



Edible crab (*Cancer pagurus*)

Cefas Stock Status Report 2014.

The Shellfish Team
2014

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Cefas Document Control

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Cefas Stock Status report 2014: Edible crab (*Cancer pagurus*)

Background

Cefas has published reports describing the status of the edible crab (*Cancer pagurus*) stocks around the UK since 2012. It is planned to re-run the assessment every 2 years. This report details the main findings of the assessments and provides background information describing how the assessments are undertaken, the data that are required, and description of the uncertainties associated with these assessments.

Biology

Edible crab can be found from Scandinavia to Portugal. Stock boundaries for edible crab remain poorly understood and both sexes move quite widely at times; females in particular have been shown to travel large distances in relation to spawning activity. Egg carrying females are largely inactive over the winter brooding period but the eggs hatch in the spring and summer. After around five weeks in the plankton, the crab larvae settle on the seabed. Growth is dependent on the frequency of moulting as well as the increase in size on each moulting occasion and it typically takes about four or five years for a juvenile crab to grow to commercial size. Mating activity peaks in the summer when the female has moulted with spawning occurring in the late autumn or winter.

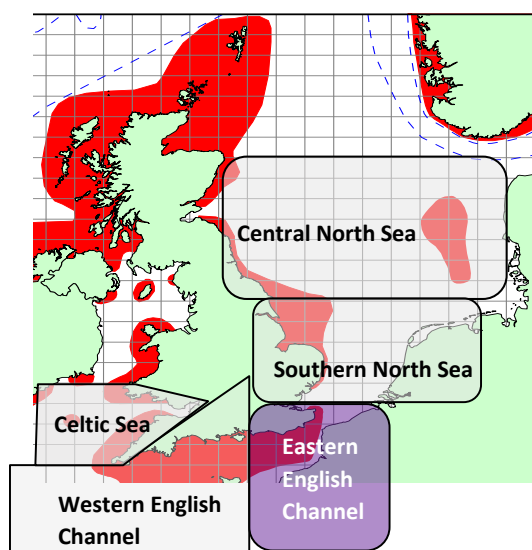


Figure 1. – The CFU's used for the assessment regions. The CFU in purple did not have sufficient data for an assessment in 2014.

Fishery Unit Definitions

There are five Crab Fishery Units (CFU) that have been defined for England. These units are based upon the understanding of larval distributions and development, hydrographic conditions and distribution of the fisheries. Each CFU encompasses waters covered by International, National and local legislation which may be different within each region. For this round of assessments Cefas only had sufficient data to successfully cover four of the CFU's. Those CFU's are presented in Figure 1.

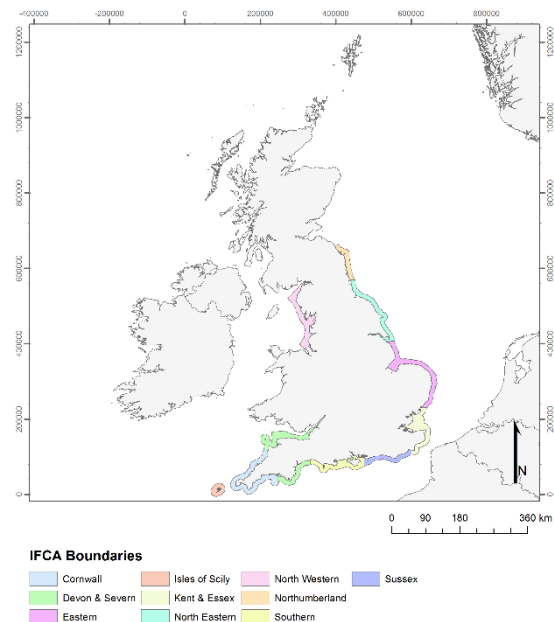


Figure 2. – The IFCA boundaries.

Fishery management jurisdiction is organised on two different scales around England. Beyond 6 nautical miles, Defra and the MMO are responsible for managing crab fisheries whereas from the coast out to 6 nautical miles, responsibility lies with the Inshore Fisheries and Conservation Authorities (IFCAs). There are 10 IFCAs within England, and their regions extend from the coast out to 6nm (see Figure 2). It is obvious that the CFU and IFCA boundaries do not match, which can make interpretation of the results for each management unit challenging. However given that one functional area is based on species biology and the other is based on governmental logistics, differences between boundaries are to be expected.

Data sources used

Landings come from the official MMO data records and there have been changes in the way the MMO (and its predecessors) have gathered landings data. For larger vessels landings and effort are taken from the mandatory EU logbooks. Prior to 2006, records of landings from smaller vessels (<10m) were gathered by local officers. Since a change in legislation in 2006, sales note returns from merchants are used to support the landings declarations. Between 2006 and 2008, MMO landings data were also supplemented by self-reported records of landings from the Monthly Shellfish Activity Return (MSAR) forms where no sales note had been generated

Fishing effort is derived by MMO from MSARs for <=10m vessels or EU logbooks for >10m vessels. There is no requirement for potting fisheries to record the number of pots being fished, so in this report effort is measured as days fished.

The changes to reporting systems over time have predominantly improved the data quality but mean that landings and effort series cannot be viewed as coherent records through time.

Scientific officers visit ports to measure individual animals from catches and determine the ratio of landings by sex. Samples are also received from IFCA's in some regions, and these length samples are combined with Cefas' and scaled up to represent the total landings of crabs.

Overall Landings trends

Figure 3 presents the total official landings data that is used within the assessments. The data pertains to all English and Welsh vessels landing anywhere, and all landings into England and Wales from any nationality of vessel. It can be seen that the overall landing appear relatively consistent between 2006 until 2011, but have been increasing thereafter.

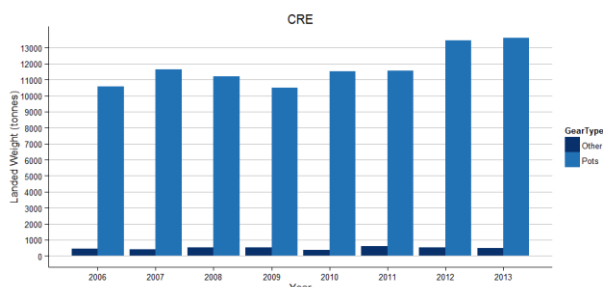


Figure 3 – The official landings for UKE&W.

Figure 4 presents the landings per rectangle for 2013, and Figure 5 presents the average landings per rectangle from 2006 to 2012. These plots show that although the overall landings appear to be increasing, the area from which the animals are being caught is decreasing.

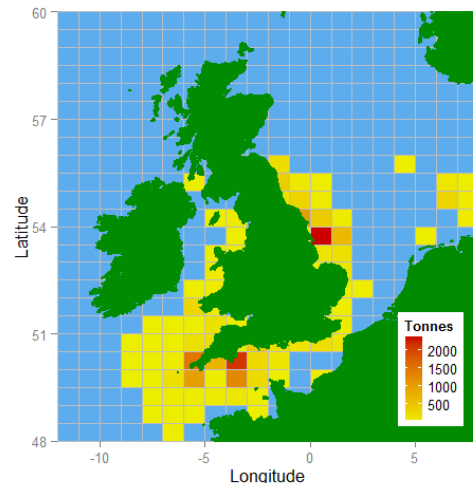


Figure 4 – The landings per ICES rectangle for 2013.

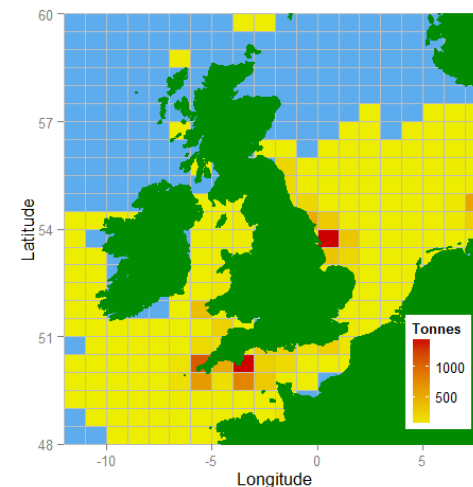


Figure 5 – The average landings per ICES rectangle from 2006 to 2012.

Assessment Methodology

Within European waters, most major stocks are assessed using methods which monitor the change in numbers over time for animals born in a particular year. This is possible because most fin-fish have bony structures which retain annual growth rings. Crustaceans shed their shell each time they moult and do not retain structures that can be easily used to determine their age, so an alternative assessment method has to be employed.

The methodology used in this assessment follows the change in shape of the length-frequency (numbers at length) from one year to the next. As animals get older they grow and die, the interplay of these two vital functions dictating how many animals at a given size there are in the population. Armed with knowledge of the growth rate of animals and the rate of natural death (M) assumed to be 0.2, the shape of the length-frequency curve can be used to infer the rate at which the fishery is removing individuals.

For further details of the Length Cohort Analysis approach see the full stock assessment report.

Reference point definition

A stock assessment result can indicate what the exploitation rate might be and how big the stock might be, but this is of limited use to fishery managers as they try to decide whether these rates are appropriate. The production of reference points aims to give managers benchmarks to see whether the management structure is being effective and whether fishing rates are above or below these points.

Reference points can be determined to achieve a number of different management objectives. For instance managers could simply want to ensure that the fishery was unlikely to collapse the stock, or alternatively managers could want the fishery to derive maximum long-term profit from the stock. Within the European Community framework, the current management objective is to achieve fishing rates likely to deliver Maximum Sustainable Yield (MSY) from fisheries. This means the maximum landings that can be regularly taken without causing stock collapse. For crustacean fisheries scientists cannot directly calculate this rate and so rely upon alternative ways to estimate it.

This assessment uses 35% of virgin Spawner per Recruit (SpR) as the MSY level proxy, and this is commonly used around the world to estimate the fishing rate likely to deliver MSY. A second point termed a limit reference point has also been calculated and having fisheries operating beyond this level is considered to carry higher risk to the production of further generations. This value is defined as 15% of virgin SpR.

Uncertainty

Fishery stock assessments are never perfect and assessment models will never exactly replicate reality. Scientific data collection (in this case landed-numbers at length) are taken from a relatively small number of landings and then scaled up to represent the whole landings, a process which cannot be exactly correct but should be broadly representative of the population as a whole. Not all landings will be recorded as there are exemptions from reporting requirements for small scale fisheries and recreational catches.

An assessment model is an attempt to simplify the real world into a few key structures and functions, so the assumptions made in the process will cause the modelled system to depart from reality. What these fishery stock assessment do is capture the main processes and data streams so that the final estimate of fishing rate and/or stock size is broadly correct. For these assessments the key uncertainties come from:

- the scientific understanding of growth and natural death rates
- the representativeness of the landings used to collect length samples
- the assumptions within the assessment model of
 - a) The population being at equilibrium (constant recruitment).
 - b) The spatial coverage of the population is constant and all size ranges are equally available to the fishery.
 - c) Fishery statistics are complete and accurate.

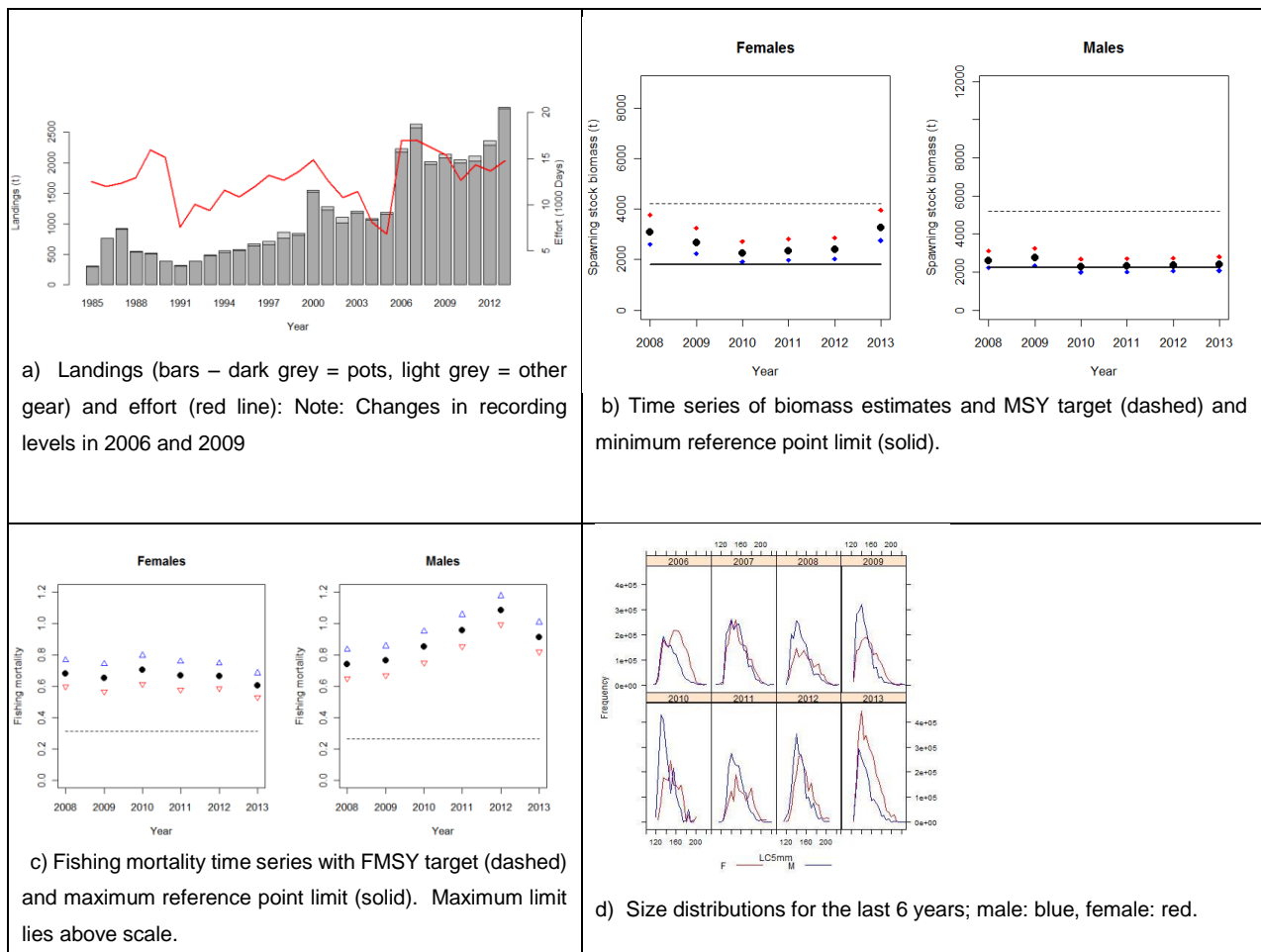
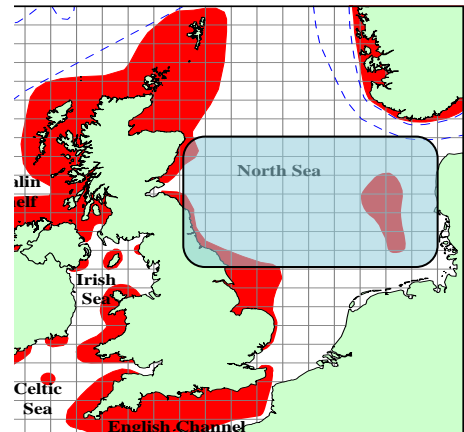
Cefas has a research program which continually searches to improve our understanding of processes governing population dynamics and there are currently projects focussing on growth and mortality rates. We are also working with the MMO to ensure that landings statistics are as complete and accurate as possible, and working with the IFCAs to ensure maximum efficiency and best practice in data collection.

Given the uncertainty in the input data and assessment model it is acknowledged that the precise value of any estimate of fishing mortality of stock size is uncertain but has sufficient reliability to indicate rates on a high-medium-low scale.

Cefas Stock Status 2013: Edible crab (*Cancer pagurus*) in the Central North Sea

Sustainability Status

Minimum Landing Size	At the MLS, around 99% of males and 86% of females should be sexually mature.
Discarding	High discard survival assumed to be > 90%.
Stock size	Around minimum reference point limit for males
Exploitation rate	Moderate, below maximum reference point limit, but recent increasing trend in males is of concern



The status of the stock of Edible Crab in the Central North Sea is low and is around the minimum recommended level. Exploitation level is moderate on females and, although likely to be sustainable is above the level required for Maximum Sustainable Yield. There had been a trend of increasing exploitation rate on males but this may have dropped slightly in recent years. The status of the stock has not changed since the last assessment in 2012.

Sampling levels

Table 2. Sample numbers collected for CNS during the last three years by Cefas, numbers in parenthesis are samples supplied by the IFCAs

Year	Number of crabs	Number of samples	Sampled wt. (kg)
2011	3367	34	1993
2012	5519	60	2998
2013	4604 (2623)	52 (20)	2474 (1737)

Fishery overview and developments

	2011	2012	2013
Fleet size < =10m / 10+ m	152 / 34	148 / 39	160 / 35
Effort (days) < =10m / 10+ m	11712 / 2685	11058 / 2590	12108 / 2443

Reported landings and fishing effort increased substantially following the introduction of Buyers and Sellers legislation and the Restrictive Shellfish License Scheme in 2006. Since this period fishing activity data are thought to be generally more reliable but the integrity of the time series, especially fishing effort, is uncertain.

The exploitation rate on males is estimated to be rising, this will be caused by a lack of larger individuals in the landings and this is mirrored by a decrease in the stock size as overall catches fall.

As well as the more traditional fisheries off Yorkshire and Northumberland a fishery off the Danish coast prosecuted by large nomadic English vessels has developed over the last decade. The fishery in this area has increased in range with the decline of trawling, as operators target grounds beyond 6nm. Increased landings and animal sizes have been noted on the quayside within the NEIFCA district. Some technology creep has occurred as either vessels or hauling equipment has been upgraded to improve efficiency. There has also been some transition to higher capacity vessels operating significant pot numbers. The inshore fishery has seen an increase in pots hauled and pots set across the NEIFCA range. Market systems can influence the landings composition with seasonal restrictions on landing males, females and specific size ranges, in periods associated with poor meat yield.

Fishery Management measures

- EC legislation sets a minimum landing size of 130mm for crabs in the North Sea south of 56°N and 140mm North of 56°N. It also restricts the proportion of the crab landings which is detached claws caught by pots or creels to less than 1% by weight of total catch. A by-catch limit of no more than 75kg per day of crab claws taken by other gear types can be landed.
- National legislation restricts the number of shellfish licences available (in England and Wales) and also prohibits landing of berried and soft crabs.
- Local IFCA legislation varies and is detailed in the table below.

Table 1. Regional byelaws on Central North Sea crab fisheries.

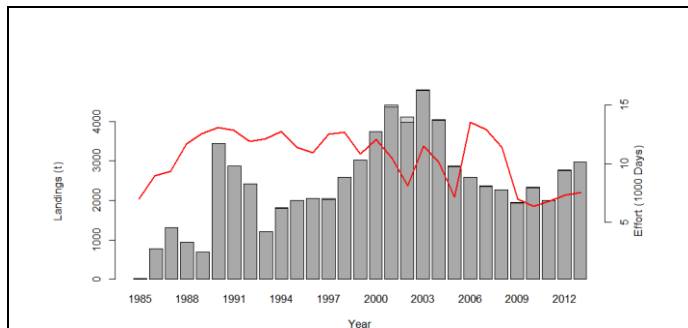
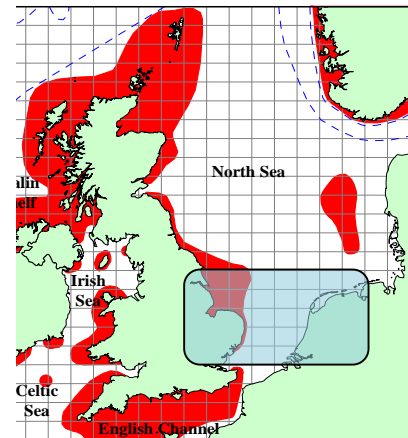
Type of Byelaw	Northumberland IFCA	North Eastern IFCA
Shellfish permits	Yes	Yes*
Minimum Landing Size	No	No
Maximum Pot Limit	Yes - 800	No
Escape Gaps	No	Yes*
Maximum Vessel Length	Yes -12m	Yes - 16m
Towed Gear Restrictions	No	No
Prohibits the Use of Crab for Bait	Yes	Yes
Prohibits the Removal of Parts of Crabs	Yes	Yes

*Only applicable within the previous North Eastern Sea Fisheries Committee District

Cefas Stock Status 2013: Edible crab (*Cancer pagurus*) in the Southern North Sea

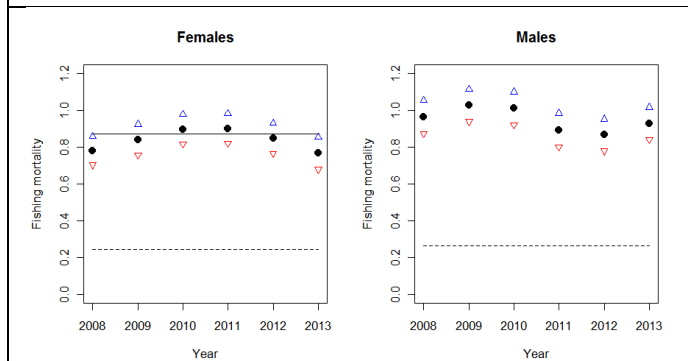
Sustainability Status

Minimum Landing Size	<i>At the MLS's applied in this region around 96-99% of males and 60-86% of females should be sexually mature.</i>
Discarding	<i>High discard survival assumed to be > 90%.</i>
Stock size	<i>Unknown due to changes in recording.</i>
Exploitation rate	<i>Moderate. Very near the maximum reference point limit for females.</i>

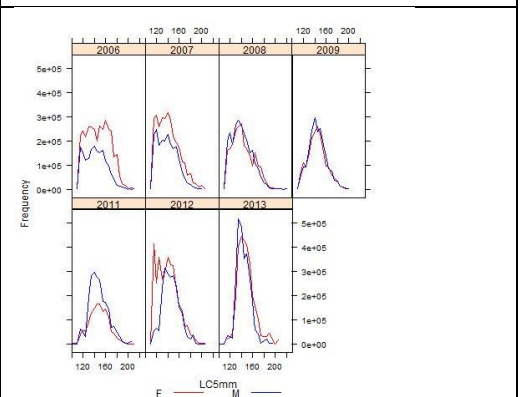


a) Landings (bars – dark grey = pots, light grey = other gear) and effort (red line): **Changes in data entry & recording occurred in 2006 and 2009. The series are inconsistent.**

b) Absolute biomass calculations unreliable due to changes in landings data recording.



c) Fishing mortality time series with FMSY target (dashed) and maximum reference point limit (solid). Maximum reference point limit for males lies outwith the scale.



d) Size distributions for the last 8 years; male: blue, female: red.

The status of the stock of Edible Crab in the Southern North Sea is unknown. Changes in the way landings have been recorded in 2006 and 2009 mean the data are inconsistent and unsuitable for assessment. Calculations of fishing mortalities are unaffected by the issues with landings and mortality rates are high, around the maximum reference point limit for females. The status of the stock has changed since the last assessment in 2012, as the females fishing mortality estimate has dropped below the maximum reference limit.

Sampling levels

Table 2. Sample numbers collected for CNS during the last three years by Cefas, numbers in parenthesis are samples supplied by the IFCA's.

Year	Number of crabs	Number of samples	Sampled wt. (kg)	Number of samples excluded
2011	6371	52	3072	7
2012	5115	43	2344	6
2013	2170 (924)	22 (10)	912 (419)	3 (4)

Fishery overview and developments

	2011	2012	2013
Fleet size < 10m / 10+ m	72 / 29	71 / 28	84 / 33
Effort (days) < 10m / 10+ m	4818 / 2122	5024 / 2284	4993 / 2165

Marked variability in annual reported fishing effort and changes to procedures for acquiring fishing effort have changed over time and integrity of the fishing effort time series is highly uncertain. Landings data since 2009 are missing those landings which did not generate sales notes (as each sale was <25kg). The absence of these landings may be a significant proportion of the true catch.

This stock supports three distinct fisheries, the Holderness fishery off Yorkshire, and two Norfolk fisheries. There are strong seasonal fluctuations in the fisheries with the spring fishery (March – May) seeing the highest catch rates.

The components of the Norfolk fishery are typified by small beach-launched vessels and larger harbour based vessels, the former being much more restricted in their activity by weather. There is a difference in the preferred size of crab by processing division. Big processors have a preference for larger crab (>125mm) during late winter whereas the smaller processors will take all sizes. In spring- early summer there is more demand for MLS (115mm) crab for tourist/day-tripper market (bite size crab). Through the summer, processors tend to take all sizes as the availability of crab reduces (owing to the biology of the animals).

Within the NEIFCA district a large size distribution has been recorded on the quayside with animals over 200mm carapace width not uncommon. Some technology creep has occurred as either vessels or hauling equipment has been upgraded to improve efficiency. There has been considerable upgrading within the fleet with some operators moving towards higher capacity vessels, operating in the more lightly exploited grounds further offshore. Market systems can influence the landings composition with seasonal restrictions on landing males, females and specific size ranges, in periods associated with poor meat yield.

Fishery Management measures

- EC legislation sets a minimum landing size of 130mm for crabs in the North Sea south of 56°N. It also restricts the proportion of the crab landings which is detached claws caught by pots or creels to less than 1% by weight of total catch. A by-catch limit of no more than 75kg per day of crab claws taken by other gear types can be landed.
- National legislation restricts the number of shellfish licences available (in England and Wales) and also prohibits landing of berried and soft crabs.
- A derogation to the EC legislation sets an MLS of 115mm in the Eastern IFCA area. Local IFCA legislation varies and is detailed in the table below.

Table 1. Regional byelaws on Southern North Sea crab fisheries.

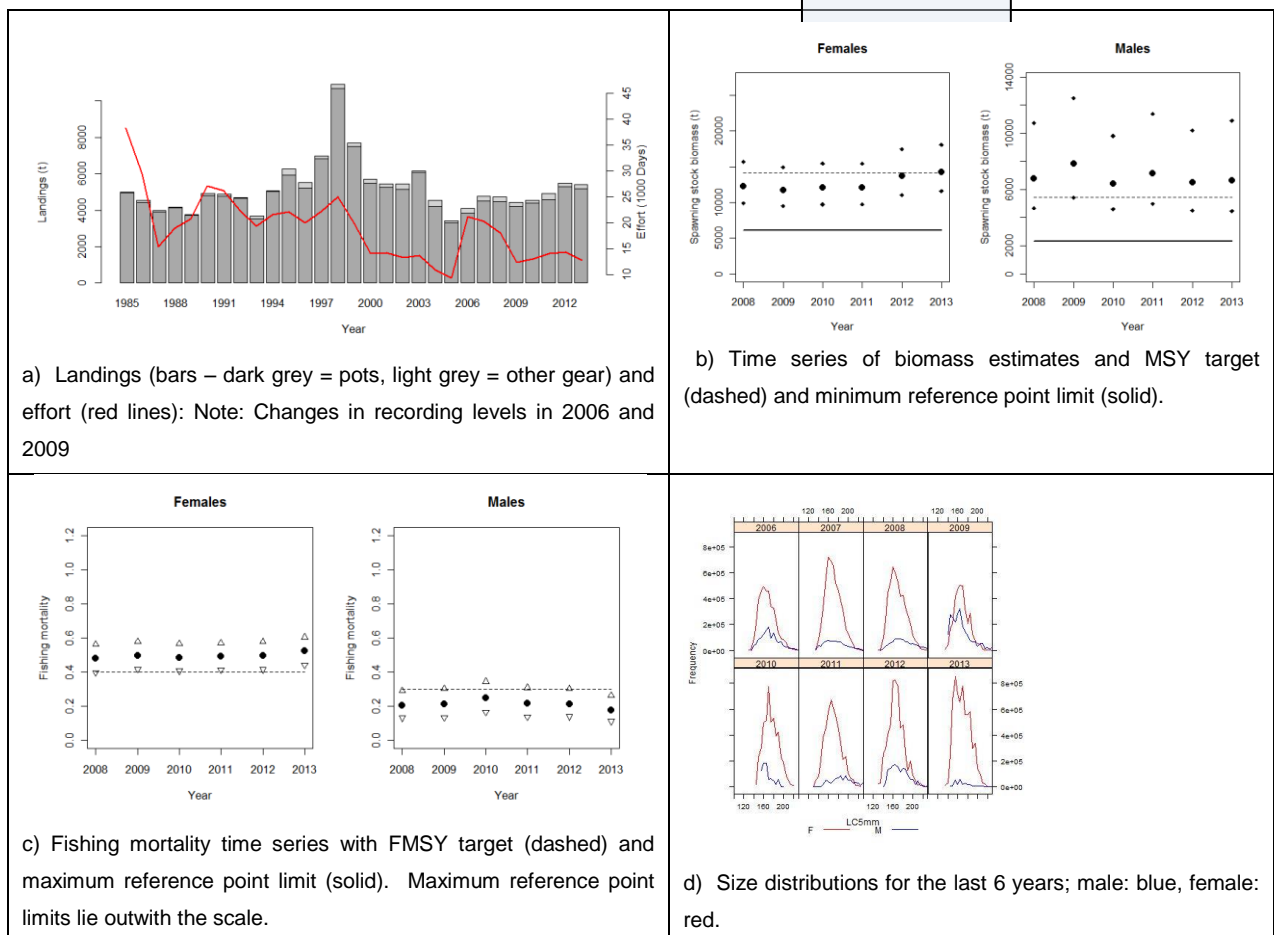
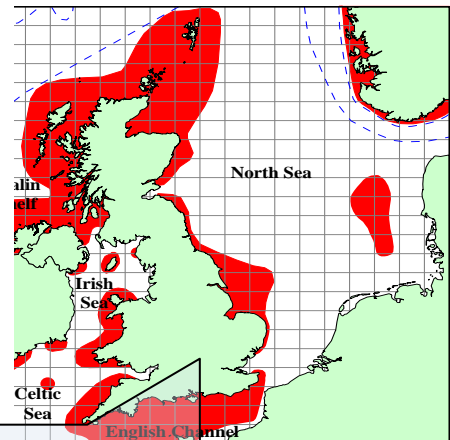
Title of Byelaw	North Eastern	Eastern	Kent & Essex
Shellfish permits	Yes*	Yes*	No
Minimum Landing Size	No	No	No
Maximum Pot Limit	No	No	No
Escape Gaps	Yes*	Yes*	Yes
Maximum Vessel Length	Yes - 16m	No	Yes - 17M
Towed Gear Restrictions	No	Yes	No
Prohibits the Use of Crab for Bait	Yes	Yes	Yes
Prohibits the Removal of Parts of Crabs	Yes	Yes	Yes

*Only applicable within the previous North Eastern Sea Fisheries Committee District

Cefas Stock Status 2013: Edible crab (*Cancer pagurus*) in the Western English Channel

Sustainability Status

Minimum Landing Size	At the MLS's used in this region around 100% of males and 94-98% of females should be sexually mature.
Discarding	High discard survival assumed to be > 90%.
Stock size	At Maximum Sustainable Yield target
Exploitation rate	Around level generating Maximum Sustainable Yield (Females above, males below)



The status of the stock of Edible Crab in the Western English Channel is good with spawning stocks around the level required to produce Maximum Sustainable Yield. The exploitation levels are close to the levels required to produce Maximum Sustainable Yield (males below, females above). The status of the stock has not changed since the last assessment in 2012.

Sampling levels

Table 2. Sample numbers collected for WEC during the last three years by Cefas.

Year	Number of crabs	Number of samples	Sampled wt. (kg)
2011	3412	34	3246
2012	2103	20	1659
2013	3566	23	2907

Fishery overview and developments

	2011	2012	2013
Fleet size < 10m / 10+ m	243 / 41	225 / 47	221 / 38
Effort (days) < 10m / 10+ m	10422 / 4683	10966 / 4593	9014 / 3655

Landings have been relatively stable over the time series except very high landings reported in the late 1990's. There is some evidence to suggest an influence of the introduction of the Restrictive Shellfish License Scheme and Buyers and Sellers legislation since which fishing activity data has been generally more reliable. Fishing effort appears to have generally declined over the time series however between 2006 and 2008 there was a change in the way official fishery data were recorded leading to an increase in records, particularly effort. It is believed that the higher levels recorded in this period represent a more accurate magnitude of activity and therefore the integrity of the full time series is potentially compromised.

The EU Western Waters Regime places a limit upon the number of kilowatt days that the >15m potting fleet can use within ICES area VII. From 2013 active management has been introduced leading to reductions in the number of days fished within this stock area. There may have also been a loss in effort (and therefore also catch) towards the end of 2013 because of the very bad weather in the run up to Christmas which is traditionally an important fishery.

Since 2008 there has been an increase in the vessel numbers and pots used in the Lyme Bay area since the Lyme Bay Statutory Instrument came into being however it is not clear if this represents new activity or a relocation of activity from neighbouring areas.

In large areas of the Devon and Severn IFCA district there is little opportunity to increase the area covered or number of pots on the ground due to the potential for gear conflicts with the mobile fishing fleets.

Fishery Management measures

- EC and UK minimum landing size of 140mm applies, but off Devon and Cornwall UK law stipulates an MLS of 160mm for males. It also restricts the proportion of the crab landings which is detached claws caught by pots or creels to less than 1% by weight of total catch. A by-catch limit of no more than 75kg per day of crab claws taken by other gear types can be landed.
- National legislation restricts the number of shellfish licences available (in England and Wales) and also prohibits landing of berried and soft crabs.
- Cornwall IFCA applies an MLS of 150mm for females. Local IFCA legislation varies and is detailed in the table below.
- There are mid-channel potting agreements in place in this region.

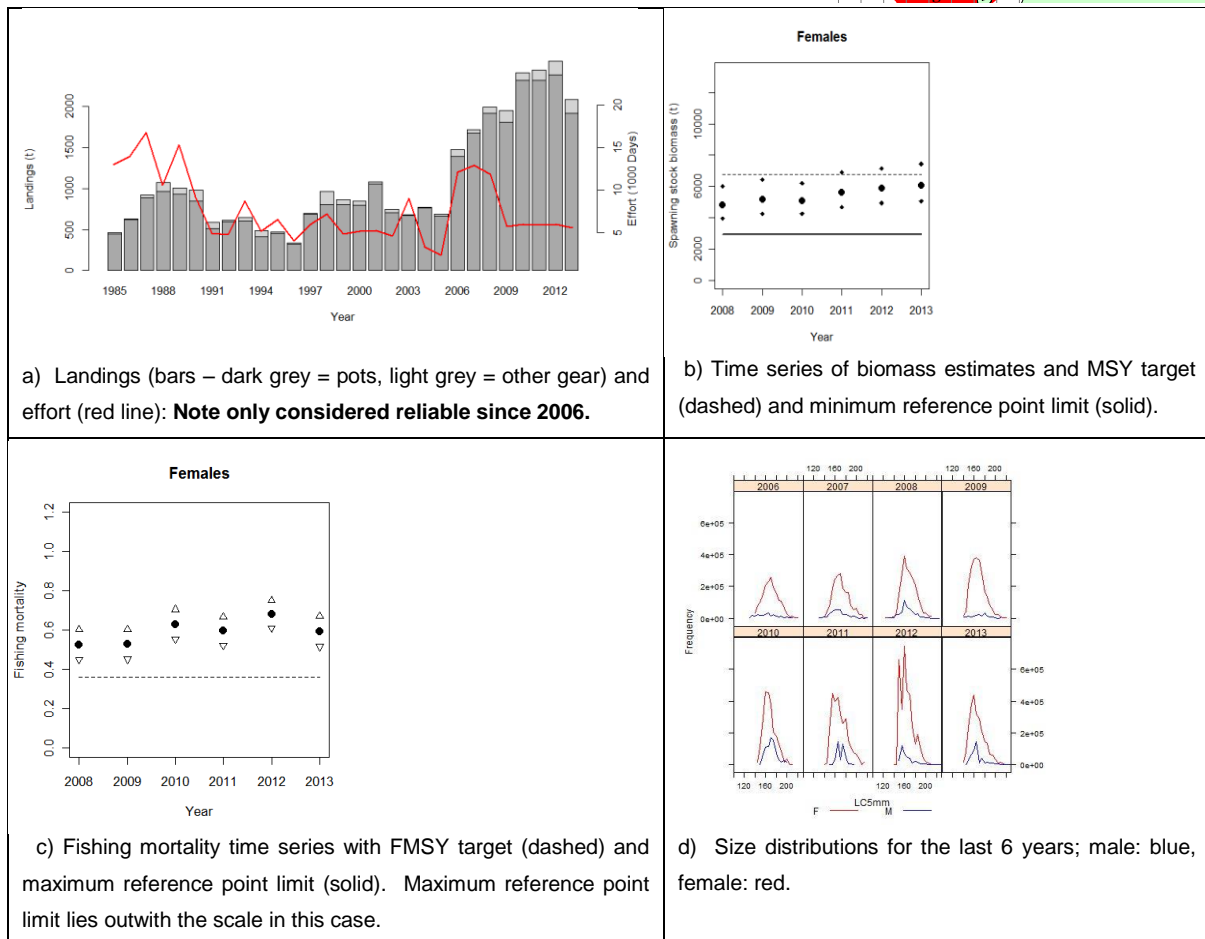
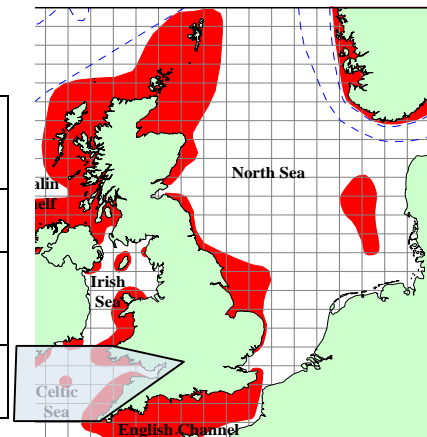
Table 1. Regional byelaws on Western English Channel crab fisheries.

Title of Byelaw	Southern	Devon & Severn	Cornwall	Isles of Scilly
Shellfish Permits	No	No	Yes	No
Minimum Landing Size	No	No	Yes, 150mm for females	No
Maximum Pot Limit	No	No	No	No
Escape Gaps	No	Yes	Yes	No
Maximum Vessel Length	Yes - 12M	Yes - 15.24M	Yes - 16.46M	Yes - 11M
Towed Gear Restrictions	No	Inshore Potting Agreement Area	No	No
Prohibits the Use of Crab for Bait	No	No	No	No
Prohibits the Removal of Parts of Crabs	No	Yes	Yes	No

Cefas Stock Status 2013: Edible crab (*Cancer pagurus*) in the Celtic Sea

Sustainability Status

Minimum Landing Size	<i>At the MLS's used in this region around 100% of males and 94-98% of females should be sexually mature.</i>
Discarding	<i>High discard survival assumed to be > 90%.</i>
Stock size	<i>Above Maximum Sustainable Yield level but below maximum reference point limit.</i>
Exploitation rate	<i>Moderate. Around level generating Maximum Sustainable Yield.</i>



The status of the stock of female Edible Crab in the Celtic Sea is approaching the level associated with Maximum Sustainable Yield. Exploitation levels are moderate for females and likely to be sustainable but above the target MSY level. The status of the stock has not changed since the last assessment in 2012.

Sampling levels

Table 2. Sample numbers collected for Celtic Sea crab during the last three years by Cefas

Year	Number of crabs	Number of samples	Sampled wt. (kg)
2011	708	10	578
2012	2375	14	833
2013	2375	17	1819

Fishery overview and developments

	2011	2012	2013
Fleet size < 10m / 10+ m	177 / 28	161 / 29	151 / 30
Effort (days) < 10m / 10+ m	3723 / 2349	3747 / 2405	3438 / 1865

Reported landings and fishing effort increased substantially following the introduction of Buyers and Sellers legislation and the Restrictive Shellfish License Scheme in 2006. Since this period fishing activity data are thought to be generally more reliable but the integrity of the time series, especially fishing effort, is uncertain. Landings for the last two years are the highest on record.

The very low level of landings for males presents the assessment methodology with significant problems in determining exploitation level and stocks size for males. In particular it means that any MSY levels for males and females are not comparable. The relative lack of males in the landings is likely to result from the males occurring on ground not covered by the fishery (either in space or time) and therefore this portion of the stock is offered a degree of protection. As it is the size of the female portion of the stock which mainly governs the potential to produce further generations, it is considered appropriate to characterise the status and exploitation rate of this stock on the fishery statistics for females.

The level of effort in the Devon and Severn IFCA district is reported to have remained fairly consistent. The potting fisheries on the district's North Coast are seasonal with boats switching target species. In the winter/spring they target whelks until around April when the water temperature increases and they target lobsters. Crabs are the main target through the autumn although they also form a bycatch in the summer lobster fishery. The ground targeted in the autumn is the optimal crab ground and is associated with movement of the females at this time of the year – they are likely to have mated and are very actively feeding. Males may be present on this ground at other times of the year when the fishery is absent.

Fishery Management measures

- EC and UK minimum landing sizes of 140mm apply to ICES divisions VIIg (in ICES division VIIg an EC MLS of 130mm is applicable), but off Devon and Cornwall UK law stipulates an MLS of 160mm for males. EC law also restricts the proportion of the crab landings which is detached claws caught by pots or creels to less than 1% by weight of total catch. A by-catch limit of no more than 75kg per day of crab claws taken by other gear types can be landed.
- National legislation restricts the number of shellfish licences available (in England and Wales) and also prohibits landing of berried and soft crabs.
- Cornwall IFCA applies a 150mm MLS for female crabs. Local IFCA legislation varies and is detailed in the table below.

Table 1. Regional byelaws on Celtic Sea crab fisheries.

Title of Byelaw	Devon & Severn	Cornwall
Shellfish Permits	No	Yes
Minimum Landing Size	No	Yes - 150mm for females
Maximum Pot Limit	No	No
Escape Gaps	Yes	Yes
Maximum Vessel Length	Yes - 15.24M	Yes - 16.46M
Towed Gear Restrictions	No	No
Prohibits the Use of Crab for Bait	No	No
Prohibits the Removal of Parts of Crabs	Yes	Yes

Glossary

Cefas	Centre for Environment, Fisheries and Aquaculture Science.
IFCA	Inshore Fisheries and Conservation Authority.
F	Fishing Mortality.
FMSY	The fishing effort which will produce Maximum Sustainable Yield.
M	Natural Mortality.
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MSY	Maximum Sustainable Yield, the maximum landings which can be regularly taken while avoiding stock collapse.
SAC	Special Area of Conservation
SpR	Spawner per Recruit



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Our customer base and partnerships are broad, spanning Government, public and private sectors, academia, non-governmental organisations (NGOs), at home and internationally.

We work with:

- a wide range of UK Government departments and agencies, including Department for the Environment Food and Rural Affairs (Defra) and Department for Energy and Climate Change (DECC), Natural Resources Wales, Scotland, Northern Ireland and governments overseas.
- industries across a range of sectors including offshore renewable energy, oil and gas emergency response, marine surveying, fishing and aquaculture.
- other scientists from research councils, universities and EU research programmes.
- NGOs interested in marine and freshwater.
- local communities and voluntary groups, active in protecting the coastal, marine and freshwater environments.



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