ICES WGCRAB REPORT 2016

SCICOM STEERING GROUP ON ECOSYSTEM PROCESSES AND DYNAMICS

ICES CM 2016/SSGEPD:10

REF. SCICOM

Report of the Working Group on the Biology and Life History of Crabs (WGCRAB)

1–3 November 2016

Aberdeen, Scotland, UK

ICES CIEM
International Council for the Exploration of the Sea
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

Recommended format for purposes of citation:

ICES. 2017. Report of the Working Group on the Biology and Life History of Crabs (WGCRAB), 1–3 November 2016, Aberdeen, Scotland, UK. ICES CM 2016/SSGEPD:10. 78 pp.

Contents

Executive summary

The Working Group on the Biology and Life History of Crabs (WGCRAB) met in Aberdeen, Scotland, 1–3 November 2016, with AnnDorte Burmeister as chair. The meeting was attended by 16 participants from 6 countries.

The objectives of the meeting were to update and provide data and knowledge on landings, fisheries and biology of the important crab and lobster stocks in the ICES area. In addition, essential objectives were furthermore to discuss important crab and lobster stocks to identify gaps in assessment programs and review application of biological and management reference points for crab fishery. The WG also reviewed alternative indicators in assessment of crab stocks without fishery independent data.

The first 2 days the work was focused on ToRs a, b, and c. Updates on landings and stock status/assessments on Brown crab and lobster in UK, Scotland, France and Brown crab in Norway; Snow crab in Canada, Greenland and Norway (Barents Sea); Spider crab in France and Red King crab in and Norway were presented.

ToR e "Review research and new knowledge of vital crab population biology parameter" was discussed on days 2–3. Presentation of topic such as: the biology and eco-physiology of *Cancer pagurus* in Norway; population genetic structure in North Eastern Atlantic; movements of brown crab around the North Coast of Scotland; VMS-based effort for the offshore brown fishery in Scotland; discard and survival and condition of brown crab; Dynamic of snow crab movements and migration along the Newfoundland and Labrador and astern Barents sea continental shelves and Size at maturity; and population dynamics of Green crabs (*Carcinus maenas L.*) in Mainland Orkney, Scotland.

The brown crab (*Cancer pagurus*) and the European lobster (*Homarus gammarus*) are both highly valuable shellfish species in the Northeastern Atlantic, but at present, whilst ICES WGCRAB provides a useful forum for brown crab scientists, there is only few lobster equivalent. Both species are typically caught using baited traps and although targeting does occur, they are often regarded as being exploited as a mixed fishery. Availability of fishing activity data and the similarity of their respective biological attributes has led to fisheries scientists using the same or similar stock assessment methodologies for both species. Furthermore, the same fisheries scientists within each fisheries institute are often responsible for both crab and lobster stock status assessments.

The WG decided to continue reviewing prospects for future assessment, advice including data availability, assessment methods and research on the biology of crab and lobster. The group agreed to make progress in evaluating assessment methods, sharing new knowledge of the species and working toward collaborating projects. The WG also agreed also to highlight research results on important crab and lobster species within the ICES, Atlantic Canada and West Greenland.

1 Administrative details

Working Group name

Working Group on the Biology and Life History of Crabs (WGCRAB)

Year of Appointment within current cycle

2014

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

3

Chair(s)

AnnDorte Burmeister, Greenland

Meeting dates and venues

22–24 April 2014, Tromsø, Norway, 11 participants

3–5 November 2015, Brest, France, 12 participants

1–3 November 2016, Aberdeen Scotland, UK, 16 participants

2 Terms of Reference a) – z)

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Compile data on landings, discards, effort and catch rates (CPUE) and provide standardised CPUE, size frequency and research survey data for the important crab and lobster (Homarus) fisheries in the ICES area, and Atlantic Canada and Greenland.	The fisheries for crabs and lobster are socio-economically important and trans-national in Europe and Canada with the demise of fin fisheries in some regions.	212.321	3 years	Landing, discard, effort and catch data on listed species, from each country. WG report chapter
b	Evaluate assessment of the status of crab and lobster (Homarus) stocks including use of indicators, empirical assessment, analytical assessment in relation to data sources and data quality, development and suitability of reference points for management.	Management of stocks in Europe is primarily by technical measures only and in most countries there are generally no management instruments to control fishing effort. Knowledge of the population dynamics of these species is still weak. These stocks may be at risk from over-fishing due to the lack of control of fishing effort, and hence an evaluation of the sustainability of these fisheries is necessary.	311, 334	3 years	Report on evaluation of alternative assessment methods.

c	WGCRAB wish to produce assessment of the main crab and lobster species in the ICES area in future. (Year 1 - 2014) Review prospects for future assessmentincluding data availability, management units, and possible reference points and assessment methods. Initiate preliminary assessment exercises. (Year 2 - 2015) Review management measures applied in crab fisheries and future options. Continue exploratory assessments. (Year 3 – 2016) Preliminary assessments of stock status for relevant crab and lobster species according to MSFD D3 WGCRAB will discuss with ACOM, SCICOM, SSGEPD the feasibility of including e assessment within its future ToRs.	WGCRAB aims to produce assess-ments on a management unit basis. Evaluate current assessment methods and identify reference points. Develop assessment methods to identify position with respect to MSY proxies and harvest rules. It would be of great interest to make progress on assessment of stock status and further develop ideas on reference points. WGCRAB will discussions advantages and disadvantages of emphasis advice on a management basis. Secondly WGCRAB will include a workshop at the 2015 or 2016 meeting to look at prospects for future assessment and management. Third step is to consult with ACOM regarding assessment from the WGCRAB.		3 years	(Year 1) Report on data availability, management units, reference points and assessment methods (Year 2) Report on management options for crab fisheries (Year 3) Preliminary report on stock status and management plans for selected species
d	Review the impact of climate divers on important crab and lobster species within the ICES, Atlantic Canada and West Greenland, including increased ocean acidification;	WGCRAB will investigate the relative importance of fishing and environment on crab and lobster recruitment. Furthermore there is a growing concern in the WG about the consequences of future climate change for important crab species in our region. Observed increases in sea water temperatures have already entailed expanded distribution areas of some species in the northeast Atlantic. However, a rise in the seawater pH would probably be the most serious consequences of the climate change on crustaceans such as crabs. These issues will be dealt with by the WGCRAB in future.	112, 113	3 years	Highlight important issues to be basis for research on effect of climate changes on important crab stocks. WG report chapter (2016)
e	Review research and new knowledge on vital crab and lobster population biology parameters;	Several stock parameters are important for analytical assessments. Biological information is therefore required to provide standardised indices and for use in analytical assessments. Crab stock	141		Updated knowledge on crucial stock parameters for important crab stocks.

	parameters may change due to size selective and single sex fisheries, through by-catch in other fisheries or through the impact of other seabed uses, such as gravel extraction. Since important crab stocks in Europe are managed without fishery independent data it may be an option to investigate any useful stock parameter indicators for assessment purposes.	

3 Summary of Work plan

Year 1	Annual standard outputs for a, b. Continue analysis for ToR d, e. Tentative plan for ToR c.
Year 2	Annual standard outputs for a, b. Continue analysis for ToR d, e. Complete evaluation of useful assessment methods to assess crab and lobster species in ICES areas. Complete request to ACOM and SCICOM (being both an assessment, advice and working group).
Year 3	Annual standard outputs for a, b. Combine analysis, research and report ToR d and e.

4 Summary of Achievements of the WG during 3-year term

4.1 Norwegian *Cancer pagurus* stock

- Annual contributions to the WGCRAB report on stock status of the *Cancer pagurus* stock along the Norwegian coast.
- Stock summary of the Norwegian *Cancer pagurus* stock in an annual IMR-report for the public

  (http://www.imr.no/filarkiv/2016/03/havforskningsrapporten_2016.pdf/nb-no).
- Postdoc (2014–2016) working on the genetic stock structure and age determining methods
- Data set on the Norwegian reference fleet of crab fishers (2001–2015) has been given to Snorre Bakke at Møreforskning to analyse as part of his PhD on edible crab
- Report from joint project by Møreforskning and Institute of Marine Research (led by Møreforskning): Woll, A., Søvik, G., Larssen, W.E., Thangstad, T.H. 2014. Ressursmessige og økonomiske konsekvenser av et fiske etter taskekrabbe (*Cancer pagurus*) utenom hovedsesong. Rapport MA 14-09. 64 pp. English translation: Resource and economic consequences of a crab fishery (*Cancer pagurus*) outside the main fishing season.
- Haig, J. A., S. Bakke, M. C. Bell, I. S. M. Bloor, M. Cohen, M. Coleman, S. Dignan, M. J. Kaiser, J. R. Pantin, M. Roach, H. Salomonsen and O. Tully (2016). "Reproductive traits and factors affecting the size at maturity of *Cancer pagurus* across Northern Europe." *ICES Journal of Marine Science: Journal du Conseil*.

4.2 England and Wales brown crab and lobster

- *Advisory products:* Centre for Environment Fisheries and Aquaculture Science (Cefas) provides management advice on the stocks of *Cancer pagurus* and *Homarus gammarus* in English and Welsh waters based upon the assessments performed every two years.
- *Datasets:* Cefas use three datasets to assess brown crab and lobster fisheries in England and Wales: landings, fishing effort and size distribution of landings. The landings and fishing effort data for over 10 meter vessels come from mandatory EU logbooks. For under 10 meter vessels the landings data are collected from first sales notes and the fishing effort from Monthly Shellfish activity returns (MSARs). Scientific officers visit ports frequently to collect size data. Additional size data have also been incorporated from local Inshore Fisheries and Conservation Authorities (IFCAs) since 2013.
- *Modelling output:* Length based Cohort Analyses are performed every two years to estimate abundance and fishing mortality at length for *Cancer pagurus* and *Homarus gammarus*. Length based VPA, Yield, spawner and egg per recruit models are performed to assess the current status of the stocks relative to reference points.

4.3 Greenland – snow crab

- Annual contributions to the WGCRAB report on stock status of the *snow crab* stock in west Greenland waters.
- Stock summary of the snow crab stock in an annual GNIR-report: http://www.natur.gl/biologisk-raadgivning/skaldyr/
- *Advisory product:* Greenland Institute of Natural Resources provides management advice on the stock *snow crab from West Greenland* waters based upon the assessments performed every two years.
- Datasets*:* Greenland Institute of Natural Resources use datasets from commercial logbooks as well as data from research survey in the management area Sisimiut to assess the snow crab fishery in Greenland..
- Modelling: No analytical assessment have been conducted, and currently the stock is assessed based on stock indies from logbooks and research survey. Nevertheless, in attempt to improve the quality of assessment, the SPiCT model and other models recommend in ICES report "ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp" and "ICES. 2015. Report of the Fifth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history Traits, Exploitation Characteristics and other Relevant Parameters for Data-limited Stocks (WKLIFE V), 5–9 October 2015, Lisbon, Portugal. ICES CM 2015/ACOM:56. 157 pp." will be investigated.

4.4 Canada

- For snow crab a draft manuscript entitled 'Dynamics of Snow Crab (*Chionoecetes opilio*) Movement and Migration Along the Newfoundland and Labrador and Eastern Barents Sea Continental Shelves' was presented in 2016. The manuscript had been submitted for primary publication prior to meeting. The manuscript was collaboratively developed by Canadian and Russian members of the working group.
- Over the past 3 years data has been presented on snow crab throughout the Atlantic Canadian region, encompassing the full spatial scale of the stock. This was not the case historically, where research was presented on smaller-scale regions within the stock range.

5 Final report on ToRs, workplan and Science Implementation Plan

5.1 Norwegian edible crab (*Cancer pagurus*) stock

5.1.1 ToR a) Landing, discard, effort and catch data

There are regional differences along the Norwegian coast regarding landings, landings and discards rates, size, and sex ratio in landed catch of the edible crab. Data are therefore presented separately for seven statistical areas as defined by the Norwegian Directorate of Fisheries (Figure 1).

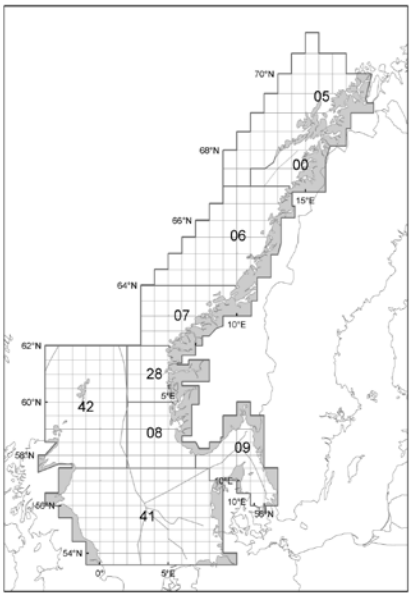


Figure 1. Statistical areas as defined by the Norwegian Directorate of Fisheries.

Landings

The Norwegian landings of edible crab have since 2008 fluctuated without trend (Figure 2). In 2015, 4744 tons were landed. Mid-Norway is the main crab fishing area (statistical

areas 6 and 7). Crabs are probably sold unregistered in all of Norway. From 2010 onwards, all crabs sold to consumers in area 9 must be reported.

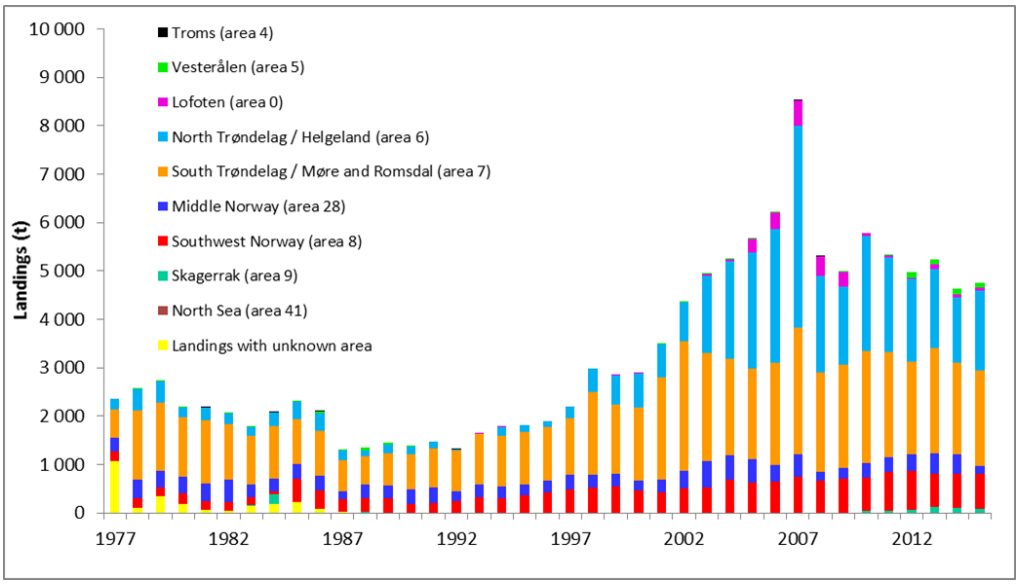


Figure 2. Norwegian landings of *Cancer pagurus* per statistical area, 1977–2015. Data from the Norwegian Directorate of Fisheries.

Stock data

There are no data on fishing effort from the Norwegian crab fleet.

Stock and catch data for the Norwegian edible crab stock come from a reference fleet of crab fishers (Table 1), providing data on landings and discards rates (unstandardised), size (carapace width) and sex ratio. The fishers are equipped with four standard experimental traps with no escape vents (inserted into chains of ordinary traps) from which they provide catch data from weekly fishing trip in 10 consecutive weeks. All crabs in the standard traps are measured and the following recorded:

- Carapace width (CW)
- Sex
- Females with external roe (discards)
- Soft crabs (discards)
- Crabs below minimum legal size (MLS); (discards)
- Other discards (damaged crabs, crabs with black spots or missing limbs)

Landings and discards rates are calculated as kg crab per standard trap per day. Data from all years were recalculated in 2014 as rates in previous years were not corrected for soaking time of the traps. Crab weight is estimated using known size-weight relationships, calculated for respectively mature females, mature males, and juveniles (< 13 cm CW); (Woll *et al.* 2006).

Table 1. Number of fishers in the reference fleet per statistical area, and total number of crabs caught in the standard experimental traps (2001–2015).

	Statistical area							
Year	8	28	7	6	0	5	Total	Total # crabs
2001			10	8		1	19	20 614
2002	4		9	9		3	25	29 831
2003	4		9	9		3	25	27 028
2004	3		6	9		1	19	7875
2005			3	7		1	11	7515
2006			4	8	2	1	15	5169
2007	4		4	6		1	15	7135
2008	1		2	4		1	8	3778
2009	3		1	1			5	2966
2010	2	2	3	3			10	4769
2011		2	2	3			7	2877
2012	2		4	6		2	14	9098
2013	2	1	4	7		2	16	9152
2014	2	1	3	3		2	11	4444
2015	2		4	5		1	12	4742

Due to few fishers in the reference fleet in 2008, 2009, and 2011, catch rates from these years are uncertain. For some statistical areas the index is based on data from only one fisher. The data situation improved in 2012 and 2013 due to an externally financed project on economical and stock effects of crab fishery outside the main season (August-October).

In area 5, landings rate (LPUE) was high compared to the discards rate (DPUE) in previous years (Figure 3). But LPUE of 3–5 kg/trap day decreased from 2012 to 2015. In area 6, LPUE has been 2–4 kg/trap day since 2001, except in 2009. The drop in LPUE in 2009 was due to sales organization introducing a MLS of 14 cm this year. Further south, in area 7, LPUE has been 2–3 kg/trap day in the first and last part of the time series, while it was around 4 kg/trap day in 2007–2011. This high LPUE might have been due to few fishers participating these years, such that the rate was influenced by the skills of these fishers. Annual LPUE-values varies a lot in area 8. In 2014, it was 5.1 kg/trap day, but decreased to 3.0 kg/trap day in the following year.

Areas 8 and 28 have the highest DPUEs (Figure 3). Area 28 is an area with little fishery and the high discards could be due to crabs of low quality not having been fished out of the stock. In area 8 (southernmost area) more than half the catch has been discarded in some years (soft crabs, specimens below MLS, crabs with black spots and missing limbs) (Figure 4). Crabs below MLS make up most of the discards from the middle and northern part of the coast, while further south, soft and damaged crabs are dominating the discards. A larger proportion of soft crabs in the catches in the southern areas compared with North-Norway indicates that a larger proportion of the stock moults each year in

South-Norway. The number of berried females is very low in the catches from the reference fleet. Berried females are inactive and thus not available to the traps.

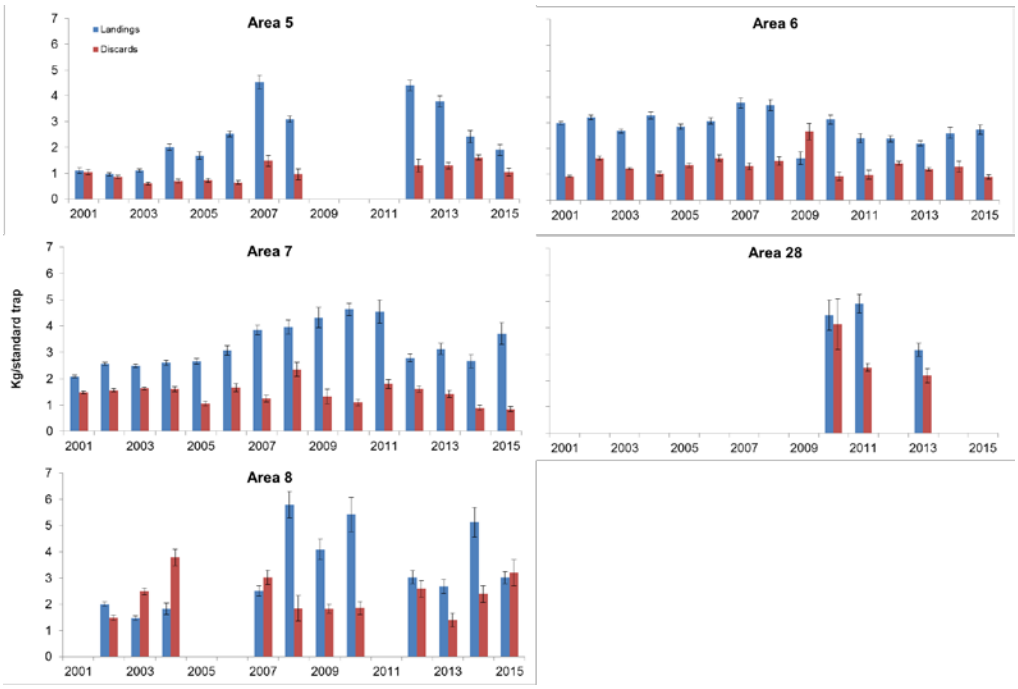


Figure 3. Indices of landings rate (LPUE) and discards rate (DPUE) from the standard experimental traps (mean +/- standard error) from the reference fleet of crab fishers, per statistical area for 2001–2015.

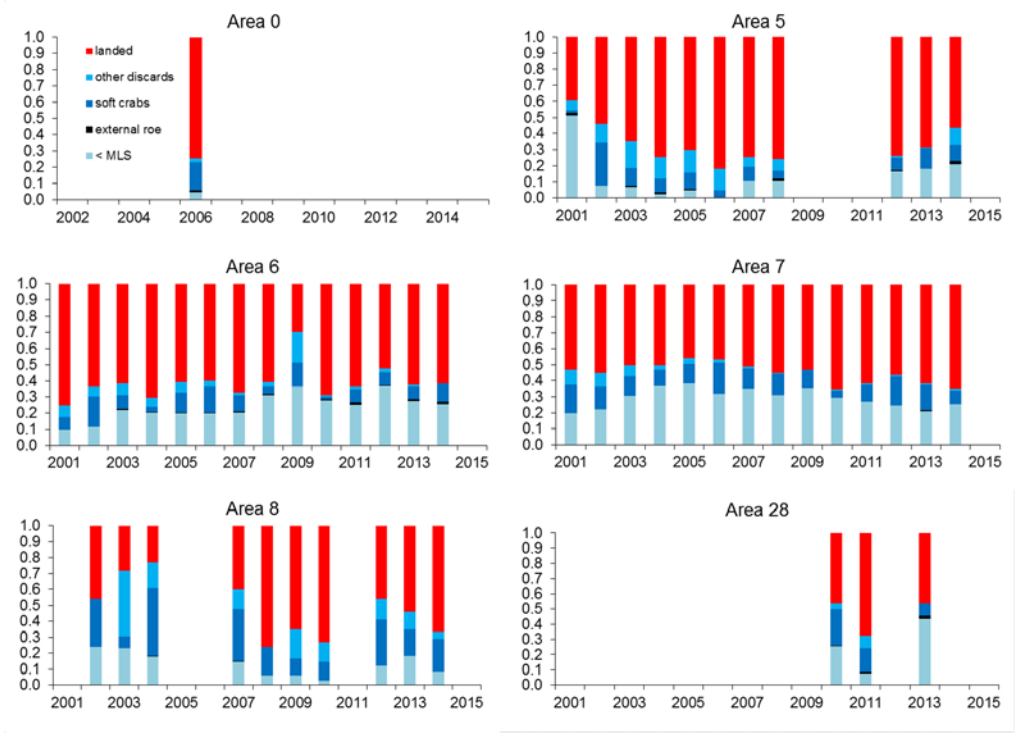


Figure 4. Proportions of landed and discarded catch from the reference fleet of crab fishers, by statistical area for 2001–2015.

In the first part of the time series there was a clear geographical trend in the proportion of females in the landings from the standard traps, with an increasing proportion with latitute (Figure 5). Since 2010, the proportion of females has been more similar in the areas 6, 7, 28, and 5. In area 8 in the south, the proportion of females in the landings has varied between 40 and 60% thoughout the whole time series. The proportion of females in the catches increases throughout the fishing season, and then declines again in October-December. This is due to the females migrating into shallower areas to feed and spawn. After spawning, as berried females, they become less active and thus less available to the traps.

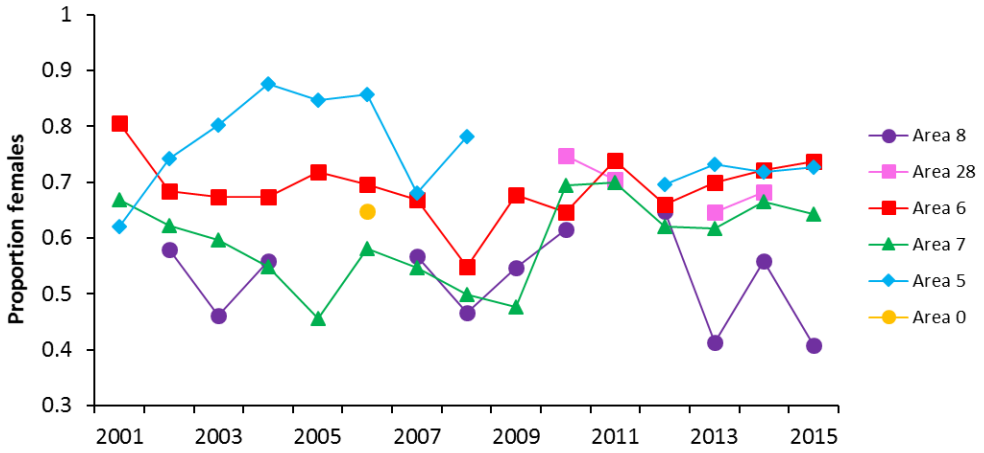


Figure 5. Proportion of females in landed catch per statistical area and year.

Mean size in landed catch is lowest in area 8 due to the lower MLS in this area. Mean CW for both males and females is between 13 and 14 cm (Figure 6). The largest crabs are found in areas 7, 5 and 28, where mean size lies between 15 and 16 cm CW. Males are generally larger than females. The large crabs in area 28 can be explained by the low fishing pressure. Area 6 stands out by a lower mean CW for both males and females, and the mean size has decreased from the start to the end of the time series (from around 15 cm to around 14 cm).

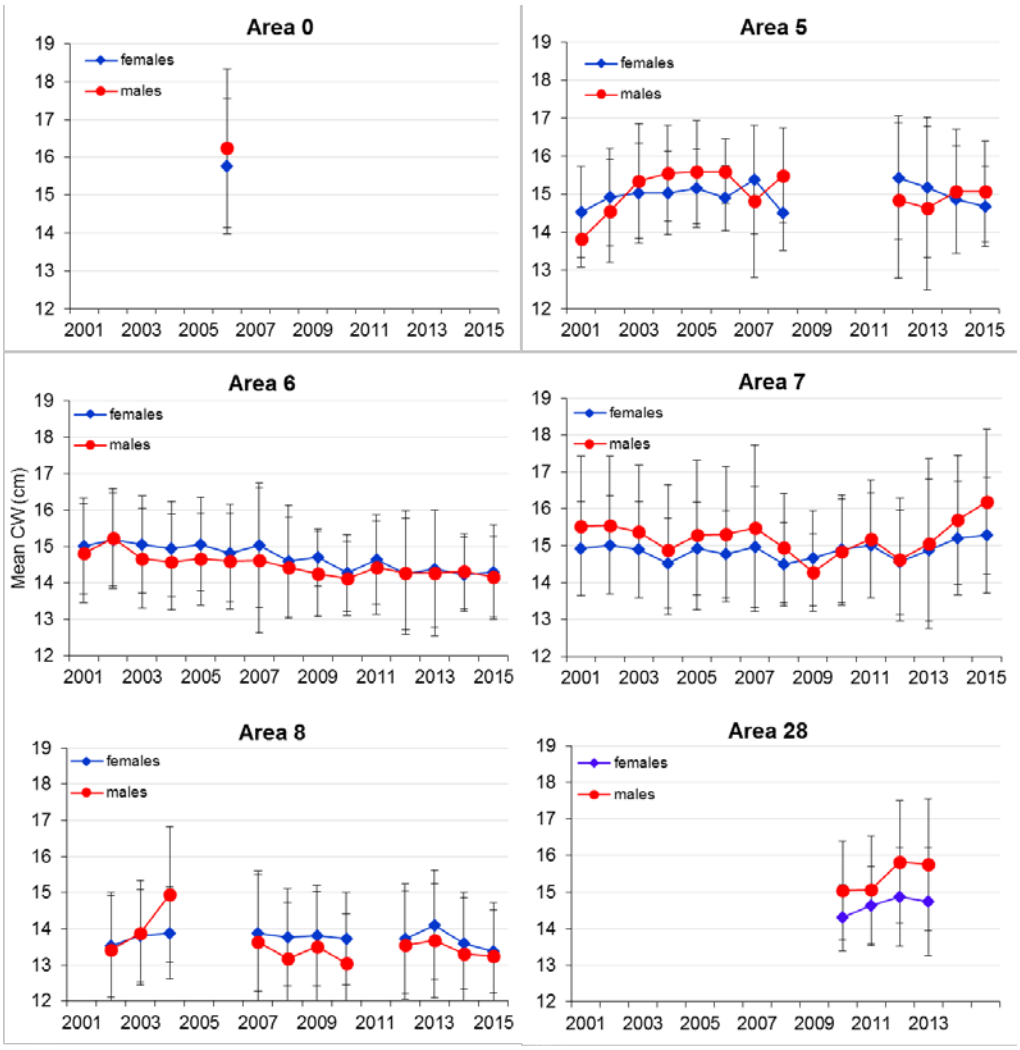


Figure 6. Mean CW (+/- stdev) of males and females in landed catch from the reference fleet of crab fishers, by statistical area for 2001–2015.

5.1.2 ToR b) Evaluation of alternative assessment methods

Alternative assessment methods have not been evaluated for the edible crab stock along the Norwegian coast.

The state of the stock is assessed by evaluating indicators from a reference fleet of crab fishers (LPUE and mean size in landings). The reference fleet has for several years and for some areas (notably 8, 28 and 5) too few participating fishers. Woll *et al.* (2006) concluded, after 4 years of collecting data from the reference fleet, that "The most efficient survey design is seemingly the collection of relatively small samples from many boats to reduce the between-vessel component of variation". In 2016, it was decided to go from an annual to a bi-annual collection of data from the reference fleet, and thereby use limited resources on a larger sampling effort every second year. There was therefore no data collection in 2016. In 2017, the goal is to collect data from 2-3 fishers in areas 8 and 5, and from 7–9 fishers in areas 6 and 7.

The assessment of the fishery on the Norwegian crab stock is suffering from a lack of effort data for the whole fleet. Electronic log books are only compulsory for vessels ≥ 15 m, and as the crab fleet is dominated by small vessels, this data source is not available. It should, however, be possible to register the number of traps upon landing of catches. Woll *et al.* (2006) noted that "A suggested strategy to obtain an abundance index would be to collect daily catch rates from all commercial landings".

5.1.3 ToR c) Preliminary assessment of stock status

It is difficult to say something certain about the total stock development of the Norwegian edible crab. Stock indicators (LPUE, mean size in landings) indicate a stable stock in most of the statistical areas. However, in area 6, mean size of both males and females have decreased from the beginning of the time series to recent years. Length frequency distributions reveal that the size of the crabs in area 6 dropped from 2007 to 2008, after record high landings in 2007, and have since remained smaller compared with earlier years. Similar changes are not seen in area 7, where landings are of equal size as in area 6. This indicates that the fishing pressure is higher in area 6 than in 7.

The development of the crab fishery has been different in areas 6 and 7. The landings from area 7 have since 2001 remained at a stable level, while the landings from area 6 increased substantially from the late 1990s to 2007 (Figure 3). The large increase may have been possible due to the stock earlier being at or just below the area's carrying capacity.

5.1.4 ToR d) Impact of climate drivers including acidification

The Norwegian crab stock is moving north along the Norwegian coast, likely due to warming of the sea. There has been no Norwegian research on the effects of acidification on the edible crab.

5.1.5 ToR e) Research and new knowledge on population biology parameters

A Spanish postdoc is working on the genetic stock structure of the edible crab in the North Atlantic from Galicia to northern Norway. The work needs to be written together and published.

The same postdoc is currently working on direct age determination of the crab, by counting zones in cuts from gastric mills.

A PhD focuses on the biological and eco-physiological differences in crabs along the coast of Norway. Results from analysis of size at maturity (size where 50 % of the crabs are mature) indicate no difference between northern and southern Norway. There is ongoing work to read growth bands in the gastric mill structures of individuals from north and south of Norway to determine if there are differences in age at same size (and maturity). Modelling of probability of molting using Generalized Additive Models have been conducted using data on presence of soft crabs in catches collected by the reference fleet of crab fishers. The analysis show that the probability of moulting is lower in the northern population of *C. pagurus* compared to southern Norway, indicating a slower growth with increasing latitude. Results from modelling further show a delayed peak period for molting in northern Norway compared with locations further south.

In the eco-physiological part of the PhD the focus is on the geographical differences in thermal preference and the effect of temperature on *Cancer pagurus* metabolism. The thermal preference of (individual) crabs from northern Norway (Senja, Troms) and from central Norway (Ålesund, Møre og Romsdal) have been investigated by monitoring their movement in a raceway system with a thermal gradient (~6–16 °C). The results show no obvious differences between crabs from Senja or Ålesund in terms of thermal preference, with crabs (irrespective of origin) spending most of its time in the range 12–14 °C. Clear differences in night/day activity were found where crabs moved throughout the whole thermal gradient during night time but returned to the warmer areas of the tank with onset of light. During daytime the crabs remained stationary (in the warmer areas of the tank) with very little or no movement. Analysis of the movement of crabs within the thermal gradient showed that crabs moved a maximum of 1.3–1.6 °C/minute. No clear differences were found in the ability of crabs to move between temperatures when comparing crabs from Senja or Ålesund.

References

Woll, A.K., van der Meeren, G.I., Fossen, I. 2006. Spatial variation in abundance and catch composition of *Cancer pagurus* in Norwegian waters: biological reasoning and implications for assessment. ICES Journal of Marine Science, 63, 421-433

5.2 Scottish edible crab (*Cancer pagurus*) stock

5.2.1 ToRs a) and b) Stock status of brown crab in Scotland

Total Scottish landings of brown crab fluctuated between 9300 and 12 300 tonnes from 2008 to 2015 (Table 2). The principal fishing areas for brown crab in Scotland are Orkney, Hebrides, Sule, East Coast, North Coast, Papa and South Minch; landings from these areas accounted for around 88% of the total in 2015. Landings from the offshore areas of Sule and Papa have increased sharply in the 1990s when the fishery expanded, but seem to have stabilized in Papa and decreased in Sule in the last three years. Landings from Orkney, East Coast and Hebrides show an increasing trend in recent years. The spatial distribution of brown crab landings by ICES statistical rectangle (including Irish landings) is shown in Figure 7. The majority of crabs fished in Scottish waters are landed in the third and fourth quarters of the year. Stock assessments based on LCAs for the period 2013–2015 were carried out for nine of the twelve assessment units, providing estimates of fishing mortality in relation to the F_{MSY} proxies. No assessments were performed for Mallaig and Ullapool as the sampling data collected were considered insufficient to run LCAs. The results of the 2013-15 assessment are still at a preliminary stage. Of the nine assessed areas, eight were fished above the F_{MSY} proxy to some extent Table 3). Fishing mortality was estimated to be above FMSY for both males and females in Clyde, East Coast, North Coast, Orkney, South East, South Minch and Sule. In the Hebrides, fishing mortality for males was at FMSY while females were fished above FMSY. In Papa, recent fishing mortality was around FMSY or lower. Overall, preliminary assessment results for the period 2013–2015 showed that brown crab in most of the assessment units in Scotland were fished close to or above the F_{MSY} proxy. In many of the assessment units, a higher yield and biomass per recruit in the long term could potentially be obtained by reducing the level of fishing mortality (effort).

Table 2. Annual Brown crab landings (tonnes) into Scotland by creel fishery assessment unit from 2006 – 2015. Data from Fisheries Management database

Assessment unit	Year								
	2006	2007	2008	2009	2010	2011	2012	2013	20
Clyde	198.2	250.3	213.7	99.4	139.3	137	182.8	159.3	189
East Coast	830.4	884.2	866.9	778.6	1029.0	1091.3	1213.9	1271.3	1305
Hebrides	2279.4	2340.0	1738.4	1822.3	1885.8	2433.3	1996.5	2130.2	2667
Mallaig	7.7	67.0	32.4	8.5	12.9	21.3	69.6	6.7	17
North Coast	435.8	513.8	348.7	568.3	681.9	428.7	514.2	571.2	537
Orkney	1467.9	1555.4	1187.3	1155.6	1462.1	1746.6	1693.7	1906.2	1958
Papa	838.2	798.0	764.1	1002.0	878.2	884.2	828.2	936.3	1239
Shetland	640.8	522.4	566.9	390.2	334.4	419	478.4	604.9	666
South East	273.8	281.8	325.5	308.0	345.7	356.7	447.1	469.9	396
South Minch	1316.2	2149.6	1141.0	1000.7	1651.3	1632.4	1094.4	869.8	1191
Sule	1663.1	2026.1	1836.2	1981.8	1928.9	2275.5	1611.2	1491.6	1703
Ullapool	358.1	376.0	241.9	192.1	245.4	244.9	687.2	439.0	400
Outside Assess. Units	120.5	154.1	73.1	158.7	261.9	188.2	74.7	34.3	31
Total	**10430.3**	**11918.7**	**9336.1**	**9466.1**	**10856.7**	**11859.1**	**10891.9**	**10890.6**	**12306**

Table 3. Brown crab stock status in terms of the relationship between F and F_{MSY} proxy for 2006-08, 2009-12 and 2013-15. The results of the 2013-15 assessment are preliminary.

Assessment period		F (Fishing Mortality) 2006-2008	2009-2012	2013-2015	
Clyde	Males	✗	?	✗	Above F_{MSY}
	Females	✗	?	✗	Above F_{MSY}
Hebrides	Males	✗	✓	o	At F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
North Coast	Males	✗	✓	✗	Above F_{MSY}
	Females	✗	✓	✗	Above F_{MSY}
Papa	Males	?	✓	✓	Below F_{MSY}
	Females	?	✓	o	At F_{MSY}
Shetland	Males	?	?	?	Unknown
	Females	?	?	?	Unknown
Sule	Males	✗	o	✗	Above F_{MSY}
	Females	o	✗	✗	Above F_{MSY}

Assessment period		F (Fishing Mortality) 2006-2008	2009-2012	2013-2015	
East Coast	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
Mallaig	Males	?	?	?	Unknown
	Females	?	?	?	Unknown
Orkney	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
South East	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
South Minch	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
Ullapool	Males	?	?	?	Unknown
	Females	?	?	?	Unknown

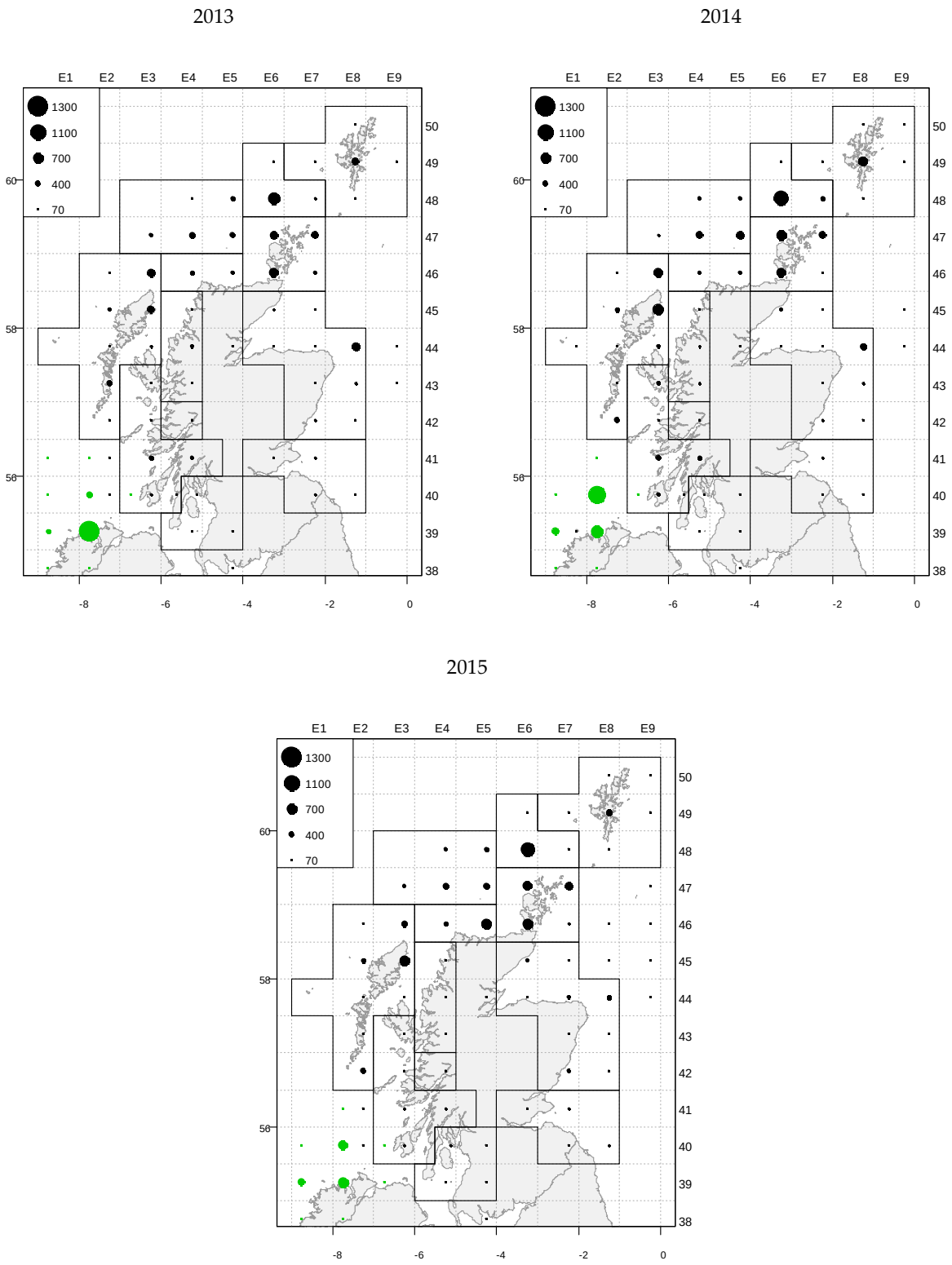


Figure 7. Brown crab landings (tonnes) by statistical rectangle between 2013 and 2015. Black circles represent landings into Scotland. Data are from Fisheries Management Database. Green circles represent landings into Republic of Ireland – data provided by the Irish Marine Institute.

5.2.2 ToR b) Length-based indicators for crustaceans stocks

In the absence of scientific surveys and ageing methods to support a stock assessment, reliable length frequency data of sampled catches can be used to support an indirect assessment of stock status of data-limited crustacean stocks. Length-based indicators are a simple tool to describe the length frequency distributions of catches. Indicators can help to evaluate the presence of very large individuals in the catches and exploitation level with regard to maximum sustainable yield (MSY) and the protection of immature individuals. We used a length-based sex-structured population model to simulation-test the selected length-based indicators, the mean length and the mean length of the largest 5% in the catch, and their reference points in harvest control rules for the management of a data-limited stock. Length-based indicators can be used in harvest control rules to recover overexploited stocks. The mean length is more sensitive to the length at first catch or minimum landing size. To restore overexploited stocks a precautionary reference point is advised to quickly reach MSY and keep the risk of collapse low.

Currently, as management measures there are minimum landing sizes implemented for crab and lobster stocks. No TAC, quota or harvest control rule in use. We illustrate the use of length-based indicators for Scottish crab and lobster stocks and attempt the description of exploitation status relative to MSY which can be compared to LCA outputs. Indicators are calculated for each sex separately, as crustaceans are sexually dimorphic. A range of length-based indicators are available to assess fisheries selectivity, monitor changes and infer stock status (Blanchard *et al.*, 2005; Shin *et al.*, 2005; ICES WKLIFE, 2015; Miethe *et al.*, 2016). Indicators and their reference points are listed in Table 4. Reference points for length-based indicators are based on life history characteristics such as the asymptotic length L_∞ from the von Bertalanffy growth equation (ICES WKLIFE, 2012). The reference point L_{mat} (length at which 50% are mature) can be used to test whether enough individuals reach maturity before being recruited to the fishery (Caddy and Mahon, 1995). $L_{F=M}$ is recognized as a proxy for the mean length at MSY (ICES WKLIFE, 2012). To sustain a healthy stock, the abundance of very large individuals can be monitored. The maximum length L_{max} varies over time due to the rarity of very large individuals in the catch. Therefore, $L_{max5\%}$ is a more suitable indicator for the presence of the largest length groups in the catch. The indicator $L_{max5\%}$ was introduced by Probst *et al.* (2013).

Length-based indicators are calculated for brown crabs and lobsters in Scottish waters for females and males, separately. Reference points are calculated according to life history parameters used in Mesquita *et al.* (2016). The ratio of indicators with their MSY reference points are evaluated for mean length $\bar{L}$ and $L_{max5\%}$ as an average for the years 2013–2015 (Table 5, 6). According to the selected indicators for brown crab (Table 7), females and males in Papa as well as males in the Hebrides appear to be sustainably harvested. For lobsters only females in Papa appear to be sustainably harvested with both indicators above their reference points. Brown crabs and lobsters are exploited with minimum landings sizes above L_{mat}. For a number of lobster stocks, the length class with maximum yield was below the expected optimum. Indicators for selected stocks are plotted for the years 2010–2015 (Figure 8.9).

Table 4. Lobster stock status in terms of the relationship between F and F_{MSY} proxy for 2006-08, 2009-12 and 2013-15. The results of the 2013-15 assessment are preliminary

Assessment period		F (Fishing Mortality) 2006-2008	2009-2012	2013-2015	
Clyde	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
Hebrides	Males	✗	✗	✗	Above F_{MSY}
	Females	✓	✓	✓	Below F_{MSY}
North Coast	Males	?	?	?	Unknown
	Females	?	?	?	Unknown
Papa	Males	?	✗	✗	Above F_{MSY}
	Females	?	✓	✓	Below F_{MSY}
Shetland	Males	?	✓	✗	Above F_{MSY}
	Females	?	✗	✗	Above F_{MSY}
Sule	Males	?	?	?	Unknown
	Females	?	?	?	Unknown

Assessment period		F (Fishing Mortality) 2006-2008	2009-2012	2013-2015	
East Coast	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
Mallaig	Males	?	?	?	Unknown
	Females	?	?	?	Unknown
Orkney	Males	✗	✗	✗	Above F_{MSY}
	Females	✓	○	○	At F_{MSY}
South East	Males	✓	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}
South Minch	Males	?	✗	✗	Above F_{MSY}
	Females	?	✗	✗	Above F_{MSY}
Ullapool	Males	✗	?	?	Unknown
	Females	✓	?	?	Unknown

Table 5. Proposed indicators, indicator ratios with reference points, reference values

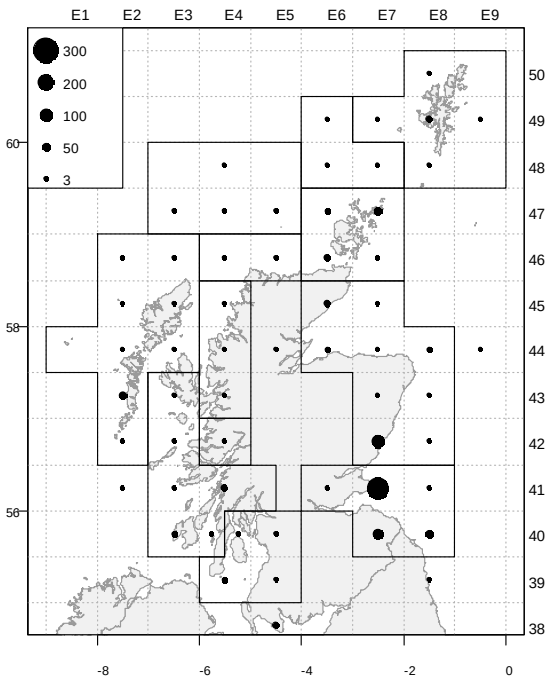
Indicator	Description	Reference values	Property
$L_{max5\%}$	Mean length of the largest 5%	>0.9 L_∞	**Conservation**
L_{25}	25th length distribution percentiles	L_{mat}	(large individuals) (immatures)
L_c	Length at first catch (length at 50% of number at the first mode on the left side of the distribution)	L_{mat}	
L_{maxy}	Length at maximum yield	L_{opt}	**Optimal yield** L_{opt} approximated with 2/3 L_∞
$\bar{L}$	Mean length	$L_{F=M}$	**MSY** $L_{F=M}$, proxy for L_{msy} ($0.75L_c+0.25L_\infty$)

Table 6. Brown crab, mean indicator ratios for the years 2013-2015 per assessment area and sex. South Minch (SM), Shetland islands (SH), Southeast (SE), Papa (PA), Orkney (OR), Hebrides (HE), East Coast (EC), Sule (SU), Clyde (CL), North Coast (NC). Indicator ratio above MSY reference point in green, below in red.

	SM	SH	SE	PA	OR	HE	EC	SU	CL	NC	Indicator ratio
Females	0.976	0.970	0.967	1.006	0.988	0.973	0.988	0.973	0.956	0.967	$L_{max5\%}/0.9L_\infty$
	0.994	1.003	0.985	1.001	1.034	0.990	1.000	0.990	1.001	0.990	$\bar{L}/L_{F=M}$
Males	0.951	0.855	0.934	1.066	0.944	1.004	0.955	0.961	1.000	0.973	$L_{max5\%}/0.9L_\infty$
	0.966	0.941	0.973	1.018	0.978	1.005	1.000	0.982	0.997	0.990	$\bar{L}/L_{F=M}$

Table 7. European lobster, mean indicator ratios for the years 2013-2015 per assessment area and sex. South Minch (SM), Shetlands (SH), Southeast (SE), Papa (PA), Orkney (OR), Hebrides (HE), Clyde (CL), East Coast (EC). Indicator ratio above reference point in green, below in red.

	SM	SH	SE	PA	OR	HE	EC	CL	Indicator ratio
Females	0.890	0.863	0.840	1.023	0.943	0.993	0.883	0.840	$L_{max5\%}/0.9L_\infty$
	0.950	0.923	0.920	1.037	0.963	1.000	0.917	0.923	$\bar{L}/L_{F=M}$
Males	0.817	0.860	0.807	0.900	0.867	0.843	0.857	0.757	$L_{max5\%}/0.9L_\infty$
	0.920	0.947	0.893	1.010	0.927	0.953	0.897	0.887	$\bar{L}/L_{F=M}$



2015

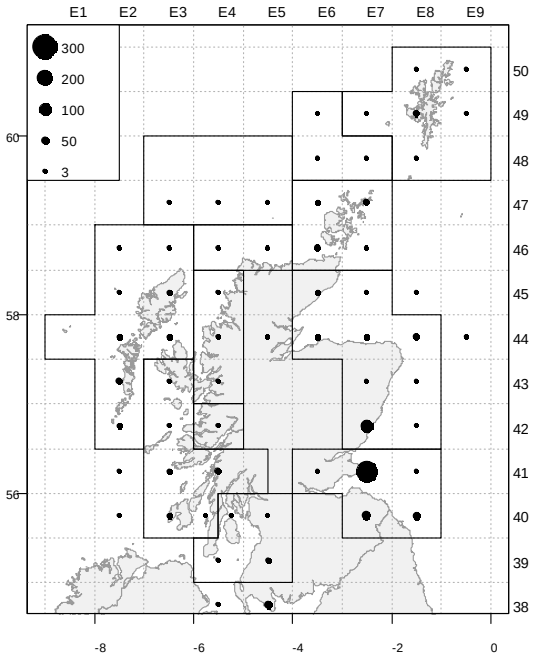


Figure 8. Lobster landings (tonnes) by statistical rectangle between 2013 and 2015. Black circles represent landings into Scotland. Data are from Fisheries Management Database.

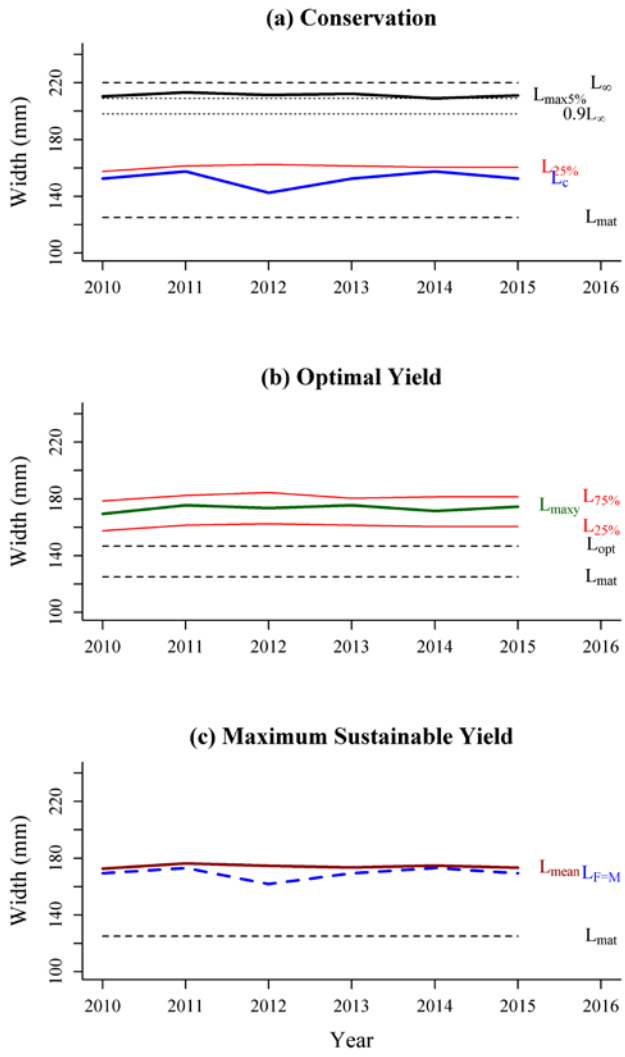


Figure 9. Brown crab, Males, in Papa (PA).

5.2.3 ToRs a) and b) Stock status of lobster in Scotland

Total Scottish landings of lobster fluctuated between 700 and 1200 tonnes from 2006 to 2015 (Table 9). The total tonnage of lobster landed in Scotland has consistently been much lower than that of crabs. However, reported lobster landings have increased substantially over the last years. Historically the majority of landings of lobster in Scotland have been from the Hebrides, Orkney and South Minch, with the South East and East Coast areas becoming increasingly important in more recent years. Landings from these areas accounted for around 85% of the total. Figure 8 shows the spatial distribution of lobster landings around Scotland in the period 2013–2015. ICES rectangle 41E7 in the South East consistently has the largest amount of landings. Small quantities of lobster were landed from grounds outside the assessment areas, including ICES rectangles to the west of South Minch, to the south of Clyde and just outside the South East and East Coast areas. The majority of lobsters fished in Scottish waters are landed in the third and fourth quarters of the year. Stock assessments based on LCAs for the period 2013-2015 were

carried out for eight of the twelve assessment units, providing estimates of fishing mortality in relation to the F_{MSY} proxies (Table 7). Sampling data were considered to be insufficient (low numbers and infrequent sampling) for running assessments in Mallaig, North Coast, Sule and Ullapool. The results of the 2013–2015 assessment are still at a preliminary stage. Lobsters in all the assessed areas were fished above the F_{MSY} proxy to some extent, particularly males. Fishing mortality was estimated to be above F_{MSY} for both males and females in Clyde, East Coast, South East, Shetland and South Minch. In the Hebrides, Orkney and Papa, fishing mortality for females was at F_{MSY} or below while males were fished above F_{MSY}. Overall, preliminary assessment results for the period 2013–2015 show that lobster in most of the assessment units in Scotland were fished close to or above the F_{MSY} proxy. A higher yield and biomass per recruit in the long term could potentially be obtained in all assessment units by reducing the level of fishing mortality (effort).

Table 9. Annual Lobster landings (tonnes) into Scotland by creel fishery assessment unit from 2006 – 2015. Data from Fisheries Management database

Assessment unit	**Year**								
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Clyde	18.5	16.8	22.2	17.4	24.8	26.3	24.7	23.5	46.2
East Coast	86.7	129.8	147.5	163.9	207.3	279.3	265.5	214.9	226.1
Hebrides	168.3	203.5	161.3	142.5	155.8	141.7	139.0	97.3	148.6
Mallaig	0.9	1.1	3.5	0.4	0.9	1.2	12.7	0.6	1.0
North Coast	15.5	14.3	15.0	12.0	14.3	15.4	10.0	10.0	10.7
Orkney	121.6	132.7	138.6	160.3	170.8	177.8	155.5	117.4	163.6
Papa	7.4	8.4	7.0	10.4	10.3	6.4	5.7	5.7	7.8
Shetland	9.3	14.1	19.8	25.7	29.8	29.2	36.8	35.9	39.7
South East	136.2	180.5	204.3	257.3	277.8	374.6	334.4	387.8	409.2
South Minch	94.6	101.7	111.4	99.8	112.0	89.9	84.7	75.2	101.3
Sule	5.3	4.8	4.8	4.0	3.4	3.6	2.1	0.6	0.7
Ullapool	20.0	24.5	13.9	12.3	18.7	10.8	11.6	15.1	16.7
Outside Assess. Units	26.9	57.9	65.8	46.8	74.4	62.9	49.7	41.8	36.3
Total	**711.1**	**890.2**	**915.0**	**953.0**	**1100.3**	**1219.1**	**1132.5**	**1025.9**	**1207.8**

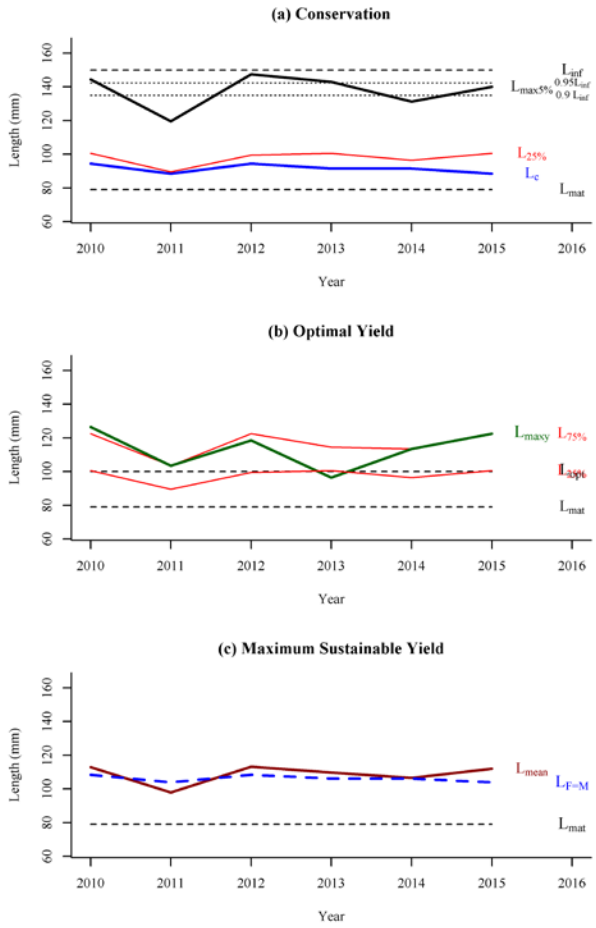


Figure 9.1. European lobster, Females, South Minch (SM).

5.2.4 ToR e) Maturity of brown crab in Scottish waters

In this study, the size at maturity of brown crab was estimated using a variety of reproductive and morphometric criteria from samples obtained in the east and west coast of Scotland; this was estimated as the carapace width (CW) at which 50% of the sample was mature (CW50). Testes and ovaries were staged to estimate the size of gonadal maturity. When stage 2 males were defined as mature, a significant difference between east (100.5mm) and west (107mm) coast samples was identified; no significant difference was found between areas when stage 2 males were defined as immature (170 mm east and 171 mm west). There was also no significant difference between the size of gonadal maturity between east (145.5mm) and west (145.6mm) coast females. Sperm plugs were considered in addition as an indicator of behavioural maturity. Although none were found in east coast females, 84% of west coast females contained them internally; this could be indicative of differences in reproductive cycles. Size of morphometric maturity was estimated using cheliped measurements of males and abdomen/pleopod measurements of females. Although a significant breakpoint was identified for cheliped depth of east coast males, no other breakpoints were found to be significant. The change from isometric to allometric growth of these features was instead best represented by a gradual change.

References

Blanchard, J. L., Dulvy, N. K., Jennings, S., Ellis, J. R., Pinnegar, J. K., Tidd, A., and Kell, L. T. 2005. Do climate and fishing influence size-based indicators of Celtic Sea fish community structure? ICES Journal of Marine Science, 62: 405-411.

Caddy, J. F., and Mahon, R. 1995. Reference points for fisheries management. FAO Fisheries Technical paper. No. 347. Rome, FAO: 1-83.

ICES WKLIFE 2012. Report of the Workshop to finalise the ICES data-limited Stocks (DLS) methodologies documentation in an operational form for the 2013 advice season and to make recommendations on target categories for data-limited stocks (WKLIFE II), 20-22 November 2012, Copenhagen, Denmark. ICES CM2012/ACOM:79: 1-46.

ICES WKLIFE 2015. Report of the Workshop on the development of quantitative assessment methodologies based on LIFE-history traits, exploitation characteristics and other relevant parameters for data-limited stocks (WKLIFE V) 5-9 October 2015 Lisbon, Portugal. ICES CM 2015/ACOM:56: 1-157.

5.3 Norwegian stock of European lobster (*Homarus gammarus*)

5.3.1 ToR a) Landing, discard, effort and catch data

Landings

The European lobster has traditionally been regarded as a valuable marine resource, supporting the coastal fishery for several centuries. The fishery for lobster goes back to the 1600s (Boeck 1869, Appelöf 1909), and the available statistics describe a national fishery that annually harvested around 900 000 lobsters during the period from 1820 to 1920, corresponding to around 450 tonnes. In the early 1930s, the landings rose sharply to a peak of 1300 tonnes (2.8 million individuals). The increase was probably a combination of good recruitment (Dannevig 1936) and greater fishing effort (Tveite 1991). For a few more decades, annual landings ranged around 700–800 tonnes. Norway was at these times one of the principal countries supplying lobster to the European market, accounting for 24% of total landings in Europe. From 1960 and on, landings declined drastically to 200 tonnes in 1970, and continued to fall to the current level of 30 to 50 tonnes a year. Decades of low landings forced many lobster dealers to close down, and since the 1990s the official recordings probably reflect the capacity of the few remaining dealers rather than actual landings. In addition, since the 1980s, the recreational fishery has increased considerably and has undoubtedly increased the fishing pressure on lobster, although numbers are not recorded (Kleiven 2010).

5.3.2 ToR c) Preliminary assessments of stock status

Regulations

At the time the fishery started, back in the 1600s, the fishery was unregulated much due to the landowner's property rights extending into the sea (Boeck 1869). A strong dispute at the beginning of the 1700s ended in a trial in 1725 with the verdict that lobster (and other marine fish/shellfish) was to be considered a common property right, i.e. for everyone to capture (Boeck op cit.). In 1737, Anderssen Lem suggested, on the basis of decreasing landings, minimum legal size (MLS) of 9–10 inches total length (TL) and a closed

season during the time when lobster were believed to hatch their eggs. This was regarded a weird suggestion at that time and was rejected and forgotten. The landings decreased in the 1830s and added new heat to the discussion about closed season. Another management plan was also suggested, implying that the coastline should be divided into several districts with alternating licenses to fish and land lobster for three years followed by closure for three years, and so on. In the face of strong objections, a closed season was introduced in 1849 (Boeck op cit.), 112 years after it had been first suggested. MLS of 21 cm TL was approved 17 June 1879. An extension of the closed season, increase in MLS and a ban on landing berried females were discussed, proposed and rejected on several occasions. Of greatest concern was that MLS was below the size where female lobster carry eggs. On the basis of this, Appelöf (1909) suggested a MLS of 25 cm TL for the western coast of Norway and 24 cm TL for the Skagerrak coast. In 1964, MLS increased to 22 cm TL. In 1992, MLS increased to 24 cm TL, and the following year to 25 cm from Rogaland county and northwards. Lobsters are legally only allowed to be landed if captured in traps, either baited or unbaited. Trap design and bait vary from location to location, and a major upgrading has taken place the last five years.

It should be noted that the official measure of the size of a lobster in Norway is TL (distance from the anterior tip of the rostrum to the end of the telson), implemented in 1879. On the other hand, in Europe as well as elsewhere in the world, carapace length (CL; distance from the posterior rim of the eye socket to the posterior edge of the carapace) is the official measure in all lobster species, including spiny and rock lobsters (Factor 1995, Phillips 2006; and references therein).

New Management Plan implemented 2008

A working group consisting of members from the Directorate of Fisheries in Norway and the Institute of Marine Research was appointed in 2005 to look at the fishery regulations to protect lobster populations. Moratorium, marine protected areas, releases of hatchery-produced lobster juveniles were debated, along with restrictions as minimum legal size, maximum legal size, prohibitions to land berried females, gear restrictions, escape vents in pots, CL as a measure of size, local management and a "lobster fee". The final working group's report and recommendations were submitted October 2007 (Veim *et al.* 2007) and some of the suggested regulations were implemented in the fishery in 2008. This includes ban on landing berried females, escape vent (60 mm in the lobster fishing season and 80 mm outside the season), MLS of 25 cm TL and seasonal closure. In addition, number of pots per recreation fisher was set to 10 and correspondingly 80 for commercial fisher. A management goal of 0.1 lobster per pot was also set. An evaluation of these regulations should be done in 2017.

Stock enhancement, sea ranching and marine protected areas were also presented.

5.4 England and Wales stock of the edible crab (*Cancer pagurus*) and European lobster (*Homarus gammarus*)

5.4.1 ToRs a) and b) England and Wales: An overview of the edible crab (*Cancer pagurus*) and European lobster (*Homarus gammarus*) fishery status

Brown crab and lobster are very valuable species exploited around the coasts of England and Wales, with landings in 2015 above 14 000t for crab, and 1885t for lobster. With the

aim of informing fisheries managers, Cefas currently produces biennial stock status reports. Each report contains information describing the status of stocks in six crab assessment areas and seven lobster assessment areas in English and Welsh waters. These assessments are run every two years although they have not been updated since the WGCRAB 2013 report.

Both fisheries are mainly targeted by vessels under 12 m that use pots and operate close to the coast, although larger vessels fishing offshore are also present. The most productive areas for crab are Western English Channel and Southern North Sea, which sum 65% of the total landings in 2015. Regarding the lobster fishery, the most productive area is Yorkshire and Humber, whose landings represented the 44% of the total in 2015. Landings in this area have increased progressively since 2006, whereas the fishing effort has been stable since 2011.

The last assessments suggest that some crab and lobster stocks are being fished at a rate either around or above the Fmsy target, and with spawning stock biomass estimates at or below the recommended level. However, problems associated with data consistency, parameter selection and model assumption violations mean that there is uncertainty associated with the assessments. In this sense, bootstrapping will be included in the future assessments to quantify uncertainty relating to the data used to estimate the size structure of the population. Additionally, Cefas has investigated the sensitivity of the assessments to growth and maturity parameters, the results of which will be available at the 2017 working group.

5.5 Orkney stock of the crabs and European lobster (*Homarus gammarus*)

5.5.1 ToR e) Size at maturity and population dynamics of Green crabs (*Carcinus maenas L.*) in Mainland Orkney, Scotland

In this study the size of maturity of green crab was estimated to ascertain the effect of the new management measure imposed onto the Orkney inshore creel fishery in March 2016. This study used two methodologies to estimate maturity, reproductive estimated based on gonad maturation and physiological maturity based on secondary morphological changes. Both methodologies would be used to estimate at what carapace width (*CW*) 50% of the population was mature (*CW50*). Gonad staging was done in line with a previous study conducted within the Republic of Irelands, defining individuals as physiological mature or immature based on testes and ovaries size and colour. Based on this methodology 50% of the Female green crabs on the Orkney mainland were defined as mature at 39.4 mm CW, whilst males were defined mature as 42.9 mm CW, a overall combined *CW50* was 40.11 mm. Morphological maturity was defined within males as changes in claw development, with such changes linked to behavioural ability to compete for mates. No significant breakpoint in male claw development was identified within green crabs indicating an isometric growth pattern. Similarly the relation between females fourth abdominal segment was investigated, no significant breakpoint in female growth was identified indicating isometric growth.

5.5.2 ToR e) The Movements of Brown Crab (*Cancer pagurus L.*) around the North Coast of Scotland

Brown crabs have been tagged as a part of an ongoing fisheries research project since 2011 on-board inshore commercial creel vessels. The aims of the project were to map the migration pattern of the inshore stock and its possible overlap with the emerging and highly productive offshore brown crab fishery.

A total of 7733 soft shell crabs have been tagged over the course of numerous sampling activities. These tagging projects have provided valuable insight into the migration behaviour of brown crab around the Northern coast of Scotland. The general trend that was observed within the fishery was a westward movement of soft shell female. Individualists were recorded migrating from the south west of the Orkney Island, moving southwest along the Scottish coast, with distances travelled ranging from 50–170km over the course of a year. The longest migration recorded by these tagging exercises were by two female crabs tagged in the September and November 2015, moving distances of 236 km and 258 km respectively, subsequently recaptured in Skye and North West outer Hebrides. These migrations demonstrate the movement of crab stock around northern Scotland, through numerous different management areas and subsequent differing levels of exploitation under current stock assessment outputs. In comparison male brown crab demonstrated limited movement from initial release sites typically <15 km, falling in line with observations documented within Sweden and Norway.

5.5.3 Discard survival and condition in Orkney brown crabs

In this study, the discard survival and condition in Orkney brown crabs will be estimated using a vitality index that supports reflex action mortality predictors (RAMP), from samples obtained on the west side of Orkney mainland; the information collected during this experiment will be used for to determine if damage, sex, shell condition and size (CW) are statistical significant predictors in the RAMP model and what effect differing discarding behaviour has on the survivability of discarded individuals.

The study will be undertaken between end of July 2016 and December 2017. The study will involve the storage of individuals within both tank and at sea storage. A total of thirty sub-legal individuals (bellow 140 mm) will be collected on board a commercial fishing vessel; 10 undamaged individuals (control individuals) and 20 damage individuals (treatment individuals); treatment categories may include varying degrees of damage or moult condition. Sub-dividing the treatment categories, e.g. based on numbers of missing limbs, would be impracticable given experimental resources. Instead, by recording individual condition and by following the fates of individuals in the experiments, the effects of degrees of damage or moult condition will be explored through statistical analysis. The designation of 'treatments' in the experiment is primarily to ensure that the primary distinctions are adequately represented; each individual will be sexed, measured (CW) and numbered with non-toxic Chalk Marker D60; each creel/tank will be baited and placed with five individuals of different sizes and sexes according to the CW range defined for this study.

The RAMP method selected has the advantage that it can be easily applied at sea on research or fishing vessels without the need for tag recoveries. This project will apply

RAMP to brown crab discarded under actual fishing conditions with the goal of evaluating estimates of discard mortality rates.

5.6 Isle of Man stock of the crabs and European lobster (*Homarus gammarus*)

5.6.1 ToR e) Static gear fisheries in Manx waters; using cameras to collect data on commercially exploited crustaceans

The introduction of the Marine Strategy Framework Directive (MSFD) and the reform of the Common Fishery Policy (CFP) requires EU member states to commence and/or improve data collection for data poor species. Even with the result of the UK referendum, there will still be a requirement to meet these reporting obligations and standards. While quota species are generally characterised by regular monitoring programs, which combine fishery dependent and independent data, most of the commercially important non-quota species are usually data deficient. This data deficiency is particularly acute in shellfisheries such as those for brown crab and lobster. While the implementation of data collection programs is essential to provide indicators of the state of commercially exploited stocks, diminishing public resources and an increasing burden of evidence collection has highlighted to the need to consider technological solutions as an alternative to traditional methods of data collection.

Currently, for most inshore shellfish fisheries, data collection relies on self-reporting of landings, point of first sale data, port sampling, and on-board sampling by fisheries officers. On-board observers and scientific vessel surveys collect detailed data, but they are expensive and time-consuming. The use of on-board camera systems to collect data has been tested in fisheries targeting shellfish (Hold *et al.*, 2015). Camera systems were found to be a reliable and accurate method for collecting data on the size and sex of crabs and lobsters. Future computer automation of image extraction and measurements should increase the application of video cameras for data collection and ensure a widespread adoption of such data collection systems.

Before it is possible to consider the development of automated software systems to measure animals in the field of view, a reliable mechanism was needed to eliminate errors associated with depth of field linked to the variable distance between the animal and the background reference scale included in the field of view (Hold *et al.*, 2015). The use of parallel-paired lasers coupled to video cameras is a simple and accurate method to obtain precise estimates of animal size from camera images (Cambie *et al.*, 2016).

Bangor University is trialling this technology (cameras with parallel-paired lasers) in the inshore static-gear shellfish fishery in the Isle of Man by having a *sentinel* fleet collect fisheries-dependent video data. The equipment is expected to be installed and operational in early 2017. An evaluation of the technology (benefits and limitations) as well as population assessment results is expected to be available for the next ICES WGCRAB.

5.7 Irish stock of the edible crab (*Cancer pagurus*) and European lobster (*Homarus gammarus*)

5.7.1 ToRs a) and b) Data on *Cancer pagurus* from Ireland

Irish vessels fish for crab in ICES Areas 4, 6 and 7. In 2010 the WG agreed a series of assessment units covering fisheries exploited by vessels from UK, Ireland, France, Norway and Sweden. Four of these assessment units, (Malin, SW Ireland, SE Ireland/Celtic Sea, N Irish Sea) surround the Irish coast and Irish inshore vessels fish in all four units. Landings (tonnes) into Ireland from 2004 to 2015 for these four assessment units and adjacent assessment units by Irish vessels are shown in Table 10. These landings are collated from the operational landings database. Table 11 shows the landings (tonnes) for the under 10 metre vessels that fish around the Irish coast within 12 nmiles of the shore.

The quality of the landings data from the official national databases are variable and may at times reflect changes in the efficacy of recording rather than the crab fishery itself. Landings data for 2016 is incomplete at this time and therefore has not been included.

Size distribution data was collected from the Malin, SW Ireland and SE Ireland/Celtic Sea assessment units during 2015. A total of 7727 brown crab were measured from both at sea and port sampling around the coast of Ireland. The majority (58%) being from the SW Ireland assessment unit. The majority of crab measured were female (83%) in both catch and landings sampling. Female crab from the Malin assessment unit ranged from 132–197 mm carapace width with a mode size of 162 mm, while male crab from the same stock ranged from 118–205 mm carapace width with the majority being 144 mm. In the SW Ireland assessment unit female brown crab ranged in size from 31–226 mm carapace width and males ranged from 41–221 mm carapace width. Both female and male brown crab from the SW Ireland had a mode size of 122 mm carapace width. Female brown crab from the SE Ireland/Celtic Sea assessment unit ranged in size from 121–215 mm carapace width while, males ranged in size from 116–221 mm carapace width. Females from this assessment unit had a mode size of 164 mm and males had a mode size of 153 mm.

No assessment methods are currently being utilised by Ireland on the four stocks/assessment units around the Irish coast.

Table 10. Landings (tonnes) by assessment unit of *Cancer pagurus* by Irish vessels from 2005 to 2015. Data is based on operational data from logbooks and does not include landings from under 10metre vessels. ('Outside'refers to landings caught from outside the assessment units agreed upon at WGCRAB 2010 and 'Not Recorded' refers to landings where the ICES Rectangle was not recorded).

Assessment Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Central North Sea	2726.4	1550.6					6.1	79.9			13.8
Clyde						2.6					
Eastern Channel											1.6
Hebrides			0.9			850.2					
Malin	403.1	1436.1	3177.2	4462.8	8931.2	6029.7	3146.2	2631.0	3788.4	3359.2	2906.3
N. Irish Sea		0.5	147.8				34.7	43.4	25.7	35.5	17.0
North Coast						249.9					
Orkney											
Outside			614.0	28.0		692.7	2.0	2.0		5.4	19.7
Papa											
SE Ireland/Celtic Sea	143.3	585.4	595.2			110.8	296.5	220.2	118.7	176.0	223.4
Shetland											
South Minch						157.7					31.8
Southern North Sea							979.7	1182.1		1389.2	
Sule						855.2					
SW Ireland	42.1	23.0	114.3	807.1	843.2	554.2	339.6	520.3	365.1	536.4	472.5
Western Channel			0.8				35.4			13.3	
Not Recorded											4.1
Total	3314.9	3595.6	4650.2	5297.9	9774.4	9503.0	4840.2	4678.9	4297.9	5515.0	3690.3

Table 11. Landings (tonnes) by assessment unit of *Cancer pagurus* by Irish vessels under 10 metre vessels from 2005–2015.

Assessment Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Malin	3825.7	3220.3	827.9	1135.8	712.7	863.0	816.6	17.8	27.8	442.7	33.0
N. Irish Sea	107.0	68.5	173.2	261.9	2.0	65.9	326.7	17.8	450.6	150.1	750.3
Outside											
SE Ireland/Celtic Sea	1116.5	91.5	45.0		249.5	609.9	807.4	1014.7	627.6	431.0	198.0
SW Ireland	592.1	1684.3	25630.2	147.0	195.9	300.5	173.4	465.4	351.4	717.7	1406.9
Not Recorded											
Total	5641.3	5064.6	26676.3	1544.7	1160.1	1839.3	2124.1	1515.7	1457.4	1741.5	2388.2

5.7.2 ToRs a) and b) Data on *Homarus gammarus* from Ireland (provided by the Marine Institute of Ireland)

The Irish fishery for lobster (*Homarus gammarus*) occurs all around the coast. Landings (tonnes) into Ireland for 2014 and 2015 are shown in Table 12. These landings are collated from the operational landings database. The landings for the under 10 metre vessels are also included.

The quality of the landings data from the official national databases are variable and may at times reflect changes in the efficacy of recording rather than the crab fishery itself. Landings data for 2016 is incomplete at this time and therefore has not been included.

Table 12. Landings (tonnes) by ICES Area (where possible) of *Homarus gammarus* by Irish vessels in 2014 and 2015. The offshore data is based on operational data from logbooks. Landings from the under 10metre vessels is also included and makes up the majority of the landings listed.

Assesssment Units	2014	2015
Central North Sea		0.06
Malin	289.69	71.75
N. Irish Sea	77.19	56.07
Outside	0.04	0.22
SE Ireland/Celtic Sea	8.69	13.59
South Minch		
SW Ireland	55.40	185.01
SW Ireland - SE Ireland	25.09	45.01

Along with the conservation measures of a minimum size limit (87 mm Carapace Length) and a v-notching programme (it is not obligatory to v-notch lobster but it is illegal to land a v-notched lobster) a maximum size limit (MSL) of 127 mm was introduced on both male and female lobsters in January 2015. This MSL was designed to have a number of effects on the lobster population over time:

a) Establish size classes of lobsters above 127 mm which are currently weakly represented in the population generally.

b) Increase egg production by large lobsters and, when combined with v-notching, bring egg production per recruit in the population over 10% of what it would be in an unfished stock.

c) Maintain the male:female sex ratio in large lobsters at a level that is present in lobsters below 127mm.

A maximum size limit of 127 mm was chosen as previous studies on historic landings data indicated that lobster ≥127 mm represented approximately 3% of the lobster caught around the coast and therefore would not have a significant economic impact on the fishery. Its effects on egg production were assessed using an egg per recruit model and although it was not very beneficial by itself when combined with high v-notching rates a significant component of lobsters above 127 mm will benefit from permanent protection.

Size distribution data from 8,495 lobsters was recorded around the Irish coast between April and November in 2015. Table 13 indicates the quantity of lobster measured from 15 sampling locations around the coast.

Table 13. Total quantity and proportions of lobster <87 mm, ≥87 mm<127mm, ≥127 mm (with v-notch), ≥127 mm (no v-notch) and v-notched sampled at sea at various locations around the Irish coast during 2015.

Location	Total	% <87mm	% ≥87mm<127mm	% ≥127mm (with v-notch)	% ≥127mm (no v-notch)	% V-notched
Donegal	38	28.95	60.53	0.00	10.53	0.00
Sligo	1,422	74.47	24.96	0.35	0.21	6.89
Mayo	922	70.61	29.28	0.00	0.11	10.63
Galway Bay Inner	474	38.19	61.60	0.21	0.00	6.12
Galway Bay Outer	59	6.78	93.22	0.00	0.00	3.39
Clare	337	37.98	59.64	0.59	1.78	7.12
Kerry North	86	65.12	33.72	0.00	1.16	0.00
Kerry West	724	35.91	59.39	0.00	4.70	1.24
Cork West	186	58.60	38.17	0.00	3.23	1.08
Cork West	370	51.35	48.38	0.00	0.27	0.27
Waterford	1,355	58.75	40.37	0.59	0.30	2.95
Wexford	1,797	47.91	50.75	0.22	1.11	1.11
Dublin	281	73.31	26.69	0.00	0.00	0.36
Dublin offshore	357	3.64	90.76	0.00	5.60	1.68
Louth	87	55.17	44.83	0.00	0.00	0.00

The proportion of lobster equal to or above the maximum landing size of 127 mm varied around the coast and ranged from 0–10.53 %. However at the majority of locations catches of MaxLS lobster represented less than 3% of the total catch. North Donegal returned the highest proportion (10.53 %) of lobster ≥127 mm. These vessels were targeting brown crab and were predominately fishing off the coast in deeper water and thus were not fully representative of the Irish lobster fleet in this area.

A high proportion (5.6%) of MaxLS lobsters were also recorded offshore from the Dublin coast. Again these vessels were fishing in deep water and approximately 96% of the total lobster catch in this area was over the minimum landing size with 1.7% being v-notched. In comparison less than 30% of lobsters caught closer to the coast of Dublin were ≥87 mm and none of these were ≥127 mm.

To the north of the Dingle peninsula 35% of the lobster caught were ≥87 mm while less than 2% were oversized. However to the west of the Dingle peninsula 64% of the lobster caught were 87 mm or over and 4.7% were ≥127 mm. In this area 1.24% of the lobster catch was previously v-notched while no v-notched lobsters were recorded from catches to the north of the peninsula.

Oversized lobster ≥127 mm made up 3.23% of catches off the south western Cork coast. In the same area only 41.4% of the catch was ≥87 mm and 1.08% was v-notched. In com-

parison only one lobster caught outside Cork Harbour was above the maximum landing size and only one had been previously v-notched.

5.8 French stock of the edible crab (*Cancer pagurus*)

5.8.1 ToRs a) and b) Stock status of brown crab in France

The French landing of brown crab is quite stable for 15 years now. The annual fluctuations are not too high and the landing is around 5500 tons per year (Figure 10). Since 2003, the number of vessel which are involved in this fishery is quite stable. The decreases in 2009 and 2010 are linked to the change in the way to store the data and a bad situation where many logbooks and fishing sheets have been lost. For the last year, all the data are not yet recorded it is why the landing seem lowest.

Figure 10. Total landing and number of vessel in the fishery.

The landings are mainly due to two fleets, the potters (caseyeurs) and netters-potters (fileyeurs caseyeurs), which represent close to 80% of the total landing (Figure 11). For this last fleet, the brown crab is targeted using classical pots for 97% of the landing. In these two fleets, the fishing strategy is not the same according the vessels. In fact, only few vessels are very dependant to brown crab where they achieve more than 50 % of the turnover thanks to this species (Figure 12). The number of these vessels is not more than 20 vessels. From these 20 vessels, 12 are offshore potters or "vivier" vessel which land close to 50 % of the total French landing. These 20 vessels are really dependent of the status of the stock but in a first place from the market where the price per kg is quite low.

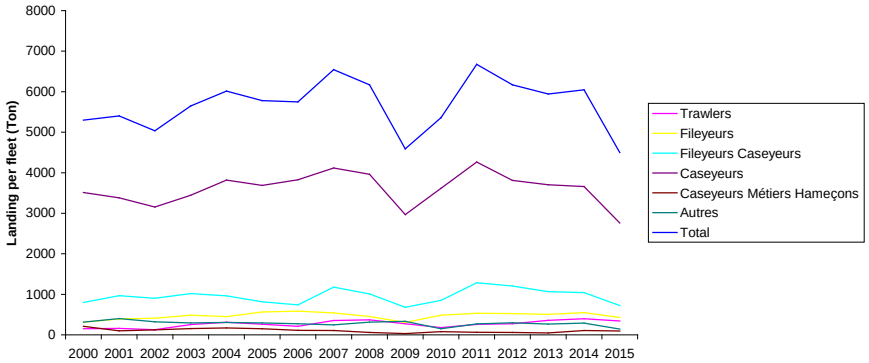


Figure 11. Annual French Landing per Fleet for the brown crab.

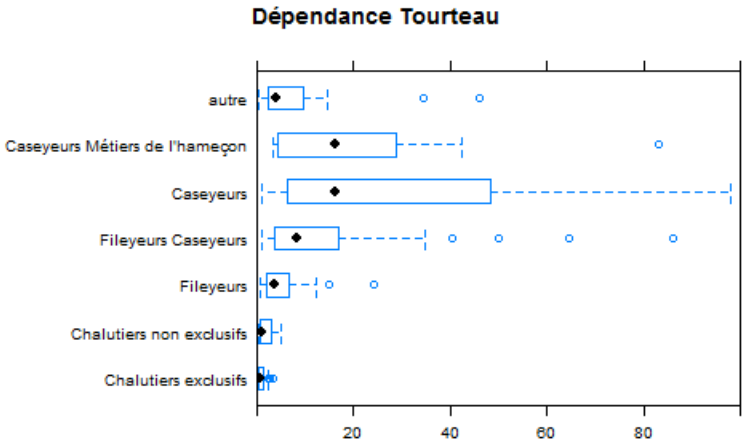


Figure 12. Boxplot of the individual turnover related to the landing of brown crab for the different fleets.

For the other fleets involved in the fishery, the brown crab is more considered as bycatch. As example, for the netter fleet which target flat fishes as turbot or monkfish, brown crab is really a bycatch, even if it can represent a turnover close to 10 % (Figure 12).

The fishery of the brown crab is seasonal (Figure 13, 15a, 15b). In a fishery where 80 to 90 % of the landing are some females, the catchability has a great importance. The berried female stays in the sand for 5 month (November to April) where the landing decrease a lot. During this period, some vessels stop to fish and other vessels change their strategies, looking for lobsters, shrimp or whelks. At the same time, the better fishing ground for brown crab are far from the shore and during winter these areas are not easily accessible due to the weather conditions.

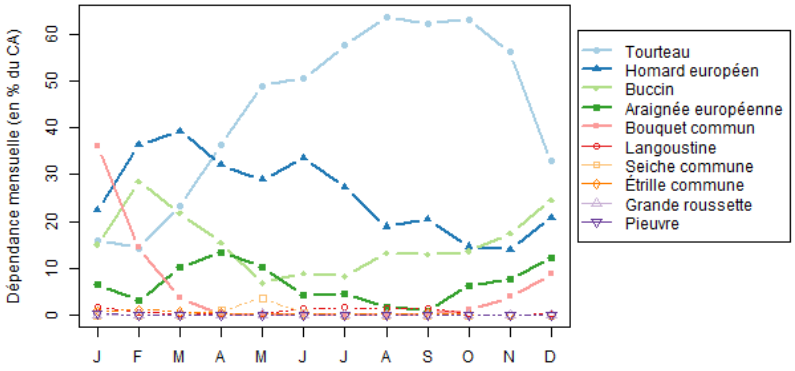


Figure 13. Part of the different species in the monthly turnover for the potter fleet.

The vessels which land brown crab come from Brittany (Figure 14) in a large part and from Normandy after. For the rest of the coast, some vessels land crab too but in a lowest proportion. There is really a fishing culture to target brown crab which is found a lot in Brittany, for the administrative areas from SM to SN.

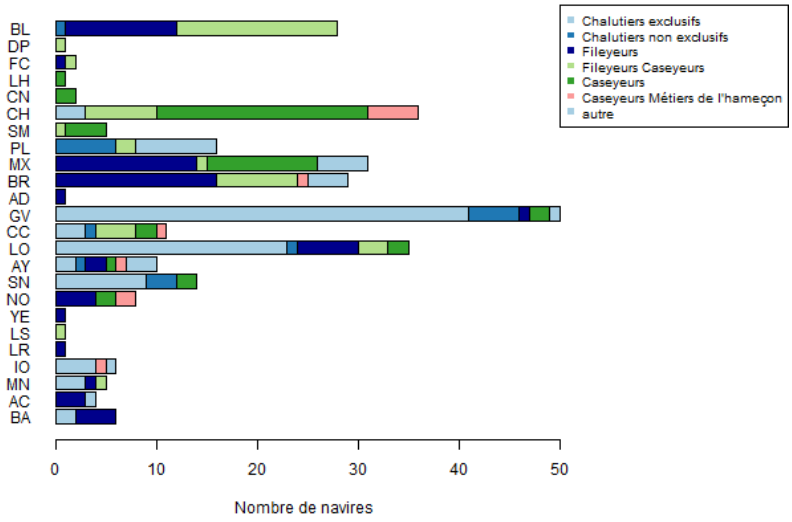
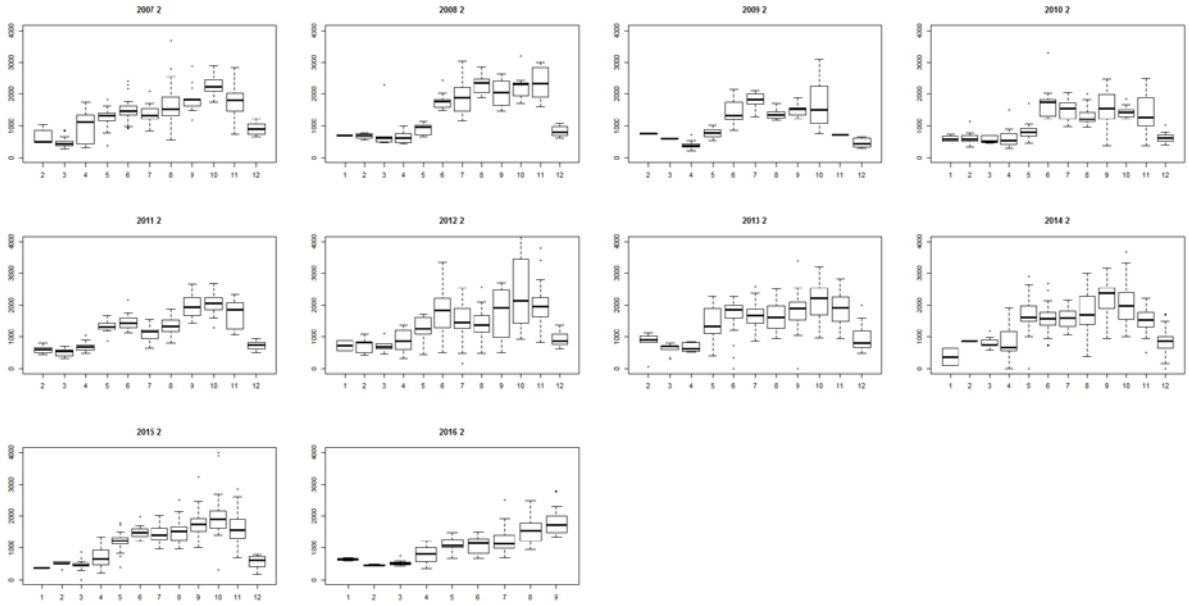
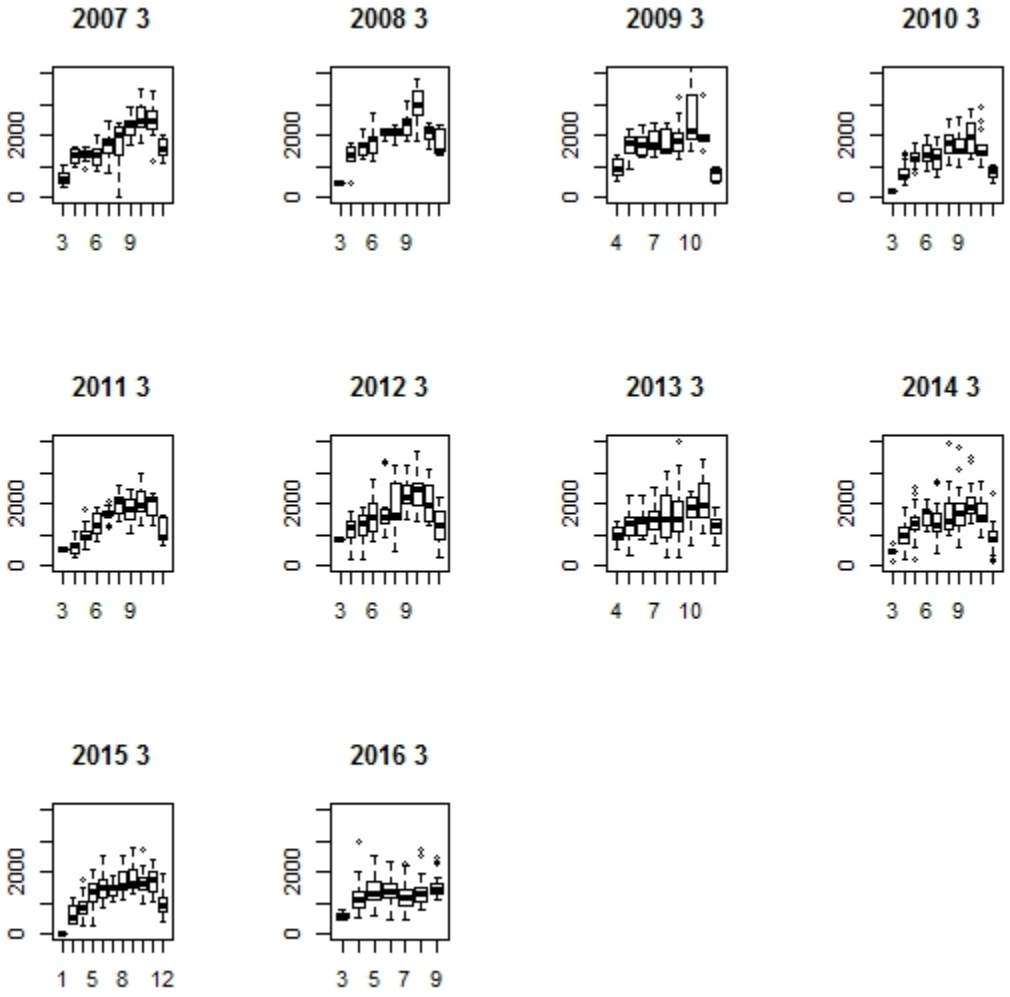


Figure 14. Repartition of the vessels which land lobster in administrative areas.

Thanks to the declaration data available now, the development of abundance index for some areas of the fishery can be performed from LPUE data. This work has been done for the two main landing areas, Western Channel and Bay of Biscay. This work is only developed from the offshore vivier vessels.


2007 2
2008 2
2009 2
2010 2
2011 2
2012 2
2013 2
2014 2
2015 2
2016 2

6a)



6b)

Figure 15b: Monthly LPUE (kg/1000 pots) for the two main fishing areas, 15a (Western Channel), 6b (Bay of Biscay).

From these data, the seasonality is well observed with very low abundance in winter. After, the general trend is really an increase with the highest value in autumn. The abundance is a little higher in Bay of Biscay compared to Western Channel. Using all the data, a glm model is developed to estimate an index abundance where the effects year, month, area and vessel are retained. All this effects are significant and they are used to estimate an annual index. With the time series available, the abundance index estimated clearly show a great stability for the last 30 years (Figure 16). From 1990 to 2016, the index increase slowly with some annual variations. The data for 2016 are not completely available for October and November. It is why the final situation will be better for the two main areas.

In the western Channel and the Bay of Biscay, where the French vessels are actives, there is very few other foreign vessels. Moreover, the management rules in place for the French vessels allow to stabilize the fishing effort. This point is really important to understand the good level of the abundance index.

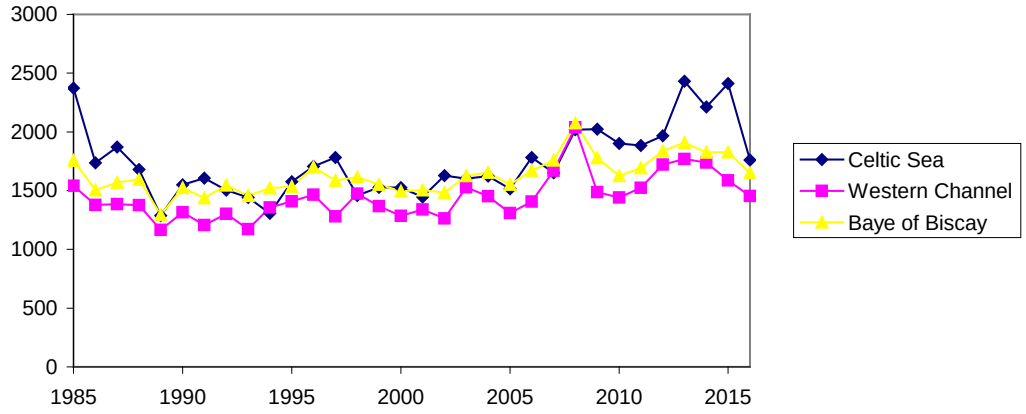


Figure 16. Abundance Index for the three main fishing areas (kg/1000 pots).

5.9 French stock of the lobster (*Homarus gammarus*)

5.9.1 ToR a) and b) Stock status of lobster in France

The French lobster fishery is located in a large part of the atlantic and channel coast. From Boulogne sur Mer in the north part to Oleron island in the south, lobsters are found in different types of rocky ground mainly in coastal water, less than 40 meters depth. In all harbours neighbouring these areas, some vessels target lobster. Nevertheless, their number is really variable along the coast. The two main areas are in the north of Brittany and the west of Normandy (Figure 17).

The French production for 15 years increases steadily to reach today around 550 tons (Figure 18). At the same time, the number of vessel increase also but in a lower proportion. We can really say that the evolution during the period from 2000 to 2005 is linked to the increase of declarations. In fact from 2000, all the vessels, for each size, have to declare their production and activity. For the vessels under 10 meters, a national fishing sheet is used as equivalent to the European logbooks.

Figure 17. Map of the main lobster fishery and position of two administrative areas (CH and NO).

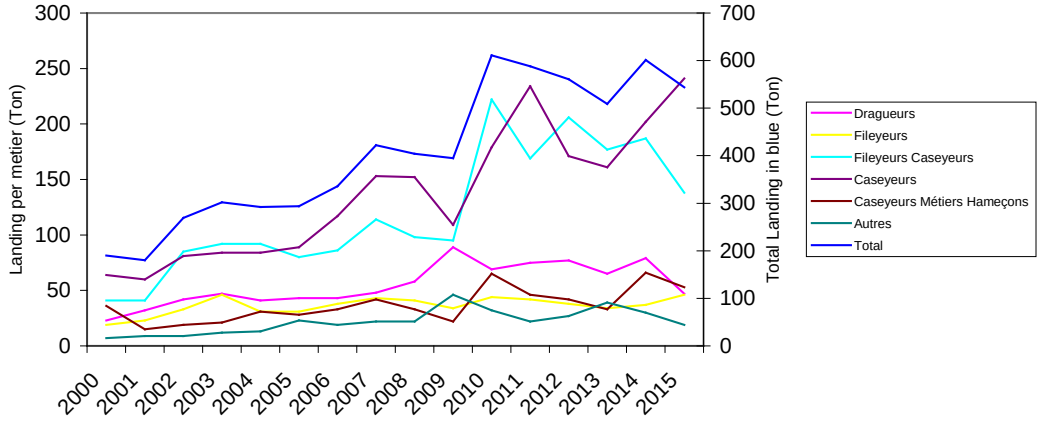


Figure 18. French landing of lobster per fleet from 2000 to 2015.

In the times series, the years 2008 and 2009 should be analysed with caution. A change in the national database has generated some errors or misses. It is why, we can estimate that the total production for these two years is upper than these official values. The two main fleets are the potters (caseyeurs) and Netters/Potters (Fileyeurs Caseyeurs) which repre-

sent around 70% of the landings (Figure 18). In the second fleet, the pot is really the gear used to target lobster. So, for these fleets, the lobster pot "métier" is largely used.

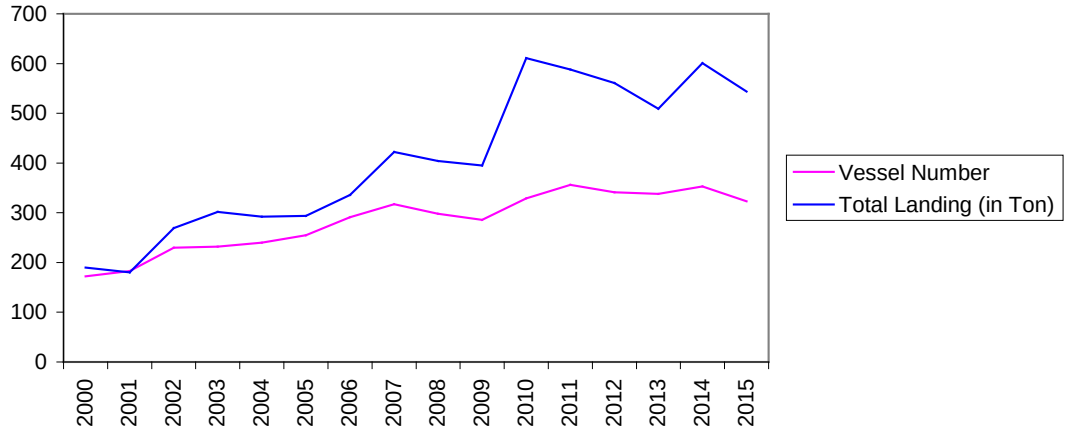


Figure19. Total French Landing and number of vessel involves in the fishery from 2000 to 2015.

Looking the trend in the number of vessels, an increase appears from 2000 to 2007 (Figure 19). One part of the increase has to be linked to the improve of the declaration by the fishing sheets. After 2007, the vessel number is more stable. This stabilisation is explained by the manage rules in place where the number of vessels are contained by licence quotas in each region. As associated rule, the number of pot per vessel is fixed with a maximum of 200 by fisherman in board. These rules have allowed to control the evolution of the fishing effort. At the same time, the respect of the minimal legal size year after year have lead to the good evolution of this fishery. The repartition of the vessels along the coast clearly shows that the two fleets which land the lobster are more abundant in Normandy and North Brittany (CH to NO) and the large part of the landing come from these areas (Figure 17 and 20).

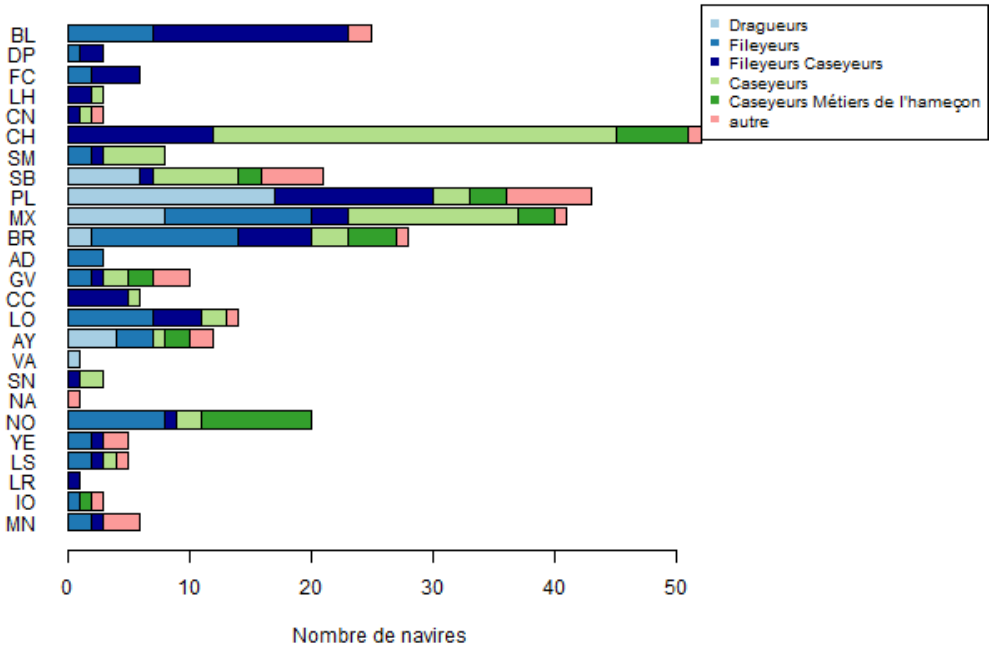


Figure 20. Repartition of the vessels which land lobster in administrative areas.

Thanks to the declaration data available now, the development of abundance index for some areas of the fishery can be performed from LPUE data. This work has been done for the two main landing areas, North Brittany and west coast of Normandy, where all the data linked to the pot activity are selected.

The LPUE clearly increase at the end of the winter to reach a maximum in June (Figure 21). The decrease in July is associated with the moult of many lobsters and a lower availability. After, in August the LPUE level increase at a level similar to June. From the end of summer to the end of autumn, the LPUE decrease in a large proportion. This evolution of the capturability seems to be associated to the temperature of the ocean, where the catchability increase with the sea temperature. One particularity seems to validate this link. In 2013, the LPUE are lowest in April at the end of a period where the sea temperature has decreased until the 14 of April. This seasonality of LPUE observed from one area in Normandy is found in all the areas along the coast.

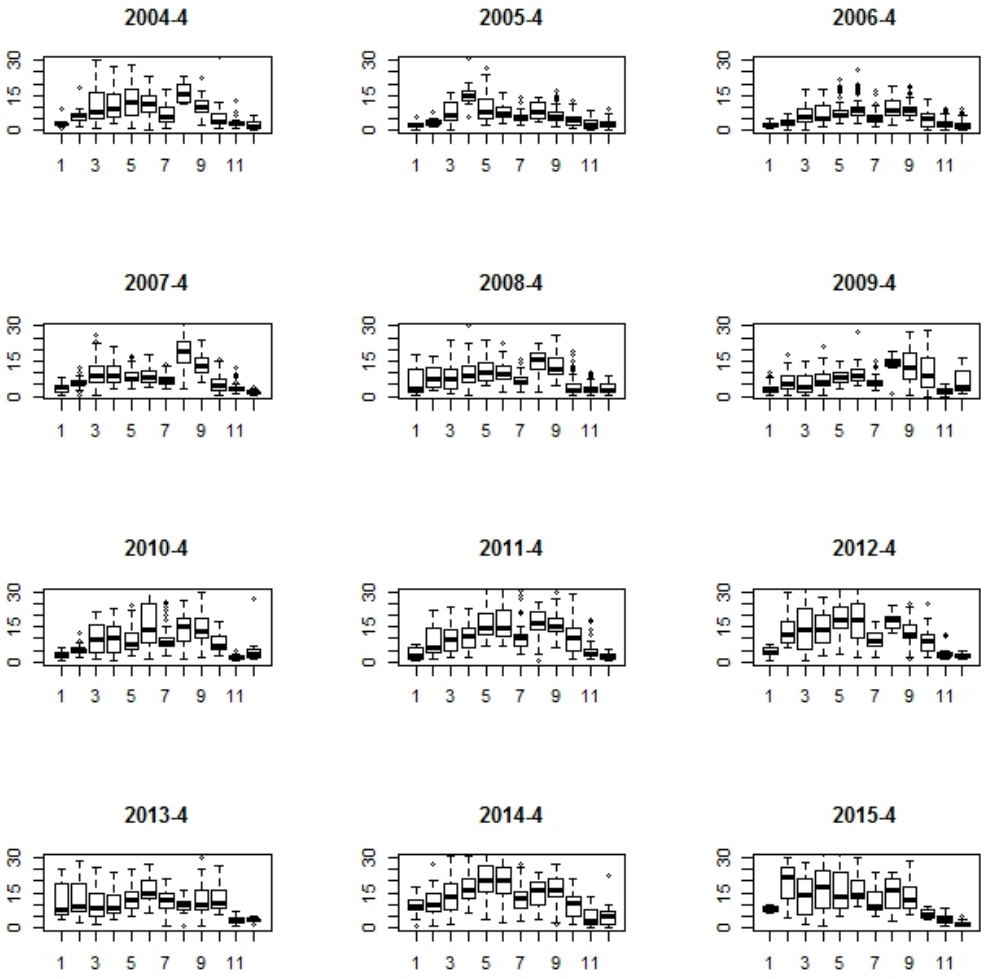


Figure 21. Seasonal evolution of the LPUE in one area of the west Normandy Coast from 2004 to 2015.

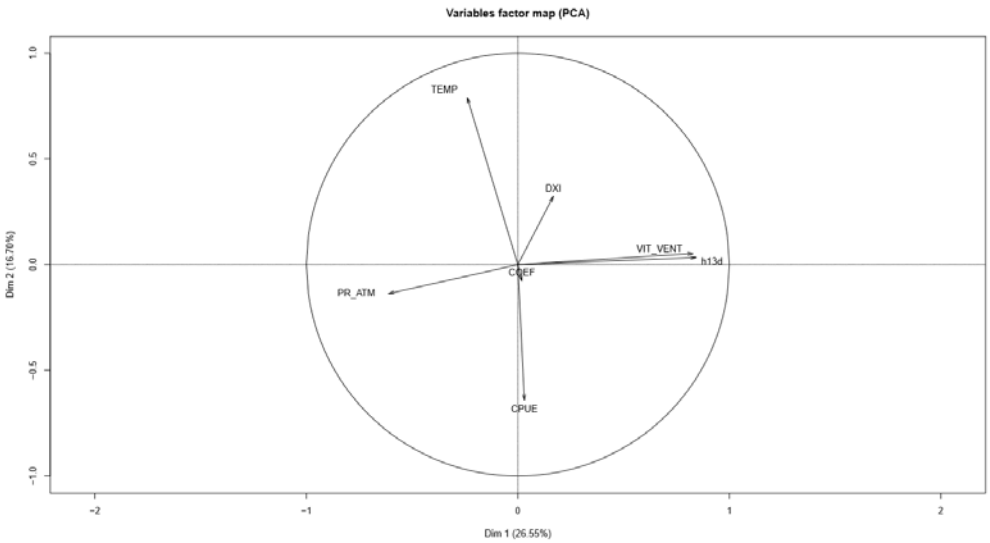


Figure 22. Factorial analyse of environment parameters explaining the LPUE values.

From many parameters of the environment, the temperature seems to impact wide the evolution of the LPUE as showed in this first ACP result (Figure 22). This result comes from three areas where daily time series of LPUE, temperature, swell and wind have been tested.

To develop the index, we have selected for the two areas (West Normandy and North Brittany), the vessels which really target lobsters during a large part of the year. The considered index is the daily landing for 100 pots (LPUE). The index comes from a GLM model where the following effects are selected: individual vessels, year, month and area.

From the two main landing areas (Figure 23 and 24), the trend of the index is really equivalent, steadily increase since 2005. There are some annual evolutions, but the general situation clearly shows an increase of the abundance.

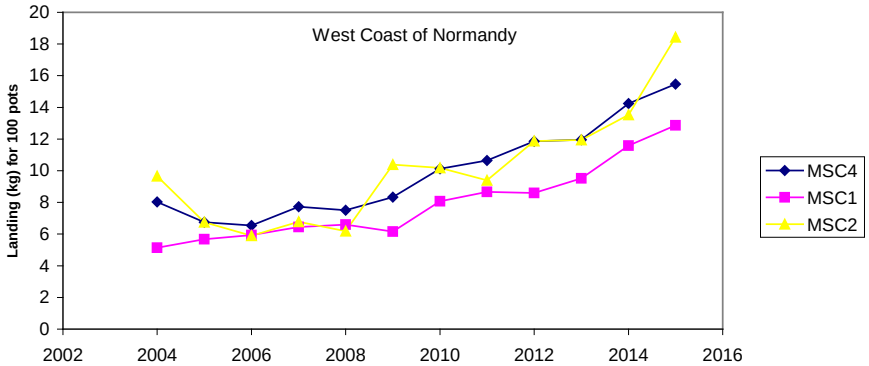


Figure 23. Index abundance for three areas in the West Coast of Normandy.

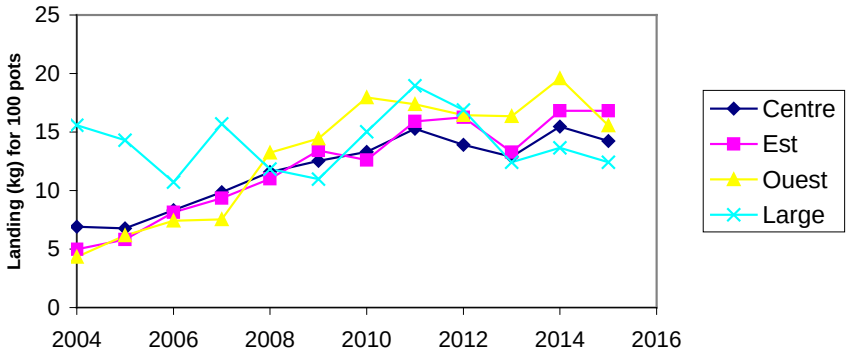


Figure 24. Index abundance for four areas in the North of Brittany.

At the boundary between the south east part of Brittany and Pays de Loire Region, in a less important lobster area in considering the landings, the evolution of the LPUE, without application of a model, shows similar trend over the last 10 years.

The works on the lobster fishery have to be improved with a largest study integrating all the areas along the French coast, where abundance indices will be associated with stock assessment models. At this stage, many data are put in place in order to be able to develop all these assessments. Nevertheless, the current situation is really positive and some discussions propose to apply more conservative management rules as increase the MLS to 90 mm LC. The negative impact will be short in the current good situation, but the positive impact at long term will be interesting.

5.10 Norwegian stock of King crab (*Paralithodes camtschaticus*)

5.10.1 ToR b) Status red king crab (*Paralithodes camtschaticus*) in Norwegian waters

The harvest of the red king crab (*Paralithodes camtschaticus*) in northern Norway has a fishery history for 22 years now. Present management regime was established in 2008, and have since then been primarily a male-only fishery, but there is also an additional small quota on female crabs. In the dual management regime there is two goals, one is to maintain a long term commercial harvest in a limited geographical area with total allowable catch (TAC) and restricted participation (East Finnmark). The other goal is to limit further spread of the crab and minimize crab abundance outside the commercial area (West Finnmark). There is also a profitable fishery going on in West Finnmark, and it is used as tool to fulfill the goal reducing the

The Institute of Marine Research carry out two annual cruises in the quota regulated area to assess the stock and advising on harvest. In addition, we perform a trap survey in coastal areas west of the quota regulated area to monitor the spread of the crab. After six years of surveillance, it seems that the free fishery is able to limit the rate of spread, and keeping the stock at low levels in areas where the crab is established.

During the last eight years the landings of the red king crab in East Finnmark has been stable. About 550 fishermen can participate in the fishery and the value of the landings

has varied between 100 to 250 million Norwegian kroner. The landings in West Finnmark has varied more due to that the variance in effort, nevertheless the first hand value of the ladings has varied between 13 to 87 million Norwegian kroner, and in average about 200 boats participate.

We are presently emphasizing improvement of logbook data from the fishery. This will give us knowledge about fishery pattern such as catches, fishing depths and effort.

Data collected on the red king crab surveys are analyzed using a compound production model. This model provides alternative harvest options with affiliated risk analysis. The quota has been stable and varied between 1000 to 2000 tones the six last years.

5.11 Norwegian stock of Snow crab (*Chionoecetes opilio*)

5.11.1 ToR a) Status on the snow crab in the Barents Sea

The snow crab (*Chionoecetes opilio*) stock has increased rapidly both in distribution and abundance in the Barents Sea since the first five specimens were found in 1996 at the Goosebank in south eastern part of the Barents Sea. The population is expanding its distribution primarily westwards and northwards into the Norwegian zone.

The snow crab is therefore now found in large parts of the Barents Sea, but still the largest part is in Russian exclusive economic zone (EEZ). The snow crab is defined as a sedentary species, which entail several challenges regarding management of the species. The Barents Sea continental shelf, including the Loophole, belongs to Russia and Norway. The border Norway and Russia agreed upon in 2010 lined up the dividing of the continental shelf between the two Parties. This implies that most of the Loophole continental shelf belongs to Russia and it also implies that it is only Norwegian and Russian registered ships that can participate in the fishery until other management arrangement has been developed.

At present, most of the snow crab fishery in the Barents Sea takes place central in the Barents Sea. There has been a fishery for snow crab in the Barents Sea for five years. It started with only small landings of 2.5 tons in 2012 and so far, in 2016 there is landed around 4600 tons. In total there is landed almost 9400 tones snow crab at Norwegian harbors from both Norwegian and foreign ships. The first hand value of the snow crab was about 250 million Norwegian kroners in 2015.

Norwegian data on the snow crab stock in the Barents Sea originate mainly from bycatches in the regular routine cruises conducted by the Institute of Marine Research using a multispecies trawl in August. We have therefore some knowledge about the stock structure and basic biological parameters for the Barents Sea snow crab.

A management proposal has been prepared and are under development and will be released in near future.

5.12 Greenlandic stock of Snow crab (*Chionoecetes opilio*)

5.12.1 ToRs a) and b) Stock Summary of snow crab in Greenland waters

Regulations

Snow crabs are distributed along the West coast of Greenland and are commercially exploited primarily from Disko Bay in the North (up to 71° 30N) to Paamiut in the South (60° 45N). Commercial fishing for snow crab began primarily in inshore areas (within basis-line) in the mid-1990s and from 1999, also included offshore areas (outside basis-line).

Since 2004, the crab resource in Greenland has been managed in 6 areas (from North to South - Upernavik, Uummannaq-Disko Bay, Sisimiut, Maniitsoq-Kangaamiut, Nuuk-Paamiut and Narsaq-Qaqortoq, Figure 1). The fishing fleet is made up of two components; small vessels (less than 75 GRT), which have exclusive rights for fishing inshore within the basis-line as well as offshore. Small vessels are, however, restricted to fishing in only two management areas during the year. Large vessels (greater than 75 GRT) may only fish in all offshore areas (outside the basis-line), but not within the "Crab Boxes". Quota restrictions have been imposed to each of the 6 management area since 1995 and individual quotas to vessels larger > 75 GRT, but have only limited the catch in 2004. Management decisions allow increasing quota in each of the six management area, when the catch achieved the first fixed quota. Unused quota from larger vessels is re-allocated to the inshore fleet (small vessels < 75 GRT). Basically, there is now quota restriction for the small vessel. The fishery is regulated by prohibitions to land females and undersized males (<100 mm CW), logbooks for all vessels larger than 10 meters and closure of the fishery north of 64°N for 3 months (1 January to 31 March).

Objective of recommendations in Greenland

There are no specific long-term management objectives for the snow crab resource in West Greenland, however since 2004 the main objective of recommendations from GINR has been to stop the decline in biomass of the crab resource in the different management areas. The recommendations are not expected to result in increased stock biomass in the short term, but only stop the current decline. If a rebuilding of the stock to achieve a higher exploitable biomass and better catch rates is the objective, then the recommended catches should be further reduced to allow the stock to grow.

The fishery

The historical development of the crab fishery in Greenland is shown in Figure 25 and Table 14. Landings increased from approx. 1000 tons in 1995 to a peak of approx. 15 000 tons (Quota 26 800 tons) in 2001. Since landings as well as quota has been markedly reduced. From 2001 to 2007 total catch declined by approx. 89% to 2189. In the subsequent years landings has been stable at approx. 2.100 tons and total landings was 2.021 tons in 2015.

Landings with in each of the management areas have vary over time (Figure 26) and in 2015 80% of total landings were taken in Management area Sisimiut and Nuuk-Paamiut, whereas the contribution from the other management area very limited.

The total fishing effort (trap hauls) has declined by 91% since 2001 (from 3416 to 319 thousand trap hauls during 2001–2012); (Figure 26). The decline in fishing effort has been mostly due to a declining number of participants in the fishery.

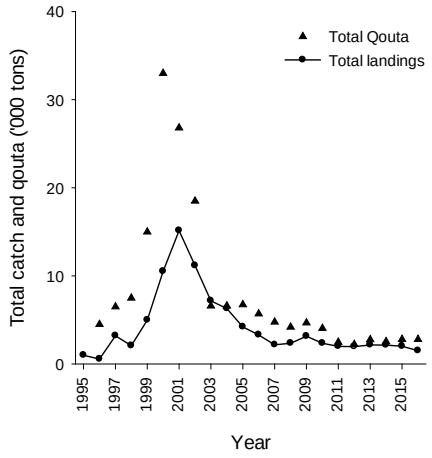


Figure 25. Total catch and quota size from 1995–2016. Data from 2016 is preliminary and incomplete.

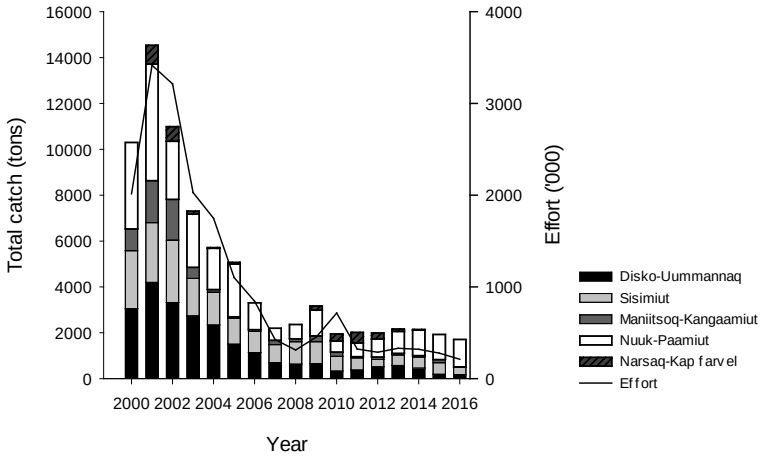


Figure 26. Snow crab landings in the four most important management areas of West Greenland 2000–2016 and used total effort. Data for 2016 are preliminary and incomplete.

Stock status

The accumulated biomass available to the fishery in 2017 is highly variable according to the stocks indices. Generally, in 2016, stocks in each management area along the west coast of Greenland were characterized a low level in the management areas of Disko Bay inshore and Sisimiut offshore, butd as stable commercial biomass in management area of Sisimiut inshore and Nuuk-Paamiut offshore. Recommendations for 2017 are status quo

in terms of TAC in all areas. In Sisimiut management area the offshore site were recommend close until the stock rebuild.

Management area Uummannaq – Disko Bay

Landings declined by 88% from 4202 t in 2001 to 188 t in 2015, while effort decreased by 96% (Figure 27 and Table 14). The exploitable biomass has been declining the past 3 years in Disko Bay inshore, but have been stable offshore at a low level. Recruitment, based on research data from 2015, has decreased since and is expected to be low over the next several years. In the Northern part of the management area recruitment decreased significant over 2017.

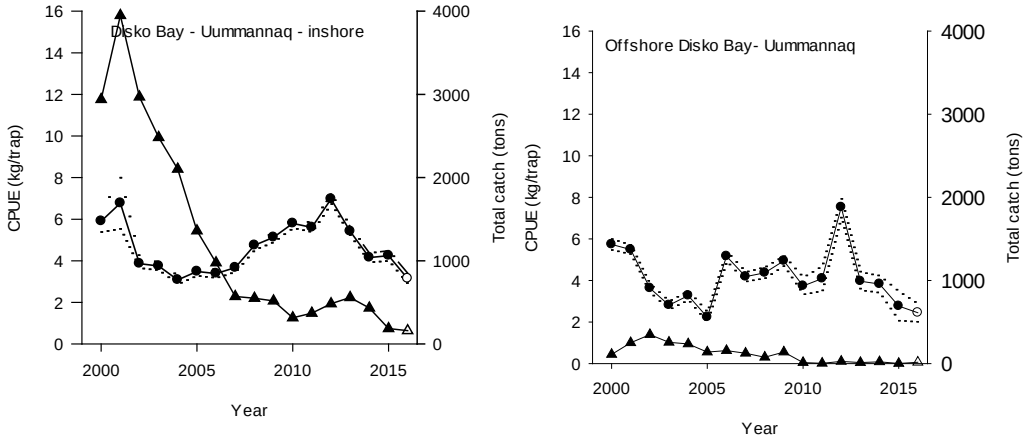


Figure 27. Standardised CPUE index and total catch based on logbook information inshore Uummannaq-Disko Bay Area from 2000–2016. Data for 2016 is preliminary and incomplete. (● is standardized CPUE, ▲ total catch and dotted line lower and upper confidence limits).

Management area Sisimiut (inshore and offshore)

Inshore landings declined from 1111 t in 2004 to 312 t in 2015 (TAC 300 t in 2015), while effort decreased by 93% (Figure 28 and Table 14) CPUE steadily increased since 2012. Offshore landings declined significantly from 2275 tons to 196 t in 2015 and CPUE remain high as a result of a huge decline in effort in the same period. The exploitable inshore biomass declined significantly inshore as well as offshore from 2009 to 2011, increased in 2012 and have remain stable as a level close to its serial mean in Sisimiut inshore, but remain low in Sisimiut offshore, except for an increase in biomass in 2015 (Figure 29). Recruitment decreased in 2009, as was especially for the offshore site reflected by the abrupt decrease in exploitable biomass while landings increased little (Figure 30). Inshore, recruitment has fluctuated since 2012 at a low level and recruitment is expected to be low in near future, but longer-term prospects remain uncertain.

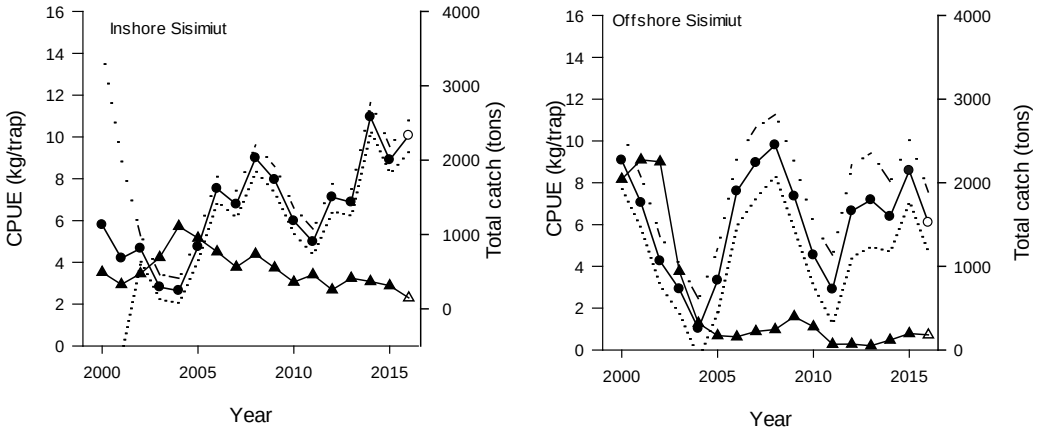


Figure 28. Standardised CPUE index and total catch based on logbook information inshore and offshore Sisimiut from 2000–2016. Data for 2016 is preliminary and incomplete. (● is standardized CPUE, ▲ total catch and dotted line lower and upper confidence limits).

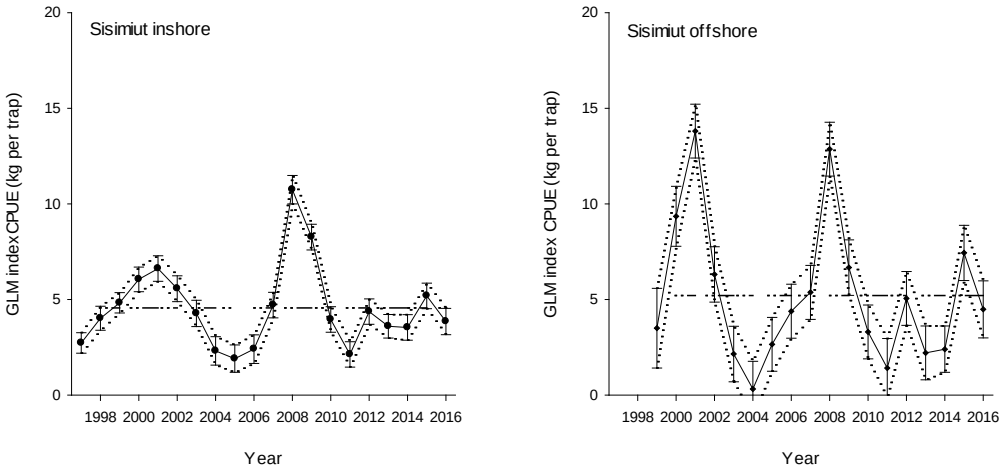


Figure 29. Annual trends in exploitable biomass (kg/trap ± S.E.) of legal-size males (≥100mm CW) from trap surveys in Sisimiut in- and offshore from 2000 to 2016. ●: CPUE (kg/trap) and dotted line is lower and upper confidence limits.

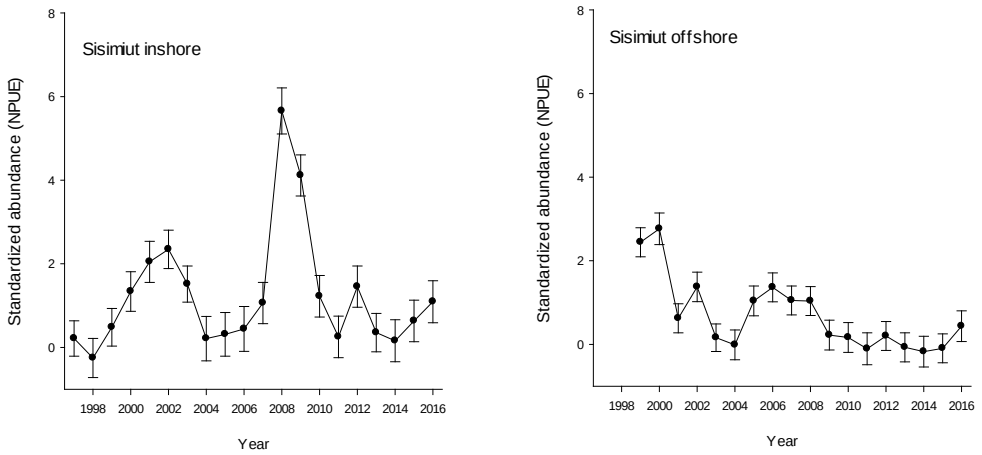


Figure 30. Recruitment index (ADO-1: 82.2 – 100 mm CW) of adolescents males from the annual trap survey in the inshore and offshore sites of Sisimiut management area, 2000–2016.

Managemnet area Maniitsoq – Kangaamiut

Landings and effort have steadily declined since 2002 to a historical low level in 2014. However, landings increased in 2015 (Table 14). No biological survey is conducted in that management area.

Management area Nuuk–Paamiut (inshore and offshore)

Landings declined by 91% from 5077 t in 2001 to 470 t in 2010, while effort decreased by 92% (Figure 31 and Table 14). Since landings increased, especially in the offshore area. The exploitable biomass is considered stable in both inshore and offshore areas. No biological survey is conducted in that management area.

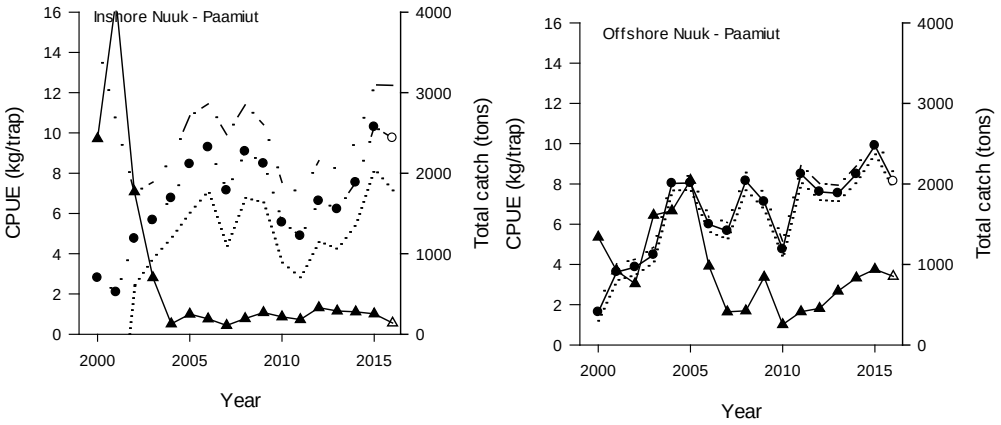


Figure 31. Standardised CPUE index and total catch based on logbook information inshore and offshore Nuuk-Paamiut from 2000–2016. Data for 2016 is preliminary and incomplete. (● is standardized CPUE, ▲ total catch and dotted line lower and upper confidence limits).

Managemnet area Qaqortoq – Kap Farvel

Landings and effort have steadily increased since 2009 from 187 tons to 450 tons in 2011, followed by a significant drop in landings to 268 tons in 2012 (Table 14). Since 2014, there have been no fishing activity for snow crab in this management area. No biological survey is conducted in that management area.

5.12.2 ToR e) Snow crab research in Greenland

A research project proposes to study some aspects of the reproductive potential of snow crab in the coastal waters of West Greenland. Fisheries exploited and non-exploited stocks will be compared as well as populations in hydrographical systems subject to different temperature regimes. Various life history traits will be examined and related to reproductive potential at three study sites along a latitudinal gradient: Disko Bay (north), Sisimiut (middle) and Nuuk (south). The goals of this project are to better understand the reproductive potential of the snow crab, as it relates to temperature conditions and fishing pressure, and to provide essential baseline information for adaptive management and conservation strategies. What is very unique about this study is the possibility of investigating life history traits of an unexploited population of snow crab, something non-existent elsewhere in the world. There are four components to this study. The effects of temperature and exploitation on snow crab population dynamics and – especially – on reproductive potential are multifaceted, complex and possibly synergistic.

Table 14. Landings, CPUE and effort by five management areas at West Greenlands waters, 2000–2016. Data from 2016 is preliminary.

Management Area	Year	Total catch (tons)	Quota	Number of issued permits	Number of active vessels	Inshore catch (tons)	Inshore CPUE (kg/trap)	Inshore effort ('000)	Offshore catch (tons)	Offshore CPUE (kg/trap)	Offshore effort ('000)
	2000	3,052	--	--	--	2,940	4.8	613	112	5.5	20
	2001	4,202	--	--	--	3,950	3.1	1,274	252	3.6	70
Uummannaq-Diskobugt	2002	3,319	--	--	--	2,970	3.3	900	349	3.0	116
	2003	2,739	--	--	67	2,482	3.7	679	257	2.6	97
	2004	2,341	--	--	48	2,103	3.3	630	238	3.6	65
	2005	1,500	1718	43	36	1,361	3.5	392	139	3.7	38
	2006	1,134	1600	43	31	977	4.1	239	157	6.3	25
	2007	698	1530	39	24	572	4.2	137	126	5.1	25
	2008	628	1400	25	11	550	5.0	110	78	5.1	15
	2009	657	700	22	15	518	5.4	97	139	5.5	25
	2010	329	600	19	11	315	5.4	58	14	4.6	3
	2011	376	500	5	13	371	4.8	77	5	3.8	1
	2012	513	500	15	12	485	5.2	93	28	7.5	4
	2013	573	600	14	22	559	4.2	134	14	4.4	3
	2014	457	600	9	12	433	3.2	136	23	4.3	5
	2015	188	600	27	9	185	2.3	80	3	2.8	1
	2016*	177	600	36	12	160	3.2	50	17	3.6	5
	2000	2,534	--	--	--	491	2.8	175	2,043	6.4	319
	2001	2,602	--	--	--	327	2.9	113	2,275	4.6	495
Sisimiut	2002	2,724	--	--	--	473	4.6	103	2,251	3.5	643
	2003	1,633	--		49	692	3.7	187	941	3.1	304
	2004	1,432	--		34	1,111	3.9	285	321	4.9	65
	2005	1,125	900	12	23	953	6.7	143	172	6.4	27
	2006	926	750	12	15	768	8.9	86	158	11.1	14
	2007	783	850	9	15	562	7.3	77	221	12.8	17
	2008	980	700+300	11	13	736	10.2	72	244	13.1	19
	2009	952	500+300	21	28	552	9.2	60	400	7.6	53
	2010	638	800	19	22	359	7.0	51	279	5.5	51
	2011	527	500	14	18	459	6.1	75	68	6.5	10
	2012	324	300	9	12	254	9.1	28	70	8.4	8
	2013	463	150+300	9	12	412	8.2	50	51	8.2	6
	2014	486	500	9	8	367	12.4	30	119	9.7	12
	2015	508	500	12	10	312	8.5	37	196	10.4	19
	2016*	318	500	14	8	148	10.1	15	180	9.0	20
	2000	944	--	--	--	563	4.3	131	381	7.6	50
	2001	1,835	--	--	--	1009	3.7	273	826	5.0	165
Maniitsoq-Kangaamiut	2002	1,775	--	--	--	1032	3.8	272	743	2.7	275
	2003	485	--	--	18	40	3.5	12	445	2.8	160
	2004	116	--	--	13	92	3.2	29	24	2.1	11
	2005	73	200 (inshore)	12	10	64	4.4	15	9	3.6	2
	2006	72	100 (inshore)	16	7	61	4.3	14	11	4.3	3
	2007	187	300	11	4	14	3.0	5	173	10.2	17
	2008	130	300	13	12	25	6.3	4	105	9.0	12
	2009	259	250	21	17	108	6.2	17	151	5.9	25
	2010	189	300	18	9	98	4.6	21	91	5.1	18
	2011	52	300	7	6	50	9.6	5	2	5.5	0
	2012	100	300	13	12	77	6.8	11	23	5.4	4
	2013	63	300	12	9	25	8.1	3	38	10.8	4
	2014	56	100	14	4	41	16.0	3	15	8.1	2
	2015	132	100	4	4	66	7.0	9	66	17.9	4
	2016*	10	100	5	1	10	5.1	2	0	0.0	0
	2000	3,769	--	--	--	2,430	5.3	458	1,339	5.4	248
	2001	5,077	--	--	--	4,157	5.3	784	920	3.8	242
Nuuk-Paamiut	2002	2,531	--	--	--	1,770	2.8	632	761	2.8	272
	2003	2,315	--	--	48	704	3.4	207	1,611	4.2	385
	2004	1,795	--	--	46	129	4.5	29	1,666	8.5	196
	2005	2,295	--	26	44	250	5.6	45	2,045	6.9	296
	2006	1,173	1,800	24	35	192	7.6	25	981	5.8	169
	2007	521	1,600	25	19	110	7.5	15	411	7.3	56
	2008	618	1,600	24	9	194	7.2	27	424	9.1	46
	2009	1,111	700+300	31	22	270	7.5	36	841	7.3	115
	2010	470	1000	22	24	216	6.2	35	254	6.3	40
	2011	595	700	18	20	182	5.3	34	413	9.5	43
	2012	784	700	22	27	329	8.1	41	455	8.5	54
	2013	959	1000	21	18	289	7.4	39	670	5.6	120
	2014	1,111	250+950	23	15	279	7.7	36	833	9.4	89
	2015	1,193	1200	27	15	253	7.8	32	940	10.3	91
	2016*	991	1,200	36	14	139	6.6	21	852	8.7	98
	2000	2	--	--	--	0	--	--	2	--	--
	2001	822	--	--	--	822	--	--	0	--	--
Narsaq-Qaqortoq	2002	643	--	--	--	642	--	--	1	--	--
	2003	133	--	--	12	123	--	--	10	--	--
	2004	34	--	--	10	32	3.9	8	2	1.0	1
	2005	76	--	7	6	76	8.3	9	--	--	--
	2006	--	--	3	--	--	--	--	--	--	--
	2007	--	--	4	--	--	--	--	--	--	--
	2008	--		0	--	--	--	--	--	--	--
	2009	187	?	12	5	187	9.2	20	--	--	--
	2010	326	450	15	7	319	6.8	47	7	8.7	1
	2011	465	430	8	8	464	6.9	67	1	4.8	0
	2012	268	430	8	6	266	5.9	45	2	6.2	0
	2013	104	430	7	5	104	7.8	13	0.2	5.2	0.04
	2014	31	200	5	3	31	11.6	2.7	--	--	--
	2015	--	200	4	0	--	--	--	--	--	--
	2016*	--	200	3	0	--	--	--	--	--	--

5.13 Canadian stock of Snow crab (*Chionoecetes opilio*)

The Atlantic Canada snow crab presented at the 2016 as well as over the past three years have directly addressed ToRs A, D, and E. Data on fishery and survey statistics have been presented (ToR A). Information on the impact of climate on crab productivity has been presented (ToR D). Finally, studies revealing novel information on snow crab behaviour and life history attributes including ocean climate effects on stage-specific distribution and growth as well as migration behaviour have been presented (ToRS D and E).

6 Summary of Working Group self-evaluation and conclusions

OUTCOME

- The WGCRAB have to update and provide data and knowledge on landings, fisheries and biology of the important crab and lobster stocks in the ICES area. In addition, essential objectives has furthermore been to discuss important crab and lobster stocks and to identify gaps in assessment programs and review application of biological and management reference points for crab fishery. The WG also reviewed alternative indicators in assessment of crab stocks without fishery independent data. See interim report from WGCRAB 2014.

PAPER OUTCOME

- For snow crab a draft manuscript entitled 'Dynamics of Snow Crab (*Chionoecetes opilio*) Movement and Migration Along the Newfoundland and Labrador and Eastern Barents Sea Continental Shelves' was presented in 2016. The manuscript had been submitted for primary publication prior to meeting. The manuscript was collaboratively developed by Canadian and Russian members of the working group.
- Haig J., Bakke Snorre., Bell M.C., Bloor I.S.M., Cohen M., Coleman M., Dignan S., Kaiser M.J., Pantin J.R., Roach M., Salomonsen H., Tully O. 2016. Reproductive traits and factors affecting the size at maturity of *Cancer pagurus* across Northern Europe. ICES Journal of Marine Science, doi:10.1093/icesjms/fsw081

METHODS

- Creation of a standard protocol for measuring size at maturity in *Cancer pagurus*.

ASSESSMENT

- For Atlantic Canada and Greenlandic snow crab. We have our own advisory processes.

ASSESSMENT METHODS/ FUTURE PLANS

- The WG decided to continue reviewing prospects for future assessment, advice including data availability, assessment methods and research on the biology of crab and lobster. The group agreed to make progress in evaluating assessment methods, sharing new knowledge of the species and working toward collaborating projects.

- It is a general agreement among the Group members that the annual meeting is of great value for each member, both to sum up the development in the different regional crab fisheries, and as a forum to discuss challenges in the management of the fisheries. WGCRAB is also a suitable arena for discussing particular issues on crab and lobster biology which is important since specialists working with the assessment on those species are mostly single scientists in this field at the different national institutions. Despite a limited number of attendants at the recent meetings, all members of the Group are enthusiastic to continue the work within the Group through annual meetings.
- AnnDorte Burmeister (Chair: 2014–2016) is stepping down.

  Martial Laurans, France, was elected as new Chair for 2017–2019.
- The WGCRAB next meeting will be held in Brest, France, 7–9 November 2017.

Annex 1: List of participants

Name	Address	Phone/Fax	Email
AnnDorte Burmeister (Chair)	Greenland Institute of Natural resources, Nuuk, Greenland	+299 361201	anndorte@natur.gl
Darrell R. Mullowney	DFO, ST Johns, Newfoundland, Canada		Darrell.Mullowney@dfo-mpo.gc.ca
Martial Laurans	IFREMER, Brest, France		martial.laurans@ifremer.fr
Rosana Ourens	Cefas, Lowestoft, UK		rosana.ourens@cefas.co.uk
Vladimir Laptikhovsky	Cefas, Lowestoft, UK		vladimir.laptikhovsky@cefas.co.uk
Ann Merethe Hjelset	Institute of Marine Research, Tromsø, Norway	+ 47 7760 9740	ann.merete.hjelset@imr.no
Carlos Mesquita	Marine Scotland Science	+ 44 1224295684	c.mesquita@marlab.ac.uk
Tanja Miethe (Guest)	Marine Scotland Science		
Jack Emmerson	Bangor, Uk		j.emmerson@bangor.ac.uk
Matthew Colemann	Orkney Sustainable Fisheries Ltd		matt@orkneysustainablefisheries.co.uk
Elisabete Rodrigues (guest)	Orkney Sustainable Fisheries Ltd		
Sarah Clake	Marine Institute, Ireland	+353 (0)91387200	Sarah.Clarke@Marine.ie
Guldborg Søvik	Institute of Marine Research Bergen Norway	+ 47 55 23 85 39	guldborg.soevik@imr.no
Ann-Lisbeth Agnalt	Institute of Marine Research Bergen Norway		Ann-lisbeth.agnalt@imr.no
Snorre Bakke (Guest)	Møreforsking Marin Ålesund Norge	+47 70 11 16	snorre@mfaa.no
Maria Pan (Guest)	Institute of Marine Norway		

Annex 2: WGCRAB Self-evaluation

1) Working Group name: **WGCRAB**

2) Year of appointment: **2014**

3) Current Chair: AnnDorte Burmeister (2014–2016)

4) Venues, dates and number of participants per meeting:

2014: Tromso, 22–24 April 2014 (11 participants)

2015: Brest, 3–5 November 2015 (12 participants)

2016: Aberdeen, 1–3 November 2017 (16 participants)

WG Self-Evaluation

5) If applicable, please indicate the research priorities (and sub priorities) of the Science Plan to which the WG make a significant contribution.

- WGCRAB does not have any research priorities as such but is agreed upon modelling data in an effort to give advice on the various North Atlantic crab stocks
- WGCRAB wich to use the data collected to perform population assessments (data-limited assessments).
- The group contribute to the goal 2 of the science plan ("GOAL 2 - Understand the relationship between human activities and marine ecosystems, estimate pressures and impacts, and develop science-based, sustainable pathways", by providing valuable information through discussion and dissemination of recent results.

6) In bullet form, highlight the main outcomes and achievements of the WG since their last evaluation. Outcomes including publications, advisory products, modelling outputs, methodological developments, etc. *

- For most WGCRAB members, the species of interest in this WG are brown crab and European lobster. However also, work of other crab species such as spider crab, snow crab and king crab is also og interests. Through annual meetings it has been possible to report and discuss with international experts on issues regarding fisheries data, biology, assessment methods, climate change and ecosystem impact on the main crab and lobster species in the countries participating in the WG.
- Irish representatives that have attended WGCRAB are due to attend a focus group meeting held by North Western Waters Advisory Council in late February/early March to inform the group in relation to stock areas that are defined around the North Western Waters area and in relation to data limited stocks and what can be put in place to improve data collection of these stocks.

- Presented work on methodologies being developed for harvest control rules using length-based indicators applied to crustaceans.
- Presented the methodologies and results of the latest MSS stock assessments for brown crab and lobster using the latest available data.
- Work by some members has begun to trial various models in an effort to get a handle on the status of the various North Atlantic Crab stocks.
- Work presented on estimating size at maturity of brown crab in Scottish waters.
- Presented work on using VMS to estimate effort in crab fisheries.
- Move towards standardised protocol for maturity assessment of Brown Crab
- Progress in ageing techniques of brown crab and lobster.
- Progress on developing a standardised catch-profile protocol (science pots etc).
- Paper: Haig, J. A., S. Bakke, M. C. Bell, I. S. M. Bloor, M. Cohen, M. Coleman, S. Dignan, M. J. Kaiser, J. R. Pantin, M. Roach, H. Salomonsen and O. Tully (2016). "Reproductive traits and factors affecting the size at maturity of *Cancer pagurus* across Northern Europe." ICES Journal of Marine Science: Journal du Conseil. The mentioned paper was a result from a trans-nationational cooperation several members of the ICES WGCRAB group participated.

7) Has the WG contributed to Advisory needs? If so, please list when, to whom, and what was the essence of the advice.

- This Working Group does not produce any advice on the included species. However, it has been agreed that the WG will continue to discuss and evaluate assessment methodologies, the use of indicators and reference points for management.

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.

- EFF funded research on brown crab maturity trial (Haig *et al*., 2016).

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

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. Specifically to apply Data Limited Methods being developed by WKLife to Crab stocks and to identify data requirements for a range of DLM approaches.
- Yes. Brown crab & lobster in particular are poorly understood in terms of stock boundaries and assessment methods. Scientific cooperation and communication in WG forum is essential going forward.
- Yes. Crab stocks represent important resources and further work in developing assessment methods/tools for these stocks is important.
- As few people are involved in crab work in the different national labs, WGCRAB serves an important function as a yearly meeting place for exchanging results and discussing new methods etc.

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?

- If the WG is ever to move towards advisory work, numerical expertise will be required to evaluate stock assessment outcomes and methodologies.
- Membership should include ICES stock assessment scientists familiar with DLM (Data limited stock assessment methods)

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)

- Movement data with reference to stock assessment units.

Annex 3: WGCRAB draft MA terms of reference 2017–2019

The **Working Group on the Biology and Life History of Crabs** (WGCRAB), chaired by Martial Laurans*, France, will work on ToRs and generate deliverables as listed in the table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2017	7–9 November	Brest, France	Interim report by 15 December 2017 to SSGEPD	
Year 2018			Interim report by Date Month to SSGEPD	
Year 2019			Final report by Date Month to SCICOM	

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Compile data on landings, discards, effort and catch rates (CPUE) and provide standardised CPUE, size frequency and research survey data for the important crab and lobster (Homarus) fisheries in the ICES area, and Atlantic Canada and Greenland.	The fisheries for crabs and lobster are socio-economically important and trans-national in Europe and Canada with the demise of fin fisheries in some regions.	10,13, 14, 25, 26, 30, 31	3 years	Landing, discard, effort and catch data on listed species, from each country. WG report chapter
b	Evaluate assessment of the status of crab and lobster (Homarus) stocks including use of indicators, empirical assessment, analytical assessment in relation to data sources and data quality, development and suitability of reference points for management.	Management of stocks in Europe is primarily by technical measures only and in most countries there are generally no management instruments to control fishing effort. Knowledge of the population dynamics of these species is still weak. These stocks may be at risk from over-fishing due to the lack of control of fishing effort, and hence an evaluation of the sustainability of these fisheries is necessary.	13, 14, 15,16,19	3 years	Report on evaluation of alternative assessment methods.
d	Review the impact of climate divers on important crab and lobster species within the ICES, Atlantic Canada and West Greenland, including increased ocean acidification;	WGCRAB will investigate the relative importance of fishing and environment on crab and lobster recruitment. Furthermore there is a growing concern in the WG about the consequences of future climate change for important crab species in our region. Observed increases in sea water temperatures have already entailed expanded	3, 4, 6	3 years	Highlight important issues to be basis for research on effect of climate changes on important crab stocks. WG report chapter (2019)

		distribution areas of some species in the northeast Atlantic. However, a rise in the seawater pH would probably be the most serious consequences of the climate change on crustaceans such as crabs. These issues will be dealt with by the WGCRAB in future.		
e	Review research and new knowledge on vital crab and lobster population biology parameters;	Several stock parameters are important for analytical assessments. Biological information is therefore required to provide standardised indices and for use in analytical assessments. Crab stock parameters may change due to size selective and single sex fisheries, through by-catch in other fisheries or through the impact of other seabed uses, such as gravel extraction. Since important crab stocks in Europe are managed without fishery independent data it may be an option to investigate any useful stock parameter indicators for assessment purposes.	3, 4, 19, 20, 21	Updated knowledge on crucial stock parameters for important crab stocks.

Summary of the Work Plan

Year 1	Annual standard outputs for a, b. Continue analysis for ToR d, e. Tentative plan for ToR c.
Year 2	Annual standard outputs for a, b. Continue analysis for ToR d, e. Complete evaluation of useful assessment methods to assess crab and lobster species in ICES areas. Complete request to ACOM and SCICOM (being both an assessment, advice and working group).
Year 3	Annual standard outputs for a, b. Combine analysis, research and report ToR d and e.

Supporting information

Priority	High. The fisheries for crabs and lobster are socio-economically important and trans-national in Europe and Canada with the demise of fin fisheries in some regions. Management of stocks in Europe is primarily by technical measures only and in most countries there are generally no management instruments to control fishing effort. Knowledge of the population dynamics of these species is still weak. These stocks may be at risk from over-fishing due to the lack of control on fishing effort, and hence an evaluation of the sustainability of these fisheries is necessary. The activity of the Group is therefore considered to be of high priority in particular if it's activity can move towards resource assessment without losing biological inputs.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible..

Participants	The Group is normally attended by some 10–15 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages today, but if the EG will produce stock assessments in future WGCRAB will have linkages to several EGs under ACOM.
Linkages to other committees or groups	The EG aims to be able to give advises on how to exploit important crab stocks in the ICES area and is therefore related to EGs such as WGCRAN and the ICES/NAFO NIPAG.
Linkages to other organizations	

Annex 4: Updated tables – fishery and survey data

Table 1a. Stock summary for *Cancer pagurus* in England, Scotland, Ireland, France and Norway.

Cancer pagurus						
	Ireland	**Scotland**	**England**	**Jersey Channel Islands**	**France**	**Norway**
Number of stocks in which national fleet is active	4	12	6	1		1
Stock areas (cross reference to map)	Malin	Clyde	Central North Sea	Western Channel	Eastern Channel	Whole Norwegian coast, Swedish border to Troms
	SW Ireland	East Coast	Southern North Sea		Western Channel	
	SE Ireland/Celtic Sea	Hebrides	Eastern Channel		Celtic Sea	
	Irish Sea	Mallaig	Western Channel			
		North Coast	Celtic Sea			
		Orkney				
		Papa				
		Shetland				
		South East				
		South Minch				
		Sule				
		Ullapool				
Indicator			Irish Sea			
Landings	1990-2015	1974-2014	1983-2013	1996-2014	1985-2014	1914-2014
Effort	1990-2015		1983-2013	1996-2015	1985-2014	
LPUE	1990-2015		1983-2013	1996-2016	1985-2014	2001-2014
DPUE	1990-2015		No		No	2001-2014
Size frequency data	1990-2015	1974-2014	1983-2013 (for most assessement units)	2004-2014	2000-2014	2001-2014
Others						
Analytical assessment methods						No
LCA	No	Yes	Yes (length based VPA excluding Irish Sea)	No	No	No
Production	No	No		No	One test	No
Change in ratio	No	Yes		Yes		No
Depletion methods	No	No		No		No
Others			LPUE selected logbook vessels		Index LPUE from selected logbook vessels	No
Data sources						
Surveys			1989 (EC & WA), 1993 (NS) + Various non targeted		No	No
Larval	2002	No				
Juvenile index /biomass	Index	No				
Adult index/biomass	Biomass	No				
Non target surveys	Scallop dredge	Scallop dredge				
Commercial						
Observer/self reporting/reference fleet	Observer/ref fleet	Observer	Selected logbook vessels from 1985		Selected logbook vessels from 1985	reference fleet
Size frequency data	Yes	Yes	Yes	No	Yes	Yes
Logbooks	Yes	Yes (EU logbooks)	Yes	Yes	Yes	Yes
Tag returns	Yes	Yes	Yes	No	Yes	No
VMS	Yes	Yes (boats > 12m)	Yes (Commercial inconfidence)	No	Yes (Commercial inconfidence)	No
Electronic logbooks	No	No	No	No	From 2013	No
Others					National logbooks for vessels under 12 m	
Biological parameters						
M	0.2	0.1	0.1 and 0.2 assumed feasible scenarios	No	0.2	No
Growth data	k = 0.1-0.2	.97 ; $Linf_m$=220; K_f=0.172 ; Lin	k=0.191 (female), 0.196 (male). Linf 240mm CW	No	0.1-0.2	No
Fecundity			a=0.0187 and b=0.0268, $f=ae^{bl}$	No		No
Size at maturity	125 - 140	130 - 150	Regional 89-105 (male), 110-126 (female)	No	130 for female, less for male	Females: L50 112 (mature), external roe: 130 mm or larger
Others		Terminal F=0.5				
Analytical assessment outputs						
Biomass	Yes	Yes	Yes	No	No	No
Spawning stock	No	No	Yes	No	No	No
Recruitment	No	No	No	No	No	No
Fishing mortality	Yes	Yes	Yes	No	No	No

Table 1b. Stock summary for *Chionoecetes opilio* in Canada, France, Greenland, Norway and Russia.

Chionoecetes opilio						
	Canada - Newfoundland	**Canada Southern Gulf**	**Greenland**	**Norway**	**Russia**	**France**
Number of stocks in which national fleet is active		4	6			
Stock areas (cross reference to map)	NAFO 2H, 2J, 3K, 3L, 3N, 3O, 3Ps, 4R	Eastern Canada, Southern Gulf of St., Lawrence	West coast	Barents Sea	Barents Sea	3PS
Indicator						
Landings	1979-2014	1979-2014	1996 - 2015	2013-	2013-2014	1996-2014
Effort	1979-2014	1979-2014	2003 - 2015	No	2013-2014	1996-2014
LPUE/CPUE	1979-2014	1985-2014	2000 - 2015	No	2013-2014	1996-2014
DPUE		Not estimated but possible to do				
Size frequency data	1979-2014	1989-2014	1997 - 2016	2004-	2004-2014	Yes, few data
Others	1979-2014	1989-2014	1997 - 2016		2004-2014	
Analytical assessment methods						
LCA	No	No	No			No
Production	Yes	No	No		Yes	No
Change in ratio	No	No	Yes			Yes
Depletion methods	Yes	Yes 1985-1989	No			No
Others	Stratified Random Biomass Estimatation	Yes 1989-2014 (Trawl survey)	Yes		Yes 2004-2014 (Trawl survey)	Yes
Data sources						
Surveys		Yes 1989-2014 (Trawl survey)	Yes 1997 - 2016		Yes 2004-2014	No
Larval	No	Sporadically	No	No	No	No
Juvenile index /biomass	Yes	Yes (Abudance estimates)	Index	No	Yes	Index
Adult index/biomass	Yes	Yes (abundance & Biomass estimates)	index	No	Yes	Index
Non target surveys	Yes	September groundfish trawl survey		No	Yes	
Commercial						
Observer/self reporting/reference fleet	Yes	At sea observer at the cxoverage of approximately 20% of total sea days	Fleet	No	Yes	Yes
Size frequency data	Yes	Yes	No	No	Yes	Yes, few data
Logbooks	Yes	Yes	Yes	No	No	Yes
Tag returns	Yes	Between 1985 and 2000	Yes	No	No	No
VMS	Yes	Yes	No	No	Yes	No
Electronic logbooks	No	No	No	No	Yes	No
Others	Dockside Monitored Landings					
Biological parameters						
M	Yes	0.47 (2013)	0.2	No	No	No
Growth data	Yes	Yes	Yes	No	Yes	No
Fecundity	Yes	Yes (until 2010)	Yes	No	Yes	No
Size at maturity	Yes		52 - 150 mm CW	No	Yes	No
Others	Environment (Temperature)					
Analytical assessment outputs						
Biomass	Yes	Yes	Yes		No	No
Spawning stock	No	Yes			No	No
Recruitment	Yes	Yes	Yes		No	No
Fishing mortality	Yes	Yes			No	No

Table 1c. Stock summary for *Paralithodes camtcshaticus* in Norway and Russia.

Paralithodes camtschaticus

	Norway	Russia
Number of stocks in which national fleet is active		
Stock areas (cross reference to map)	ICES Aera 03	ICES Area Ib Russian coast of South-East of Barents Sea
Indicator		
Landings	1994-2015	1994-2014
Effort	1994-2015	1994-2014
LPUE		1994-2014
DPUE		
Size frequency data	Yes	Yes
Others		
Analytical assessment methods		
LCA		
Production	2011-2015	
Change in ratio		
Depletion methods		2010-2014
Others		CSA (2006-2013)
Data sources		
Surveys		
Larval		
Juvenile index /biomass		Yes
Adult index/biomass	Annual	Yes
Non target surveys		Yes
Commercial		
Observer/self reporting/reference fleet		Yes
Size frequency data		Yes
Logbooks	Yes	No
Tag returns		Yes
VMS	Yes	Yes
Electronic logbooks	No	Yes
Others		
Biological parameters		
M	0.2	0.08961
Growth data	Increment and moulting frequency	Yes
Fecundity	Yes	Yes
Size at maturity	Yes	Yes
Others		
Analytical assessment outputs		
Biomass	Yes	Yes
Spawning stock	Yes	No
Recruitment	Yes	Yes
Fishing mortality	Yes	Yes

Table 1d. Stock summary for *Maja brachdactyla* in England, Scotland, France, Ireland and Jersey Channel Islands.

Maja brachdactyla					
	England	**Scotland**	**France**	**Ireland**	**Jersey Channel Islands**
Number of stocks in which national fleet is active				2	1
Stock areas (cross reference to map)				SW Ireland	Western Channel
				Malin	
Indicator					
Landings	1983-2013	2006-2013	1973-2014	2004-2015	1996-2014
Effort	Targetted potting and netting effort not available	No	Targetted potting and netting effort not available	No	1996-2015
LPUE	No	No	No	No	1996-2016
DPUE	No	No	No	No	
Size frequency data	Yes. At least recent i.e. 2004-2013 maybe much longer series	No	Few data from some periods	Data from some target studies, 1985, 2000, 2003-2007 and 2009	2004-2014
Others	No	No		No	
Analytical assessment methods					
LCA	No	No	No	No	No
Production	No	No	No	No	No
Change in ratio	No	No	No	No	Yes
Depletion methods	No	No	No	No	No
Others	No	No	No	No	no
Data sources					
Surveys			Yes (1986-1996)	Yes (1985, 2003 & 2009)	
Larval	No	No		No	
Juvenile index /biomass	Possibly	No	No	No	
Adult index/biomass			Yes		yes 2004-214
Non target surveys					
Commercial					
Observer/self reporting/reference fleet	No	No	No	Data for some years; 2003 & 2009	No
Size frequency data	Yes	No	Few data from some periods	Data for some years; 2003 & 2009	No
Logbooks	No	No	Yes	Yes from reference fleet	Yes
Tag returns	No	No	No	No	No
VMS	No	No	Yes	Yes (2005 - 2007)	No
Electronic logbooks	No	No	For some vessels	No	No
Others	No	No		No	No
Biological parameters					
M			No	No	No
Growth data			No	No	No
Fecundity			No	No	No
Size at maturity			No	No	No
Others					No
Analytical assessment outputs					No
Biomass	No	No	No	No	No
Spawning stock	No	No	No	No	No
Recruitment	No	No	No	No	No
Fishing mortality	No	No	No	No	No

Table 1e. Stock summary for *Homarus gammarus* in Scotland, France, Ireland, Jersey Channel Islands and England.

Homarus					
	Scotland	**France**	**Ireland**	**Jersey Channel Islands**	**England**
Number of stocks in which national fleet is active	12		4	1	5
Stock areas (cross reference to map)	Clyde	Western Channe	Malin	Western Channel	Northumberland Durham
	East Coast	Bay of Biscay	SW Ireland		Yorkshire Humber
	Hebrides		SE Ireland		East Anglia
	Mallaig		N Irish Sea		Southeast and South coast
	North Coast				Southwest
	Orkney				
	Papa				
	Shetland				
	South East				
	South Minch				
	Sule				
	Ullapool				
Indicator					
Landings	1974-2014	Yes	1995-2015	1996-2014	1983-2013
Effort		Yes		1996-2015	1983-2013
LPUE		Yes	1995-2004	1996-2016	Yes
DPUE		No			No
Size frequency data	1974-2014	Yes	1995-2015	2004-2014	
Others					
Analytical assessment methods					
LCA	Yes	Yes	No	No	Yes (length based VPA)
Production	No	Yes	No	No	No
Change in ratio	Yes	No	No	Yes	No
Depletion methods	No	No	No	No	
Others			EPR assessment	Index LPUE from selected logbook vessels	LPUE selected logbook vessels
Data sources					
Surveys		No			
Larval	No	No	No		No
Juvenile index/biomass	No	one test in 2015	No	Yes Index and CL (2 per year, very small - 180 pot lifts)	No
Adult index/biomass	No	No	No	Yes Index and CL (2 per year, very small - 180 pot lifts)	No
Non target surveys	No		No		No
Commercial					
Observer/self reporting/reference fleet	Observer	Yes	Yes	ref fleet	Selected logbook vessels from 1985
Size frequency data	Yes	Yes	Yes	no	
Logbooks	Yes (EU logbooks)	Yes	Yes (EU & some regional areas for some years)	yes	
Tag returns	No	Yes	Yes	no	
VMS	Yes (boats > 12m)	Few data	Yes (boats > 12m)	no	Yes
Electronic logbooks	No	No	No	no	No
Others				1 off volunteer survey of CL and berried proportions	
Biological parameters					
M	0.1	0.2	0.1-0.2	No	0.15
Growth data	K_m=0.11 ; $Linf_m$=173.4; K_f=0.13 ; $Linf_f$=150;	k arround 0,25	k=0.12; Linf=172	No	
Fecundity		Yes		No	
Size at maturity	~80 mm	L50, from 93 to 104	L50 95mm	No	
Others	Terminal F=0.5				
Analytical assessment outputs					
Biomass	Yes	Yes from few areas	No	No	Yes
Spawning stock	No	Yes from few areas	No	No	Yes
Recruitment	No	Yes from few areas	No	No	No
Fishing mortality	Yes	Yes from few areas	No	No	Yes

Table 2a. Management measures table for *Cancer pagurus* in England, Scotland, Ireland, Jersey Channel Islands, France and Norway.

Species: *Cancer pagurus*	Legislation and in particular local by laws are continually reviewed. The following may not be current.													
	Central North Sea	Southern North Sea	Eastern Channel	Western Channel	Celtic Sea	Irish Sea	Norwegian coast	Scotland	Eastern Channel	Western Channel	Celtic Sea	Bay of Biscay	Ireland	Jersey, Channel Islands
Management measure	UK	UK	UK	UK	UK	UK	Norway	UK	FR	FR	FR			
Licensing	MSAR/EU	MSAR/EU	MSAR/EU	MSAR/EU	MSAR/EU	MSAR/EU	No	MSAR/EU	Yes	Yes	Yes	Yes	Yes	yes
Limited Entry	Yes for <10m	Yes for <10m	Yes for <10m	Yes for <10m	Yes for <10m	Yes for <10m	No	Yes for <10m	Yes	Yes	Yes	Yes	No	Yes 3-12nm (Granville Bay Treaty Area permit -capped Numbers)
Closed seasons	No	Generally No but regional ban on white footed crab Nov-June	No	No	No	No	No	No	No	No	No	No	No	No
Days at sea	No	No	No	No	?	No	No	No Under EU Regulations the annual fishing effort of UK vessels over 15 m participating in the brown crab fishery is restricted to 702,292 KW days in ICES areas V and VI and 543,366 KW days in ICES are VII.	No	No	No	No	ICES Area V, VI Vessels >15m, are limited to 465,000 kw.days; ICEAS Area VII, Vessels >15m are limited to 40,960kw.days; ICES Area VII (Biologically Sensitive Area), Vessels >10m are limited to 63,198 kw.days	No
Closed areas	No	No	No	No	Lundy	No	No	Fishing with creels is prohibited in certain areas (Article 5 of The Inshore (Prohibition of Fishing Methods) (Scotland) Order 2004).	No	Yes	Lundy	Yes	No	No
Others														Closed area to parlour pots
Minimum size	130mm CW (140mm north of 56N)	115 and 130mm CW	130mm in Southern Bight and 140mm CW	Various/regional 140mm - 150mm(CRH) 140-160mm (CRC)	Various/regional 130mm - 150mm(CRH) 130-160mm (CRC)	Various/regional 130mm - 140mm(CRH) 130-140mm (CRC)	110mm CW Swedish border-59 30 N, 130mm CW northwards	130mm CW 140mm north of 56N 150mm in the Hebrides	140 mm CW	140 mm CW	140 mm CW	130 mm South of 48°	130mm Area VII, Area VI south of 56°N; 140mm Area VIIf, e, d (Channel), Area IV and VI north of 56°N	140mm
Maximum size	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Berried female legislation	Yes	Yes	Yes	Yes	Yes	Yes	No but release	Yes	No	No	No	No	No	
Soft crabs	Yes	Yes	Yes	Yes	Yes	Yes	No but release	Yes	Yes	Yes	Yes	Yes	No	Yes
Single sex fishery	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Claws or parts	Claws <1% by wt. or <75kg for other gears. No parts regional	Claws <1% by wt. or <75kg for other gears. No parts regional	Claws <1% by wt. or <75kg for other gears	Claws <1% by wt. or <75kg for other gears. No parts regional	Claws <1% by wt. or <75kg for other gears. No parts regional	Claws <1% by wt. or <75kg for other gears	Not sufficient information	Claws <1% by wt. or <75kg for other gears. No parts regional	Claws <1% by wt for potters or quotas by fisherman of others gears	Claws <1% by wt for potters or quotas by fisherman of others gears	Claws <1% by wt for potters or quotas by fisherman of others gears	Claws <1% by wt for potters or quotas by fisherman of others gears	Claws <1% of total catch weight	Claws <1% by wt. or <75kg for other gears
Use as bait	Regional	Regional	No	No	No	No	Regional, in whelk fishery	Regional	No	No	No	No	Yes	
Vessel size	Regional <12 and 16m inside 6nm	Regional <16 and 17m	Regional <14 and 17m	Regional <11, 15.24 and 16.46m	Regional <14, 15.2 and 16.46m and 21m	Regional <12, 13.7, 14, 15 and 21m	< 21.35 m inside 4nm	Regional	No	No	No	No	No	In certain zones or areas
Vessel power	No	No	No	No	No	No	No		No	No	No	No	No	In certain zones or areas
VMS	>15m	>15m	>15m	>15m	>15m	>15m	>15m	>12m	>12m	>12m	>12m	>12m	>12m	>12m
Log book returns	Yes	Yes	Yes	Yes	Yes	Yes	≥ 15 m (≥ 12 m in Skagerrak)	Yes	Yes	Yes	Yes	Yes	EU logbooks	Yes
Others							logbooks from reference fleet		National log book for vessel under 12 m	National log book for vessel under 12 m	National log book for vessel under 12 m	National log book for vessel under 12 m	Fishing activity reports for some vessels as part of the Sentinel Vessel Programme	National logbook for under 10m vessels, EC Logbook for over 10m. E logs for over 12m
									National VMS system for some vessels under 12 m	National VMS system for some vessels under 12 m	National VMS system for some vessels under 12 m	National VMS system for some vessels under 12 m		
								No						
Trap limits	Yes	No	Regional	No	No	No	No limits for commercial fishery, max 20 per recreational fisher	No	Yes, Regional and National. Max 1200 traps per vessel and max 250 traps per fisherman.	Yes, Regional and National. Max 1200 traps per vessel and max 250 traps per fisherman.	Yes, Regional and National. Max 1200 traps per vessel and max 250 traps per fisherman.	Yes, Regional and National. Max 1200 traps per vessel and max 250 traps per fisherman.	No	Yes
Trap size	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Entrance size							No	No	yes, minimum of 14 cm diameters	yes, minimum of 14 cm diameters	yes, minimum of 14 cm diameters	yes, minimum of 14 cm diameters	No	Yes
Escape vents	No	Regional and gear specific Yes	Regional and gear specific Yes	Regional and gear specific Yes	Regional and gear specific Yes	Regional	Yes, for lobster, regional	Regional	No	No	No	No	No	Yes
Biodegradable panels	No	No	No	No	No	No	No	No	No	No	No	No	No	no
Marked gear	Regional	Regional	Regional	Regional	Regional	Regional	Yes	Regional	National Regional	National Regional	National Regional	National Regional	No	Yes

Table 2b. Management measures table for *Chionoecetes opilio* in Canada, France, Greenland, Norway and Russia

***Species:* Chionoecetes opilio**						
	West coast of Greenland	Newfoundland	Sourthern Gulf	SouthNova Scotia	Barent Sea	Barents Sea
Management measure	Greenland	Canada	Canada	France, Saint Pierre et Miquelon	Norway	Russia
Licensing	Yes	Yes	Yes	No	Yes	No
Limited Entry	Yes for < 75 Brt	Yes (no new licences available)	Yes	Yes	Yes	No
Closed seasons	No	Yes	Yes	Yes	No	No
Days at sea	No	No	No	Yes	No	No
Closed areas	Yes	Yes	Yes		No	No
Others		Dockside Monitored Landings, Soft-shell protocols, Trip Limits	Soft crab control			
				95 mm CW		
Minimum size	100 mm CW	95mm CW	95mm CW	No	No	No
Maximum size	No	No	No	Yes - prohibation to land females	No	No
Berried female legislation	Yes - prohibation to land females	Yes - prohibation to land females	Yes - prohibation to land females	Yes	No	No
Soft crabs	Yes	Yes	Yes - prohibation to land soft crab	Yes		
Single sex fishery	Yes	Yes	Yes	no	Yes	Yes
Claws or parts	no	no	No	No	No	No
Use as bait	Squid	Squid / Herring	Mackerel, Herring, Squid	Squid	No	Herring
Vessel size	Regional <10m	Various fleet sectors (<40', 40-64'11", 65-89'11")	65 fts or less	No		49.6-54.8 m
Vessel power	No	No	No	No		700-1700 hps
VMS		Yes	Yes	No	Yes	Yes
Log book returns	Yes	Yes	Yes	Yes	Yes	No
Others		Observer Coverage	100% dock side landing monitoring & at-sea observer coverage at approximately 20%			
				Yes		
Trap limits	No	Yes	Yes (the number varies depending on the area from 50 to 150/ licence), Area 19 has total trap number at 1699	No	No	No
Trap size	Yes (meshsize 1400mm)	Yes (135mm)	Yes (volume should not exceed 2 cubic meter) and maximum and minimum mesh sizes at 65 and 75 mm	Yes	No	No
Escape vents	No	No	No but see below	No	No	No
Biodegradable panels	No	Yes	Biodegradable twine	No	No	
Marked gear	Regional / overseas trade	Yes	Yes			

Table 2c. Management measures table for *Paralithodes camtschaticus* in Norway and Russia.

Species: *Paralithodes camtschaticus*		
	Barents Sea	Barents Sea
Management measure	Norway	Russia
Licensing	Yes	Yes
Limited Entry	Yes	Yes
Closed seasons	No	Yes
Days at sea	No	No
Closed areas	No	Yes
Others		
Minimum size	130mm CL	150mm
Maximum size	No	No
Berried female legislation	No	Yes - prohibation to land females
Soft crabs		
Single sex fishery	No	Yes, only males
Claws or parts	No	Sections by different weight
Use as bait	Herring	Herring
Vessel size	6-22 m	49.6-54.8 m
Vessel power		700-1700 hps
VMS	Yes	Yes
Log book returns	Yes	No
Others		
Trap limits	Yes	Yes
Trap size	Yes	Yes
Escape vents	Yes	No
Biodegradable panels	No	Yes
Marked gear	Yes	No

Table 2d. Management measures table for *Maja bracdactyla* in UK and France.

Species: Maja Bracdactyla				
Management measure	UK	France	Ireland	Jersey, Channel Islands
	All			
Management measure	E&W			
Licensing	Yes	Yes	Yes	yes
Limited Entry	<10m	Yes	No	Yes 3-12nm (Granville Bay Treaty Area permit -capped Numbers) No for 0-3nm limit of territorial waters
Closed seasons	No	(September to 15 October)	No	Yes for soft shell
Days at sea	>15m in Celtic Sea	No	ICES Area V, VI Vessels >15m, are limited to 465,000 kw.days; ICEAS Area VII, Vessels >15m are limited to 40,960kw.days; ICES Area VII (Biologically Sensitive Area), Vessels >10m are limited to 63,198 kw.days	No
Closed areas	No	Yes	No	No
Others				Closed area to parlour pots, closed seasonal areas to static nets
Minimum size	120mm CL females; 130mm for males	120 mm CL, male and female	125 mm CL Females; 130mm CL for Males	120mm
Maximum size	No	No	No	No
Berried female legislation	No	No	No	
Soft crabs	No	No	No	Yes
Single sex fishery	No	No	No	No
Others				Must be retained whole
Vessel size	Regional	No	No	In certain zones or areas
Vessel power	No	No	No	In certain zones or areas
VMS	>15m	>12m	>12m	>12m
Log book returns	Yes	Yes	Yes for >12m	Yes
Others		National log book for vessel under 12 m	Sentinel Vessel Programme Data	National logbook for under 10m vessels, EC Logbook for over 10m. E logs for over 12m
Trap limits	Regional	Yes	No	Yes
Trap size	No	No	No	No
Escape vents	Regional and gear specific	No	No	Yes
Biodegradable panels	No	No	No	No
Others	No	yes, minimum of 14 cm diameters	No	
Marked gear	Regional	Yes for pots	No	yes
Gillnet limits		Yes	No	yes
Gillnet mesh		Yes	No	yes

Table 2e. Management measures table for *Homarus gammarus* in England, Scotland, Ireland, Jersey Channel Islands and France.

Species: Lobster						
Management measure	Scotland	France	Norway	Ireland	Jersey, Channel Islands	England
Licensing	MSAR/EU	Yes	No	Yes	Yes	Yes
Limited Entry	Yes for <10m	Yes	No	No	Yes 3-12nm (Granville Bay Treaty Area permit -capped Numbers) No for 0-3nm limit of territorial waters	Yes
Closed seasons	No	No	Yes; 1 30 Nov-30 Sept from Hvaler to Sogn& Fjordane; 1 Jan-30 Sept rest of the country	No	No	No
Days at sea	No	No	No	No	No	No
Closed areas	Fishing with creels is prohibited in certain areas (Article 5 of The Inshore (Prohibition of Fishing Methods) (Scotland) Order 2004).	Yes	Yes; some MPA in some areas	No	No	MCZ restrictions (regional)
Others			Fishing with lobster pots only		Closed area to parlour pots	
Minimum size	87mm CL (all areas except Shetland and Hebrides) 90mm CL (Shetland) 90mm CL (Hebrides)	87 mm CL, male and female	250mm	87mm CL for both sexes	87mm	87mm CL national, 90mm within 6 miles of coast (Devon, Cornwall, Isles of Scilly)
Maximum size	Yes - for famales only 155mm CL 145mm CL (Hebrides)	No	No	127mm CL for both sexes (since Jan 2015)	No	No
Berried female legislation	No	No	Yes	No	Yes but not in effect - has to be brough in by Ministerial Order	Yes (regional)
Soft crabs	No	No	No	No	Yes	Yes
Single sex fishery	No	No	No	No	No	No
Claws or parts	It is illegal to land 'V'-notched lobsters, or animals that have been mutilated in any way. Lobsters can only be retained on board or landed whole.	No	No	It is illegal to land 'V-notched' or mutilated lobster. Lobsters can only be retained on board or landed whole.	Must be retained whole	Limits on percentage/ quanitity caught (regional)
Use as bait	No	No	No	No	Not Lobster	
Vessel size	No	No	No	No	In certain zones or areas	Yes (regional)
Vessel power	No	No	No	No	In certain zones or areas	
VMS	>12m	>12m		>12m	>12m	>12m
Log book returns	Yes	Yes	No	No	Yes	Yes
Others		National log book for vessel under 12 m	Logbooks for fishermen in the reference fleet	Sentinel Vessel Programme data	National logbook for under 10m vessels, EC Logbook for over 10m. E logs for over 12m	
Trap limits	No	Yes	Yes	No	Yes	Yes (regional)
Trap size	No	No	No	No	No	No
Escape vents	No	No	Yes	No	Yes	Yes (regional)
Biodegradable panels	No	No	No	No	No	No
Marked gear	Regional	Yes for pots	Yes	No	Yes	Yes (regional)
Entrance size		yes, rigid and minimum of 14 cm diameters	No	No	Yes- parlours	No
Parlour pot		Regional Legislation	No		Prohibited in some areas	No

Table 3a. Landings (tones) of *Cancer pagurus* in England, Scotland, France, Norway, Ireland and Jersey (UK).

Species: *Cancer pagurus*						
Total catch tons						
Site	England	Scotland	France	Norway	Ireland	Jersey, Channel Islands
Year						
1990		4,282	6,076	1,374		
1991		5,485	5,310	1,462		
1992		4,648	5,583	1,316		
1993		3,820	5,896	1,641		
1994		4,759	6,086	1,781		
1995		6,092	6,823	1,806		
1996		5,528	6,527	1,889		495
1997		7,470	7,000	2,205		523
1998		8,021	6,490	2,984		521
1999		7,437	6,087	2,836		473
2000	12,363	9,650	5,182	2,890		440
2001	13,013	8,458	5,513	3,478		447
2002	11,973	7,874	5,963	4,344		524
2003	13,349	7,525	6,327	4,944		540
2004	10,825	6,761	7,813	5,248	11,662	541
2005	8,484	8,332	6,259	5,671	7,911	438
2006	11,043	10,430	5,423	6,205	8,779	349
2007	12,074	11,919	6,178	8,514	6,486	412
2008	11,697	9,336	6,416	5,295	6,737	481
2009	11,001	9,466	4,353	4,970	10,934	361
2010	11,902	10,857	5,487	5,774	11,394	409
2011	12,089	11,859	5,690	5,319	6,964	434
2012	13,844	10,892	5,990	4,981	6,195	474
2013	13,804	10,890	5,570	5,242	5,755	358
2014	16,330	12,298	5901	4,629	5,859	
2015	14,249	11,089	4,500		6,078	
2016						

Table 3b. Landings (tones) of *Chionoecetes opilio* in Canada, Greenland, Norway and Russia.

Species: *Chionoecetes opilio*		Chionoecetes opilio			
Total catch tons					
Site	Canada	Greenland	Norway	Russia	France
Year					
1990	26,233				
1991	35,295				
1992	37,232				
1993	47,819				
1994	60,662				
1995	65,505	997			
1996	65,505	563			189
1997	71,388	3,214			368
1998	75,236	2,094			354
1999	95,381	4,982			589
2000	93,411	10,521			550
2001	95,241	15,139			485
2002	106,547	11,174			139
2003	96,360	7,179			83
2004	102,776	6,295			159
2005	95,996	4,213			157
2006	89,271	3,305			191
2007	90,280	2,189			166
2008	93,166	2,354			123
2009	96,635	3,191			169
2010	83,393	2,363			236
2011	83,979	2,015			242
2012	93,090	1,983			325
2013	98,089	2,162	189	62	251
2014	96,310	2,157	1,850	3,100*	100
2015	95,910	2,021	4300'		28
2016		1,506	4600**		
*provisional					
Only Norwegian vessels					
** Only Norwegian vessels and per 14th of November					

Table 3c. Landings (tones) of *Paralithodes camtschaticus* in Norway and Russia.

Species: Paralithodes camtschaticus			
Total catch tons			
Site	Norway	Russia	
Year			
1990			
1991			
1992			
1993			
1994	11,000	22	
1995	11,000	9	
1996	15,000	24	
1997	15,000	63	
1998	25,000	90	
1999	37,500	143	
2000	37,500	113	
2001	100,000	300	
2002	100,000	900	
2003	200,000	1,950	
2004	280,000	1,105	
2005	280,000	3,021	
2006	300,000	9,389	
2007	300,000	9,953	
2008	596,000	8,823	
2009	1,185	6,142	
2010	900	3,787	
2011	1,200	3,698	
2012	1,000	5,209	
2013	1,000	5,531	
2014	1,100	6,000*	
2015	1,300		
2016			
*provisional			
Norway: 1994-2008: Number of individuals			

Table 3c. Landings (tones) of *Maja brachdactyla* in France, Ireland, Scotland and Jersey (UK).

Species: *Maja Brachdactyla*					
Total catch tons					
Site	France	Ireland	Scotland	Jersey, Channel Islands	England
Year					
1990					
1991					
1992					
1993					
1994					
1995					
1996				383	
1997				162	
1998				160	
1999				175	
2000	3515.0			172	1.01
2001	3892.0			236	1.20
2002	4,219			270	1.17
2003	4,499			233	1.03
2004	4,354	180		223	0.62
2005	4,286	141		163	0.49
2006	4,662	153	0.7	129	1.57
2007	4,697	70	0.1	106	1.45
2008	4,540	153	3.1	179	1.03
2009	4,717	443	6.0	177	0.85
2010	4,220	415	3.1	173	0.77
2011	4,033	290	1.2	144	0.95
2012	3,549	818	1.7	108	0.89
2013	4,026	229	0.2	77	0.52
2014	4,705	140			0.44
2015	4,650	190			0.38
2016					

Table 3d. Landings (tones) of *Homarus gammarus* in England, Scotland, Ireland, France and Jersey (UK).

Species: Lobster						
Total catch tons						
Site	England	Scotland	Ireland	France	Jersey, Channel Islands	Norway
Year						
1990		769				33
1991		687				31
1992		513				28
1993		369				28
1994		457				30
1995		565				34
1996		453			164	30
1997		653			166	35
1998		638			157	45
1999		509			153	59
2000	786	411		191	128	52
2001	776	289		180	130	40
2002	832	341		294	157	42
2003	1,008	353		348	167	52
2004	921	404	853	339	167	52
2005	910	409	635	324	139	58
2006	1,587	711	625	388	131	62
2007	1,700	890	308	475	155	57
2008	1,695	915	498	444	163	44
2009	1,640	953	431	329	177	50
2010	1,531	1,100	477	863	225	59
2011	1,845	1,219	735	802	257	58
2012	1,888	1,132	249	535	237	62
2013	1,821	1,026	374	465	198	58
2014	2,019	1,208	456	654		42
2015	1,885	1,042	371	544		46
2016						