ICES WGScallop REPORT 2014

ICES ACOM Committee

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Report of the Scallop Assessment Working Group (WGScallop)

6–10 October 2014

Nantes, France

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

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

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

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Executive summary

The second Scallop Assessment Working Group meeting was held from 6 to 10 October 2014 Ifremer Center, Nantes, France. The focus of the 3 year working group is to providing scientific advice on scallops, defining a common approach to the assessment of stocks. During the 2013 meeting, the workshop focused on the following 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 group developed a working Matrix with points for each of the ToR compiling the existing information on surveys, available data and stock assessment approaches; several key factors emerged. All research groups rely heavily on aging methods and proportion by year class is a fundamental dataset. Many of the other factors varied between research groups.

The 2014 meeting opened with a review of the ToR discussion on 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." The group began to develop a common database of fisheries landing effort for ICES areas. Expanding on the 2013 work, two tables were developed: one focusing on estimates of F, F_{max}, von Bertalanffy growth parameters by stock/ICES rectangle, the second compiling the existing stock assessments from 2004 to 2014, including the unit of measure.

The group concluded that:

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.

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.

Strong concern was raised over the reduced funding for research and specifically independent fishery surveys continuing critical time-series that will jeopardize our ability to produce stock assessments if not maintained. From 2002 to 2011, the Queen scallop harvest has averaged 18 203 Mt while the King scallop has averaged 50 967 Mt; combined equal to 8.8% global production for scallops (Yearbook of Fishery Statistics, Capture Production, FAO, Rome, 2012). Effort to accurately estimate the stocks of these species should be of a high priority given their global value.


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ICES Areas with known or
likely scallop aggregations.

1 Introduction

1.1 Opening of the meeting

Experts on scallop stock assessment and life history were present. The meeting (Annex 1) began with a review of the ToR and overview presentations on the available fisheries data, a review of stock boundaries and identification of stock assessment units.

1.2 Background to the meeting

The Scallop Assessment Working Group met at the Marine Institute, Rinville, Oranmore, Galway from 2 to 5 September 2013, progress towards provision of scientific advice on scallops, with a focus on defining a common approach to assessment of stocks. The proposal to initiate a Working Group 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 last ICES Working Group to report on scallops met in Brest France from 30 May to 1 June 1991 (C.M. 1991/K:43).

2 ToR and Descriptor 3

Table 1a and b summarizes Descriptor 3, where the goal is that, 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, including fishing mortality (F lower than F_{MSY}), catch/biomass ratio, spawning-stock biomass and biomass indices.

Everyone is finding that F_{MAX} is flat-topped. F_{max} estimates are coming out at 1.6 (England), above 2.0 (Scotland), above 1.6 –Wales (using Scottish selectivity). This is suggesting that as soon as the scallops enter the fishery they should be fished. However, if that is the case it might result in a single spawning event depending on size and age of maturity which varies by area. It seems that F_{max} is not a good proxy for F_{MSY}. In addition the spatial variability, even within ICES rectangle, in scallop growth rates means that managing F at F_{max} would be difficult as different exploitation patterns at fine spatial scale would need to be planned for.

Table 1a.

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 1b.

				Fishing mortlaity (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	NA					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 +			

2.1 Distribution of fishing effort and landings for scallop inshore and off-shore waters, and explore the development of a common database.

In the English Channel there are large nomadic vessels, outside 6 nautical miles, info on landings and effort on EU logbook; smaller vessels VMS but limited. All rectangle based fishing data assembled. Everyone's reported landings. For French vessels the biggest 18 m from northern part of France, near shore many vessels 13 m long to 11 m, database landings and logbook, per ICES rectangles for the last 10 years, catch and effort. VMS all scallopers for last 3 years, the data exists but difficult to get. For the Isle of Man all vessels inside and outside have VMS data and they have access to all of it. For the 2014 Queen scallop fishing season within the Isle of Man territorial sea all vessels were required to carry a GPS recorder on a 30 sec interval and complete daily log sheets with tow to tow information and daily bag limits were in place. Sales notes, all the ICES rectangles and tow by tow data for the Queen scallops, discussions on King scallops. Can validate with the logbooks and GPS recorders. For the Welsh fishery, since 2012 all vessels with 10 min ping, no access to data for science purposes; similar data to rest of England: VMS for >12 m, logbooks, ICES rectangles reporting units for <12 m. Scotland is the same as the rest of the UK, VMS data etc.

In the English Channel outside of 6 nautical miles a large-vessel nomadic fleet operates and provides information on landing and effort to EU logbooks. For much of the EU (England, France, Scotland) VMS data for >12 m vessels as well as catch, effort, landings and log books per the ICES rectangles. The nearshore vessels are usually 11 to 13 m. These vessels provide catch, effort these provide landings and log books per the ICES rectangles but VMS data is limited (over the last 10 years). Exceptions include vessels fishing queen scallop seasonally within the Isle of Man territorial sea all are required to carry a GPS recorder on a 30 sec interval and complete daily log sheets with tow to tow information and daily bag limits were in place. Sales notes are available for all the ICES rectangles and tow by tow data for the Queen scallops, discussions on King scallops. These can be validated with the logbooks and GPS recorders. In the Welsh fishery, all vessels have VMS (beginning of 2012) with a 10 min ping interval. However there is no access to these data for science purposes; similar data to rest of England:

Some of the smaller vessels operating in the Channel have VMS but fleet coverage is limited. What VMS data that is collected is difficult to get. The largest French vessels are 18 m and they are mostly from Northern France. This differs from the fisheries around the Isle of Man where all vessels have VMS data and it is accessible.

In Ireland the scallop fleet is mainly over 18 m in length and fishes in the Celtic Sea, Irish Sea and English Channel. Smaller vessels fish inshore. VMS data for vessels over 15 m are available and can be used to estimate the annual dredge effort (footprint) when combined with information on the number of dredges used per vessel. The VMS data are coupled to the logbook data and provides information on the spatial distribution of landings. An LPUE index has been derived from the logbook data and independent data on dredges per vessel and the relationship between vessel length and number of dredges.

2.2 Surveys Identification of stock assessment and management units

Fishery-independent scallop surveys have been undertaken in a number of areas in recent years. The time-series available are variable (Table 2). However, due to costs and resource issues a number of these are ending while others are expanding:

1) Wales – 3rd survey completed in 3 years, project ending.

2) France – Two assessment surveys are conducted in France on the two main fishing areas, located in the bay of Saint-Brieuc (inshore fishery within the 12 nautical miles limit, in the north of Brittany, Western Channel) and in the bay of Seine (Normandy, Eastern Channel). These surveys that started respectively in 1965 in the bay of Saint-Brieuc and in 1976 in the bay of Seine, are completely standardize since 1992, and now based on a stratified random sampling plan. The sampling gear is a French dredge with diving plate, equipped with small 50 mm inside diameter rings. Data collected are used to define the status of the two stocks (Abundance index, structure of population, density of King scallops, and also data on associated benthic species). These surveys are supported by IFREMER, and there is today a high risk for their continuation for the next years. The 2015 surveys are scheduled, discussions are ongoing for subsequent years.

3) Scotland – 3 surveys continuing, year-on-year basis

4) Isle of Man – Continuing with 1 survey (April) but it is an extended survey outside the 12 nm limit as well.

5) England – looking at what data to use to undertake stock assessments, probably the recommendation will be some type of fisheries independent data (Wales will probably use the same thing).

6) Ireland – no surveys have been undertaken since 2006 and none are likely to take place in the near future. Data from VMS, logbooks, port sampling where samples can be referenced to ICES rectangle and on board observer programmes for catch sampling (including bycatch and discards) are used.

Table 2 Summarized stock assessment data currently available 2012 to 2014; data tabulated from to 2004 in Excel support file. Refer to text for details on estimation methods.

ICES	Stocks	Species	Yes/No 2015	2014	2013	2012	Estimation technique and metric
IVa	Shetland	King	Yes	in prep	in prep	in prep	Commercial catch age-based survey
	Moray Firth	King	Yes (maybe)	in prep	in prep	in prep	Commercial catch age-based survey
IVb	East coast Scotland/England	King	Yes (maybe)	in prep	in prep	in prep	Empirical survey based index
VIId	Bay of Seine	King	Yes	10966	27295	54438	Exploitable mt
	Greenwich Buoy	King	No				
	Sussex	King					
	Bassurelles	King	No				
VIIe/h	Cornwall	King					
	Bay of St Brieuc	King	Yes	15910	11790	15860	Exploitable mt
	Other Breton-Normand Gulf	King					
	West Brittany	King					
	Lyme Bay	King					
	Bay of Brest	King					
	Casquets	Queen	No	NA	NA	NA	
VIII	Glenan	King					
	Pertuis/Charentais	King					
	Belle ile en Mer	King					
VIIg	Celtic Sea	King					
VIIa	Tuskar	King					
VIIa	Cardigan Bay/Liverpool Bay	King	Maybe/No	2.81	4.46	1.8	mean density estimates
Man)	Liverpool Bay/Isle of Man/Scot coast inshore	Queen	Maybe/No	0.23	0.26	0.44	mean density estimates
Isle of Man	Isle of Man Territorial Sea	Queen	Yes	4708	Yes	Yes	Catch-Survey Analysis Stock Assessment
Isle of Man	Isle of Man Territorial Sea	King	Maybe	In prep.			mean density estimates
Man)	Liverpool Bay/Isle of Man/Scot coast inshore	King					
	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen	Maybe/No	0.38	0.36	0.43	mean density estimates
(Ireland)	Liverpool Bay/Isle of Man/Scot coast inshore	King/Queen					
	2013)	King/Queen					
	Northern Irish Coast	King					
VIa	Clyde	King	No				
	West of Kintyre (including NI)	Queen					
	West of Kintyre (including NI)	King	Yes (maybe)	in prep	in prep	in prep	Commercial catch age-based survey
	North west	King	Yes (maybe)	in prep	in prep	in prep	Commercial catch age-based survey
VIa and IVa	Orkney	King	No				
V	Iceland	Icelandic	No	NA	NA	NA	Swept area method. Exploitable mt
IIa	Frøya, Trøndelag	King					

Management units

Irish Sea – Based on the maps of scallop fishing grounds put together by the working group in 2013, Bangor University conducted a larvae transport modelling exercise. The work is presented in an MSc thesis (Hayden Close, 2014). It shows which areas of the Irish Sea are connected and suggests a divide north/south with a split from the tip of the Llyn Peninsula, North Wales (Figure 1). The Celtic Sea and Cardigan Bay appeared the main self-recruiting areas. A sensitivity analysis was conducted to assess the influence of the model parameters (spawning date, swimming behaviour etc.) on the output with regards mostly to connectivity among patches and retention within patches (Figure 2). The results suggested that the percentage of connectivity between patches was affected by such changes. However the links between patches (i.e. the sources and sinks) remained similar. Further research is needed to confirm those initial outputs, especially since a problem with the PLD (Pelagic Larval Duration) was spotted (i.e. PLD was largely overestimated in the model – it is a work in progress and a mortality rate is being included to correct for it).

Similar work (*unpublished*, Harnett *et al.*, 2007) in Ireland shows strong meteorological forcing of larval transport in the south Irish Sea and eastern Celtic Sea. The southwestern Irish Sea is a source of larvae for the Celtic Sea and there is a net westward transport of larvae along the south Irish coast. Stocks in the north Irish Sea have lower connectivities and are not connected to south Irish Sea or Celtic Sea.

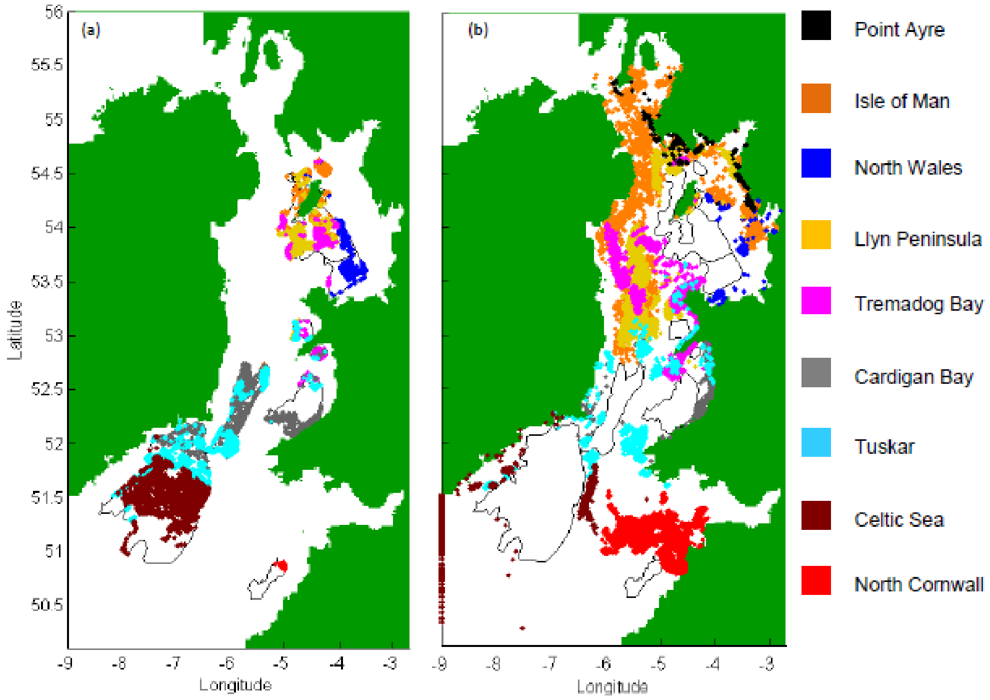

Figure 1. Example of simulation of larval dispersal in the Irish Sea. The colours indicate the origin of the larvae. (a) represents the "successful" larvae ending up on a fishing ground, (b) the unsuccessful ones (see Close, 2014).

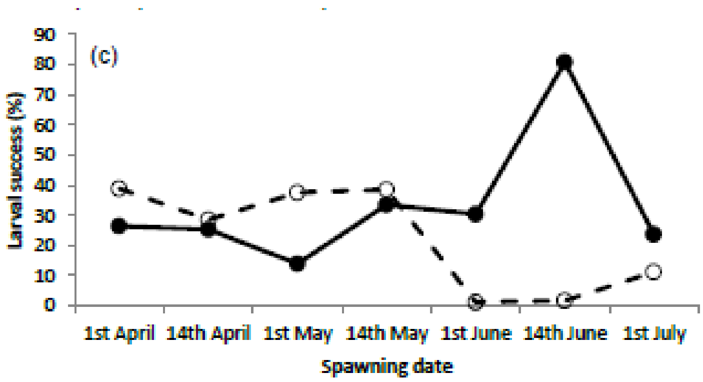

Figure 2. Influence of spawning date on retention and connectivity in/from Cardigan Bay. Solid line= connectivity to other fishing grounds, dash line= retention in Cardigan Bay.

Stock assessment

Table 2 summarizes the resent stock assessment data. Assessments for ICES IVa, Shetland and Moray Firth, are currently being updated 2011 to 2014 using SSB (muscle weight, t) from stock assessment using commercial catch-at-age and age-based survey indices. Pre 2011 values will be updated following finalization of new stock assessment. This fishery is managed under a Regulating Order by Shetland Shellfish Management Organisation on the basis of cpue indices (unpublished) from vessels licensed to fish in the area. Future assessment estimates will be presented as SSB total weight. For IVb, East coast of Scotland and England, the assessments are also currently being updated 2011 to 2014 and will use empirical survey based index of stock abundance (SSB) and recruitment (Values unpublished, for Figure, see Dobby *et al.*, 2013.

http://www.scotland.gov.uk/Resource/0041/00412344.pdf). For VIId, Bay of Seine, the assessment time-series is extensive and begins well before 2004. The assessment is estimated as exploitable biomass in Mt and calculated from independent fishery surveys. For VIIa, Cardigan Bay, Liverpool Bay, Isle of Man, Scottish coast inshore estimates are available from 2012 to 2014 as mean density estimates (see below). For the Isle of Man territorial sea there is an estimate for the Queen scallop but there is a retrospective pattern produced by the model changes among years. This estimate is obtained by the Isle of Man Catch-Survey Analysis Stock Assessment Method Estimated Mean Biomass in tonnes (modelled biomass - taken from 2014 stock assessment). The King scallop assessment for this area is in preparation. For VIa, West of Kintyre, the Northwest and Orkney Islands, assessments are currently being updated 2011 to 2014 using SSB (muscle weight, t) from stock assessment using commercial catch-at-age and age-based survey indices. Pre 2011 values will be updated following finalization of new stock assessment. These fishery is managed under a Regulating Order by Shetland Shellfish Management Organisation on the basis of cpue indices (unpublished) from vessels licensed to fish in the area. Future assessment estimates will be presented as SSB total weight. For V, Iceland, there are no recent assessments but pre-2012 stocks were assessed using a swept-area estimate and expressed in exploitable biomass.

Specific details on the assessment of scallops in the Irish sea around the Isle of Man and in Welsh waters are provide below.

Queen scallops in the Isle of Man: Stock assessment, stock status

Stock Assessment: A stock assessment has been undertaken for the Isle of Man queen scallop stock since 2012 using a Catch-Survey Analysis Method. Around the Isle of Man a survey is undertaken each year in spring across 44 fixed stations. At each station a 20 minute tow with 4 dredges (2 king scallop dredges and 2 queen scallop dredges) is undertaken at 2-2.5 knots. At present, the stock assessment is conducted within ICES rectangles 36E5 and 37E5.

Stock status: Following a period of high landings following good recruitment in 2010/2011 modelled biomass has decreased. The predicted median biomass for 2014 is 4708 t which is well below the minimum biomass threshold (13 000 t) below which recruitment may be impaired. As such, it was not possible for a scientific TAC to be advised for this year as the biomass is below that which is considered to affect recruitment.

The future: In response to several events the Isle of Man government has suggested an initiative to bring together UK jurisdictions to look at the current situation and to better coordinate assessment and management of queen scallop stocks in the Irish Sea. The initiative (Pan-Irish Sea Approach) includes DEFRA, DARD, Marine Scotland, WAG, DEFA and its main priorities are to develop an evidence base to scope the problem, to collect metadata, to identify knowledge gaps, especially on stocks and biology, to agree to 4 or 5 high level objectives and to get industry involved early on.

Irish Sea – Welsh waters:

Bangor University conducted in July 2014 their 3rd stock assessment survey, sampling around the Welsh coast onboard the RV Prince Madog. They use 4 dredges (two king scallop and two queen scallop dredges) and tow for 20 minutes at selected sites following a random stratified design. The surveys suggested that the stock of king scallops was not doing well in 2014 compare to 2012 and 2013 in Cardigan Bay. No particular trend was observed at the Llyn Peninsula or north of Anglesey (Liverpool Bay). In Cardigan Bay densities of all age classes (or length classes) went down significantly between 2013 and 2014. This did not appear to be due to fishing since the decline was also observed in the Cardigan Bay closed area. The bad winter of storms could have caused the decline although this was not directly evident since in April 2014, after the storms, the densities of scallops remained high in a significant part of the closed area where an experiment was conducted (see section on fishing impact). However the yield of scallops was very poor in the closed area in April 2014, during the mentioned experiment. The poor scallop yield could however not be linked to scallop densities. The decline in density of scallop caught during the 2014 survey could be due to a change in catchability since video surveys showed a stable average density of scallops over the 3 years of sampling.

2.3 Biological parameters

2.3.1.1 Scallop population age and growth variability.

Scallop (*Pecten maximus*) populations display considerable variation in growth rates and in the pattern of growth over time. This can be observed over relatively small spatial scales (<50 km) and so can introduce serious problems into stock assessments.

Scallops, like other bivalves, can be aged from annual shell marks caused by slowing of growth in winter. This is relatively straightforward in some populations (Irish Sea, Scotland) where annuli are clearly visible to the naked eye, but are more problematic in other areas, particularly the English Channel and western approaches, where the shells require microscopic examination of the individual growth striae to identify annuli. In the latter case, for some areas, the method has been verified using stable isotope analysis. This is particularly important for the position of the first winter annulus where scallops have both spring and autumn spawning periods and thus overwinter at different sizes. There remains doubt about the position of the first winter for populations for which fisheries have recently developed for which there has as yet been no verification and for which there is no information about spawning seasons. These populations are currently aged assuming that the first discernible annulus is formed during the second winter. In the absence of verification there must be doubt about this assumption for fast growing populations.

An example of the very significant differences in growth rate that have been observed for scallop populations can be seen in the English Channel. In the eastern channel (ICES Subareas 107D) growth is very fast while in the western English Channel (107E) it is significantly slower. This difference has justified a larger MLS in 107D. Within 107E there are further variations in growth rates between populations inshore and offshore and between those east and west of Start Point in Devon. At a smaller scale still, a population inshore off Polperro in Cornwall is extremely slow growing, recruiting to the fishery at age 8, while less than 20 km to the west, scallops in Veryan Bay grow faster and recruit at age 4 to 5. Similar significant variations have been reported between other *P. maximus* populations.

In the eastern Celtic Sea there is east west cline in the growth rate with faster growth in the east. Growth rate is partially driven by temperature and in particular near seabed currents. Scallop beds under stratified water columns may have lower growth due to lower temperature and current flows. Water column stratification indices could be used perhaps to stratify sampling for growth and estimation of F reference points.

Nevertheless, such variations cause severe problems in sampling for biological data without bias, both because the number of samples required is higher than would otherwise be the case (which stretches resources) but also because the reporting of landings at the statistical rectangle level means that catches cannot be apportioned to the different populations and sampling does not necessarily reflect fishing activity. Coupling of logbook data and VMS would allow landings to be estimated at spatial scales below ICES rectangle level.

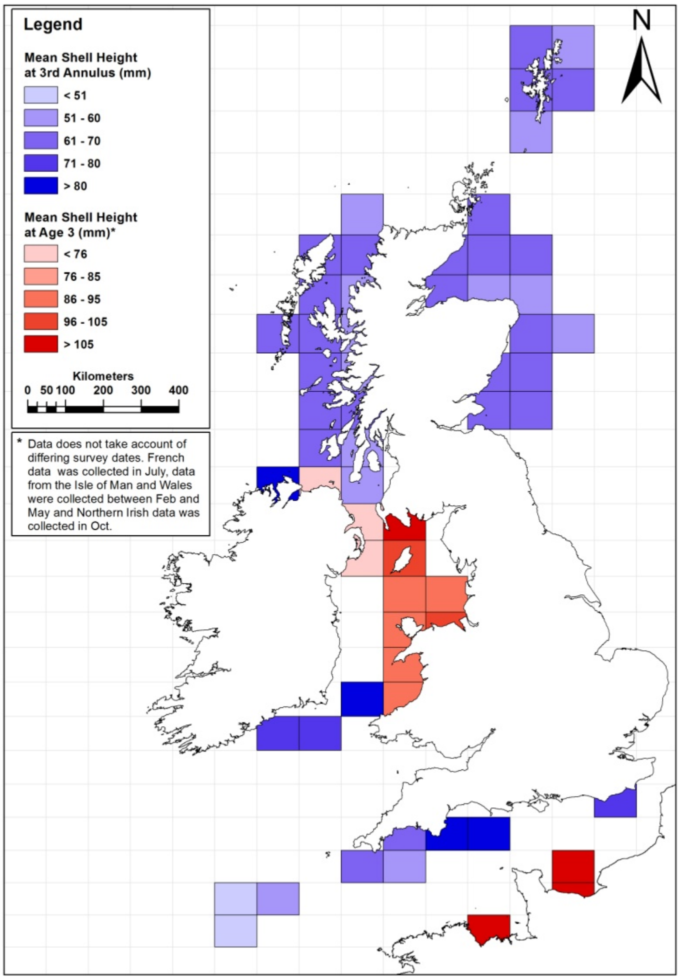

Figure 3. Map of the size at age 3 data compiled by Samuel Dignan scallops measuring shell height and height to the third annulus are separated. This highlights the need standardize methods. The shell height data are dependent on the time of year sampling occurred which could explain the bigger French scallops, as they were sampled at least 3 months later.

2.3.1.2 Growth and natural Mortality in the Great Scallop *Pecten maximus*

Accurate biological parameters are an essential component of accurate stock assessments. Determining these from exploited populations is difficult and estimates may be affected by the intensity of exploitation. Examining populations which have been well protected for a reasonable amount time should offer a better alternative. We have conducted two such studies; in both cases the data were collected by scuba surveys which are close to 100% efficiency for all size classes. However, as a precaution we only used scallops of 2 years and above when conducting catch curve analysis to estimate natural mortality.

1) Port Erin Closed Area (Beukers-Stewart *et al.*, 2005): Protected for 14 years at time of study. Some sporadic low level illegal fishing by dredgers, which has decreased in the last 3 years.

Natural mortality in the protected area (M)=0.3 (based on mean age compositions 2001–2003)

Growth parameters from the protected area:

2002: L_∞=152.39, k=0.48, t_0=0.18

2003: L_∞=147.94, k=0.52, t_0=-0.14

Growth parameters from adjacent the fishing ground (Bradda Inshore)

2002: L_∞=138.25, k=0.52, t_0=0.08

2003: L_∞=138.99, k=0.46, t_0=-0.14

2) Lamlash Bay Marine Reserve, Scotland (Howarth *et al.*, in review). Protected for 5 years at the time of study. Possibly some sporadic low level illegal fishing by both dredgers and divers.

Natural mortality in the protected area (M)=0.38 (based on mean age compositions 2010, 11, 13)

Growth parameters from the protected area:

2010, 11, 13: k=0.46, L_∞=151.01, t_0 =0.13

Growth parameters from the adjacent fished areas[1]

2010, 11, 13: k=0.38, L_∞=153.18, t_0=0.13

In both cases these studies have produced considerably higher estimates of natural mortality than those commonly used in scallop stock assessments (e.g. 0.15 or 0.20). Small amounts of illegal fishing may have raised our estimates a little, but this is unlikely to account for the full difference between estimates. Growth curves calculated from protected population in the Isle of Man produced similar k values to those on the fishing ground (which is heavily fished) but higher estimates of L_∞. Off the Isle of Arran L_∞ was similar in the two areas (the open area is only lightly fished), but k was higher in the protected area.

2.4 Stock assessment methods and evaluation of indicators of stock status and identification of reference points

An overview of the French COMANCHE project was presented as an example of how to address this ToR.

COMANCHE project (Eric Foucher) University of Brest presentations

The COMANCHE project (Ecosystem interactions and anthropogenic impacts on king scallop populations in the English Channel) aims to improve our knowledge of King scallop at the level of the whole English Channel, through an ecosystem approach to

[1] The mean age of scallops in this area was significantly higher than in the wider Clyde, suggesting it is fairly lightly fished

fisheries, by calling upon a large range of scientific disciplines (physics, chemistry, genetics, ecology, geostatistics, modelling, economics).

The project proposed to better characterize the spatial distribution of the King scallop at the English Channel scale, and better understand the mechanisms of connectivity between the main layers implying larval dispersal. The temporal fluctuation of recruitment have been studied in relation to environmental variables. The relationships of the king scallop with its ecosystem has been conducted through studies on the dynamics of its food, and especially the conditions of the appearance of toxic blooms which highly affect scallop populations. This project has also shown new methods to model individual growth and population dynamics according to food and abiotic environment fluctuations. Moreover, the complex interactions between king scallop and one of its competitors, the slipper-limpet, has been investigated. Fishing activity of scalloping has also been studied with the aims of quantifying its impact on the ecosystem and analysing the economic performance of the channels supported by the different layers of the English Channel.

The project COMANCHE presents a double interest, scientist on the one hand since it allowed the acquisition of new knowledge in the field of the ecosystem approach to fisheries (the publication of the results in international journals is ongoing, as well as a broad diffusion near the scientific community), and directly operational on the other hand by proposing new tools of decision-making within the scope of sustainable management of scallop stocks in the Channel.

Modelling larval dispersal of *Pecten maximus* in the English Channel: a tool for spatial management of stocks. Nicolle (2013)

To support strategies of spatial fishery management, a high-resolution biophysical model has been developed to study scallop dispersal in two bays along the French coasts of the English Channel (i.e. the Bay of Saint-Brieuc and the Bay of Seine) and to quantify the relative roles of local hydrodynamic processes, temperature dependent planktonic larval duration (PLD) and active swimming behaviour (SB). The English Channel currents and temperature are simulated for 10 years (2000–2010) with the MARS-3D code and then used by the Lagrangian module of MARS-3D to model the transport. Results were analysed in terms of larval distribution at settlement and connectivity rates.

While larval transport in the two bays depended both on the tidal residual circulation and the wind-induced currents, the relative role of these two hydrodynamic processes varied among bays. In the bay of Saint-Brieuc the main patterns of larval dispersal were due to tides, the wind being only a source of variability of the extent of larval patch and the local retention rate. Conversely, in the bay of Seine, wind-induced currents altered both the direction and the extent of larval transport. The main effect of a variable PLD in relation to the thermal history of each larva was to reduce the spread of dispersal and consequently increase the local retention by about 10% on average. Although swimming behaviour could influence larval dispersal during the first days of the PLD when larvae are mainly located in surface waters, it has a minor role on larval distribution at settlement and retention rates. The analysis of the connectivity between subpopulations within each bay allows identifying the main sources of larvae which depend on both the characteristics of local hydrodynamics and the spatial heterogeneity in the reproductive outputs.

Data at the whole Channel have now been analysed, to highlight high connectivity areas and show possible management zones.

How environmental conditions affect recruitment of King scallops populations in the Bay of Seine?

In the Bay of Seine (Eastern English Channel, France), assessment surveys are used to estimate King scallop's stock recruitment abundance, which shows high interannual variability. It is known that weather affects life cycles of marine species, but how are we able to link climate and recruitment variations? The approach of weather patterns recently developed by the community of climate scientists seems to provide some answers. Climate in Northern Europe is characterized by different situations, which depend on the strength of the North Atlantic Oscillation.

This study aims to highlight the influence of environmental conditions on recruitment and shows how these conditions could explain the variability. The analyses demonstrate that average temperatures between May and July (breeding season in the Bay of Seine) have a major influence on recruitment variations. The effect of other environmental conditions is difficult to estimate. Nevertheless, the climate index Atlantic Low (AL) that summarizes a set of environmental conditions is the most relevant variable to explain variations in recruitment. We propose a GLM model incorporating these variables "temperature" and "climate index AL" between May and July, which can explain up to 70% of scallop recruitment fluctuations in the Bay of Seine.

Energetic and latitudinal variablility of growth in bivalves

Bivalve growth patterns along latitudinal gradients show characteristics which we show that they can be partly explained by the variation of temperature and its seasonality. We show what lessons can be learned about the effects of a possible warming of coastal waters.

Ecology of the King scallop

Dynamic Energy Budgets (DEB) theory proposed by Kooijman formalizes metabolic processes involving energy transfers within an organism by modelling. This theory, applicable to all living beings, allows to understand the use made of energy intake via a substratum (food). Thus, it is possible to follow over time the evolution of growth, maturation, reproduction and maintenance of the body, using temperature data and food availability.

A DEB model was developed and fitted for the King scallop through a database from the bay of Brest. This model allows to monitor larval and adult growth, in length and weight, and the reproduction activity.

Particular attention was paid to the food sources for the scallop to improve the energy supply into the model. For this, a seasonal trophic study was conducted to qualitatively and quantitatively determine the feeding activity of the King scallop during the season. This helped to highlight a regime adapted to changes in the environment, including among others a significant part of dinoflagellates.

Finally, a reversed model was tested to see if it is possible to reconstruct trophic availability signal from high-resolution growth series. This would trace the feed conditions and the dynamics of the reserves of the animal during its life.

Modelling the distribution of the King scallop in the English Channel: linking physical and biological processes to define scallop habitats.

A modelling approach has been proposed in order to better understand the determinism of the distribution of the great scallop, integrating both physical and trophic constraints. Thus a three-dimensional bio-hydrodynamical model (ECOMARS3D developed at Ifremer) providing environmental conditions has been coupled to a population dynamics model and an individual physiological model of scallop. Both these approaches contribute to the understanding of the biogeographical distribution and especially enlighten the respective role of biological or physical factors in defining *P. maximus* habitat in the English Channel.

Scallops and slipper limpets

The gradual occupation of space in the bay of Saint-Brieuc by the American slipper-limpet and its impact on King scallop recruitment success shows the interest to calculate an index of abundance of this species. The COSB scientific survey based on a standardized protocol provides for several years the availability of this estimator. We have so a standardized tool to calculate an abundance index of the slipper limpet in the bay of Saint-Brieuc.

For each dredging point, the volume of the dredge and its contents (five content types could be found in the bay of Saint-Brieuc, the slipper limpet being one of them) is noted. Volume is expressed by the load height (number of meshes in the experimental dredge bag) and thickness (measured on a few stations). Fitting a sigmoid curve allows calculation of the thickness according to the height and, thereafter, the volume that is well correlated with the total weight of *Crepidula* in the dredge.

The resulting weight of *Crepidula* contains both living and dead individuals. The living/total ratio (%) varies in the range 55–85% depending on the area of the bay: a stronger presence of dead animals is discovered to the west of the bay explained by currents (the lowest residual currents near the western coast), but also the history of colonization (Western zones were the first colonized by the slipper limpet, around thirty years ago). The ratio has been calculated on different stations of the bay over several years and a geostatistical development allowed to extrapolate the total sampled area. A first analysis of the years 2001–2012 estimated the total biomass of slipper limpets in the bay between 230 000 and 300 000 tonnes

2.5 Data provision and feasibility of obtaining data

Common Database:

This dataset is being compiled:

- Landings and effort (KW days) by month and rectangle, split into vessel length categories ("<10", "10-11.99", "12-14.99", "15+"), by gear class.
- Time range, all years that you have data for!
- For gear classification we will follow the STECF/ICES coding approach.

Gear	Mesh	Gear Class
Beam	>120	BT1
	80-119	BT2
	<80	BT3
Otter	>100	TR1
	70-99	TR2
	<70	TR3
Dredge	NA	DRG

2.6 Efficacy of scallop fisheries management measures

What are the list of measures?

Cooperative fisheries management of scallops in the Ramsey Bay Fisheries Management Zone

In 2009 Ramsey Bay, a small but nonetheless economically important area in the Isle of Man (IOM), was closed to scallop dredging. Subsequently the area was designated a Marine Nature Reserve (MNR), within which a Fisheries Management Zone (FMZ) was established. The lease to manage fishing within the FMZ is held by local fishers through the Manx Fish Producers Organisation (MFPO). In December 2013, following extensive cooperation between fishers, scientists and government a strictly controlled fishery, targeting *Pecten maximus*, was prosecuted within the FMZ. The MFPO adopted a novel cooperative approach contracting three of their member boats to attain the Total Allowable Catch (TAC) and sharing the profits between its members. The fishery afforded a unique opportunity to evaluate the efficacy and socio-economics of such a strategy.

In total approximately 181 hectares (1.81 km^2) of seabed were affected by the fishery (approximately 2.9% of the FMZ). Catch rates from the fishery averaged 1.37 bags per dredge per hour. *P. maximus* from Ramsey Bay were on average seen to be larger and faster growing than the Island-wide average for autumn 2013, with individuals reaching MLS (110mm) at a lower age. Yields from the fishery were approximately 27.5kg of scallop meat or ca. £300 per hectare.

Total GHG emissions resulting directly from the fishery would have been in the region of 3.6 tonnes. The calculated edible protein Energy Return On Investment (ep-EROI) ratio for the Ramsey Bay fishery was approximately 0.712 which meant that, for every kg of chemical energy expended, in the form of fuel, 712 g of edible energy, in the form of protein were obtained. The Ramsey Bay fishery was as a result of its high capture rate, the extremely short steaming distances involved and the lack of interference competition between vessels, as much as nine times more energy efficient than the Manx *P. maximus* fleet as a whole.

2.7 Impact of scallop harvesting on habitat and habitat recovery rates

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 6: Seafloor 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.

There is a great deal of research underway in this area. The group would like to draw on work of others looking at the amount of effort in high energy environments compared to low energy environments (Firth of Lorn, SASI) ICES habitat working group, Mike Kaiser and Ray Hilborn – global perspective; overlay vulnerable habitat compared to fishing effort for scallops – have this for the Isle of Man, Scotland. Problem with scale 0.5 degree for VMS data coarse compared to maps of critical habitat. Simon Jennings Jann H. Barry O'Niell Benthis project? Could the Benthis project give an overview at the next ICES scallop working group meeting?

Fishing impact on habitat in Cardigan Bay:

Bangor University conducted a large-scale BACI experiment in Wales in April 2014. They tested the impact of scallop dredging along a fishing gradient in a hydrodynamic area of the seabed, in the Cardigan Bay SAC, with the participation of 5 fishing vessels. They conducted a pre impact (in March), post impact (in May) and recovery survey (in September). They sampled using video sled, beam trawl and Hamon grab. The samples are being processed and data are being analysed at the time of writing this report. Preliminary results show that the area might have recovered in terms of epifauna between May and September 2014 (Figure 3). Further recently published research suggests that recovery of epifauna on scallop grounds was linked to hydrodynamics and that it could take 2 to 4 years to recover (Lambert *et al.*, 2014).

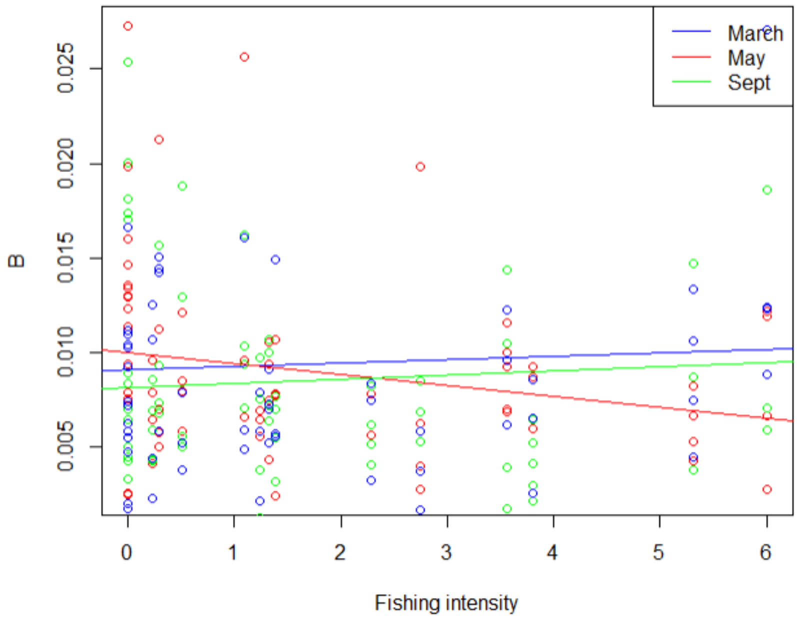

Figure 3. Relationship between total biomass of epifauna collected in the beam trawls samples during the pre-, post- and recovery surveys (respectively March, May, and September 2104) and fishing intensity.

An impact on the physical structure of the seabed is however still seen after 4 months with no dredging, which could suggest that infaunal community might take longer to recover. No data are available yet regarding infauna but fishing appears to have decreased the proportion of fine sediments and increase the proportion of coarse sand which is likely to affect the animals living in the sediment (Figure 4).

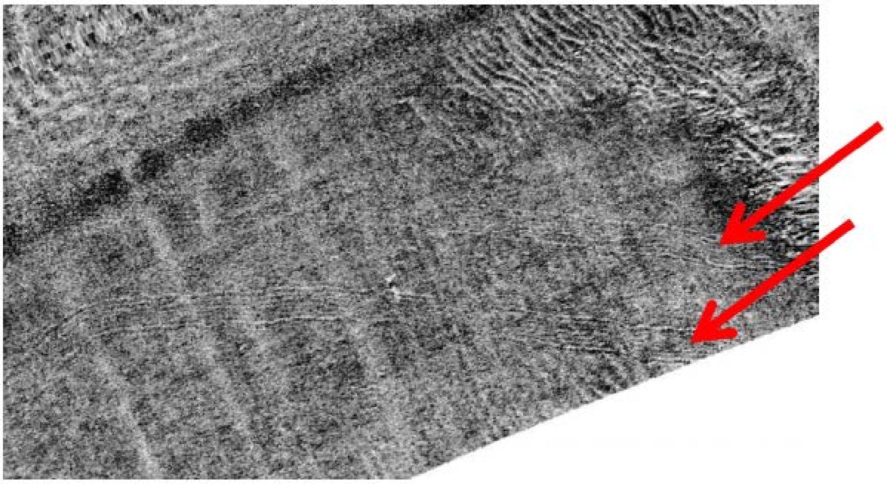

Figure 4. Sidescan sonar image showing scars left by scallop dredging within 2 weeks after impact, Cardigan Bay SAC.

Effects of Temperature and Ocean Warming on Scallops and Benthic Communities

There is evidence that ocean warming has effects on the ecology, including recruitment dynamics, of marine organisms. In association with rising mean spring temperatures in the Irish Sea, a time-series of juvenile scallop *Pecten maximus* density around the Isle of Man showed a significant increasing trend since 1991. Favourable conditions (warmer water and correspondingly greater food availability) during gonad development can increase scallop gamete production. We examined the possibility that ocean warming has directly increased recruitment of exploited *P. maximus* around the Isle of Man by enhancing gonad development. From 1991–2007, there was a significant positive correlation between scallop recruitment and mean spring (the main period of gonad development) temperature in the year of larval settlement. De-trended (i.e. accounting for a time effect) recruitment data showed a marginally non-significant correlation to temperature. Gonadal somatic index of adult scallops and temperature were positively correlated. These relationships support the hypothesis that greater gamete production associated with ocean warming may be primarily responsible for observed increases in recruitment success and cpue in a commercially important shellfish stock.

The Isle of Man fishing industry is currently dominated by two lucrative and heavily exploited scallop fisheries targeting *Pecten maximus* and *Aequipecten opercularis.* The impacts of these fisheries have previously been investigated, however, without the addition of environmental information. This thesis represents a unique long-term investigation (1992–2006) into the combined impacts of fishing pressure and environmental variation on the benthic invertebrate communities of fishing grounds found around the Isle of Man. A significant temporal increase in seawater temperature was found, along with an inverse correlation with chlorophyll-α. Fishing pressure was found to have small, significant negative effects on the diversity of benthic communities; however, environmental variables were unable to explain the remaining patterns in diversity. The composition of the benthic communities was then investigated in more detail. Fishing pressure had a significant negative effect on densities of benthic invertebrates at some grounds; however, this study showed that many of the heavily fished sites were composed of dredge-tolerant species. Significant relationships were found between the densities of the starfish *Asterias rubens* and *Porania pulvillus* and several environmental variables (temperature – positive, chlorophyll-α - negative) on southwest fishing grounds, suggesting that environmental variation, rather than fishing pressure, was responsible for variations in these species. Further evidence of the negative impact of scallop dredging was found from long-term analysis of a closed area, implemented in 1989. Dramatic recovery of *P.maximus* populations have occurred within this closure, but without concurrent increases in numbers of its main predator, the starfish *A.rubens*, as predicted by other studies. Relationships between densities of several benthic species within the closed area and environmental variables (temperature and NAO index – positive, chlorophyll-α -negative) were found. However, the results of this study indicate a complex ecosystem, which is also affected by predator–prey interactions. The overall findings of this research indicate that closed area management is a relatively straightforward and effective management measure in this region. Future management decisions will however, have to account for the potential effects of climate change and ocean acidification.

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Annex 1: List of participants

NAME	ADDRESS	EMAIL
Kevin Stokesbury	School for Marine Science and Technology - USA	kstokesbury@umassd.edu
Gwladys Lambert	Bangor University - UK	g.lambert@bangor.ac.uk
Ewen Bell	Cefas - UK	ewen.bell@cefas.co.uk
David Palmer	Cefas - UK	dave.palmer@cefas.co.uk
Helen Dobby	Marine Laboratory - UK	H.Dobby@MARLAB.AC.UK
Eric Foucher	Ifremer – France	Eric.Foucher@ifremer.fr
Spyros Fifas	Ifremer - France	Spyros.Fifas@ifremer.fr
Bryce Beukers-Stewart	University of York - USA	bryce.beukers-stewart@york.ac.uk
Isobel Bloor	Bangor University – UK	ismbloor@bangor.ac.uk
Samuel Dignan	Bangor University - UK	s.dignan@bangor.ac.uk

Annex 2: ToRs of the 2014 WGScallop meeting

2012/ACOM42 The **Scallop Assessment Working Group (WGScallop)**, chaired by Kevin Stokesbury, USA, will meet from 6 to 10 October 2014 Ifremer Centre, Nantes, France, to:

Terms of Reference:

Building on the 2013 working group meeting and report we will review and update the information on the 7 ToRs:

1) Distribution of fishing effort and landings for scallop inshore and offshore waters, and explore the development of a common data base.
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

a. There is a problem of global assessment; for example in ICES division VIId there is a problem of regulation of the stock (between UK, Ireland and France), and VIIA is a complex mix of 'stocks' with Irish, Northern Irish, Scottish, Isle of Man and English vessels. Discuss and build upon the experience in other fisheries and working groups (i.e. *Nephrops*; the North Western Water Regional Advisory Council (NWWRAC).
b. Continuing the discussion on standardizing between surveys, age methods, and life-history/reference points is critical to sustainable management.
c. 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 discrete populations. It is fundamental to the assessments and subsequent management of scallop stocks that the connectivity's between adult scallop beds is better understood.
d. Different management alternatives including spatial management and the increasing use of closed areas and their effect on scallop stock and habitats will be examined.

WGScallop will report by 6 November 2014 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 north west Europe and North America. There is currently no common scientific or assessment forum for discussion and development of common assessment methods for scallops. These justifications used in 2013 continue to be valid and provide a basis to build upon. **ToR 1** will provide the data on the distribution of fishing effort and landings for scallop in inshore and offshore waters in ICES Areas VI and VII. These data have not been compiled for the region to date. The meeting in 2014 will review information, including simulations of larval dispersal and seabed habitat, to identify stock assessment and management

	units (**ToR 2**). This work will identify priority source areas for larval production and generally increase understanding of the source-sink dynamics of scallops. The biological characteristics of scallop are known to vary geographically. **ToR 3** will review the available information and cross-reference to the proposed assessment units (ToR 2). Progress towards provision of scientific advice on scallops will be greater where a common approach to assessment of stocks can be developed. Various approaches are currently used, in many cases without a sound biological basis. **ToR 4** will review the application of various methods with a view to developing a standard approach and will consider the indicators that could be used to identify safe biological limits for scallop stocks as required by the Marine Strategy framework Directive (MSFD) (2010/477/EU) in terms of the level of fishing pressure, reproductive capacity of the stock and population age and size distributions. Data provision and the feasibility of obtaining data relevant to appropriate assessment methods is an important consideration in developing an advisory system for scallops and will be discussed in ToR 5. Scallop fisheries are managed under legislation at the national level and more locally (e.g. in Special Areas of Conservation in the UK). The scientific rationale behind present scallop fisheries management measures and their effectiveness, both in terms of maximising productivity and minimising ecosystem impacts, will be investigated to allow advice to be provided where data deficiency prevents formal stock assessments (ToR 6). Understanding the direct and indirect impacts of scallop dredging and trawling on ecosystems, especially on benthic habitats, is fundamental to achieving successful management of scallop fisheries and to evaluate the effect of the fishery on good environmental status (GES) of the seafloor as required by the MSFD (Descriptor 6, seafloor integrity) and favourable conservation status (FCS) of habitats where these fisheries occur in European marine Sites (designated under the Habitats Directive). Under ToR 7 the impact of scallop dredging will be examined in relation to habitat type (cross-referencing with ToR 2) using fishery-dependent and fishery-independent data (ToR 4). Quantifying recovery rates of benthic flora and fauna will facilitate the provision of advice in an ecosystem context.

Resource requirements:	None.
Participants:	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), Sarah Clarke, Ireland (Marine Institute), 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:	There are no obvious direct linkages.
Linkages to other organizations:	There are no obvious direct linkages.

Annex 3: Agenda

Agenda

WGScallop – Scallop Assessment Working Group

6—10 October 2014

Nantes (France), Ifremer Centre Atlantique

(http://wwz.ifremer.fr/institut_eng/The-Institute/Ifremer-Sites/Atlantic)

Attendants:

Kevin Stokesbury, Gwladys Lambert, Ewen Bell, David Palmer, Helen Dobby, Eric Foucher (host), Bryce Beukers-Steward, Isobel Bloor, Sam Dignan, Spyros Fifas (host)

Unable to attend:

Brad Harris, Jonas Jónasson, Carrie McMinn, Heather Moore, Pieter-Jan Schon, Ollie Tully, Øivind Strand, Lynda Blackadder, Claire Catherall, Lee Gordon Murray

Monday 6 October 2014

Morning -9.30 am

- Introductions
- Review 2013 report and go over ToR for this meeting considering the emails below (from Ollie and Henrik)

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.

3.1 Level of pressure of the fishing activity

3.1.1. Fishing mortality (F lower than F_{MSY})

3.1.2. Ratio between catch and biomass index (catch/biomass ratio)

3.2 Reproductive capacity of the stock

3.2.1. Spawning-stock biomass (catch-at-age or length and ancillary info; SSB that would achieve MSY under a fishing mortality equal to F_{MSY})

3.2.2. Biomass indices

3.3. Population age and size distribution (large proportion of old, large individuals)

3.3.1. Proportion of fish larger than the mean size of first sexual maturation

3.3.2. Mean maximum length across all species found in research vessel surveys.

3.3.3. 95% percentile of the fish length observed in research vessel surveys.

3.3.4. Size at first sexual maturation.

Other factors:

Closed areas? Spatial management; portion of stock unexploited

Afternoon

- Distribution of fishing effort and landings for scallop inshore and offshore waters, and explore the development of a common database.

Common Database development

- Identification of stock assessment and management units

Sensitivity of scallop larval distribution modelling for Irish Sea stock units definition to model input parameters. Gwladys Lambert

Independent fish surveys discussion.

Tuesday 7 October 2014

Morning -9.00 am

Follow up from Monday:

Multi-annual management of Science Expert Groups (Guidelines for ICES expert groups Version 2014-1; page 4).

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.

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.

Following up on yesterday we are compiling the von B parameters and using the YPR to estimate F_{MAX}.

- Biological parameters
- Stock assessment methods and evaluation of indicators of stock status and identification of reference points

Queen scallops in the Isle of Man: Stock assessment, stock status and the future. Isobel Bloor

Stock status in Welsh waters after 3 years of research survey – biological parameters and trends. Gwladys Lambert

Afternoon

Further discussion, adjourned at 2.30 pm for a tour of Nantes.

Wednesday 8 October 2014

Morning -9.00 am

Further examination of F max.

Data provision and feasibility of obtaining data

Spent the morning compiling tables, database, and writing portions of the report.

12:00 pm colleagues from the University of Brest arrived. Eric Foucher gave an overview of the COMANCE project (9 authors): 8 scientific tasks divided into 3 axis; biology, function of the system, and uses.

Afternoon

- COMANCHE project (Eric Foucher) U of Brest presentations

Modelling larval dispersal of *Pecten maximus* in the English Channel: a tool for spatial management of stocks. A Nicolle U of Brest.

How environmental conditions affect recruitment of King scallops populations in the Bay of Seine? Eric Foucher.

Energetic and latitudinal variablility of growth in bivalves. F. Jean U. of Brest.

Ecology of the King scallop. F. Jean U. of Brest. (Lavaud *et al.*, in preparation PhD student)

Modelling the distribution of the King scallop in the English Channel: linking physical and biological processes to define scallop habitats. . Jean U. of Brest. (P. Cugier *et al.*, in preparation PhD student)

Scallops and slipper limpets. Spyros Fifas.

Population genetics on P. *maximus*. Gregory Charrier U. of Brest.

Thursday 9 October 2014

Morning -9.00 am

- Efficacy of scallop fisheries management measures

Cooperative fisheries management of scallops in the Ramsey Bay Fisheries Management Zone.Sam Dignan

Evaluation of the annual stock of *P. maximus* in the Bay of Seine. Eric Foucher

Evaluation of the annual stock of *P. maximus* in the Bay of St Brieuc. Spyros Fifas.

- Impact of scallop harvesting on habitat and habitat recovery rates

Quantifying recovery rates and resilience of seabed habitats affected by bottom fishing. Gwladys Lambert

Afternoon

Scallop ring measurement data collection and subsequent growth analysis. Helen Dobby.

Using a BACI experiment to assess seabed resilience to scallop dredging in a dynamic area. Gwladys Lambert

Recovery of scallop populations and the marine ecosystem in the Lamlash Bay marine reserve: implications for wider management. Bryce Beukers-Steward

- Review missing components, work on sections, writing.

Friday 10 October 2014

Morning -9.00 am

- Report Review, please note WGScallop will report by **15 November 2014** for the attention of SCICOM (updated by Lise Cronne ICES)
- ToR for next meeting,
- Location
- Logistics

End at 11:00 am.

Annex 4: Terms of reference of 2015 WGScallop

2014/ACOM24 The **Scallop Assessment Working Group (WGScallop)**, chaired by Kevin Stokesbury, USA, will meet in Early October 2015.

Meeting hosted by Greg Morel | Marine and Coastal Manager | Department of the Environment Howard Davis Farm, Trinity, Jersey, JE3 5JP T: +44 (0)1534 441620 | F : +44 (0)1534 441601 | E: g.morel@gov.je | W: www.gov.je/fisheries

The original ToR's for this working group were:

8) Distribution of fishing effort and landings for scallop inshore and offshore waters, and explore the development of a common database.

9) Identification of stock assessment and management units

10) Biological parameters

11) Stock assessment methods and evaluation of indicators of stock status and identification of reference points

12) Data provision and feasibility of obtaining data

13) Efficacy of scallop fisheries management measures

14) Impact of scallop harvesting on habitat and habitat recovery rates

Over the past two meetings we have discussed and compiled information on these ToRs. In the upcoming meeting we will finalize our analysis by:

a) Have recommendation on wither 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 3 year report, self-evaluation.
f) Prepare the 3 year report, self-evaluation.

WGScallop will report by 2 November 2015 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 3 year 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. The group developed a working Matrix with points for each of the ToR compiling the existing information on surveys, available data and stock assessment approaches; several key factors emerged. All research groups rely heavily on aging methods and proportion by year class is a fundamental dataset. Many of the other factors varied between research groups.

In 2014, the group began to develop a common database of fisheries landing effort for ICES areas. Expanding on the 2013 work the group collected information on estimations of F, F_{MAX}, von Bertalanffy growth parameters by stock/ICES rectangle, and the existing stock assessments from 2004 to 2014, including the unit of measure. Fmax was not a good proxy for Fmsy for King or Queen scallops due to flat topped YPR curves, at current selection patterns. There was no evidence of a stock recruitment relationship. There was evidence of connectivity between beds and work is underway on examining these processes through the study of environmental conditions and genetics. 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 this meeting the group will compile the information from the previous two meetings, add additional information and address the three descriptors in a final report.

Resource requirements:	None.
Participants:	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), Sarah Clarke, Ireland (Marine Institute), 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:	There are no obvious direct linkages.
Linkages to other organizations:	There are no obvious direct linkages.