L50=86 mm	illicit catches (notably summer)+unknown contribution of Channel Islands	Y (restrictive SB)	Y (Jersey: NA)
	West Brittany	dredges (2 types: inshore diving plate offshorespring loaded)	yearly observation of fishery industry on fixed points	rel	NA	L50=86 mm	inaccurate limits of the offshore fisheries	N	Y
	Lyme Bay								
	Baie de Brest	dredge (1 type with no diving plate<170 kg)	only on grounds involved by farming activities	NA	asymptotical upper limit of 0.65	L50=84 mm	not annually conducted assessment	N	Y
	Casquets								
VIII	Glenan								
	Pertuis/Charentais								
	Belle ile en Mer								
VIIg	Celtic Sea		Toothed dredge (Ring size 55, 75 & 89mm; tooth length 80-100mm)	Dredge selectivity & efficiency at 3 different ring sizes on sand or gravel substrates		DE commerical sized scallop ranged from 5-17%; DE for undersized scallop ranged from 4-25%	Have data for 3 ring sizes; 55, 75 & 89mm		Limited CPUE from discard sampling
VIIa	Tuskar		Commercial gear	Trends		None	75mm ring size; tooth spacing of 65mm		Limited CPUE from discard sampling
VIIa	Cardigan Bay/Liverpool Bay	2 king scallop dredges - 2 queen scallop dredges + video estimates	Random stratified	Relative	No estimate		King dredges catch 20 to 50% (based on comparison between videos and dredging)	unknown	Only 2 years of survey
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	2 king scallop dredges - 2 queen scallop dredges	fixed stations	Abundance Indices (1993 to 2013)			No	0.35 (scallops<50mm)	Difficulty in sampling juveniles
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore	2 king scallop dredges - 2 queen scallop dredges	fixed stations		No estimate	Data available	33.3 % for scallops of 110 mm or larger (Beuker-Stewart et al., 2001)	unknown	Possible inconsistencies in aging
	Liverpool Bay/Isle of Man/Scot coast inshore	2 king scallop dredges - 2 queen scallop dredges + video estimates	fixed stations	Relative	5-20% (based on comparison between videos and dredging)	?	?	Yes - see Lee Murray	Yes - see Lee Murray
(Ireland)	Liverpool Bay/Isle of Man/Scot coast inshore		Commercial gear	Trends		None	75mm ring size; tooth spacing of 65mm		Limited CPUE from discard sampling
	Liverpool Bay (separate survey from IOM until 2013)	2 king scallop dredges - 2 queen scallop dredges + video estimates	Random stratified		No estimate	Relative	King dredges catch 20 to 50% (based on comparison between videos and dredging)	unknown	Only 2 years of survey
	Northern Irish Coast	4 dredges pre-2013 2 foot, 2013 2 foot 6 inches	historical survey areas and new areas established through VMS and engagement with fishermen. Random sampling within fixed areas	Relative	no gear trials carried out	juvenile scallops not retained by gear	boundaries of scallop beds	data available	do not have effort data (will contact DARD to check if available)
VIa	Clyde	Dive surveys around Arran only	Fixed stations	Relative	High ~ 90%	Age 2+ scallops fully selected	Limited spatial coverage (southern half of Arran only)	NA	Effort data not available
	West of Kintyre (including NI)	Scotland 6 dredges per side using commercial dredge with 9 teeth on one side and standard belly rings and scientific dredges on other side with 11 teeth at smaller belly rings; NI 4 dredges width 2 foot pre 2013 and 2 foot 6 inches from 13 onwards	Scotland fixed stations; Northern Ireland random sampling within fixed areas	relative	no gear trials in NI; Scotland ?	juvenile scallops not retained by dredge	Scotland based on historical so boundaries may differ. NI boundaries of stock unclear	data available	Scotland effort data not available; NI landings data does not contain effort data (will contact DARD to see if this is available)
	North west	6 dredges per side; one side of commercial dredges (9 teeth and 80mm standard belly rings), second side of scientific dredges (11 teeth and 60mm belly rings)	Fixed stations	Relative index of abundance	Unknown	Juvenile scallops (<3 years) not retained by dredge	Fixed stations are based on historical information on the fishery. May not cover complete stock area.	Data available	Effort data not available
VIa and IVa	Orkney	NA	NA	NA	NA	NA	NA	NA	Effort data not available
V	Iceland	Roller dredge	Fixed stratified	Abs	0.285	NA	Not taken into account	100 – 210 kg per hour per fishing feet	
IIa	Frøya, Trøndelag	Scuba handpicked			NA				

Table 1d. Summary of efficacy of scallop fisheries management measures (ToR 6) and impact of scallop harvesting on habitat and recovery rates (ToR 7).

		ToR 6			ToR 7
ICES	**Stocks**	**Management**	**Fleets**		
IVa	Shetland	Has a regulating order	Shetland		
	Moray Firth	Landing size, # of dredges	Scottish		
IVb	East coast Scotland/England	Landing size, # of dredges	Scottish/UK		
VIId	Bay of Seine	landing size, # of dredges, vessel length, season, input/output			Studies underway
	Greenwich Buoy	landing size, # of dredges, input/output, ring size	French, UK, Irish, Dutch		Studies underway
	Sussex	landing size, # of dredges, input/output, ring size	French, UK, Irish, Dutch		Studies underway
	Bassurelles	landing size, # of dredges, input/output, ring size	French, UK, Irish, Dutch		Studies underway
VIIe/h	Cornwall		French, UK, Irish, Dutch		
	Greater Baie de St Brieuc	landing size, # of dredges, input/output, ring size	French, Jersey		
	West Brittany	landing size, # of dredges, input/output, ring size	French,		
	Lyme Bay	landing size, # of dredges, input/output, ring size	French,		
	Baie de Brest	landing size, # of dredges, input/output, ring size	French,		
	Casquets	landing size	French, UK		
VIII	Glenan	landing size, # of dredges, input/output, ring size	French,		
	Pertuis/Charentais	landing size, # of dredges, input/output, ring size	French,		
	Belle ile en Mer	landing size, # of dredges, input/output, ring size	French,		
VIIg	Celtic Sea	landing size	Irish/Scottish		
VIIa	Tuskar	landing size	Irish/Scottish		
VIIa	Cardigan Bay/Liverpool Bay				
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore				
(Isle of Man)	Liverpool Bay/Isle of Man/Scot coast inshore				
	Liverpool Bay/Isle of Man/Scot coast inshore	landing size, # of dredges, gear specs, closed areas	Irish/Scottish, English, Welsh, N Irish		
(Ireland)	Liverpool Bay/Isle of Man/Scot coast inshore	landing size, # of dredges, gear specs, closed areas	Irish/Scottish, English, Welsh, N Irish		
	survey from IOM until 2013)				
	Northern Irish Coast	gear specs, closures, curfews, effort	N Ireland		
VIa	Clyde	landign size, # of dredges, weekend closures	Scottish		
	West of Kintyre (including NI)		N Irish, Scottish, Dutch		
	North west	landing size, # of dredges	Scottish		
VIa and IVa	Orkney	landing size, # of dredges	Scottish		
V	Iceland	closed	Icelandic		Studies underway
IIa	Frøya, Trøndelag				

Table 2a and b. summarizes Descriptor 3, where the goal is that, populations of all commercially exploited fish and shellfish are within safe biological limits.

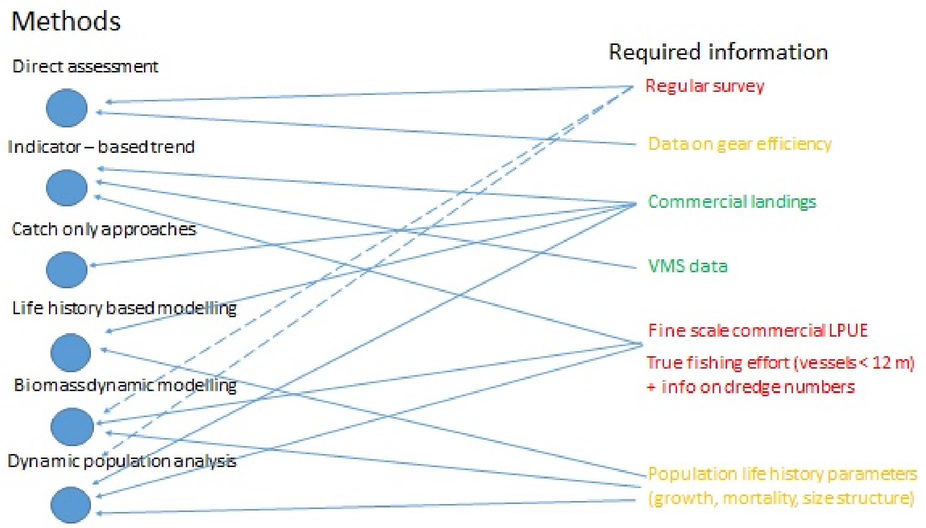
ICES	Stocks	Species	Data support	Assesments
IVa	Shetland	King	Landings (sq), VIMS, 2 surveys, C at Age,	C at Age TSA, VPA, LPUE
	Moray Firth	King	Landings (sq), VIMS, 1 surveys, C at Age,	C at Age
IVb	East coast Scotland/England	King	Landings (sq), VIMS, 1 surveys, C at Age (limited)	Survey based
VIId	Bay of Seine	King	Survey; logbooks; effort; landings; VMS	TAC
	Greenwich Buoy	King	logbooks;effort; landings;VMS	Effort
	Sussex	King	logbooks;effort; landings;VMS	None
	Bassurelles	King	logbooks;effort; landings;VMS	Effort
VIIe/h	Cornwall	King	VMS, historical survey	None
VIIe/h	Bay of St-Brieuc	King	Survey;logbooks; effort; landings	TAC
VIIe/h	Other Breton-Normand Gulf	King		
	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
	Pertuis/Charentais	King	logbooks;effort; landings; historical surveys	Effort
	Belle ile en Mer	King	logbooks; effort; landings	Effort
VIIg	Celtic Sea	King	logbooks, VMS; historic survey, size data	Trend
VIIa	Tuskar	King	logbooks, VMS; historic survey, size data	Trend
VIIa	Cardigan Bay/Liverpool Bay	King	landings; logbooks; VMS; 2 years survey	None
(Isle of Man)	Isle of Man	Queen	21 yrs surveys(I of M); logbooks; VMS; landings	Catch-Survey Analysis (undertaken since 2012)
(Isle of Man)	Isle of Man	King	21 yrs surveys(I of M); logbooks; VMS; landings	In Preparation
	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	15 yrs surveys(I of M); logbooks; VMS; landings	CSA -queen, none for King
(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
VIa	Clyde	King	landings, VMS, C at Age	None
	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
	North west	King	survey; landings, VMS; C at Age	C at Age
VIa and IVa	Orkney	King	landings; VMS; C at Age (limited)	None
V	Iceland	Icelandic	survey; landings; logbooks;	TAC
IIa	Frøya, Trøndelag	King	logbooks; effort	landing size

Table 2b.

				Fishing mortality (3.1.1)							
ICES	**Stocks**	**Species**	**F**	**FMAX**	**SH inf (mm)**	**k**	**to**	**M**	**Fmax 95%**	**F0.1**	**SPR%**
IVa	Shetland	King	Calculated from stock assessment					0.15			
	Moray Firth	King	Calculated from stock assessment					0.15			
IVb	East coast Scotland/England	King	Proxy calculated as ratio of catch to survey SSB index					0.15			
VIId	Bay of Seine	King		0.749	119	0.785	0.262	0.15			
	Greenwich Buoy	King	NA	NA	NA	NA	NA	0.15			
	Sussex	King									
	Bassurelles	King									
VIIe/h	Cornwall	King		1.6					0.45		35
VIIe/h	Bay of St-Brieuc	King	combined survey and market sampling	1.157	103.977	0.681	0.201	0.15		0.253	28
VIIe/h	Other Breton-Normand Gulf	King	NA	NA	NA	NA	NA	0.15			
	West Brittany	King	NA					0.15			
	Lyme Bay	King									
	Baie de Brest	King	NA					0.15			
	Casquets	Queen	NA	NA	NA	NA	NA	NA			
	Pertuis/Charentais	King									
	Belle ile en Mer	King									
	Western Channel (offshore); Irish data 2001-2005	King				0.254	-0.16				
VIIg	Celtic Sea	King		0.32-1.22		0.379	0.19	None			
VIIa	Tuskar	King		0.55		0.361	0.11	None			
VIIa	Cardigan Bay/Liverpool Bay	King	NA	>1.7	123.6	0.45	0	0.2		0.6	
(Isle of Man)	Isle of Man	Queen	Calculated from stock assessment	None	75.91	None					
(Isle of Man)	Isle of Man	King		1.7	122.87	K = 0.31	0.31 to 0.61				
	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	estimated in stock assessment for queens?								
	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	None					None			
	Liverpool Bay (separate survey from IOM until 2013)	King/Queens	Yes - from undersize scallops in queen dredges								
	Northern Irish Coast	King	not currently available								
	and Liverpool Bay; Irish data 2001-2005	King				0.388	0.182				
VIa	Clyde	King	Calculated from dive survey age structures		153.18 (SL)	0.38	0.13	0.15			
	West of Kintyre (including NI)	King/Queen	Scotland calculated from stock assessment					0.15			
	North west	King	Calculated from stock assessment					0.15			
	Donegal coast	King				0.295	0.226				
VIa and IVa	Orkney	King	NA					0.15			
V	Iceland	Icelandic	NA		108.1	0.139		0,05 – 0,40			
IIa	Frøya, Trøndelag	King	NA		109	0.238		aged 2 +			

3 Third meeting:

- We reviewed the ToRs and determined that the definition of "Stock" as used by individual countries was not well suited for the biological distribution of the resource. Therefore we began to set out a plan to develop new stock areas using VMS/logbook data, which each group can provide, as a bases and assuming that the VMS data are a proxy which defines the distribution of scallop beds. This is probably valid if all VMS data for a number of years are integrated so that the entire spatial coverage of the commercial fleet over time is captured.
- A schema for identifying data requirements for different assessment methods was proposed (below):



- The group proposed developing a dataseries that would provide a standardized catch and effort time-series. This would be derived from logbook/VMS information which everyone is collecting (see Table 1, ToR 1). These would allow the indicator –based trend and biomass dynamic (production) modelling but would also lead towards more complex models. This dataset could be used to:
  - Produce maps of the LPUE index (kgs scallop.dredge.hr, kgs scallop.VMS.hr)
  - Sediment maps and maps of shear stress of the seabed could be used to standardize the LPUE index using GLM/GAM methods
  - The proportion of a stock boundary exposed to fishing each year could be estimated; similar to a PSA where the proportion fished is the susceptibility of the stock to the fishery in that year
  - The LPUE maps could be overlain on MPA maps and maps of European marine Sites (SACs). The use of these protected areas as sources of scallop recruitment could be evaluated by larval dispersal modelling

The number of dredges used by vessels needs to be obtained independently as it is not well recorded in logbook data. There are also reasonably predictable relationships between vessel length and number of dredges:

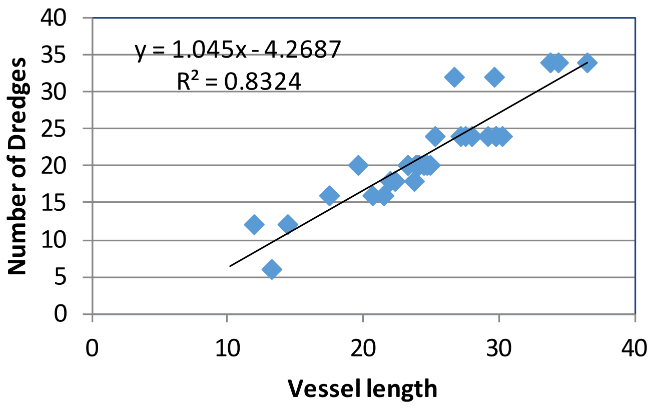


Figure 1: Relationship between number of dredges and vessel length in the Irish fleet.

- Data structure:
  - Date, vessel CFR, number of dredges, nationality, ICES rectangle, GPS positions, stock to which the effort is allocated, catch, effort hours, VMS hours,
  - Standardizing covariables; plotting technology on board, shear bed stress, sediment type
  - Indicators
    - Landings per dredge per VMS hour
      - Disaggregation to size or age classes based on port or observer sampling

An example of a time-series of the LPUE indicator (kgs.dredge.day) is shown below for Irish vessels fishing in different stocks. The resolution of the indicator could vary depending on data quality from kgs.dredge.hr (good resolution) to kg per day (poor resolution)

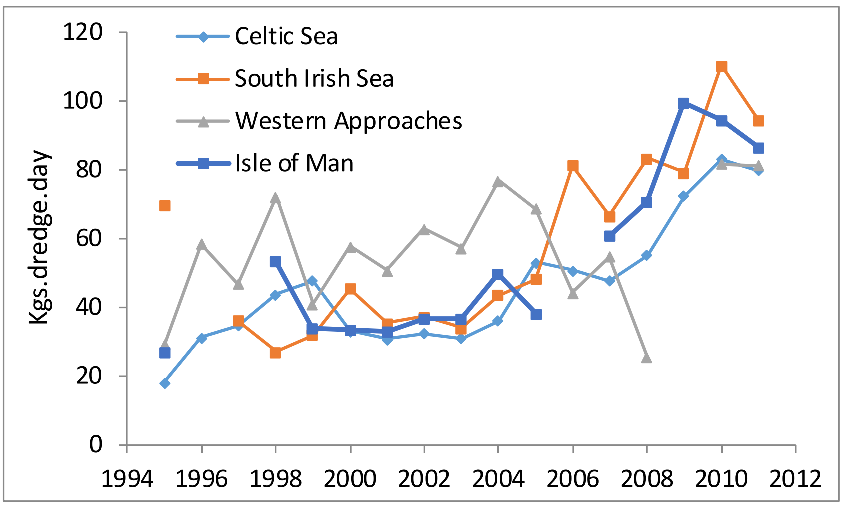


Figure 2: Example output of an LPUE indicator based on logbook, VMS data and independent data on dredge numbers per vessel

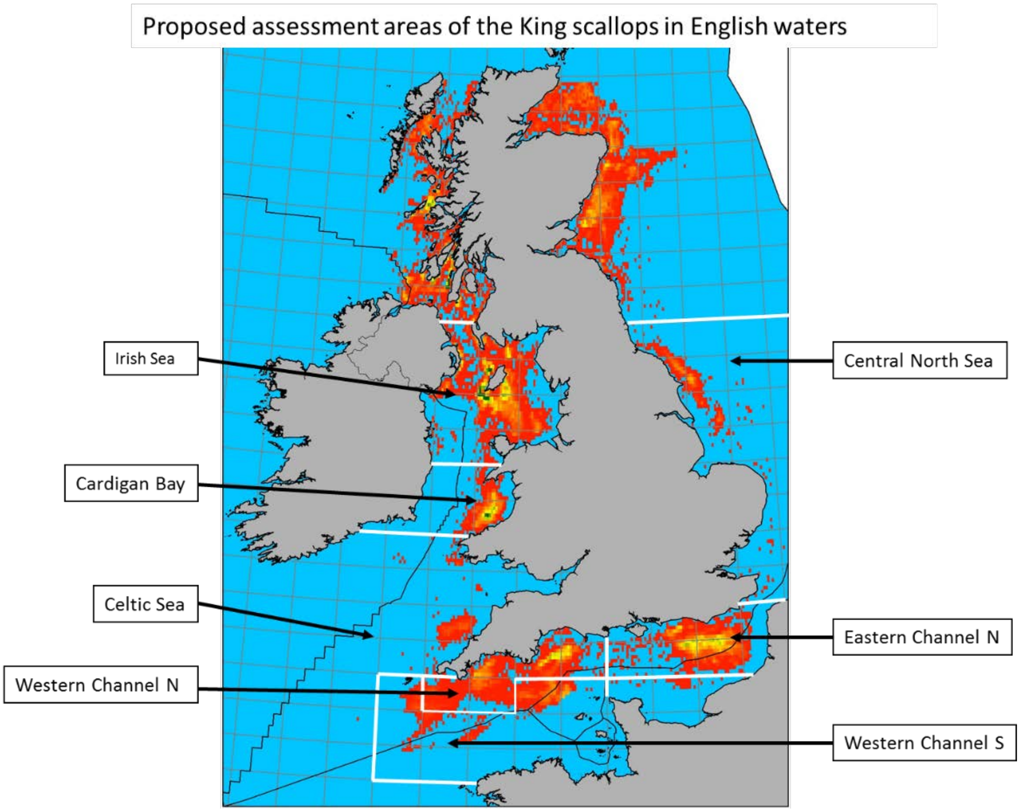


Figure 3. Sample output of VMS data for all UK vessels showing distribution of fishing activity 2006–2013 plotted at 5km² resolution. Proposed assessment unit boundaries are shown.

3.1 Summary of presentations at the 3rd meeting

3.1.1 Proposal for some King Scallop Assessment Units

Unless the stock in question is contained within a fixed area with definite boundaries, then any definition of a stock unit becomes a compromise on both spatial and temporal levels. As the purpose of stock assessment is to inform the management of human activities affecting the stock, the definition of a functional stock unit needs to balance the temporal and spatial scales of fishery developments and the biological processes driving growth and recruitment. In reality this means that a stock unit should be one across which growth and reproduction rates are broadly similar to fairly well defined fishery practices. Genetic isolation of stock units also serves to provide distinct boundaries, and wherever possible stock assessment units should not include multiple genetic groups (this only really applies where fisheries operate on feeding aggregations of multiple isolated breeding stocks and doesn't apply to scallops).

Centres of existing fishing activities to define stock boundaries are shown on the Figure 3, that demonstrate densities of VMS data of the UK vessels > 15 m that were integrated for a period of 2007-2013 at 5 x 5 km resolution.

There are currently eight assessment units in Scottish waters, which were originally defined to reflect the characteristics of fisheries in the past. The units are based on the ICES statistical rectangles as follows:

Assessment unit	ICES Statistical Rectangles
Irish Sea	35-37 E3-E7; 38 E4-E6
Clyde	39-40 E5; 40 E4 (Eastern half)
West of Kintyre	39-40 E2-E3; 39 E4; 40 E4 (Western half); 41 E4
Northwest	41-46 E1-E3; 42-46 E4
Orkney	47 E4; 46-47 E5-E6; 47 E7
Shetland	48-51 E7-E9
Northeast	44 E5-E8; 45 E6-E9; 46 E7-E9; 47 E8-E9
East Coast	39-43 E8-F0; 40-41 E6; 40-43 E7; 44 E9-F0

Note that 40E4 is a split square with the east side included in the Clyde assessment area and the west side in the West of Kintyre.

A total of the eight potential stock assessment units are proposed for waters of the Channel, central and south North Sea, Irish and Celtic Seas each of them including a number of the ICES statistical rectangles.

1) Irish Sea (including Isle of Man). The area represents a rectangular shaped "block" of fishing activity following VMS data. The local population is genetically distinct from that of Cardigan Bay on the south. A further subdivision into Liverpool Bay and the Isle of Man could be deemed appropriate as there is relatively little connectivity perceived between these two areas which also have quite distinct management regimes.

2) Cardigan Bay. This is based upon a distinctive centre of fishing activity and local scallops are genetically different from adjacent part of the Irish Sea to the north. There is also a substantial spatial separation of this area from the next fishing grounds to the south – Celtic Sea; the stock is likely shared with Ireland and might extend further into Irish waters. There is a separate scallop bed to the west (Tuskar) off the Irish coast. These two areas are likely to be oceanographically connected.

3) Celtic Sea – this stock area encompasses distinctive fishing grounds off North Cornwall. The scallops on these grounds though genetically indistinguishable from the scallops south of the westernmost Cornwall (Falmouth – Penzance) due to low-level connectivity still represent a separate area of fishing activity and is likely to be predominantly self-recruiting. Scallop beds occur also in the northeast Celtic Sea and extends approximately 40 miles south of the Irish coast. This bed straddles the border of the Irish Sea and Celtic Sea assessment units shown in Fig 3.

4) Western Channel North – from Penzance to Bournemouth. This unit encompasses a region of the south Cornwall (Penzance – Falmouth) and the western part of the North Channel population that is characterized by slower growth compared to animals to the east or south.

5) Eastern Channel North – from Bournemouth to Dover. This stock unit, although genetically the same as the western Channel, is typified by faster growth rates and shorter lifespan (although this may be a fishery induced artefact).

6) Central North Sea: There are few scallop grounds identified in the North Sea, the only significant concentration of fishing activity south of

the Scottish boarder being a distinctive and at times intensive fishing area around the Lincolnshire up to North Yorkshire.

7) Western Channel South – waters along the French shores in which the most important area (St. Brieuc) is already routinely assessed by French authorities.

8) Eastern Channel South. This area largely corresponds to fishing grounds of Baie de Seine, which scallops are genetically distinct from those of English coasts and are also routinely assessed in France.

3.1.2 Exploring possibilities of using the depletion method in assessment of King scallop fisheries

In some areas (like Isle of Man) the King scallop fisheries are highly seasonal with periods of intensive exploitation interspersed with periods of biological rest for population to recover. Depletion during these periods of exploitation could be intensive enough to be detected by decrease in CPUEs (Beukers-Stewart *et al.*, 2003) and therefore used for estimation of the initial scallop numbers (taking into account growth and natural mortality if the depletion event takes an extended period of time). Because of this, a pioneer study has been initiated to explore applicability of this approach in practice of scallop fisheries in the English Channel.

Two King scallop stock units (Eastern Channel North and Western Channel North) were chosen for this trial as supplied by a good quality landing statistics and a large set of VMS data for the UK vessels >15 m collected at 2 hours resolution. The number of dredges was available for 59 of the 62 vessels taking into account. The individual CPUEs were estimated as landing weight (allocated in a particular day to a particular ICES rectangle) divided by time the vessel spent fishing in this rectangle and by number of dredges. There was no correlation found between CPUE and vessel power (r^2=0.01) neither between CPUE and vessel length (r^2<0.01). It might be explained by the fact that though larger boats might deploy larger number of dredges (r^2=0.56, Figure 4) (so to have higher daily catches), efficiently the catch per dredge might be the same unless larger boats will tow at higher speed that probably is not the case for dredging as a métier. Despite a range of setback this calculated CPUE value likely is a good proxy for a real time fine scale CPUE.

One ICES rectangle with the most intensive fishing activity was defined in each of two stock assessment units (29 E 7 for the West Channel and 30 F 0 for the East Channel) for a detailed search of evidence of depletion followed the stock recovery after temporary interruption in fishing activity when CPUEs became too low and scallopers would move to other area. Each rectangle was split in small cells of 10 x 10 km and spatial occurrence of fishing activity was analysed to reveal the most important cells or group of cells that might provide statistical material for the depletion method.

Distribution of fishing fleet activities in these two ICES rectangles was different between analysed years (2009–2012) making quite difficult to track CPUE dynamics at the small scale level. Analysis of the data did show that in both Channel areas the recruitment and respective increase in CPUEs take place late in the calendar year, somewhere between weeks 40 and 50. Consequent depletion events that might be used for local assessment occur occasionally like between weeks 14 and 27 in 2012 in a small fishery-important area of the Western Channel (Figure 5); week 48 of 2009–week 10 of 2010 in a small important area of the Eastern Channel (Figure 6). However, occurrence of these events is very rare and might be discovered only on negligible part of the fishing grounds.

The depletion approach likely might be useful in a very particular situation of excessive (too high for all year-round fishery) existing fishing capacity that is legislatively allowed to exert itself on the stock for a relatively short period of time provoking its important depletion after which the stock is given a lengthy period to recover until the next fishing event.

References:

Beukers-Stewart, B.D., Mosley, M. W. J., and A. R. Brand. 2003. Population dynamics and predictions in the Isle of Man fishery for the great scallop (*Pecten maximus*, L.). ICES Journal of Marine Science, 60: 224–242.

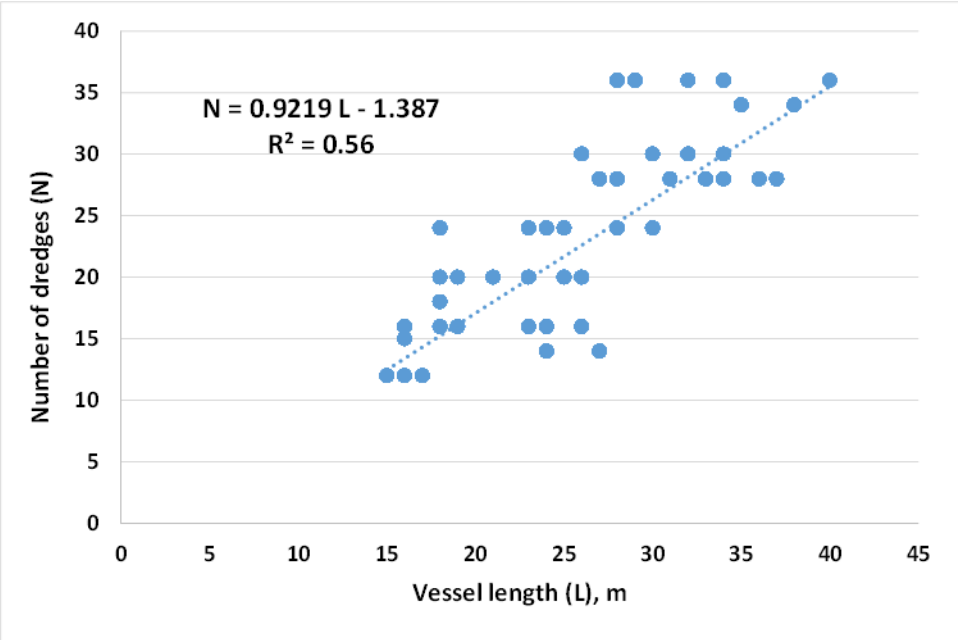


Figure 4 Correlation between number of dredges and vessel length for the UK fleet > 15 m.

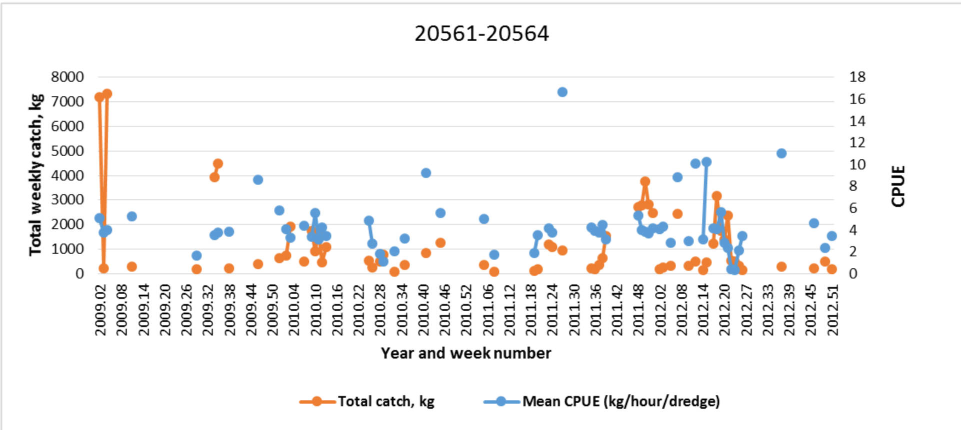


Figure 5. Evolution of CPUEs and weekly catches in cells 20561-20564 (West Channel, rectangle 29 E 7).

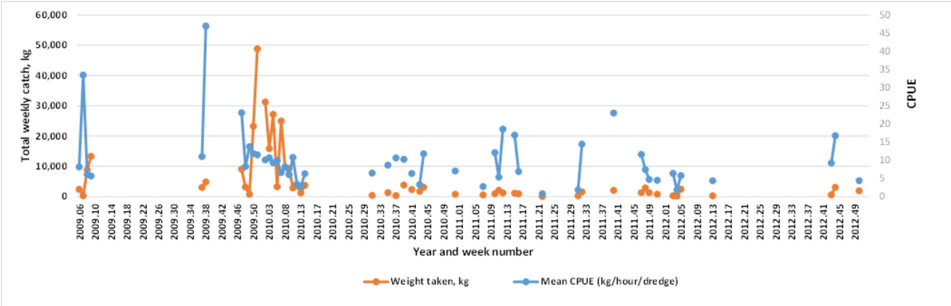


Figure 6 Evolution of CPUEs and weekly catches in combined cells 21230-21232 and 21532-21533 (East Channel, rectangle 30 F 0).

4 Scottish scallop fishery

The Scottish commercial dredge fishery for the king scallop (*Pecten maximus)* began in the 1930s as a seasonal fishery in the Clyde. It has since expanded all around the coast of Scotland to become the second most important shellfish fishery in Scotland.

There are eight assessment areas in Scottish waters, which were defined to reflect the characteristics of the fisheries in the past. The most important areas in terms of total landings are the Irish Sea, West of Kintyre, Northwest, Northeast and East Coast. Some areas, such as the Irish Sea, have shown systematic increases in reported landings, while in other areas the landings are characterized by occasional and rapid increases or declines. Some of these are associated with fishery closures due to the presence of amnesic or paralytic shellfish toxins, but others appear to be associated with strong year classes. Approximately 95% of the landings are from dredge fisheries with the remainder taken by commercial divers.

The scallop dredge fleet consists of approximately 100 vessels ranging in size from under 10 m to around 30 m in length. Smaller vessels tend to work locally in inshore waters while larger vessels are more nomadic and may move between fishing grounds around the coast of Scotland and the rest of the UK. The fleet characteristics are different for each assessment area, for example Shetland is characterized by smaller (under 15 m) vessels, in contrast to the East coast where landings are dominated by the over 15 m vessels.

Following a consultation with the scallop industry (2014–2015), an increase in king scallop minimum landing size (100–105 mm) has been accepted and will be implemented in spring 2016. Regulations will also restrict the bar length within 12 nm and limit the number of dredges to eight per side. Recent changes that have already been implemented include the suspension of licence entitlements and rules to restrict the ability of vessel owners to increase the power of replacement vessels.

4.1 Scottish scallop stock assessment

The population structure of Scottish scallop stocks is not well understood, and there is currently a project underway which aims to develop a spatial population model for scallops to simulate the dispersal patterns of larvae with models of the growth, survival and spawning of settled individuals. This should provide further information on the connectivity between scallop populations around Scotland.

Scottish regional scallop stock assessments carried out by Marine Scotland Science (MSS) are based on commercial catch-at-age and survey data. The last assessment was carried out in 2011 with data up to and including 2010. Full analytical assessments were presented for four assessment areas (West of Kintyre, Northwest, Northeast and Shetland), with catch data presented for the Clyde, Irish Sea and Orkney. An exploratory analysis of the East Coast data were presented for the first time (Dobby *et al*., 2011).

There are no agreed biomass or fishing mortality reference points for Scottish scallop

Stocks and advice is therefore currently provided on the basis of estimates of recent fishing mortality, recruitment and biomass in relation to historical values.

Work is currently underway to undertake full analytical assessments to include data up to 2014. In areas for which sufficient data are available, an age-structured Time-series Analysis (TSA) analytical assessment method will be employed. TSA provides an estimate of stock status, makes use of multiple data sources (commercial catch-at-age and survey indices by age) and can cope with the omission of poor quality or missing data. In addition, the estimates of abundance and fishing mortality are calculated with confidence intervals.

This work will hopefully be available to discuss at next year's meeting.

4.1.1 Isle of Man Queen Scallop: Stock status, assessment and trawl fishery for 2015

Isobel Bloor[1], Sam Dignan[1], Lee Murray[1] and Michel Kaiser[1]

[1]Fisheries and Conservation Science Group, School of Ocean Sciences, Bangor University, Wales

Following a decline in stock status the Marine Stewardship Council (MSC) certification for the Isle of Man queen scallop trawl fishery was suspended in 2014. As part of a rebuilding strategy to increase stock levels a range of additional management measures were subsequently implemented including additional monitoring of landings through a licence requirement for vessels targeting the fishery to operate a GPS logger (reporting at 30 second intervals) and to submit a daily catch return providing tow level data. In addition effort was reduced through a reduction in licences following a public consultation and a reduced TAC was implemented for the territorial sea along with closed areas.

The duration and extent of the annual scallop stock assessment was also increased to permit sites inside and outside the territorial sea to be sampled. Despite the increased management measures put in place within the territorial sea effort outside this management area, but within the boundaries of the biological stock, remain unregulated and the results of the 2015 stock assessment indicated a further reduction in overall stock biomass, although large variations in densities around the Island were highlighted.

For the 2014/15 fishing season a network of four small temporary closed areas was implemented within the territorial sea (one in each of the four main fishing grounds). The purpose of these closures was to protect areas of scallops at high densities to try and promote successful spawning and thus subsequent recruitment to the fishery. These areas were selected based on the densities and size structures observed during the annual spring scallop surveys. As queen scallops are a short lived species the spatial location of these closures will need to be revisited on an annual basis. For the 2015/16 fishing season the closed area on the west coast (TAR) was moved to allow fishing to occur in a high density bed containing large (70 –80 mm) queen scallops of a single class within an area that had been effectively closed (both as a result of natural events and legislation) for a period of up to four years. By closing areas of good recruitment and allowing the queen scallops to grow on to a larger size the fleet was able to target a more efficient fishery, increasing the yield and value of the catch and reducing both the time spent fishing at sea and the area impacted by the fishing fleet on the seabed and habitat within the territorial sea.

A comparison of the spatial origin of landings from the 2014/15 and 2015/16 seasons indicated a large change in the fishing behaviour between years. Whereas fishing effort during the 2014/15 season was focused on a large low density area to the east of the Island (EDG) in the 2015/16 season fishing effort was focused on a very small but high density area to the west (TAR). As a result, the 2015/16 fishing season was more efficient with 1015 t landed from 1940 hr of active fishing compared to 969 t from 4249 hours of active fishing in the 2014/15 fishing season.

4.1.2 Influence of environmental variability on recruitment in king (*Pecten maximus*) and queen scallops (*Aequipecten opercularis*) around the British Isles

Robin Livesey-Shilland[1], Helen Dobby[2] and Bryce Stewart[1]

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King (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallop populations are highly variable both temporally and geographically. King, and less so queen, scallops are very valuable to the European fishing industry, and with few restrictions on their harvesting, most populations are heavily fished. As a result the annual success of these fisheries is often highly dependent on the strength of recruitment. The ability to predict recruitment strength as far in advance as possible could therefore be used to optimize management and fishing strategies.

No definitive predictors of scallop recruitment have been found, although previous studies have identified relationships between recruitment and variables such as spat settlement (Beukers-Stewart *et al*., 2003), oceanic currents (Caputi *et al*., 1996) and climatic phenomena such as the El Niño-Southern Oscillation (Wolff, 2011) and spring seawater temperatures (Shephard, *et al*., 2010; Foucher *et al*., unpublished data) in certain regions. Here, environmental variables (mean seasonal temperatures and the North Atlantic Oscillation) in years of spawning were compared to subsequent recruitment in Scotland (using 20 years of detailed fisheries-independent survey data) and the UK, Ireland and Isle of Man (using FAO landings data).

The strength of these relationships at varying spawning-stock biomass was also investigated. Although significant relationships between sea surface temperature and recruitment did exist in some areas, none were consistent between geographical regions. More promisingly, the NAO index appeared to negatively correlate with recruitment, with relatively consistent results indicating this relationship. High NAO indices corresponded to warm winters and cool summers, both of which may impede production and survival of scallop spat.

The influence of environmental conditions on recruitment was found to be strongest at low spawning-stock biomass, indicating that stocks at higher abundance may be somewhat buffered against environmental variability. On the basis of these findings it would appear beneficial to maintain stocks at a relatively high biomass in order to reduce the risk of stock depletion or recruitment failure/collapse after unfavourable environmental conditions. Exploratory analysis revealed strong correlations between king scallop landings in different European countries, suggesting that climatic effects may effect recruitment on a broad-scale.

These results are particularly significant given predicted future trends of anthropogenic climate change and ocean warming. Further work is now needed to investigate the role of other environmental variables (e.g. chlorophyll concentrations) and to extend the study using fisheries-independent data from other areas.

References:

Beukers-Stewart, B., Mosley, M. and Brand, A. (2003) Population dynamics and predictions in the Isle of Man fishery for the great scallop (*Pecten maximus*, L.). ICES Journal of Marine Science 60: 224–242

Caputi, N., Fletcher, W., Pearce, A. and Chubb, C. (1996) Effect of the Leeuwin Current on the recruitment of fish and invertebrates along the Western Australian coast. Marine and Freshwater Research 47: 147–155

Shephard, S., Beukers-Stewart, B., Hiddink, J., Brand, A. and Kaiser, M. (2010) Strengthening recruitment of exploited scallops *Pecten maximus* with ocean warming. Marine Biology 157: 91–97

Wolff, M. (2011) Population dynamics of the Peruvian scallop *Argopecten purpuratus* during the El Niño Phenomenon of 1983. Canadian Journal of Fisheries and Aquatic Sciences 44: 1684–1691

4.1.3 Scottish bycatch dataset

Bycatch data has been collected regularly (since 1994) as part of the annual Marine Scotland Science (MSS) scallop dredge survey. Surveys prior to this (1981-1993) only collected data on king scallops (*Pecten maximus*) and queen scallops (*Aequipecten opercularis*). Fixed stations are surveyed on three research cruises (Shetland, East coast and West coast) using one array of commercial spring-loaded Newhaven type dredges (2.5′ wide, 9 tooth bar, with 80 mm internal diameter belly rings) and another array of smaller configuration sampling dredges (2.5′ wide, 11 tooth bar, with 60 mm internal diameter belly rings). At each station dredges were towed for approximately 30 minutes at a speed of 2.5 knots.

All bycatch species were identified to species level and the length measured (to the nearest whole mm below). The sex of species which could be identified from visual observation was also recorded. From 2014 starfish and brittlestar species were recorded in the bycatch data however the length of these individuals was not taken. A damage index was assigned to all bycatch species using a four point scale based on criteria appropriate to each taxonomic group.

Only preliminary analysis has conducted on the dataset. A total of 61 scallop dredge surveys were carried out between 1994–2014. All 61 surveys recorded bycatch data and 5,669 of the 5,889 tows contained bycatch (96%). The aim is to assess the trends in the relative abundance and species composition of bycatch species between survey areas (East coast, West coast and Shetland) and years (1994–2014) using multivariate and univariate analysis. It is hoped that further work will be available to present at next year’s meeting.

5 Studies into the efficiency of commercial spring loaded dredges.

5.1 Introduction:

Worldwide, estimates of catchability for scallop dredges have been made for many different scallop species and dredge types. Only those that have involved *Pecten maximus* and employed commercial spring loaded dredges have been considered here.

Pecten maximus inhabits substrata from fine sand through to coarse sand and gravels in which it lies recessed into the seabed. However, such substrata may exist among varying amounts of rocks, stones, outcrops of bedrock and associated benthos, all of which will affect the efficiency of the fishing gear. In order to assess the spatial distribution of the stock, whether from commercial catch per unit of effort (CPUE) data, or from research surveys, it is important to be able to account for such variations in gear performance.

Dredge efficiency divides into two aspects: the likelihood that a scallop in the path of the dredge will enter the dredge (efficiency of capture) and the probability that the scallop will remain in the dredge (selectivity).

5.2 Methods

1 Mark recapture : Seeding with marked scallops, allowing to settle, then fishing.

2 Depletion fishing: Experimental: RVs, commercial charters.
Commercial: CPUE/VMS

3 Diver observation Animals left in the dredge track compared to retained catch

A selection of historical gear efficiency studies for commercial spring-loaded dredges

Cefas studies on different ground types.

Mark re-capture experiment.

This experiment was carried out by evenly seeding two plots of known area with scallops marked with a hole drilled through the ear. Scallops were allowed to settle for 2 days before the areas were fished. After fishing tows were carried out just outside the plots to ascertain if scallops had moved out during the settlement period. None were found. The seabed characteristics of each plot were defined by towed UW video.

The hard stony ground included rocks up to 50cm diameter and the efficiency estimate was 6% for scallops above the minimum size (90mm shell height). The clean ground consisted of sand and gravel with some shell and the efficiency estimate was 41% for the same size group.

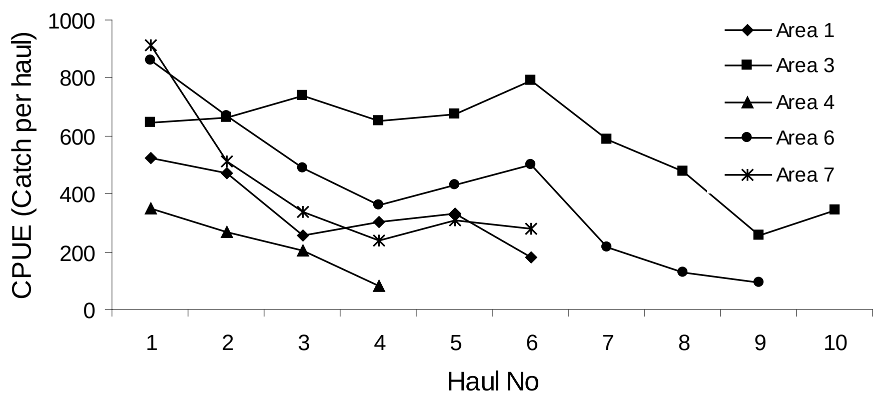
Depletion fishing experiment

This experiment was carried out on five grounds of varying substrata, identified during a previous study of scallop distribution at different spatial scales.

Plots were defined on each ground and each was subjected to a series of dredge tows, each of which resulted in ~75% of the plot being fished. Dredging continued until CPUE declined to below 50% of the initial rate. Catchability (q) was estimated from a generalized version of the Leslie model. Efficiency was then calculated from the proportion of the total area of the plot swept by the gear.

Area	Catchability	Efficiency (&)	Ground characteristic
1	0.21	33	Clean becoming stony after several tows.
3	0.07	11	Rocky
4	0.36	58	Clean
6	0.18	29	Clean becoming stony after several tows.
7	0.27	43	Flint cobbles

While the efficiency estimates provided by these experiments is broadly in line with those from other sources, examination of the depletion process shows up some anomalies.



Area 3.

This area was the roughest, with dredges catching large quantities of stones and boulders, up to 40cm in diameter. The regression of CPUE against cumulative catch is the least well correlated of all the areas, though still significant (p=.05). The catchability estimate for this area is the lowest of the five areas (scallops ≥90mm). However, figure 2 shows that there was no reduction in CPUE over the first six hauls but that then the catch rate declined quite rapidly over the final four. This pattern throws doubt on the validity of the abundance estimate from the regression.

Since the dredges were full of rocks on hauling, it is likely that they became so early in the course of each tow and so stopped fishing. Thus the depletion is negligible over the first five tows and it is likely that the decline in catch rate over the final four is due to falling catchability rather than stock depletion, perhaps as a result of rocks being pulled from the seabed and piling up in the path of the dredge.

Area 6.

The regression of CPUE against cumulative catch is strongly correlated and the catchability estimate is 0.18 (scallops ≥ 90mm).

This ground initially appeared clean and a steady decline in catch rate occurred over the first four tows. However the following tows caught large numbers of stones and this was accompanied by a rise in catch rate in tows five and six after which the decline resumed.

There was no evidence from the GPS that the vessel had strayed from the plot so the change in catch-rate must be a result of the dredging itself. One explanation is that patches of stones buried in the substratum protect part of the scallop population whereas scallops on clean ground are depleted. Eventually the dredges start to pull the stones out of the seabed and the scallops among them are caught, giving a temporary boost to catch-rates.

Area 1

The catchability estimate for this ground was # (scallops ≥ 90mm) and once again there was a strong correlation between CPUE and cumulative catch. The trend in catch rates on this ground is similar to area 6 and again the increase in the catch rate, in this instance in the fourth tow, was accompanied an increase in the quantity of stones in the catch.

Area 7

On this ground the dredges were consistently filled with flint cobbles of 15 –20cm diameter. Despite this, the catchability estimate was high at 0.27 (scallops ≥ 90mm). Catch rates declined quite rapidly over the first four hauls, before levelling off over the final two. Once again this might suggest that a proportion of the stock is fished down at a high rate whereas the remainder, perhaps protected by the stones, is removed at a significantly slower rate.

Area 4

This was clean ground and a straightforward, rapid depletion was observed. The catchability estimate was the highest of the five at 0.36 (scallops ≥ 90mm). However, after only four hauls the catch rate had fallen to 20% of the initial rate and dredging ceased.

It is clear that the trends in CPUE from these experiments are not simple and that continuous dredging can change the catchability of the population on it. It is also likely that there are different components of the stock on a given plot, perhaps relating to patches of rough ground, which will be caught at different rates. Thus it may be that initially depletion occurred on clean sand patches, which deplete quickly. If stony areas are present where the efficiency is lower, the catches from later tows will contain a larger proportion of scallops from them and the depletion rate will slow. There was also evidence from Areas 1 and 6 that after continued dredging quite sudden increases in catchability could occur, associated with increased catches of stones. These factors suggest that not dredging for long enough to initiate any secondary depletion risks significantly underestimating abundance and overestimating catchability.

Area 3 is not viable for commercial scallop dredging, but judging from the catch-rate achieved despite that fact, there is clearly a significant stock density on this ground that is effectively protected from fishing. It is unclear what the extent of this ground type is, or how much scallop biomass it protects, but it has the potential to provide an important component to the spawning stock in the western channel and it would be of great use to investigate this potential.

6 TOR 7. Impact of scallop harvesting on habitat and habitat recovery rates

6.1 Comparison of fishing performance and habitat impacts of spring loaded and N-Viro scallop dredges

A limited study of the performance of two dredge types was undertaken in Clew Bay, west coast of Ireland. The inner part of the Bay is designated as a Special Area of Conservation (SAC) with a number of habitats that are sensitive to physical disturbance pressure from fishing gears.

The standard scallop dredge used in the Irish inshore and offshore scallop fishery is the Newhaven spring loaded dredge. This was compared with the N-Viro dredge which is relatively new on the market (www.n-virodredge.com) and is already used by some vessels in Ireland and UK.

Comparison of paired parallel tows (one tow of spring loaded dredge and one tow of the N-viro dredge on consecutive days; the two dredges were not towed at the same time) showed that the N-viro dredge had slightly higher scallop catches and lower variability of catch rate than spring loaded dredge. This difference was maintained subsequently during over 200 tows under normal commercial fishing conditions. Bycatch was similar in both dredges and consisted of brown crab, spider crab, whelk and juvenile Raja spp. A comparison of size composition of scallops in the catch showed no apparent difference in selectivity of the dredges.

Diver observation of dredge activity and impact on the seabed failed to detect significant differences in impact of the two dredge types. Impact descriptions are as follows;

- The habitat in the study area was defined as Eunis class A5.33 (infralittoral sandy mud) and A5.43 (infralittoral mixed sediments). Diver observations using relative abundance estimates of epifauna and analysis of infauna core samples allowed more detailed classification to Eunis level 5.
- Sources of physical impact include the rollers at the end of the dredge beam, the dredge teeth or tines (N-Viro dredge) and the weight of the of the dredge bag (chain mat)
- Dredge teeth on Newhaven dredges were observed to penetrate the seabed while tines on the N-Viro dredge were observed penetrating the sediment to the full extent of their length i.e. up to c. 12–15cm. This may be a reflection of the habitat type (relatively fine sediments for scallop fishing) and may not reflect the penetration depth of scallop gear on all habitats.
- Tracks from both dredges were clearly visible by divers the day following dredging
- Observations of impact: Homogenization of surface relief, Stones turned over and stones brought to surface, Suspension of sediments, Absence of hydroids in areas previously dredged, Scavenging fauna present, Burrowing bivalves brought to surface, Broken Ensis shells (damaged infauna indicating subsurface impacts
- Scallop dredging, irrespective of dredge type, may not be consistent with maintenance of the conservation objectives for sedimentary habitats in SACs in that significant changes to species composition and habitat structure and function is expected. The spatial extent of such fisheries and the frequency of fishing activity should be closely managed to minimize such impacts.

7 Cooperation

- Cooperation with other WG: WG Scallop will consider the report of WKLife 2015 at its 2016 meeting
- Cooperation with Advisory structures
- Cooperation with other IGOs

8 Summary of Working Group self-evaluation and conclusions

The first benefit is the gathering of the group of scientists working on the King, Queen and Icelandic scallop fisheries together to exchange knowledge, experience and insights. Before this group there was no organized effort to work together consistently, this group provides opportunity to address questions globally as well as locally and sharing and expanding resources and knowledge.

Annex 1: List of participants

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Annex 2: Recommendations

Scallop dredging may have a number of effects on fish and shellfish habitats (seabed). These should be considered in association with other working groups and included in discussions of MPA development.

Recommendation	Adressed to
Coordinate with other ICES Working Groups such as WKLIFE, PGDATA, SIMWG, and WGMHM.	
Emphasize the increased benefit of continuing fisheries independent surveys that become more valuable as the time-series lenghtens	

Annex 3: Terms of reference of 2016–2018 WGScallop

2016/ACOM24 The **Scallop Assessment Working Group (WGScallop)**, chaired by Kevin Stokesbury, USA, will meet in Aberdeen 3–7 October 2016.

Meeting hosted by Lynda Blackadder and Helen Dobby, Marine Scotland – Science

Scottish Government | Marine Laboratory | PO BOX 101 | 375 Victoria Road | Aberdeen AB11 9DB

WGScallop TORs 2016–2018

1) Compile and present data on landings and fishing effort that permits 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 standardized 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 larval source sink patterns to
    a) Inform managers of MPAs and European Marine Sites (EMS) of 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, 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) Bycatch fish, discard scallop mortality – compile data, see if we can create a universal database (observer trips).

WGScallop will report by 2 November 2016 for the attention of ACOM.

Supporting Information

PRIORITY:	ESSENTIAL
Scientific justification:	The proposal to initiate a WG on scallops is justified on the basis of the national and international importance of this fishery in a number of countries in northwest Europe and North America. There is currently no common scientific or assessment forum for discussion and development of common assessment methods for scallops. The qualitative descriptors for determining good environmental status (Directive 2008 EU) we are concentrating on are: Descriptor 1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Descriptor 3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. Descriptor 6: Seabed integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. The focus of the working group is to providing scientific advice on scallops, defining a common approach to the assessment of stocks. In the 2013 meeting the workshop examined ICES areas: IIa, IVa, IVb, V, VIa, VIa and IVb, VIIa, VIId, VIIe/h, VIIg, and VIII. Scallop species and biological stocks were identified in each of the ICES areas.
Resource requirements:	None.
Members:	Oliver Tully, Ireland (Marine Institute), Lee Murray, Isle of Man (Bangor University), Ewen Bell, England (Cefas), Helen Dobby, Scotland (Marine Scotland Science), Eric Foucher, France (Ifremer), Spyros Fifas, France (Ifremer), Gwladys Lambert, Wales (Bangor University), Kevin Stokesbury, United States (University of Massachusetts), Brad Harris, United States (Alaska Pacific University), Heather Moore, Northern Ireland (AFBI), David Palmer (Cefas), Lynda Blackadder Scotland (Marine Scotland Science), Jonas Jónasson, Iceland (HAFRO), Carrie McMinn, Northern Ireland (AFBI), Isobel Bloor, Isle of Man (Bangor University), Bryce Beukers-Stewart England (University of York), Strand Øivind, Norway (IMR)
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	ACOM
Linkages to other committees or groups:	WKLife, WKProxy
Linkages to other organizations:	There are no obvious direct linkages.

Annex 4: Copy of Working Group self-evaluation

Working Group evaluation

1) Working Group name.
  1.1) WGScallop
2) Year of appointment.
  2.1) 2013
3) Current Chairs.
  3.1) Kevin Stokesbury
4) Venues, dates and number of participants per meeting.
  4.1) Galway 3–5 Sept 2013 (15 participants), Nantes Oct 6–10 2014 (13 participants), Jersey Oct 5–8 2015 (10 participants)

WG Evaluation

The first benefit of this working group is the gathering of the group of scientists working on the King, Queen and Icelandic scallop fisheries together to exchange knowledge, experience and insights. Before this group there was no organized effort to work together consistently, this group provides opportunity to address questions globally as well as locally and sharing and expanding resources and knowledge.

5) If applicable, please indicate the research priorities (and sub priorities) of the Science Plan to which the WG make a significant contribution.
  5.1) Understanding ecosystem function
    5.1.1) Scallop life history information
    5.1.2) Climate change: effects of environment on scallop life history
  5.2) Understanding interactions of human activities within ecosystems
    5.2.1) Impacts of scallop fisheries on benthic ecosystems
  5.3) Development of options for sustainable use of ecosystems
    5.3.1) Marine spatial planning; potential benefits of MPAs and European marine sites as conservation zones and recruitment supply areas for scallop populations
6) In bullet form, list the main outcomes and achievements of the WG since their last evaluation. Outcomes including publications, advisory products, modelling outputs, methodological developments, etc. *
  6.1) Data compilations
  6.2) Maps of scallop distribution and distribution of fishery
  6.3) Review of surveys
  6.4) Assessment case studies
  6.5) MSc thesis on effects of environmental variation on recruitment.
7) Has the WG contributed to Advisory needs? If so, please list when, to whom, and what was the essence of the advice.
  7.1) Advisory needs have not been defined. There is no request for advice. However the WGScallop has identified the main data

sources that would be used in the advisory process, compiled information on biological parameters, made a preliminary list of assessment or management units, discussed the merits and limitations of fisheries dependent and fisheries independent methods for scallop assessment. We have also discussed the use of MPA's and effects of scallop fishing gear on marine habitats.

8) Please list any specific outreach activities of the WG outside the ICES network (unless listed in question 6). For example, EC projects directly emanating from the WG discussions, representation of the WG in meetings of outside organizations, contributions to other agencies' activities.

8.1) Presentations and participation at International Pectinid workshops

9) Please indicate what difficulties, if any, have been encountered in achieving the workplan.

9.1) The main difficulties are the resources within the national fisheries laboratories allocated to research and assessment of scallop fisheries.

9.2) The WG started from a 'low base' with respect to the availability of data and in identifying a clear path to provision of advice.

Future plans

10) Does the group think that a continuation of the WG beyond its current term is required? (If yes, please list the reasons) YES.

10.1) To complete compilation of landings, effort, fishing distribution data and to derive basic indicators of stock status

10.2) Evaluate how stock assessment methods proposed by WKLife can be applied to scallop stocks

10.3) Evaluate the potential benefit of MPAs and European marine sites as sources of scallop recruitment

10.4) Evaluate and report on bycatch species composition and also on discard mortality rates of underside scallops with reference to the EU landings obligation

11) If you are not requesting an extension, does the group consider that a new WG is required to further develop the science previously addressed by the existing WG.

(*If you answered YES to question 10 or 11, it is expected that a new Category 2 draft resolution will be submitted through the relevant SSG Chair or Secretariat*.)

12) What additional expertise would improve the ability of the new (or in case of renewal, existing) WG to fulfil its ToR?

12.1) Links to WKLife, WKMSYproxy, PGDATA, SIMWG, and WGMHM.

12.2) Participation of scallop stock assessment scientists from outside Europe in the WG

12.3) Mapping (GIS) for overlaying datasets

13) Which conclusions/or knowledge acquired of the WG do you think should be used in the Advisory process, if not already used? (please be specific)

13.1) None at this point

13.2) During the next 3 year term

  13.2.1) assessment reports for some stocks could be used in the advisory process

  13.2.2) spatial data products produced could inform the implementation of MSFD Descriptor 6 (seabed integrity) and the conservation objectives that have been defined for European Marine Sites (Habitats Directive)