


Management recommendations for English non-quota fisheries:

Common cuttlefish

Blue Marine Foundation

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Submitted by

MRAG

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List of Abbreviations

BTS	Bottom Trawl Survey
CFP	Common Fisheries Policy
CGFS	Channel Ground Fish Survey
CRPM	Comité Régional des Pêches Maritimes
EMFF	European Maritime and Fisheries Fund
EC	European Commission
EMFF	European Maritime and Fisheries Fund
eNGO	Environmental Non-Government Organisation
ETP	Endangered Threatened or Protected species
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FLAG	Fisheries Local Action Groups
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authorities
LPUE	Landings Per Unit Effort
MCRS	Minimum Conservation Reference Size
MCZ	Marine Conservation Zone
ML	Mantle Length
MLS	Minimum Landing Size
MMO	The Marine Management Organisation
MPA	Marine Protected Area
MSP	Maritime Spatial Planning
MSY	Maximum Sustainable Yield
NGO	Non-Government Organisation
RFMO	Regional Fisheries Management Organisation
SAC	Special Area of Conservation
SSB	Spawning Stock Biomass
TAC	Total Allowable Catch
TAG	Technical Advisory Group
VPA	Virtual Population Analysis
WGCEPH	Working Group on Cephalopod Fisheries and Life History

1 Introduction

The Blue Marine Foundation ('the Client') has requested the provision of management recommendations for a key non-quota fishery in England, namely the common cuttlefish (*Sepia officinalis*). Recommendations are supported by a desk-based review of the current state of knowledge using available literature and insights from stakeholders, where possible.

1.1 Study Context

English non-quota fisheries are characterised by diversity and dynamism - employing a wide range of fishing methods and gear types to target a variety of species, sometimes changing approach in response to seasonal abundances or demand. Many non-quota species are exploited inshore, and as such they can be of great significance for coastal communities and economies, with some ports being highly dependent on their continued productivity. Yet, despite economic and social importance, they have been somewhat neglected in terms of the level of investment in research and scientific study. Indeed, several important non-quota fisheries are controlled through relatively few regulations and minimal stock assessments.

English inshore fisheries are managed using a range of policy measures, including those at the European level under the Common Fisheries Policy (CFP), the national-level, and on a regional basis through the Inshore Fisheries and Conservation Authorities (IFCAs).

The coast of England is divided into ten IFCA jurisdictions, which extend to six nautical miles from the coast. IFCAs are responsible for conservation and sustainable management of fisheries resources within their jurisdiction - balancing the social and economic benefits of exploitation with the need for environmental conservation. The IFCAs act as statutory regulators and manage marine resources according to European, national and local government legislation. As such, IFCAs have the authority to create and enforce local byelaws, drawing on national, local and expert knowledge and evidence. Alongside the Marine Management Organisation (MMO), the IFCAs are important managers of many of England's non-quota fisheries, including common cuttlefish fisheries that form the focus of this study.

Cuttlefish landings comprise the highest proportion of cephalopods landed in Western Europe, mostly caught over the continental shelf of the southern Celtic Sea, the approaches to the English Channel, and the north-eastern Bay of Biscay (Pierce *et al.* 2010). The majority of landings are composed of a single species, *S. officinalis*, the common cuttlefish, which is found all around the UK, but UK fishery statistics indicate that ports in Devon and Cornwall currently record the highest volume of landings. Cuttlefish are exploited across all life stages and targeted by a number of different fisheries within inshore and offshore areas. There have been dramatic increases in landings over the last ten years, which has drawn the attention from both regional[1] and national press[2] - being referred to as 'black gold' due to the high prices obtained. However, there is currently no EU or national legislation in place to manage cuttlefish fisheries, and there are no cuttlefish-specific IFCA byelaws in force at present.

Common cuttlefish exhibit a complex and multi-staged lifecycle, which in turn creates difficulties in assessing their stock status. Combined with the growing importance of the fishery

[1] https://www.devonlive.com/news/devon-news/ugly-fish-sparked-multi-million-517743
[2] http://www.fis.com/fis/worldnews/worldnews.asp?monthyear=&day=27&id=93930&l=e&special=0&ndb=0

to regional economies and the limited ability to regulate fishing effort or entry, common cuttlefish have been identified as being vulnerable to overfishing in the English Channel.

2 Review of the Fishery

Below, we review some of the key information relating to the cuttlefish's biology, fisheries and stock assessment, in support of developing management decisions. The review focuses on information from the UK, with relevant insight to fisheries and management within the EU.

2.1 Biology

Sepia officinalis (herein referred to as the common cuttlefish) generally inhabit sandy and muddy bottoms (FAO, 1984) and are distributed in the eastern Atlantic from the North Sea to approximately the border between Mauritania and Senegal, through the English Channel and in the Mediterranean Sea (Jereb and Roper, 2005). A sibling species, *Sepia hierreda* occurs further south, down to the South Africa. The following review of biology and ecology relates to cuttlefish populations in the English Channel, where landings from English fisheries are greatest.

It is a short-lived species with a life cycle lasting between one and two years, depending on the latitude at which it lives and corresponding with local sea temperatures (Gras *et al.* 2016). In more southern latitudes (e.g. from West Africa to the Portuguese coasts) one-year life cycles have been observed, while further north, in the Bay of Biscay, there is a transition zone where the two different life-cycle groups have been identified; Group I Breeding (GIB), able to breed at one year of age; and Group II Breeding (GIIB), breeding at two years of age (Gras *et al.*, 2016). In the English Channel the life cycle was originally described as exclusively lasting for two years, but subsequent studies have indicated increased proportions of males and females (ca. 4%) exhibiting GIB cycles (Gras *et al.*, 2016; Dunn, 1999a).

Typical of cephalopods, common cuttlefish are considered to be semelparous, characterised by a single reproductive episode after which adults suffer mass mortality (Boyle & Rodhouse, 2006). Semelparity has key implications for management, as unlike other reproductive strategies where several overlapping cohorts can increase stock resilience, cephalopods can suffer from inter-annual recruitment fluctuations as there is only one year-class spawning on each occasion (Lipiński, 1998a; Lipiński *et al*, 1998b). However, a range of reproductive behaviours have now been observed in common cuttlefish (Bloor *et al.*, 2013a). They are reported to be intermittent terminal spawners, whereby individuals lay eggs in separate batches (Guerra *et al.* 2016; Rocha *et al*, 2001), but can result in individuals spawning in multiple events through the duration of the breeding season or spawning during a single event (Bloor *et al.*, 2013a). As eggs at multiple stages of protoplasmic growth and yolk accumulation exist within the ovaries of intermittent spawners, it is difficult to determine whether a female has spawned or not at point of capture without detailed histological study (V. Laptikhovksy, pers. comm.).

The spawning season of English Channel cuttlefish extends from February or March, to July (Dunn, 1999; Royer *et al.*, 2006; Wang *et al.*, 2003). Individuals spawn inshore, laying hundreds of eggs in depths down to 30-40m, attached in clusters to plants, sessile animals or structures, as well as artificial structures including fishing traps and nets (Bloor et al., 2013a; Bloor et al., 2013b). Spawning locations have been identified along the UK coast, including areas in Lyme Bay and from Poole harbour to the Solent on the Sussex coast (Dunn, 1999). A series of recent studies (Bloor *et al.*, 2013a; Bloor *et al.*, 2013b) investigated the distribution, movements and behaviour of spawning and sub-adult cuttlefish, and thus provided a baseline for the inshore waters of the English Channel. Methods used included acoustic telemetry tracking techniques, *in situ* subtidal observation of spawning and presence-only species distribution modelling. A modelling approach was also used to determine the distribution of eggs. Information collected on the presence of common cuttlefish egg clusters in the English Channel indicated there is a range of suitable habitats and conditions for spawning, including a certain weak-bed shear stress[3], sea-surface temperatures of 10˚C and above, soft sediment, a salinity of between 34.5 to 35.5 PSU, water depths of between 0-30 m and within close proximity of the coastline (2 to 12 km) (Bloor, 2012). The model developed to predict spawning areas also identified that the Eastern Channel was more favourable than the west, with, Torbay, Exmouth, Poole, Selsey, Eastbourne and Hastings, being identified as important locations (Bloor, 2012).

Bloor *et al.* (2013b) investigated the fine-scale movements and behaviour of adult and sub-adult cuttlefish within the inshore waters of the English Channel using acoustic telemetry to assess habitat use and site fidelity. The results indicated that even within the inshore spawning grounds, cuttlefish were relatively mobile over the long spawning phase (up to 6 weeks), with a high degree of plasticity in reproductive behaviour and general movement patterns (Bloor *et al.*, 2013b). The results from the tagging study indicated that while some individuals may demonstrate seasonal short-term site fidelity, there are also individuals that can exhibit a more complex pattern of movement along the coast that lasts a number of months. This may be explained by site fidelity over a region rather than one specific location, utilisation of multiple spawning sites or uni-seasonal-iteroparous spawning alongside semelparous spawning. In summary, in-depth studies on the spawning behaviour of common cuttlefish reveal a high degree of plasticity in their reproductive behaviour and demonstrate a complex range of behavioural patterns in spawning adults (Bloor *et al.*, 2013b) which adds a level of complexity when determining appropriate management measures.

Estimates of fecundity are not readily available specifically for English Channel cuttlefish. However, estimates of between 3,700 and 8,000 eggs per spawning event have been reported for individuals occurring in the Aegean Sea (Laptikhovsky *et al.* 2003). Cuttlefish eggs hatch during the summer, approximately two to three months (ca. 85 days) after being laid (Dunn, 1999). The emerging hatchlings are benthic in nature, have limited dispersal capacity (Xavier *et al.*, 2016) and benefit from no parental care (Jereb *et al.*, 2015). Eggs laid on traps and nets are sometimes removed, and this had led to some concern that this additional mortality could affect cuttlefish abundance the following year (Melli *et al.*, 2014). However, a direct impact on subsequent biomass has yet to be confirmed (see Section 2.2.3 and Section 2.4).

In addition to annual inshore spawning migrations, cuttlefish within the English Channel undergo annual over-wintering and feeding migrations (Figure 1). After hatching, juveniles remain in coastal waters until late autumn when, at ca. 3 months, they begin to migrate to deeper waters generally in the Western Channel, as well as north of the French Atlantic coast (Wang *et al*, 2003). The following summer, individuals (ca. 12 months) migrate back inshore to resume feeding and, by September, males complete their maturation. In October, a second offshore migration occurs to over-wintering grounds, where the females complete their

[3] Sheer stress is a measure of the force of friction from a fluid acting on a body in the path of that fluid. In the case of open channel flow, it is the force of moving water against the bed of the channel.

maturation, at ca. 15 months. The final inshore spawning migration for both sexes occurs after approximately 20 months (Dunn, 1999; Gras *et al*, 2016).

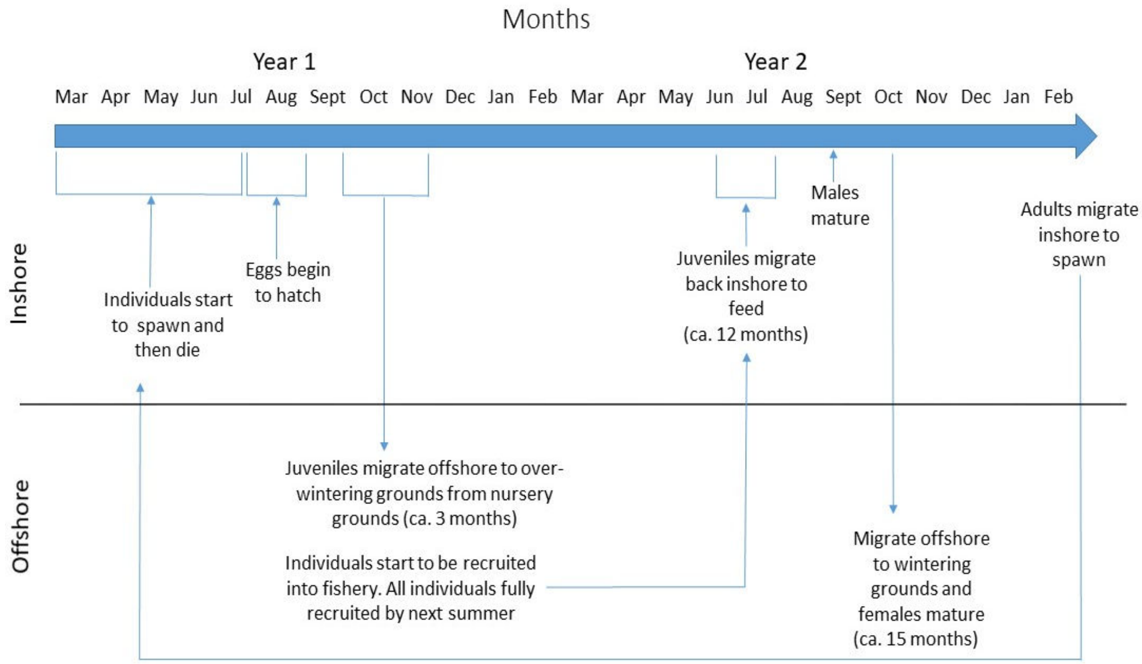

Figure 1: Schematic of the common cuttlefish life cycle in the English Channel. (Sources: Wang *et al*, 2003; Gras *et al*, 2016 and Alemany *et al.* 2016).

As a result of these migrations, seasonal aggregations of cuttlefish occur within particular areas (Dunn, 1999; Wang *et al.* 2003). For example, during the spring and early summer, cuttlefish abundance is high inshore (with hatchlings, juveniles and spawning adults present) and low offshore; whereas by autumn the migration to deeper waters has begun and abundance becomes more evenly distributed between inshore and offshore areas (Dunn, 1999; Gras *et al.* 2014). In winter the abundance is highest offshore in the Western Channel, although there remains moderate abundance along the coastline. Adult common cuttlefish are limited to depths up to 150 to 200 m, as the chambers within the cuttlebone can implode beyond this depth (Ward and Boletzky 1984). Again, these seasonal dips and peaks in abundance of different stage cuttlefish adds complexity to their management.

Temperature is a key parameter influencing cephalopod life cycles, from egg development and growth, to reproduction (Rodhouse *et al.*, 1992; Robin *et al.*, 2014). An increase in environmental temperature generally accelerates growth and shortens the life cycle duration by accelerating maturation (Gras *et al.*, 2016). The growth rate of common cuttlefish is significantly affected by environmental conditions (Gras *et al.* 2016), furthermore, common cuttlefish abundance in the English Channel has been demonstrated to correlate with sea surface temperatures (Wang *et al.* 2003). Recent observations of warming seas in the English Channel could be the cause of the appearance of GIB groups, composed of both males and females (Gras *et al.*, 2016).

Common cuttlefish can reach a dorsal mantle length (ML) of about 450 mm and a body weight of about 4 kg (Seafish, 2017a). Dunn (1999) reported that cuttlefish growth of both sexes was rapid and seasonal during the last 12 months of life but found a significant difference between the length-weight relationship of males and females; males grew faster than females and reached larger overall lengths and weights. Based on samples taken from commercial landings of cuttlefish, Dunn (1999) found that 4% of males in the English Channel matured in August, at approximately 1 year old and at between 81 mm and 91 mm ML. Of the remaining males, the first mature at 114 mm ML and all were mature at 170 mm ML. First maturity of females was recorded at 142 mm ML, 50% were mature at 164 mm ML, and all females were mature at 230 mm ML (Dunn, 1999). A later study by Gras *et al.* (2016) which aimed to assess population structure during the spawning season (i.e. in spring) reported lower size-at-maturity than that observed by Dunn (1999) - on average 122 mm for males and 124 mm for females, in 2010 and 2011 respectively, and 100% maturity at 160 mm.

Bloor *et al.* (2013a) reviewed factors that may affect spawning, early life stage survival and recruitment variability across three main areas - maternal effects, pre-recruit environment and recruitment into the fishery. The review indicated that environmental conditions were key to recruitment success, especially at the early life stage. Variability in egg production and quality, timing and location of spawning is related to environmental conditions encountered by the embryonic and paralarvae stages[4], which in turn is related to preceding maternal effects such as oviposition site selection. In the English Channel, water temperature, food availability and hatchling size are thought to be the three key factors that affect growth rates and age-at-recruitment (Bloor *et al.*, 2013a). These factors will be different spatially and temporally along the English Channel, as habitat varies along its extent, which could impact recruitment success and early life stage survival. The location that the females choose to lay their eggs can therefore heavily impact upon offspring performance and fitness (Bloor *et al.*, 2013).

2.2 Fishery

2.2.1 Landings volume, value and markets

National Sea Fisheries Statistics indicate that over the past decade common cuttlefish have become of increasing importance to southern regions of England - with minimal landings from both UK and non-UK vessels, observed elsewhere (Figure 2). Most notable, are significant landings recorded in ports located within the Devon and Severn IFCA (DSIFCA) district, with landings increasing from 2,495 tonnes in 2008 to 5,478 tonnes in 2017. Total DSIFCA district UK landings in 2017 were five-fold those reported in ports in the Cornwall IFCA (CIFCA) - the second most important district, in terms of cuttlefish landings in England (Figure 2). Of the top ten UK ports for common cuttlefish landings, ports located within the DSIFCA districts represent 40% of landings, with Brixham ranked highest from 2014 to 2016 (Table 1). However, a large proportion of cuttlefish landings at these ports are from vessels of 10 m or greater in length and therefore predominantly represent catches from areas outside of the IFCA districts.

Total UK vessel landings of cuttlefish into English ports have increased over the last decade from 3,589 tonnes in 2008 to 5,123 tonnes in 2016[5]. The majority of landings into English ports were made by UK vessels (98-99%) between 2008 and 2016, primarily by English, Scottish and Welsh vessels (91%, 8% and 1% in 2016 respectively). Additional landings were made

[4] Paralarvae; young cephalopods in the planktonic stages between hatchling and sub-adult.
[5] https://www.gov.uk/government/collections/uk-sea-fisheries-annual-statistics

mostly by Belgium and Ireland, and to a lesser extent by France and the Netherlands between 2008 and 2016 (see Figure 3).

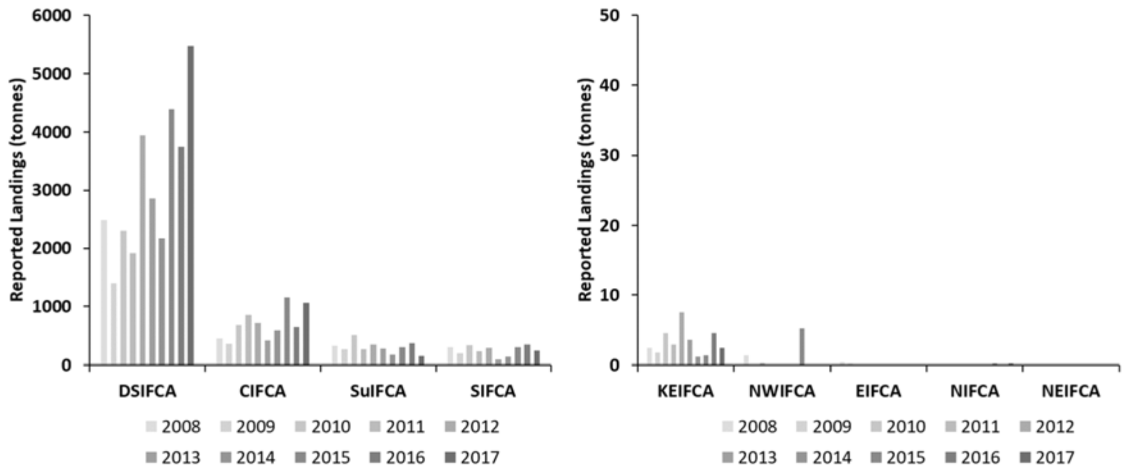

Figure 2: Total annual landings (tonnes) of common cuttlefish by IFCA district. Note the different y-axis values. Data from 2017 exclude landings from foreign vessels. (Source: MMO, 2008-2017).

Table 1: English ports with greatest common cuttlefish landings (tonnes) in 2016 (MMO, 2017).

Rank	Port	District	Total Landings (Tonnes)		
			2014	2015	2016
1	Brixham	Devon & Severn IFCA	1,506.4	3,326.7	2,883.4
2	Plymouth	Devon & Severn IFCA	584.3	895.3	658.2
3	Newlyn	Cornwall IFCA	448.6	964.7	476.7
4	Shoreham	Sussex IFCA	74.5	152.9	137.6
5	Portsmouth	Southern IFCA	53.6	84.4	127.7
6	Torquay	Devon & Severn IFCA	46.2	85.0	110.9
7	Looe	Cornwall IFCA	105.2	144.5	96.8
8	Exmouth	Devon & Severn IFCA	27.5	64.3	74.8
9	Hastings	Sussex IFCA	16.5	32.6	68.4
10	Eastbourne	Sussex IFCA	26.6	27.3	62.4

During this period the estimated overall value of landings has more than doubled, increasing from £5.2 million in 2008 to £14.4 million in 2016 and continued to increase in 2017 to £25 million (without inclusion of landings from foreign vessels for this year) (Figure 4). From January to September 2017, landings of cuttlefish into the UK by UK vessels amounted to 3,790 t at a value of £3,792 per tonne (MMO, 2017) – landings made by under 10 m vessels amounted to 530 t (~14% of total landings), at a value of £3,859 per tonne during the same period (MMO, 2017). Data from Plymouth fish market corroborate the continuing and increasing importance of cuttlefish in this region both by weight and by value (Figure 5 and Figure 6).

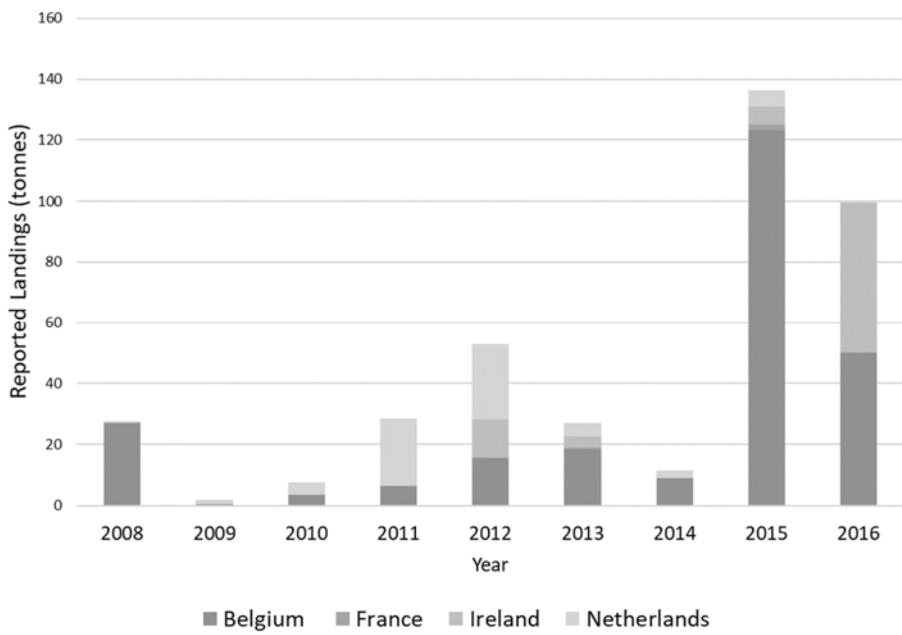

Figure 3 Total annual common cuttlefish landings (tonnes) by non-UK vessels into English ports, between 2008 and 2016. (Source: MMO, 2008-2016).

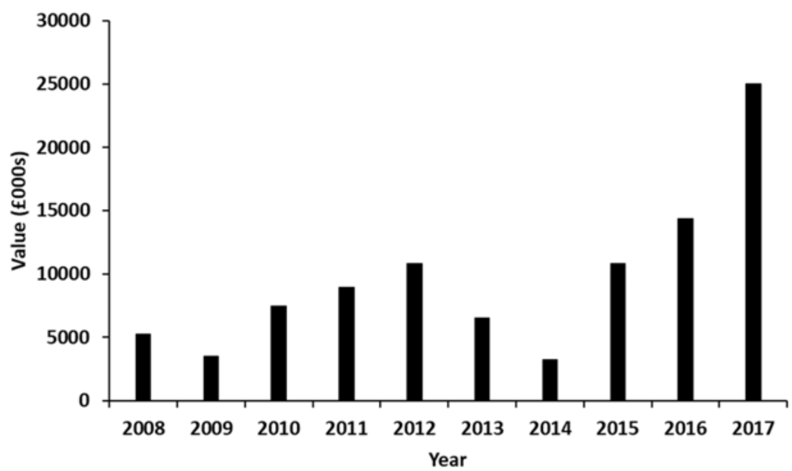

Figure 4: Annual value (£'000s) of landed common cuttlefish in England (MMO, 2008-2017). Data from 2017 does not include the value of landings by foreign vessels into UK ports.

Historically, the increasing trend in reported cuttlefish landings began in the 1970s, from little over 1 tonne in 1973 to over 2,000 tonnes in 1993 reported for England and Wales (ICES, 2002). There is anecdotal evidence of 'large quantities' of cuttlefish being caught commercially in the 1970s, but they are thought to have been discarded as they had little commercial value at the time (ICES, 2002). Cuttlefish now represent one of the top three species in terms of volume and value sold by auction at Plymouth Fish Market (Figure 5). The increase in landings since the 1980s has been attributed to the increasing unit price of cuttlefish due to the development of overseas markets (namely southern Europe), a diversification of fishing effort following declining catches and more restrictions on established species, in combination with an apparent increase in cuttlefish abundance and improved reports of landings (ICES, 2002). More recently, anecdotal reports of the collapse of an Indian Ocean cuttlefish fishery is considered to be further driving prices and landings in the south-west (Plymouth Trawler Agents, pers. comm). Increasing sales value for cuttlefish is also evident in the results of a recent study undertaken by the Cornwall IFCA, which showed that there has been a 50 to 130% increase since 2014 (CIFCA, 2017).

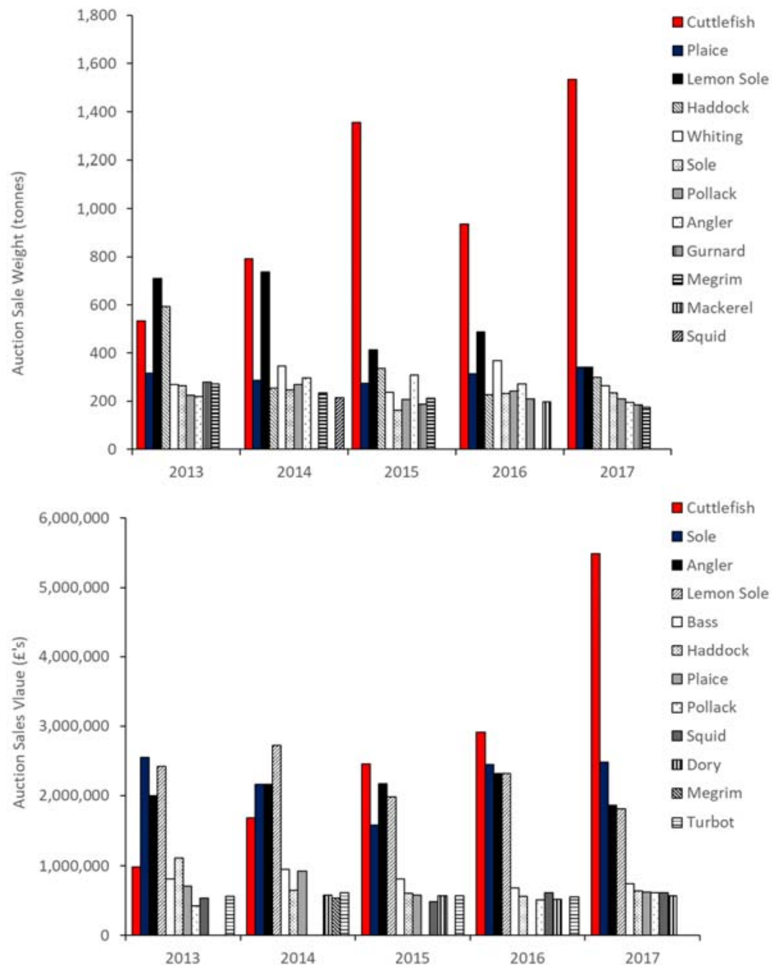

Figure 5: Weight (tonnes) and value (£) of the most important species sold at auction at Plymouth fish-market for the last five years (Source: Plymouth Trawler Agents data, 2018).

Most of the cuttlefish landed in the UK is exported to other parts of Europe, namely Italy, France, Spain and other Mediterranean countries (Plymouth Trawler Agents, pers. comm; MMO SWMA Principal Marine Officer, pers. comm.). Although the Mediterranean has its own cuttlefish fishery, it is thought that supply cannot support current demand. Some cuttlefish is exported whole and fresh, in insulated containers, whilst some is shipped as frozen product (Plymouth Trawler Agents, pers. comm.). Landings are separated into three size grades (size 1: ≥ 0.5 kg; size 2: 0.3 – 0.5kg; size 3: 0.1-0.3kg[6]), but most landings are generally size 1 and

[6] See Council Regulation (EC) No 2406/96 laying down common marketing standards for certain fishery products https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31996R2406&from=en;

size 2 (Plymouth Trawler Agents, pers. comm.). Anecdotal observations suggest that recently there has been a shift in the proportions of size grades landed in Devon; previously distinct sizes of cuttlefish would appear in landings at specific times of the year or from vessels fishing in specific areas (e.g. ~ size 1 during spring or from the mid channel fishery), whereas last year, a mixture of sizes was landed at these times or from these fleets (DSIFCA Deputy Chief Officer, pers. comm.; Plymouth Trawler Agents, pers. comm.).

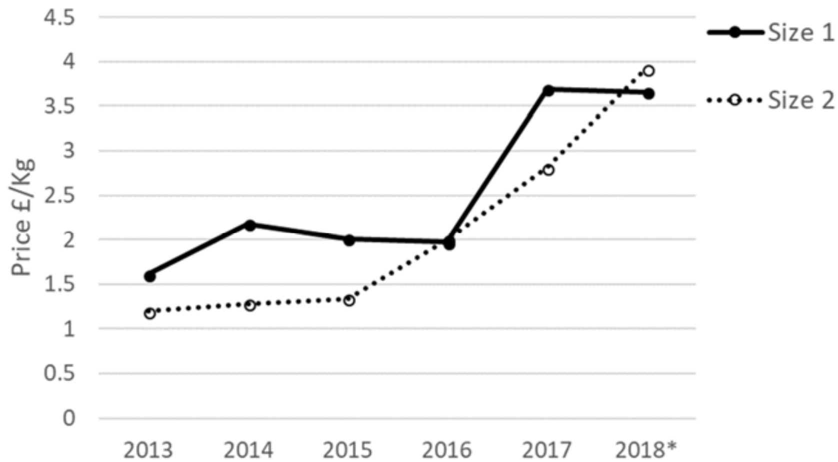

Figure 6: Average sale prices for two size grades of common cuttlefish at Plymouth Fish market, 2013-2018. (Source: Plymouth Trawler Agents, 2018).
* 2018 prices do not take into account the full year average.

2.2.2 Fleets and gears

Exploitation patterns of the main fleets that target cuttlefish are shown to be a function of the region fished; with gears varying with the growth and migrations of the cuttlefish (Dunn, 1999). The majority of UK cuttlefish catches are made using mobile gears, including demersal otter trawls and beam trawls, which harvest juveniles and adults in autumn and winter (Seafish, 2017b, c). In these fisheries, particularly beam trawls, cuttlefish may be targeted directly or taken as bycatch from mixed demersal fisheries. Static gears including pots and nets (gillnets, trammel nets and drift nets) are also used to target spawning individuals in spring, but landings from these fisheries contribute a small proportion of UK landings based on reported data (ICES 2013; MMO, 2017; Pierce *et al.,* 2010) (Figure 7). Furthermore, UK Sea Fisheries Statistics indicate that the majority of cuttlefish landings are made by vessels over 10m in length (Figure 8).

The English Channel fishery has previously been described as consisting of two main sectors, based on season, areas fished and the primary fleets involved (ICES, 2002). One sector targets cuttlefish during autumn and winter, peaking in offshore waters from November to March, with catches being made throughout the southern British Isles, but primarily from the Western Channel (ICES, 2002). This sector is usually characterised by vessels of over 20 m

However, grading of cuttlefish is currently a 'grey area' due to the impracticalities of separating catches by size once landed.

in length, which use beam trawls (80-90 mm mesh). The key landings ports for this fishery are Brixham, Newlyn and Plymouth (ICES, 2002).

This sector has primarily exploited a single cohort of cuttlefish offshore and in the later stages of maturation, prior to their inshore migration to spawn the following spring (Dunn, 1999). However, more recently, the start of the winter part of this fishery, from September, occurs further inshore and coincides with the main period of recruitment (ICES, 2002). In recent years there is evidence that the fishery is beginning earlier, in late summer (Figure 9).

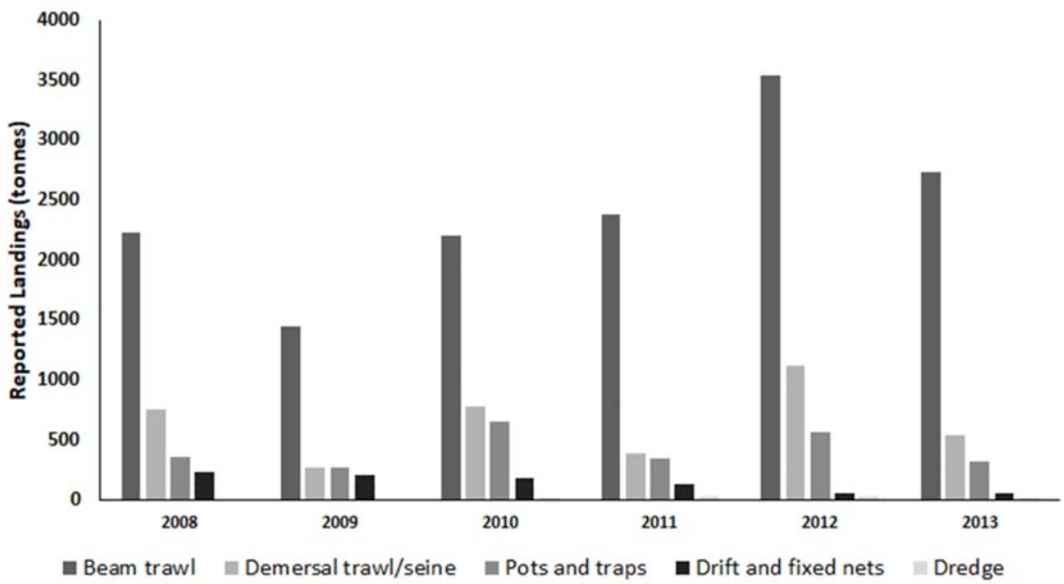

Figure 7: Total reported UK common cuttlefish landings, 2008 to 2013, by gear type. (Source: MMO, 2008-2017).

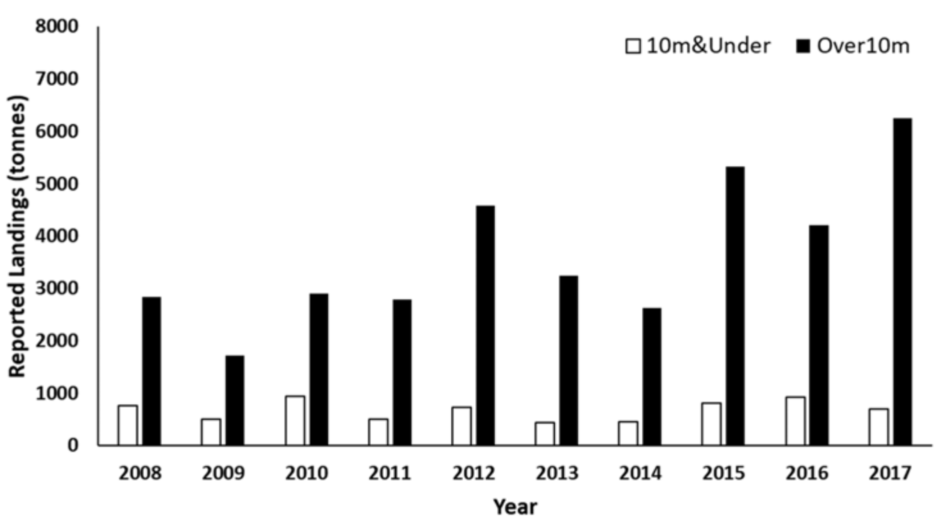

Figure 8: Total annual common cuttlefish landings (tonnes) by all vessels into English ports, between 2008 and 2017. Data from 2017 excludes landings by foreign vessels (Source: MMO, 2008-2017).

The second sector targets cuttlefish further inshore in the spring and early summer, from March to August, and is comprised of beam trawlers (80-90 mm mesh) and otter trawlers (70-99 mm mesh) between 6 and 12 nm, and fixed nets (e.g. gill nets, 100 and 120 mm mesh; and trammel nets, 90-160 mm mesh) and pots or traps (Dunn, 1999; ICES, 2002; MMO 2018). This sector exploits the same cohort as the offshore fishery but later in the lifecycle when these individuals return to spawn. Therefore, landings are dependent on the abundance and subsequent mortality from the autumn-winter fishery (ICES, 2002, Vause and Clark, 2011; J. P. Robin, pers. comm.).

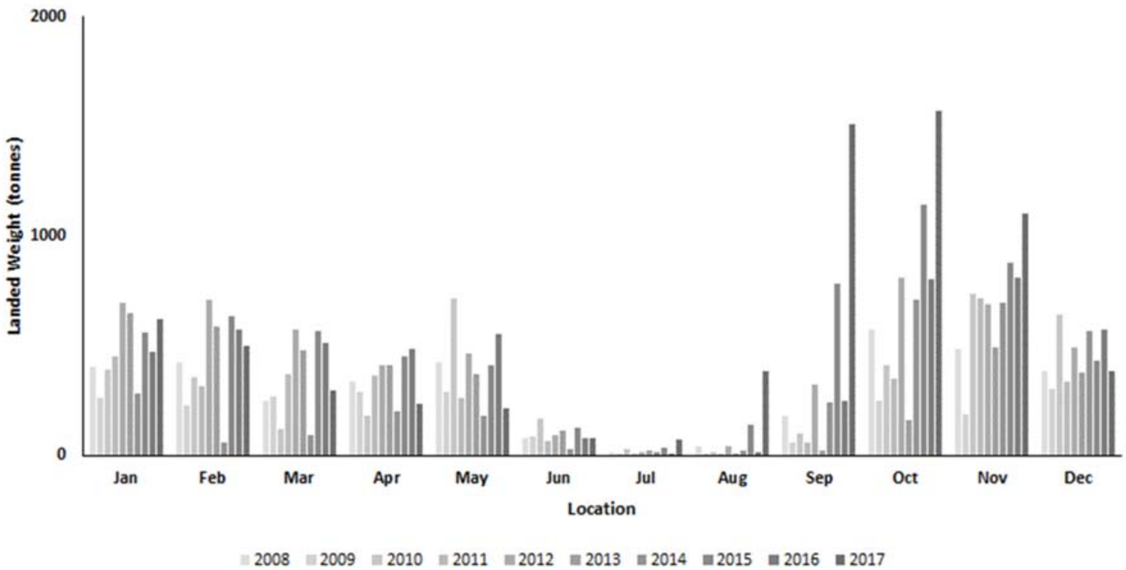

Figure 9: Monthly common cuttlefish landings (tonnes) into English ports, between 2008 and 2017. Data from 2017 exclude landings from foreign vessels to UK ports (Source: MMO, 2017).

Monthly landings into English ports broadly reflect the timing of these key fishery sectors (Figure 10), but also illustrate the variation between years. It is clear that the autumn fishery has been peaking during September and October in recent years (e.g. 2015 to 2017) (Figure 9). Dunn (1999) describes exploitation patterns of fleets active during 1994 to 1996, and provides a summary of their timing, location and ML of cuttlefish landed by these fleets (Figure 11). Figure 12 and Figure 13 illustrate the location and size of catches by ICES rectangle for beam and otter trawls in 2016 and 2017, and for dredges, gillnets and trammel nets in 2017, (MMO, 2018).

Although the offshore sector is comprised of vessels referred to as the mixed-demersal, once cuttlefish begin to aggregate in large numbers in specific areas, these vessels are able to target cuttlefish and catches are reported to be relatively ‘clean’ (Plymouth Trawler agents, pers. comm.). Exploration of these fleets by Dunn (1999) also reports that discarding of cuttlefish from trawl nets was rare, with landings broadly representing catches. (Dunn, 1999).

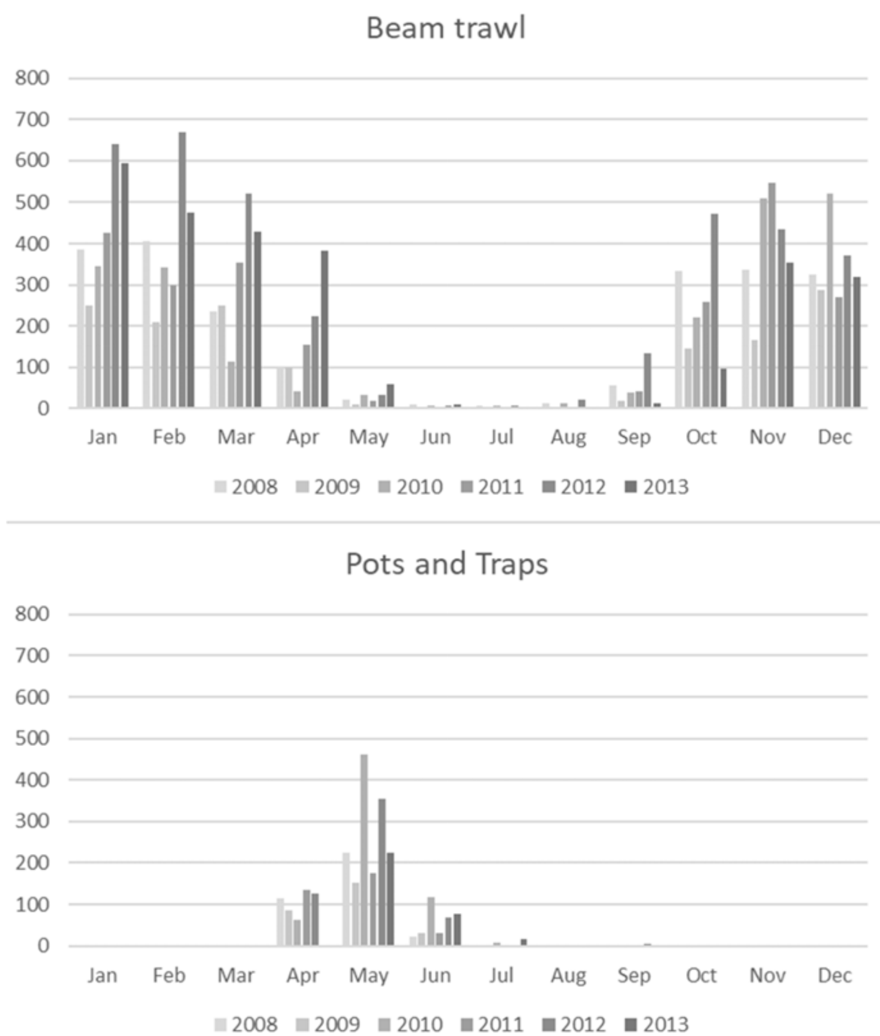

Figure 10: Monthly common cuttlefish landings (tonnes) into English ports from beam trawls (top) and pots and traps (bottom), between 2008 and 2013 (Source: MMO, 2017).

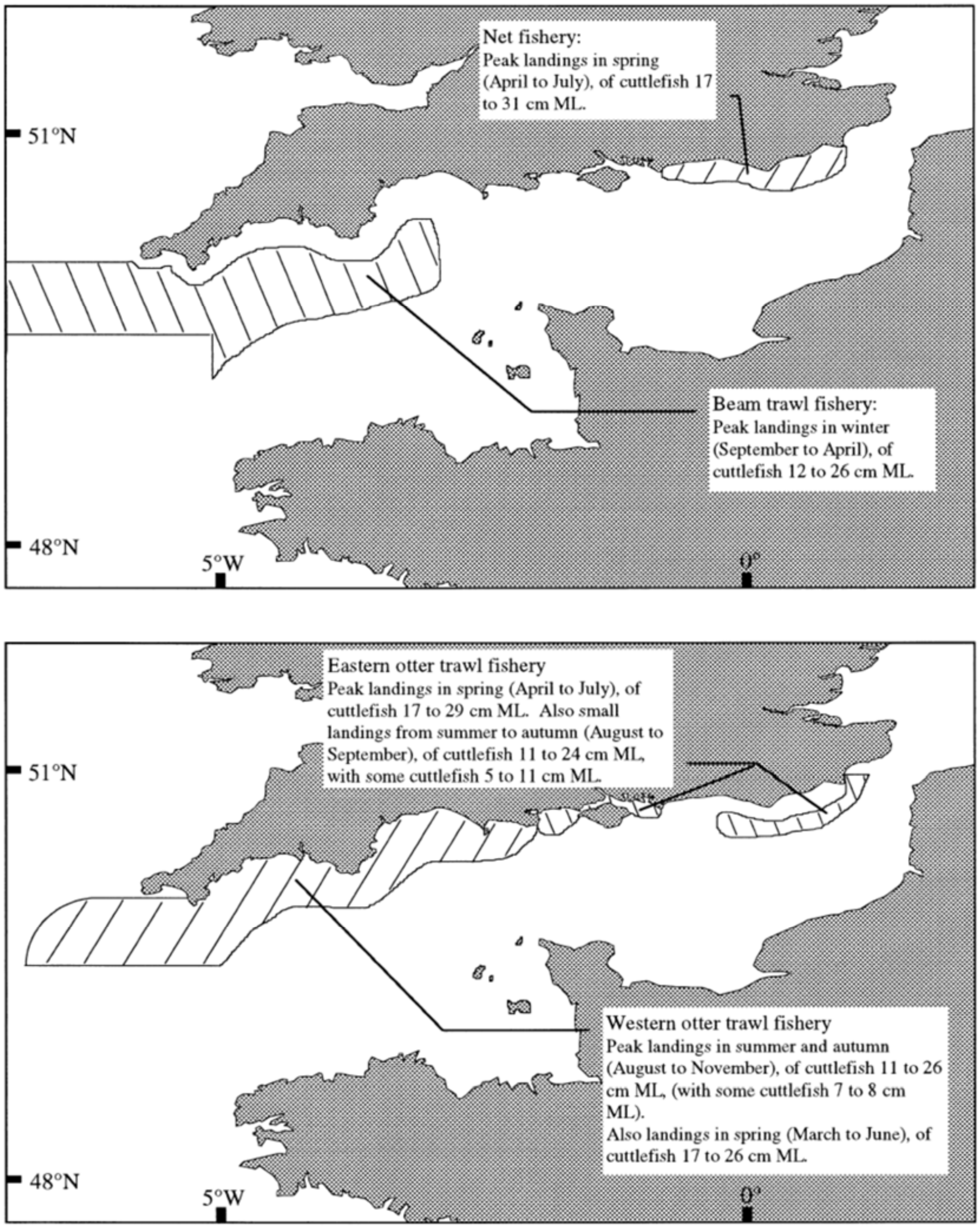

Figure 11: The area fished by key commercial English Channel fleets with respective times of peak landings and corresponding ranges of ML landed (Source: Dunn, 1999).

Figure 12: Catch (tonnes) by ICES rectangle in 2016 (left) and 2017 (right) for beam trawls (top), otter trawls (middle) and pots / traps (bottom).

Figure 13: Catch (tonnes) by ICES rectangle in 2017 – dredges (top), gillnet (middle) and trammel nets (bottom).

2.2.2.1 Characteristics of the regional inshore fleets

2.2.2.1.1 Trawl fleets

Although trawling for cuttlefish mainly occurs in the mid-channel region, outside of the IFCA districts, there are some trawl fleets that operate within 6 nm. In the Southern IFCA a trawl fishery occurred in 2017, during late summer and early autumn, with effort largely concentrated in the area around 5 to 6 nm offshore, in Lyme Bay (Southern IFCA Officer, pers. comm.). Prior to 2017, however, there had been no trawl fisheries within the district for a number of years, with trawling effort concentrated outside of 6 nm (Southern IFCA Officer, pers. comm.).

Trawling does occur within the Devon and Severn IFCA (DSIFCA); however, this is restricted to lighter and smaller otter trawls. Beam trawling only occurs between 6 and 12 nm and mid-channel (>12 nm) (DSIFCA Deputy Chief Officer, pers.com, 2018). Otter trawling for cuttlefish occurs for a relatively short period in spring during spawning time, dictated by the location and abundance of the cuttlefish themselves (DSIFCA Deputy Chief Officer, pers. comm,).

Within the Cornwall IFCA (CIFCA), there is minimal activity undertaken by trawlers for cuttlefish within 6 nm, while targeting cuttlefish with pot or traps is an emerging fishery in Cornwall (CIFCA Enforcement Officer, pers. comm.).

2.2.2.1.2 Potting or trapping fleets

Pot or trap fisheries targeting spawning cuttlefish occur from April to June within all IFCA districts bordering the English Channel. These fisheries operate for short periods, ranging between 6 to 10 weeks, and coinciding with the arrival and presence of spawning cuttlefish in inshore areas. The timing of this fishery is temperature dependant; for example, in the Sussex IFCA district, cuttlefish appear once water temperatures are 13 to 14°C (around May) (Vause and Clark, 2011). Consultation with the Cornwall IFCA supported this, stating that the cuttlefish trap fishery was highly seasonal, usually very short and weather dependent.

Across various IFCA districts most fishers use between 5 and 20 traps per string, depending on the size of the vessel, with spacing of roughly 15 m between each trap. The total number of pots set per day varies, between 60 to 100 per day (Mudeford skipper, pers. comm.) Each string is hauled every two days (Vause and Clark, 2011).

Two designs of traps are often used (Figure 14). Rectangular/square cuttlefish traps that usually have a steel frame and nylon net and are sometimes baited with live females to attract males (Seafish, 2017a). The second type is a smaller round trap, also known as a 'French style' trap (Vause and Clark, 2011). Both traps have a 'feathered' entrance, designed to enable cuttlefish to enter but not escape, and a trap door for emptying and baiting (Vause and Clark, 2011).

As well as trap and pots, trammel nets are also used to target cuttlefish in some districts, and in some areas, trammel nets are used to catch females to bait the pots or traps. Consultation with a fisher from the Cornwall district, who operates in the Falmouth area, revealed that trammel nets tend to be used to target cuttlefish for around 6-8 weeks, from April.

Figure 14: Rectangular (left) and round (right) pots, used in Devon and Severn IFCA.

2.2.3 Environmental impacts

Common cuttlefish are caught within the English Channel by three main gear types: beam trawl; otter trawl; and traps or pots. This section reviews the known impacts of these three fishing activities on the environment and on other species. However, it is important to note that some of the most important spawning grounds for common cuttlefish are located in Torbay, off the UK coast. This area has been declared as a Marine Conservation Zone and therefore parts of these spawning grounds are already protected from fisheries impacts.

To date, there have been no studies that specifically considered the environmental impact of common cuttlefish traps (Walmsley *et al.,* 2015). However, in general pots are highly selective and therefore bycatch is considered to be minimal[7]. Cuttlefish traps are also lighter and larger than most crustacean pots, and as they are relatively stationary and have limited bottom contact, their impacts are thought to be negligible (Seafish, 2017a).

As cuttlefish often lay eggs on the outer surface of traps without being caught, these eggs may be considered a type of bycatch. Eggs are often removed from traps when hauled (Seafish, 2017a). Various studies have discussed the potential impacts on cuttlefish populations of damage to eggs laid on traps (Blanc *et al*., 1998; Bloor, 2012; Melli *et al*., 2014). For example, in Morbihan Bay, France, Blanc *et al*., (1998) estimated that the process of washing eggs from traps can remove up to 18 to 40 million eggs per season. Bloor (2012) estimated that between 1,000 and 3,000 eggs can be laid on one trap, which equates approximately to the fecundity of one female cuttlefish. A study by Melli *et al.* (2014) on the effects of the artisanal fishery on cuttlefish offspring suggested that traps placed in coastal areas during the breeding season had a high impact on cuttlefish eggs, with over 3 million eggs likely to be destroyed by 3,750 traps over two fishing seasons. However, a direct link to reduced productivity has not yet been demonstrated.

Studies have been conducted on the environmental impacts of beam trawling. As this type of fishing requires close bottom contact, they are reported to leave detectable marks on the sea floor[8], particularly on sandy and muddy bottoms (Linnane *et al.,* 2000) - the preferred habitat of common cuttlefish. Beam trawlers can stir up sediment resulting in direct faunal mortalities, habitat modifications and can damage species leaving them more susceptible to predation (Linnane *et al.,* 2000). In addition to this, other studies have shown that beam trawling can also 'flatten' the seafloor, removing natural features such as ripples, bioturbation mounds and faunal tubes (Løkkeborg, 2005). However, the degree of impact is dependent on the speed of the towing vessel, the gear specifications and the characteristics of the sediment. In relation to bycatch, beam trawlers targeting mixed demersal fish are highly unselective and therefore large numbers of non-target species may be caught (Seafish, 2017b). In the UK a large proportion of cuttlefish have previously been caught as bycatch rather than as the target species (Seafish, 2017b) and between 2000 and 2005 cuttlefish were one of the main species discarded by English and Welsh beam trawlers. However, discarding has begun to decline due to increased market demand (Seafish, 2017b).

The environmental impacts of otter trawling are also well documented and have been shown to result in the physical disturbance of the seafloor. They can also cause direct and indirect effects on biological communities due to changes in the physical attributes of the areas being

[7] http://www.seafish.org/geardb/gear/pots-and-traps/
[8] http://www.fao.org/fishery/geartype/305/en

trawled. This includes changes of the sediment surface characteristics in areas that have been repeatedly trawled, but are thought to eventually recover (Løkkeborg, 2005). Studies have indicated that areas that are more prone to tidal and wave action may be more resilient to the impacts of otter trawling. This may apply to the cuttlefish fishery which in part targets shallow waters which are subject to high wave and tidal action (Seafish, 2017b). When targeting mixed demersal fish, otter trawls catch many non-target species. For example, catches of skates, rays and sharks are common in European otter trawls, which are vulnerable to overfishing due to their low fecundity, unreliable catch data and data limited assessments (Seafish, 2017c). However, data on catch composition from trawl gears when targeting cuttlefish were not readily available for this report.

2.3 Stock Status

2.3.1 Stock definition

Common cuttlefish are distributed from ICES Subarea III to Division IXa, Mediterranean waters and North African coast (ICES, 2013). However, total landings from ICES subareas III, IV and VI represented only 390 t (2000 to 2010 average) but have since dropped to much lower levels (86 t, 2011 to 2013 average). The bulk of these cuttlefish comes from the North Sea (subarea IV: 117 t in 2013) and are caught mainly by France (114 t in 2013) (ICES 2014). Much larger catches are reported for ICES Subarea VII and catches in the English Channel (ICES Division VIId and VIIe) accounted for 81% to 99% of area VII landings between 2010 and 2013 (ICES, 2014). The bulk of these landings are made by French vessels; however, English vessel landings are also significant (ICES, 2014).

For management purposes, the English Channel cuttlefish population is defined as two stocks: Division VIId (Eastern Channel) and Division VIIe (Western Channel). There is a degree of connectivity between the stocks, with both recruits and adults migrating between Division VIId and Division VIIe (ICES, 2013), while cuttlefish stocks in the English Channel, Northeast Atlantic, western Mediterranean and eastern Mediterranean are considered genetically distinct. Temporal trends in abundance (based on catches) are monitored across ICES Divisions by WG CEPH, and to date there are no trends in abundance between Divisions VIId and VIIe and neighbouring divisions in the North and Celtic Seas (J.P. Robin, pers. comm.). Therefore, the cuttlefish population in Divisions VIId and VIIe has traditionally been defined and managed as a discrete spawning stock, separate from other populations in its northern distribution, namely, those in the Bay of Biscay (ICES Areas VIII and IX) and the North Sea (ICES Area IV) (Royer *et al.*, 2006; Bloor *et al.*, 2013).

This stock has been assessed periodically by the ICES Working Group on Cephalopod Fisheries and Life History (WGCEPH) since 2013. To date, assessments have essentially been exploratory, as being a non-quota species, the European Commission does not request advice on cuttlefish. However, WGCEPH and several of the members are however working towards a position where routine assessments might be feasible, at least for locations where appropriate data collection is in place (J.P. Robin, pers. comm.) The following section describes progress to date.

2.3.2 Developments in stock assessment for English Channel stock

Assessment and understanding of common cuttlefish exploitation is a challenge for a number of reasons. Firstly, their distribution and abundance are influenced by environmental conditions (Royer *et al.*, 2006). Secondly, fishing is conducted by a range of gears and interacting fleets and at various life stages. Finally, the cuttlefish's life-cycle and population dynamics differ markedly from those of finfish. Cephalopods differ fundamentally from most temperate finfish by being short-lived and having highly variable growth and recruitment (Pierce and Guerra, 1994, Royer *et al.,* 2006). Their breeding is synchronous, and although the two-year life cycle means that there are two overlapping annual cohorts, only one cohort spawns each year, and annual recruitment accounts for almost the entire stock biomass for the following two years.

Fisheries in the English Channel target spawning aggregations; as a result, the stock is at risk of recruitment over-fishing. Especially since it is uncertain whether inshore spawners are caught before or after egg laying (Royer *et al.,* 2006).

Recruitment to the fishery is complicated further by the numerous seasonal migrations and the two overlapping annual cohorts (3+ and 12+ months), each also including two sub-groups of recruits. The first group of recruits in October originate from July hatchlings, while the second group recruiting in April originate from hatchlings born late in the hatching season which have experienced slower juvenile growth than the first group (Royer *et al.*, 2006).

As might be expected for short-lived species, cephalopod growth is rapid and sensitive to environmental conditions (Pierce and Guerra, 1994, Rodhouse *et al.,* 2014). Growth rates are correlated with temperature, and inversely so with size (Pierce *et al.*, 2010). However, in the English Channel, statolith analysis has indicated that hatchlings exhibit an exponential growth rate, larger size classes fit logistic curves (Pierce *et al.,* 2010). As such, age-based stock assessment methods are difficult to employ and are complicated further by time-consuming age determination of statoliths (Alemany *et al*, 2017). Length based proxies for age-based analyses are also problematic, due to wide variation in growth rate between cohorts, regions, and years.

Depletion methods are therefore the most commonly applied stock assessment methods for cephalopods (Pierce and Guerra, 1994). However, the underlying assumptions of this abundance model are not best suited to common cuttlefish population dynamics (Royer *et al.,* 2006). Depletion method assumes constant catchability, which is unlikely to be appropriate for English Channel cuttlefish, not least due to fluctuating abundances following their marked seasonal migrations; catchability is subsequently likely to differ (Royer *et al.*, 2006).

The most recent model used applies a Bayesian state-space two-stage biomass dynamics model (Alemany *et al.*, 2017, ICES, 2017). Prior to this a Lesly-Delury depletion model was applied by Dunn (1999) based only on the UK beam trawl fleet (despite the French landings being higher than those in the UK). Royer *et al.* (2006) developed a monthly Virtual Population Analysis (VPA) (which applies cohort analysis), but this method could not be applied routinely due to inconsistency in size structures and was considered too data demanding for a routine stock assessment (Alemany *et al.,* 2017).

The much less data-demanding two-stage biomass model was first developed for the English Channel stock by Gras *et al.* (2014) and subsequently adopted by the ICES Working Group

CEPH. This model is an alternative for short-lived species with a lack of reliable age-data (Alemany *et al.,* 2017). The model developed by Gras *et al.* (2014) represents the biomass of group 1+ year individuals only and assumes two stages among the exploited population: recruitment and full exploitation. Recruited biomass (evaluated on the first of July) is estimated using abundance indices from the English Bottom Trawl Survey (BTS) and the French Channel Ground Fish Survey (CGFS) (Alemany *et al.,* 2017). Spawning stock biomass is then estimated using landings per unit effort (LPUE) from French and UK bottom trawl fisheries. The model is fitted to the time series of catches and abundance indices using a maximum likelihood framework that assumes observation errors only, and uncertainties about estimates are quantified using bootstrapping (Alemany *et al.,* 2017).

Alemany *et al.,* (2017) suggest that this model suffers from several weaknesses, including:

1. observation errors only are considered, process errors are not accounted for;
2. there is a lack of flexibility to change model assumptions and/ or to assimilate other sources of available information or data;
3. model outputs are highly sensitivity to the growth rate parameter which is assumed to be known and constant (between 12 and 23-month-old cuttlefish) from year-to-year even though it is known to be highly sensitive to environmental fluctuations[9]; and
4. the model only captures dynamics of the 1+ component of the population without accounting for presence of 0+ in the abundance indices.

The updated model (Alemany *et al*., 2017), improves on the Gras *et al*., (2014) model, based on three substantive developments:

5. It is based on a Bayesian state-space framework (Rivot *et al.,* 2004; Parent and Rivot, 2013), which allows for comprehensive integration of the different sources of uncertainty by considering both process errors in the biomass dynamics and observation error in the data.
6. It incorporates an informative prior (Hilborn and Liermann, 1998) on the biomass growth rate that takes advantage of various sources of available data to quantify the average growth rate and provide a more realistic range of variability over the years.
7. Improved quality of data and reflection of the stocks demographics by taking into account that two separate age classes (0+ and 1+) comprise the abundance indices and the exploited biomass.

As a result, the model now allows inferences to be made on the stock biomass at the start, middle and end of the fishing seasons and also provides predictions of the unexploited biomass in winter, based on survey data, which could aid management in the event of significant depletion (Alemany *et al.,* 2017). Alemany *et al.* (2017) suggest that predictions of the unexploited biomass in winter could be used as an evidence-base to authorise or *veto* exemptions, currently in place in French trawlers, which allow trawlers to fish cuttlefish spawners for six weeks in spring inside three nautical miles of the coast (see Section 2.5).

Whilst Dunn (1999) did not give a clear indicator of the stock status, Royer *et al*., (2006) and Gras *et al.* (2014) concluded that the common cuttlefish has been fully exploited since the beginning of the 1990s (Gras *et al*., 2015). In accordance with the conclusions of Gras *et al.* (2014), Alemany *et al.* (2017) did not find any stock-recruitment relationship. However, results differ in relation to trends in exploitation rates. The latest assessment by Alemany *et al*., (2017)

[9] Gras *et al.* (2014) advocated the use of more recent data that would provide a more accurate estimate of growth.

adds six years of data, and results detect a decreasing trend of exploitation rate from 2001 to 2009, with the highest exploitation rates occurring in 2001 and 2011 (0.64 and 0.62, respectively). (Alemany, *et al.*, 2017; ICES, 2017). These higher exploitation rates were associated with low estimates of recruited biomass and spawning stock biomass in 2001, and a high estimate of the biomass growth rate parameter for 1+ in 2011 (Alemany *et al.,* 2017).

The exploratory assessments to date have been conducted with the aim of illustrating trends in exploitation rates and ongoing research has determined that trends in exploitation rate should be analysed together with trends in recruitment (J.P. Robin, pers. comm.). For example, initial observations of a stable exploitation rate with decreasing recruitment indicated that the surviving (spawning) biomass was low and suggested the stock was being overexploited. However, subsequent observations, in particular after a peak in exploitation rates in 2001, did not show a low recruitment the following year or even the year after (J.P. Robin, pers. comm.).

At this stage, therefore, reference points for this stock are not available with respect to maximum fishing mortality or minimum SSB (J.P. Robin, pers. comm.). However, there are plans to update the assessment based on the Gras *et al.* (2015) model[10].

2.4 National and Regional Research

CEFAS are currently studying reproduction in English Channel cuttlefish, including spatial and temporal patterns of spawning; estimates of fecundity; and uses citizen science (e.g. U.K. Cephalopod Reports group) to gather data on cuttlefish and egg mass sightings. The vulnerability of spawners to static gears (e.g. pots) is also being investigated; initial results indicate that there is no sex selectivity of the pot fishery, but more data is needed to confirm this result (V. Laptikhovsky pers. comm.).

Over the last year CEFAS have also worked on cuttlefish ageing techniques and are aiming to secure longer term funding for this research. Ageing is problematic in cuttlefish as statoliths become crystallized after about 6 months, making it difficult to age individuals beyond this age (V. Laptikhovsky pers. comm.). However, supposedly daily rings are laid down in cuttlefish beaks and their periodicity needs confirmation. Ongoing research is therefore exploring the utility of beaks for cuttlefish ageing. The objective is that if beaks are a feasible tool they would be not only more reliable but also a much quicker method to age specimens (C. Barrett, pers. comm.).

CEFAS are also in communication with the IFCA Technical Advisory Group (TAG), and periodically join quarterly meetings. A recent IFCA TAG meeting discussed local cuttlefish fisheries and shared information on completed and ongoing research within respective districts (C. Barrett, pers. comm.).

The Sussex IFCA has received funding from the Hastings Fisheries Local Action Group to further research on cuttlefish, focusing on; summary of biology and fisheries pressures; field trial of methods to increase egg survival in the potting fishery; and lab trials of egg survival once removed from pots (Sussex IFCA Conservation and Research Manager, pers. comm.).

[10] The Alemany *et al.*, (2017) model is a working version and therefore available assessment scripts are not suitable for updating the assessment.

In 2017, the Cornwall IFCA undertook a questionnaire with fishers who use cuttlefish traps in the district (CIFCA, 2017). The aim was to gather information about the fishery in order to improve understanding and gauge opinions about potential mitigation to safeguard egg development. A majority of the nine fishers in the study, indicated that they intend to increase their gear capacity in 2018. All the fishers reported egg coverage on their traps and 89% thought that it was important or very important to preserve eggs on traps. Despite this, 78% stated that they removed the eggs during the fishing season but only eggs from the trap entrance. Participants were then asked to rate five measures covered by a code of practice that have been adopted in other IFCA Districts. Suggested codes of practice were generally supported, but fewer would actually implement certain measures or thought they were practical.

The DSIFCA recently trialled the use of artificial media that detached from the pots as a means of protecting the eggs however, the trial was inconclusive due to a small number of eggs laid that season. Inshore fishers targeting cuttlefish in the DSIFCA district are receptive to management measures to ensure the fishery is sustainable; so long as these are proportionate to the scale of inshore catches, particularly when compared with the scale of catches taken by large beam trawlers operating mid-channel (DSIFCA Deputy Chief Officer, pers. comm.).

2.5 Current Management

As a result of their non-quota status, no European regulations currently apply specifically to stocks of common cuttlefish and they are not subject to the landings obligation. In addition, there are currently no national management measures applied specifically to cuttlefish. However, European legislation applicable to gear types used to target cuttlefish include mesh size restrictions, encompassed within the Technical Measures (EU Regulation No 850/98) and the Control Regulation (EC No 1224/2009)[11], which have some indirect impacts on fleets fishing for cuttlefish in English waters.

Current requirements of the Control Regulation mean fishing vessels over 10 m in length must keep a logbook of operations, containing information on the species taken, the geographical area, the gear and mesh size and estimated weight of the catch of each species in kilograms. For vessels over 12 m, electronic logbooks are required and information must be submitted daily. Each month the flag State must notify the Commission of its aggregated catch data. However, this only applies to quota-species and for fishing effort in areas subject to fishing effort regimes. Other fish caught must be reported in aggregated form for each stock before the end of the first month of each quarter. Within this Regulation, fishery closures only apply to quota stocks when the data indicates that the quota has been exhausted or if the maximum allowable fishing effort has been reached.

Under the current Control Regulation, there is no statutory requirement for vessels 10 m and under to declare their catches, as at the time of adoption, this was considered to cause a disproportionate burden in relation to their catch[12]. In 2005 the Registration of Buyers and Sellers of First-Sale Fish Scheme was introduced whereby registered buyers must legally

[11] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:343:0001:0050:EN:PDF

[12] On 30/05/2018 the European Commission adopted a proposal to revise the fisheries control system; within the proposal are measures to modernise the system for recording and reporting fishing activities, becoming fully electronic, irrespective of the vessels' size. See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018PC0368

provide sale notes for commercially sold fish in order to allow catches to be followed[13]. Sales notes do not require the seller or buyer to report gear or effort associated with sales weight being reported.

The EU Technical Measures aim to conserve fishery resources, largely through the protection of juveniles. Article 4 and Article 11 provide restrictions on the use of fixed and towed gear types when fishing for cuttlefish. Article 4 covers towed gear and states that the minimum percentage of cuttlefish per catch when using mesh size 80-99 mm must be at least 70%. Catches of cuttlefish by towed gears with a mesh size of over 100 mm and less than 80 mm are prohibited. Article 11 applies to fixed gears and prohibits the use and keeping on board of bottom set gillnet, entangling net or trammel net unless the catch taken with that net and retained on board includes a percentage of target species no less than 70 % or its mesh size for cuttlefish is 100 mm or larger. Also, within this Regulation, Article 34 prohibits the use of any beam trawl inside the 12 nm of the coast around the UK and Ireland. However, there are some exemptions to this provision, including:

1) A vessel which entered into service before 1 January 1987, and whose engine power does not exceed 221 kW, and in the case of derated engines did not exceed 300 kW before derating;
2) A vessel which entered into service after 31 December 1986 whose engine is not derated, whose engine power does not exceed 221 kW, and whose length overall does not exceed 24 metres; and
3) A vessel which had its engine replaced after 31 December 1986 with an engine which is not derated and whose power does not exceed 221 kW.

Notwithstanding the above exemptions, no beam trawl is allowed to operate if the beam length, or aggregated beam length, is greater than 9 m.

Vessels targeting cuttlefish are subject to various byelaws in place within IFCA districts depending on the gear and the size of the vessel. For example, while no specific byelaws exist to control fisheries targeting cuttlefish with trawls, some measures are in place that indirectly help to conserve stocks. For example, a Southern IFCA byelaw[14] excludes vessels >12 m in length operating, except a small number of trawlers (based in Brixham) that have fished historically in the district, but these vessels have not recently targeted cuttlefish and are not active within 3 nm. Within the Cornwall IFCA, there is a Trawling byelaw[15] that restricts trawlers to a maximum boat size of 18.28 m (Cornwall IFCA Officer, pers. comm.). There is also a byelaw on vessel length[16] in place within the Sussex IFCA which prevents vessels over 14 m from fishing for sea fish in the District, except if that vessel was fishing before the byelaw came into force and if fishing is occurring between 3 and 6 nm off the coast. A Trawling Exclusion byelaw[17] also exists to protect juvenile fish within specific areas of the Sussex IFCA district, which prohibits trawling in the District from the 1st May until the last day in October, within an area extending a quarter of a nautical mile out to sea from the lowest astronomical tide. In the Devon and Severn IFCA, trawling is limited to smaller otter trawls and a mobile fishing permit

[13] https://www.gov.uk/guidance/fishing-activity-and-landings-data-collection-and-processing
[14] SIFCA Vessels used in Fishing byelaw; http://www.southern-ifca.gov.uk/byelaws
[15] CIFCA Trawling byelaw; https://www.cornwall-ifca.gov.uk/Byelaws_Regulations
[16] https://www.sussex-ifca.gov.uk/vessel-length
[17] Sussex IFCA Trawling Exclusion byelaw; https://www.sussex-ifca.gov.uk/trawling-exclusion-byelaw

byelaw covers trawling activities[18]. Within this byelaw, mobile fishing gear is prohibited unless the gear is in accordance with a permit, the vessel is under 7 m in length and uses a certain mesh size for sand eels.

Some cuttlefish spawning grounds off the coast of the UK are also protected through the designation of a Marine Conservation Zone near Torbay, which prevents impacts from fishing activities on seagrass beds (Huntingdon, 2015; Marine Conservation Zones, 2013). Straddling across the Devon and Severn and Southern IFCAs is the Lyme Bay reserve SAC; within this reserve, the use of mobile gear is prohibited and there is a voluntary pot limitation in place[19] of 250 per vessel when potting for crabs or lobsters (with no more than 10 in each string).

For static gear such as pots and traps there are some specific byelaws in place within IFCA districts that aim to regulate cuttlefish fishing. The Sussex IFCA currently operates a shellfish permit byelaw, restricting commercial permit holders to a maximum of 300 cuttlefish pots within 6 nm[20]. Under this byelaw, permit holders are required to submit information on shellfish catch and fishing effort to the IFCA. Information should be provided every three months for CPUE (kg per pot) and include data on quantity of shellfish caught and retained per month, average number of pots hauled each fishing trip and the number of trips during which a particular gear was worked. This information is used in conjunction with data from the MMO Shellfish Licence catch returns, biological information and at sea surveys to support sustainable exploitation[21].

Devon and Severn IFCA have a potting permit byelaw in place that, while does not specifically apply to common cuttlefish, prohibits the use of pots for fishing in the District unless that person is in accordance with a permit[22].

There are no byelaws in place that restrict static gear specifically for cuttlefish exploitation in the Southern IFCA but they are currently undertaking a review of their static gear measures (Southern IFCA officer, pers. comm.). In the District of the Southern IFCA, a Code of Practice[23] was implemented in relation to common cuttlefish traps; it was deemed that only a small change to fishing practices was needed and therefore did not warrant a byelaw. These rules apply to any person carrying out common cuttlefish trapping and include:

- If common cuttlefish eggs are found attached to common cuttlefish traps take care to minimise damage caused to these eggs when hauling and shooting gear;
- Avoid cleaning or washing traps when common cuttlefish eggs are found attached;
- Once traps have finished fishing for the season fishermen should not remove their traps from the sea until the common cuttlefish eggs attached have hatched, typically during late August or September;
- When leaving traps in the sea, users should seek to avoid conflict with other users of the sea and avoid damaging features of Marine Protected Areas; and
- When leaving traps in the sea, users should regularly attend their traps to remove captured creatures or remove entrance panels to avoid ghost fishing.

[18] https://secure.toolkitfiles.co.uk/clients/15340/sitedata/4E/Mobile_Permit_Byelaw/Mobile-fishing-permit-byelaw.pdf
[19] http://www.lymebayreserve.co.uk/download-centre/files/Lyme_Bay_Fisheries_and_Conservation_Reserve_Voluntary+Code_of_Conduct.pdf
[20] https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Byelaws/Shellfish-Permit-Guidance.pdf
[21] https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Byelaw_docs/Catch-Returns-Instructions.pdf
[22] https://secure.toolkitfiles.co.uk/clients/15340/sitedata/4E/Potting_Permit_Byelaw/Potting-Permit-Byelaw.pdf
[23] http://www.association-ifca.org.uk/Upload/News/Southern%20IFCA%20Newsletter%20Summer.pdf

Across the Channel, in France, exploitation of cuttlefish in inshore waters is managed by local management measures put in place by Regional Fisheries Councils (Comité Régional des Pêches Maritimes – CRPM). These include a minimum marketing size of ≥100 g[24], mesh sizes > 80 mm in otter trawls, and bans on vessels from operating within 3 nm (Gras *et al.,* 2014). However, two exemptions to the inshore ban exist, one during four weeks in spring to enable trawl fleets to exploit spawners and one during two weeks in summer, to enable them to exploit juveniles. A license system is also in place along the coast of Normandy to limit fishing effort and access to the fishery, managed by the CRPMs (ICES, 2017). Pot and trap fishing licences are restricted to vessels under 12 m and authorise fishing in a defined area only. There are currently no restrictions on the number of fishing days (Seafish, 2017a). There is currently no specific regulation for offshore trawling on common cuttlefish stock although regulations that are defined for multispecies bottom trawling applies (Seafish, 2017a).

The effectiveness of the minimum marketing size for cuttlefish targeted by demersal trawls is questionable. According to length-weight relationships, 100 g corresponds to about 90 mm ML (J.P. Robin, pers. comm.), but the University of Caen fish market sampling programme includes observations of thousands of juvenile cuttlefish of this category with a mean size of 113 mm ML (1st quartile = 100 mm and smallest specimen 60 mm). The survival rate of discarded cuttlefish has been studied by Revill *et al. (*2015) who reported an immediate survival rate of 31% for cuttlefish smaller than 150 mm ML, and that additional mortality occurred later (Alemany, *et al*., 2016). In addition, the exemptions for fishing within 3 nm in spring and summer are automatically granted in Normandy, which might result in a loss of production as well as a destruction of juvenile habitats (Alemany, *et al*., 2016).

2.6 Issues and Concerns

Cuttlefish fisheries in the English Channel present a complex management situation that is influenced by multiple factors which can potentially impact long-term sustainability.

Firstly, the relative vulnerability of the common cuttlefish to overfishing is largely created by their complex and multi-staged lifecycle, which in turn creates difficulties in assessing their stock status and our ability to predict responses to management interventions. Cuttlefish are generally considered to be semelparous, completing complex feeding and overwintering migrations at various stages in their lifecycle, before spawning. However, both their spawning cycle (e.g. GIB or GIIB) and related migratory behaviours are highly variable in space, time and within a population, driven largely by the influence of environmental conditions, particularly temperature. Furthermore, the significant (and little understood) impacts of environmental factors creates highly variable growth and maturity rates, leading to difficulties in determining growth parameters, which in turn limits our options for length, age or cohort analyses.

Their semelparous nature means that annual recruitment accounts for almost the entire common cuttlefish stock biomass for the following two years. However, due to their variable migrations and the difficulties in determining the environmental conditions an individual (and a population) has been exposed to throughout the duration of their lifecycle, the development

[24] Based on Council Regulation 2406/96 laying down common marketing standards for certain fish products; 100 g is the lower bound of the smallest category defined at the EU level for sorting out commercial catches (category #3).

of a stock-recruitment relationship is problematic and recruitment strength cannot be predicted in order to determine future biomass estimations.

Secondly, cuttlefish are exploited by a number of different fleets encompassing a range of vessel sizes and gears. Fisheries exist both inshore and offshore, across all their life stages, and on both sides of the Channel. The relative performance of these fisheries is inherently linked due to their sequential nature, the connectivity of the stock and by the various migrations of each cohort from one fishery to the next (J.P. Robin, pers. comm.; Royer *et al*., 2006). In addition, although there are some limits in place for inshore fisheries, through shellfish licensing schemes and restrictions on towed gear, there are fewer restrictions further offshore for vessels using mobile gear.

Inshore spring cuttlefish fisheries operate for a limited period (between 6 and 10 weeks) and largely target adult sections of the stock. Although the scale of removals is currently relatively low in comparison to removals by the offshore fishery, potential impacts still exist, including; removal of adults before spawning; removal of juveniles by relatively unselective gears (otter and beam trawls and fixed nets); and damage to spawning and nursery habitats.

Fisheries taking place in autumn and winter, tend to target immature cuttlefish offshore with mobile gears. Due to the limited selectivity of these gears, with respect to the size of cuttlefish retained, the same cohort may be targeted twice (at 3+ months and 15+ months) if offshore migrations coincide with the onset of the autumn/ winter fishery. Cuttlefish removed prior to 15+ months will not have had a chance to spawn and discard survival of very small (3+ months) or unwanted cuttlefish is reported to be limited (Revill *et al.*, 2015). As a result of these factors, there is increased risk of recruitment overfishing in the offshore environment.

The multifaceted exploitation of cuttlefish linked with the variable and difficult to predict lifecycle traits, makes them particularly vulnerable to recruitment overfishing, and what is more, makes them difficult to manage with any certainty of future implications.

Due to the consistently high market prices of cuttlefish, an annual ‘race to fish’ is often described (based on local and national press and stakeholder observation), with large (>24 m length) vessels with the capacity to freeze catches *in situ*, joining the offshore fleet from areas further afield. Furthermore, this has led to shifts in the behaviour of local fleets being observed in recent years. For example, there is evidence (based on reported landings and stakeholder observation), that the lure of high prices is beginning to influence fleet behaviour, with the seasons extending beyond the ‘usual’ seasons for targeting the species (i.e. inshore spring fisheries targeting spawning cuttlefish and offshore winter fisheries targeting adults prior to spawning); with the onset of the autumn fishery occurring earlier in the year and closer inshore, and the spring fishery extending beyond periods of large spawning adult abundances.

Although there may be aspects of each of the fisheries targeting cuttlefish that require further research and management considerations, especially with respect to minimising secondary impacts (e.g. prevention of damage to eggs laid on traps and reduction in damage to spawning and nursery habitats), the potential impacts of removals of immature individuals (<1-year-old) across a number of the fleets targeting the species warrant greater, and possibly more urgent, attention. However, given the current limited reporting and data collection requirements for cuttlefish, it is difficult to ascertain the scale at which removals of juvenile cuttlefish is occurring. Data limitations exist primarily because common cuttlefish are a non-quota-species, therefore there is no EU obligation to collect data for the purpose of stock assessment.

3 Management Recommendations

Common cuttlefish fisheries in the English Channel present a management challenge as a result of their complex lifecycle and gaps in our understanding of the impact of environmental variables on population dynamics, which limits our ability to perform stock assessments. Added to this is the fact that cuttlefish are exploited on both sides of the English Channel, and by a number of different fleets, encompassing a range of vessel sizes and gear types.

Here we synthesise the information included within this report, in order to present a number of recommendations to improve current management of common cuttlefish. Table 2 below summarises currently recognised sustainability issues for common cuttlefish fisheries in the English Channel, by gear type and associated management jurisdictions, alongside current research and management status and future needs.

The following recommendations address four key priorities in a sequential approach, with the first two providing the evidence base with which to determine the appropriate management measures put forward to address current conservation issues in the last two recommendations:

- **Develop an English Channel data collection plan:** Consolidate and review available data encompassing fisheries dependent and independent data available across national and international jurisdictions (IFCAs, MMO, French Maritime Affairs and CRPM) and develop a long-term, cross-cutting data collection plan that addresses data gaps. For example, data collection might include:
  - *Spatial and temporal extent of current exploitation by all gears:* reporting of cuttlefish catches including estimated weight in kilograms and associated effort, by geographical area, gear and mesh size, for all vessel length groups;
  - *Size frequency of cuttlefish caught:* fisheries independent port sampling and/ or on-board data collection sampled proportionally across all gears;
  - *Maturity of cuttlefish caught:* fisheries independent port sampling and/ or on-board data collection sampled proportionally across all gears.
- **Instigate regional coordination of scientific research for improved monitoring, stock assessment and management:** Options and funding should be explored to establish a national and/ or English Channel cuttlefish working group. The working group should include management, science, policy and industry representatives to facilitate coordination of on-going monitoring, research and management. This could be implemented through a series of national and/ or regional workshops, taking a phased approach, starting with consolidation and review of available data and the development of a long-term data collection plan; followed by review of previous and expected research outputs to date to prioritise and coordinate future research efforts. Examples of research could include:
  - *An assessment of the variation in growth rates and length at maturity in space and time* i.e. both between and within years throughout the English Channel.
  - *An assessment of the effectiveness and environmental* impacts of potential management measures e.g. MCRS, effort limits, temporal and spatial limits to catches of cuttlefish

   - *An assessment of the socio-economic value of cuttlefish to fleets* currently targeting cuttlefish and the potential socio-economic impacts of potential management measures.

Outcomes of the data collection and associated research resulting from the preceding recommendations, should help further the understanding of the proportion of juvenile cuttlefish being exploited across fleets and inform decision making on management measures such as seasonal closures or control of un-selective gear capacity.

- **Limit catches of juvenile (<1-year-old) cuttlefish:** Potential options include:
   - *temporal limits on catches of cuttlefish for all gears* e.g. between August/September and October;
     and/or
   - *spatial restrictions for certain gears* e.g. protecting known concentrations of juvenile stocks

  It is important to note however, that temporal and spatial distributions of juvenile cuttlefish are not fixed due to environmental variation within and between years, and as such associated temporal and spatial limits could be difficult to determine and management mechanisms by which they are applied would need to be adaptive.
  Any move towards closed seasons or areas, should be done based on outcomes of an assessment of the socio-economic and environmental impacts, including effort displacement to other gears and/ or areas (See Recommendation 2 above).

- **Establish appropriate effort limits across all gears:** A review of options for limiting effort should be completed, particularly for fleets active beyond 6 nautical miles and for unselective mobile gears, through a review of licensing/permitting conditions. This recommendation is based upon the assumption that outcomes of data collection and associated research indicate such an action is appropriate. However, if data cannot be gathered to determine whether current exploitation levels are sustainable or not, then the Precautionary Approach implies effort should be capped at current exploitation levels based on the most up to date information available.

Table 2: Recognised sustainability issues for common cuttlefish fisheries in the English Channel and management/research status and future needs.

Sustainability	Detail and potential impacts	Gears & vessel sizes	Jurisdiction	Management/research status and future needs
Targeting of spawning adults and impacts of sexual selectivity	Although the pot fishery is generally considered to be a ‘low impact’ fishery, which is targeting individuals once they have reached maximum biomass potential at the end of their life-cycle and after spawning; it is possible that some cuttlefish will be removed prior to spawning has been completed. Due to the intermittent nature of spawning in cuttlefish where individuals may spawn in multiple events through the entire duration of the breeding season, or spawn during a single event within only a small fraction of the breeding season, it is currently not possible to determine what proportion of spawners are caught before/after spawning. The extent to which the pot fishery is selecting males or females is also not confirmed; initial results indicate that there is no sex selectivity of the pot fishery, but more data are needed to confirm this observation (V. Laptikhovsky, pers. comm). Otter trawls and beam trawls are also active during the spawning season, but detailed information on location of this activity is yet to be determined.	**Pot/traps** **<10m vessels**	<6 n miles; IFCA	Research is currently underway at CEFAS to further explore intermittent spawning which should contribute to understanding better the extent to which spawning females are being removed before/after spawning by all gears targeting adults within spawning period. The vulnerability of spawners to static gears (e.g. pots) is also being investigated by CEFAS; initial results indicate that there is no sex selectivity of the pot fishery, but more data is needed to confirm this result (V. Laptikhovsky pers. comm).
		Gill nets (mesh sizes ranging from 40-260mm, with 70% catches 2015-2017 from mesh sizes 100 and 120, MMO, 2018) **Trammel nets** (ranging from 90-264mm, with 98% catches 2015-2017, from 90-120mm, MMO, 2018 **<10m vessels**	<6 n miles; IFCA	There is no research currently under way exploring impacts of static nets on spawning adults and impacts of sexual selectivity. **Data available from these fisheries should be consolidated and reviewed** to **determine spatial and temporal extent of fisheries, and the size frequency and maturity of cuttlefish caught** (e.g. CEFAS fisheries independent port sampling; MMO sales note data; IFCA permit condition data) **Data gaps addressed through development of a data collection plan cross-cutting IFCA and MMO jurisdictions.** The Southern IFCA has recently begun a review of their static gear measures.
		Otter trawls **mesh size 70-99 mm**	<6 n miles; DSIFCA SIFCA	No research currently under way exploring impacts of otter or beam trawls on spawning adults and impacts of sexual selectivity.

Sustainability	Detail and potential impacts	Gears & vessel sizes	Jurisdiction	Management/research status and future needs
		<12m vessels	6-12 n miles; MMO	**Data available from these fisheries should be consolidated and reviewed to determine spatial and temporal extent of** fisheries, and **the size frequency and maturity of cuttlefish caught** (e.g. CEFAS fisheries independent at sea and port sampling; MMO annual statistics) **Data gaps addressed through development of a data collection plan cross-cutting IFCA and MMO jurisdictions.**
		Beam trawls **mesh size 80-90 mm** **>12 m vessels**	6-12 n miles; MMO >12 n miles, MMO	
Damage to eggs laid on traps	Female cuttlefish lay eggs on the traps, both on the outside/inside of the structures, and concern has been raised as to the potential impact damage/mortality to these eggs might have on Various research has been completed (Blanc et al., 1998; Bloor, 2012; Melli et al., 2014), with a variety of conclusions drawn. Damage to these eggs undoubtedly has a negative impact, however, this stage is not considered to be a limiting factor to stocks/recruitment at the present time (J.P. Robin, pers. comm).	**Pot/traps** **<10m vessels**	<6 n miles; IFCA	Research is underway by CEFAS and IFCAs to explore the impacts of damage to eggs laid on traps. CEFAS are researching estimates of fecundity and collaborating with the Marine Conservation Society to gather data on cuttlefish and egg mass sightings. Sussex IFCA are carrying out field trials of methods to increase egg survival in the pot fishery, and laboratory trials exploring the survival of eggs once removed from pots. The DSIFCA trialled the use of artificial media that detached from the pots as a means of protecting eggs, however, the trial was inconclusive due to a small number of eggs laid during the field season.
Juvenile/immature (<1-year-old) cuttlefish targeted prior to reaching maximum biomass potential and prior to spawning	Winter trawl fisheries are generally targeting >1-year-old cuttlefish distributed in areas further offshore; at this stage most males are mature and females are in the process of maturing. However, there have been observations and reports of trawl fleets beginning to target cuttlefish earlier in the year in late summer, and further inshore than historical locations of the autumn winter fishery, and as a result cuttlefish are being exploited before the	**Possibly trammel nets** mesh size: see above **<10m vessels**	<6 n miles; IFCA??	Length/size frequency data are not collected routinely for any of the static gears targeting cuttlefish at present. **Data gaps addressed through development of a data collection plan cross-cutting IFCA and MMO jurisdictions**
		Otter trawls **mesh size 70-99mm**	<6 n miles; DSIFCA SIFCA 6-12	Length/size frequency data are not collected routinely for any of the fleets/gears targeting cuttlefish at present.

Sustainability	Detail and potential impacts	Gears & vessel sizes	Jurisdiction	Management/research status and future needs
	cohort of interest has reached maximum biomass and economic potential (J.P. Robin, pers. comm). At this stage, growth is very fast and a few months later the weight of the animals (and cohort biomass) will be much greater (J. P. Robin, pers. comm). There is also a possibility that annual offshore winter fisheries are exploiting 3+ month juveniles once during the first migration made in their lifecycle. Same cohort potentially targeted twice (3+month and 15+ month).	**10-12m vessels** **Beam trawls mesh size 80-90 mm** **>12 m vessels**	n miles; MMO 6-12 n miles; MMO >12 n miles, MMO	**Data available from these fisheries on size frequency and maturity of cuttlefish caught** (e.g. CEFAS fisheries independent at sea and port sampling; MMO annual statistics) and landings data reported by fish markets to MMO/CEFAS by size grade to be consolidated and reviewed. **Data gaps addressed through development of a data collection plan cross-cutting IFCA and MMO jurisdictions** **Research is required to explore the effectiveness and social/economic impacts of spatial limits (for inshore nursery areas) and temporal (August-October) limits for non-selective gears.**
Limited discard survival	Due to non-quota status, cuttlefish are not subject to the landing obligation, therefore any unwanted catches can be discarded at sea. Although, cuttlefish are increasingly being targeted, in certain circumstances, for example if the vessel is targeting another species such as sole, megrim etc., cuttlefish may be unwanted catch and discarded. Cuttlefish caught in trawls have limited survival (ranging from 16-30% based on survival studies (Revill et al., 2015); the concern is that small individuals may be caught and discarded, before they have reached their maximum biomass potential and will also be removed from the spawning stock. Cuttlefish caught in pots generally have high survival rates, and small individuals can easily be returned to the sea alive; however, there is no/limited data on the level of discarding in this fishery.	**Otter trawls mesh size 70-99mm** **10-12m vessels** **Beam trawls mesh size 80-90 mm** **>12 m vessels**	<6 n miles; DSIFCA SIFCA 6-12 n miles; MMO 6-12 n miles; MMO >12 n miles, MMO	Length/size frequency data are not collected routinely for trawl fleets targeting cuttlefish at present. **Data available from these fisheries on size frequency and maturity of cuttlefish caught** (e.g. CEFAS fisheries independent at sea and port sampling; MMO annual statistics) and landings data reported by fish markets to MMO/CEFAS by size grade to be consolidated and reviewed. **Data gaps addressed through development of a data collection plan cross-cutting IFCA and MMO jurisdictions** Minimum Conservation Reference sizes may not be appropriate for cuttlefish, given their limited survival if caught by trawl gears; however, putting such measures in place might discourage targeting of juvenile cuttlefish. **Research is required to explore an appropriate MCRS and potential effectiveness** given spatial and

Sustainability	Detail and potential impacts	Gears & vessel sizes	Jurisdiction	Management/research status and future needs
	Cuttlefish caught in trammel nets also have relatively high survival rates (Mudeford skipper, pers. comm), but this depends on the length of time the net has been left to soak. There is no/limited data on the level of discarding in this fishery.			temporal variation in impacts of environmental variables on growth/maturation of cuttlefish.
Unlimited effort/entry into the fishery	Historically (~35 years ago), (beam) trawl fisheries took cuttlefish (and squid and monkfish) but this was a time when communications between markets and fleets was more limited and so there was little incentive for landing these species. The situation has reversed now, in that there is much greater communication between market demands and fleets operating in the region; and cuttlefish, squid and monkfish are now in the top three species in terms of landings and value in the south-west (Plymouth Fish Market Data). The main drivers of these increased landings include: 1) the increase in unit price of cuttlefish due to the development of overseas markets (namely southern Europe) 2) a diversification of fishing effort following declining catches and more restrictions on established species (including cod and sole) 3) in combination with an apparent increase in cuttlefish abundance and improved reports of landings Various factors have been referred to anecdotally as drivers of the continued increasing trend in cuttlefish market price; most recently, the collapse in an Indian Ocean cuttlefish fishery is referred to as being the driver of the elevated prices (up to £5/kg) observed in 2017 (CIFCA, 2017).	**Pot/traps** **<10m vessels**	<6 n miles; IFCAs	Effort limits for potting are currently in place within the Sussex IFCA (shellfish permit byelaw limiting 300 pots/6 nautical miles for cuttlefish). To date, there are no limitations on the number for cuttlefish traps in Lyme Bay Reserve SAC. However, there is a voluntary limitation in place for whelk pots and crab and lobster pots within this area. This is currently 500 whelk pots per vessel with no more than 30 in each string and 250 crab and lobster pots per vessel with no more than 10 in each string; the reserve straddles the Southern and Devon and Severn IFCA Districts. **Consideration of implementing effort limits for those IFCAs for which no permit conditions apply to cuttlefish potting/trapping, taking into account potential social/economic impacts.**
		Trammel nets mesh size: see above **<10m vessels**	<6 n miles; some IFCAs	DSIFCA static gear permit is in place **Consideration of implementing effort limits for those IFCAs for which no permit conditions apply to static nets targeting cuttlefish taking into account potential social/economic impacts.**
		Otter trawls **mesh size 70-99mm** **10-12m vessels**	<6 n miles; IFCA?? 6-12 n miles; MMO	Vessel size restrictions are in force within the Southern (>12m); Sussex (>14m) and Cornwall (>18.28) IFCAs; vessels greater than these overall lengths are excluded from fishing within
		Beam trawls	6-12 n miles; MMO?	

Sustainability	Detail and potential impacts	Gears & vessel sizes	Jurisdiction	Management/research status and future needs
	This elevated price has led to a ‘race to fish’ for vessels ranging in size across small day boat trawl vessels, local large beam trawlers; larger pair trawlers entering the region from elsewhere in the UK, right up to freezer trawlers travelling from as far afield as Northern Ireland, Ireland and Scotland. Gear used is considered to be unselective with respective to the size of cuttlefish that can be caught; but there is limited data on the size frequency of catches; mainly limited to market data categorised by size grades used for sale (size 1, size 2 and size 3 to a lesser extent).	**mesh size 80-90 mm** **>12 m vessels**	>12 n miles, MMO	their districts except in certain circumstances[25]. These limits are considered to be relatively effective in limiting trawl gear often deployed by the larger vessels (Southern IFCA, pers. comm). Beyond 6 nautical miles there are no measures in place to limit effort from trawl gears on cuttlefish. Current stock assessments are not currently able to make reliable predictions on stock biomass from one year to the next or to set limit reference points, due to significant impacts of environmental variability on key population parameters (growth, recruitment). However, given the consistently high demand for and market prices obtained for cuttlefish, some protection is required to prevent effort and catches becoming unsustainable. **Options for limiting effort beyond 6 nautical miles should be considered either through a review of licensing conditions or exploration of temporal/spatial limits on use of or landings from unselective gears targeting cuttlefish.**
Connectivity between fisheries throughout the English Channel	The analysis of interactions between fishing fleets exploiting English Channel cuttlefish (Royer et al, 2006) has shown that the exploitation of cuttlefish cohorts was made in a temporal sequence by a series of fishing fleets. Because of this, inshore trap fisheries are highly dependent on the extent to which catches have been made earlier in the fishing season by trawlers fishing further offshore. Another example of the consequence of this temporal organisation of effort was observed between summer 2017 and spring 2018. In late	All gear and vessel types, <6 nm, 6-12 nm, >12 nm	Add French management bodies	There is limited coordination of French and English National research or management directed at fisheries occurring on both sides of the English Channel. There is currently involvement of French and English/UK scientists at WGCEPH but currently, no English/UK representation within the stock assessment sub-group of WGCEPH. Coordination/communication of research and management takes place between IFCAs through

[25] Expect for a small number of vessels (based in Brixham that have fished historically in the district, which do not currently target cuttlefish or fish within 3 nautical miles.

Sustainability	Detail and potential impacts	Gears & vessel sizes	Jurisdiction	Management/research status and future needs
	summer beginning of autumn 2017, English 'inshore' trawlers (exact location still to be determined) exploited significant numbers of one-year-old cuttlefish (which appeared to be spatially concentrated for some undetermined hydro-climatic reason), subsequent very low landings in winter and also in spring during the spawning season are believed to be the consequence of such catches (J. P. Robin, pers. comm.). This illustrates that the resource cannot be managed at the local scale of an inshore bay, or even at the larger scale of the offshore central zone, where the more extensive winter fishery takes place; all of these different fishing grounds are connected to each other (J. P. Robin, pers. comm.).			the IFCA Technical Advisory Group (TAG), CEFAS participate in these meeting periodically. There is also informal management coordination between MMO and IFCAs via MMO membership of IFCA Committees, MMO participation in IFCA CEO meetings and IFCA TAG; through which 'emerging risks' can be raised. However, it is not clear whether a formal mechanism is in place for tracking, communicating and managing potential interactions between inshore and offshore fisheries targeting non-quota stocks in England/UK. **Explore options and funding to instigate a national and/or cross-channel working group on cuttlefish fisheries involving management, scientific, policy and industry representatives to facilitate on-going monitoring, research and management coordination.**
Impact of environmental variables on productivity of cuttlefish stocks	Environmental variables have substantial impacts on growth, maturation and associated migration patterns across all stages of the lifecycle and therefore impact ultimate biomass of stock; this makes it difficult to determine stock-recruitment relationship and also to make biomass predictions into the future.	NA	NA	Alemany at al., (2017) suggest **that the variation in growth rates and the length-weight relationship of cuttlefish both between and within years also requires further research.**
Damage to spawning and nursery habitats (e.g. seagrass beds)	Impacts of trawling have been well documented to result in the physical disturbance of the sea bed and also cause direct and indirect effects on biological communities due to changes in the physical attributes of the areas being trawled. Trawling in spawning areas will not only impact the seabed but may also damage/trawl previously spawned eggs.	**Otter trawls** **mesh size 70-99mm** **10-12m vessels**	<6 n miles; DSIFCA, SIFCA 6-12 n miles; MMO	Some of the key spawning areas in English waters within the English Channel are protected through the designation of SACs/MCZs (e.g. Lyme Bay Reserve SAC; Torbay MCZ). **Consolidation and review of data available on spawning areas should be carried out to determine options for spatial management measures on unselective mobile gears inshore.**

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