Centre for Environment Fisheries & Aquaculture Science

Cefas

Report: Western Channel Cuttlefish: Sepia officinalis Biological Sampling at Plymouth and Brixham Fish Markets December 2018– June 2019.

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1 Executive Summary

This project used port-based sampling to investigate if there were distinct combinations of time, space and gear which indicated targeting of juvenile cuttlefish. The capture of smaller, immature animals in substantial numbers is likely to be sub-optimal in terms of both yield potential and spawning potential. Cuttlefish are typically mature when above 16cm mantle length and die after spawning at 2 years old.

Landings of cuttlefish from UK vessels are predominantly from the English Channel and, although variable, have risen from an average of 3712t (2000-2014) to 5400t (2015-2019), suggesting an increase in exploitation. Two ports dominate the landings, Brixham (57%) and Plymouth (11%). Landings in Brixham are predominantly from beam trawls with otter trawls predominating landings into the port of Plymouth. Cuttlefish landings from beam and otter trawls represent 87% of total UK cuttlefish landings.

Between December 2018 and June 2019, weekly samples of Cuttlefish landings were taken at Brixham and Plymouth with the majority of samples coming from beam and otter trawls.

The data revealed that all gears catch immature (<16cm mantle length), mature and pre-spawning individuals, although results from the static and dredge gears should be taken with caution as there were few samples for these gears (31 out of a total of 198). When viewed over the whole season, around 75% of individuals landed by trawl gears are immature, however because these animals are small they only make up ~26% of the tonnage landed.

Otter trawl landings into Plymouth saw a particular concentration of immature individuals from ICES rectangle 29E5. Likewise, in Brixham, landings from otter trawls saw a particular concentration of small individuals from 30E6. On a trip by trip basis for both Plymouth and Brixham, the catch composition from beam trawls was polarised to either almost all large or all small with little evidence of an even mix. This implies some level of spatial separation between small and large cuttlefish, however, given the spatial resolution for reporting the catches and the weekly sampling design we cannot assess whether there is specific targeting of size classes occurring or if the catch composition occurs by chance. Addressing the issue of targeting would likely require a sampling program directly involving the industry and collection of samples directly from the hauls rather than reliance upon the sampling of landed catches.

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2 Introduction

Between 2008 and 2018, weight of common cuttlefish (primarily *Sepia officinalis*) by UK vessels to the UK has increased by 60%. The average landings between 2008-2014 was around 3,600 t compared to around 5,200t for the period 2015-2018). The increase in value is double the increase in landings at around 130% comparing the same periods. The English Channel (ICES Division 7.d and 7.e) contribute to 99% of cuttlefish landings from ICES Subarea 7.

The increase in landings has occurred at a time of increasing market price per kilo, possibly as a result of reduced squid fisheries in South America. This combination of factors resulted in strong growth in the economic importance of cuttlefish fisheries to the UK. There are currently no management measures in place for cuttlefish fisheries at either EU or National levels. Some preliminary international stock assessments have been undertaken, but there are no regular assessment programs in existence, nor are there extensive fishery monitoring schemes for these fisheries.

The increase in the fishing effort targeted at cuttlefish has raised concerns over exploitation levels, particularly as most individuals have a relatively short lifespan of up to 2 years (cuttlefish die after spawning). Concern has been voiced from some sectors that landings may comprise substantial volumes of the immature portion of the stock (1-year olds) and that this practice may be impacting stock development and potential yield. This project is designed to quantify the landing composition of cuttlefish over the 2018–2019 winter fishery with a view to establishing if there are identifiable fishing practices (gears/locations/times) which result in larger proportions of juvenile cuttlefish in the landings and to estimate the relative proportion of juveniles in the overall landings. The results of this research could then be used to develop management structures aimed at ensuring fishery practices are sustainable whilst maximising economic opportunities.

3 Methods

3.1 Biological data collection

Ocean Ecology Limited (OEL) were contracted by Centre for the Environment, Fisheries and Aquaculture Science (Cefas) to collect biological sampling data from the common cuttlefish (*Sepia Officinalis*) landed into Brixham and Plymouth fish market for the 6-month fishing season (December 2018–June 2019). Each fish market was visited by OEL once a week for the duration of the sampling period. The target was to collect five cuttlefish samples from each market, each week.

A stratified sampling design was used whereby each sample consisted of 200 animals from ungraded landings (mixed size) or 40 animals per grade when landings were graded by size (2 grades) from one vessel. These numbers were chosen based on experience from other sampling exercises and were considered sufficient to characterise the size composition of each catch. Unstratified sampling (i.e. based on a % of each landing) would have led to vast oversampling of large landings.

Where cuttlefish are landed by grade, Grade 1 animals are typically below 15 cm mantle length, with Grade 2 being mostly animals above 15 cm. Grading is performed by eye hence the 15 cm boundary is approximate. Where landings were pre-sorted by grade, only those landings where both grades were available to the sampler were used to ensure proper characterisation of the catch. For each sample vessel name, PLN number, gear type, sample weight, individual weight and date sampled were also recorded to allow for comparison analysis between vessel size, gear type, location and seasonality.

Project sampling commenced on 4 December 2018 and occurred weekly until 4 June 2019 (6-month period). The only exception to this was during the fourth week of sampling (the week of 25 December) when the markets were closed for the Christmas holidays, therefore making the market inaccessible. Over the course of the project each market was visited on 17 separate occasions. The fish markets were mostly visited by OEL on Monday and Tuesday mornings between the hours of 0200 and 0600. Markets were visited on alternative days when small catches were expected on the respective Monday and Tuesday. The markets were visited in the early hours of the morning to allow of the maximum number of landings from the previous day and not to interfere with the Market which commenced at 0700. Mondays' were deemed to be the best day for sampling as there were inflated number of landings due to there being no markets held on Sundays.

OEL submitted raw data tables and a short progress report to Cefas every two weeks throughout the program. A final report and final full raw data table was submitted to Cefas on 4 July 2019 by the OEL project lead.

3.2 Official landing data

Reported landings from the official national database (source: Marine Management Organisation) were downloaded on the 1 February 2020 in order to have the most recent available landings.

3.3 Data processing

The sample data were used to estimate the length distribution of landings by gear type and rectangle over the sample period. The sampling unit is the week's landings

for a particular vessel (calendar week). In order to estimate the location of fishing, we allocated the sample to the rectangle from which that vessel recorded the most landings in the preceding week.

A number of discrepancies between the gear type recorded by the sampling team and the officially recorded gear (iFISH database) occurred. It is not clear which data source contains the correct gear classification as errors are known to be occur in both MMO and market sampler data sources. In the absence of any data to identify which source was likely to be more accurate the gear allocated to each sample was taken as the iFISH reported gear. A future sampling exercise that directly involves fishers taking the samples may avoid this issue.

The numbers at length for each sample were then raised up to be representative of the previous weeks catches for that vessel. Numbers at length for a sample were multiplied by the ratio (raising factor) calculated as the official (iFish) landings for that vessel and week divided by the sample weight.

$$RF = \frac{Total\ Grade\ Weight}{sampled\ weight\ for\ Grade}$$

Jereb *et al*. (2015), suggest that the length of 50% maturity (MLm50%) for males was reached at 14.6 cm mantle length (ML) in the English Channel with 100% maturity at 17.0 cm, whist for females MLm50% was 16.4 cm ML and 100% maturity by 23.0 cm. The division between "immature" and "mature" size classes in the analysis has therefore been set at 16 cm to better match the maturity profile of cuttlefish rather than the 15 cm commercial grade boundary.

3.3.1 Data Overview

The location of the main fishing grounds where activity targeted at cuttlefish (i.e. trips where cuttlefish comprised at least 40% of the catch, beam trawls 2012-2017) is given in Figure 1.

The 6-month long programme resulted in 347 vessel landings being sampled, 169 from Plymouth and 178 from Brixham market. Valid samples comprised of a total of 11,008 individual measurements of cuttlefish, 5,179 from Plymouth market and 5,832 from Brixham market.

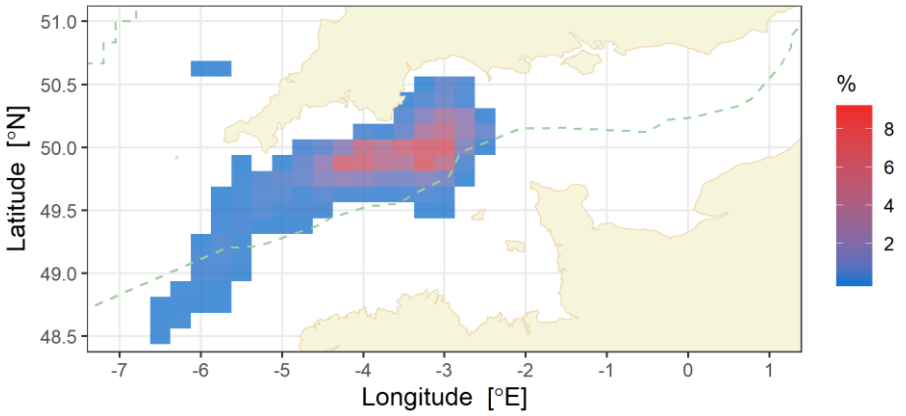

Figure 1: Fishing location of UK fleet (>=12m) fishing for cuttlefish using beam trawls 2012-2017.
Green dashed line represents the UK EEZ. Target species is defined as comprising at least 40% of total catch per trip

Table 1: Summary table of the data from the two market samples.

	Brixham	Plymouth	Total
Samples	178	169	347
Individuals	5,832	5179	11,008
Unique vessels	70	54	

At Plymouth, 54 different vessels were sampled ranging in length from 5.6 m to 22 m. The mantle size for the common cuttlefish sampled at Plymouth ranged from 4.5–31 cm corresponding to individual weights of 30 and 2,950 g.

At Brixham, 70 different vessels were sampled ranging in length from 4.76 m to 34 m. The mantle size for the common cuttlefish sampled at Brixham ranged from 4–31 cm corresponding to individual weights of 40 and 3,015 g.

At both Markets samples were taken from vessels across 5 different fishing gears (Beam Trawl (TBB), Otter Trawl (OTB), Nets (GNS), Pots (FPO) and Dredges (DRB)).
Historic data analysis

Landings in the UK from 2000 to 2019 have fluctuated throughout the years with landings oscillating between around 2,000 t and 7,000 t with an average of 4,140 t (2000–2019) (Fig. 2). From 2015-2019 average landings have been higher than the long term average at 5400t. Landings from Beam trawls have dominated the catches from 2000 to 2018 followed by otter trawls. Landings from other gears have been relatively low compared to towed gears (9% pots , 2% gill nets, 1% dredges, 1% other). The UK fishery is dominated by fisheries operating at least 6nm from the coast characterised by the use of towed gear (Davies, D. and Nelson, K. 2018). The increase

in overall landings is almost entirely driven by increases in the landings from towed fishing gears between 2008 to 2017.

Landings of cuttlefish in the ports of Brixham and Plymouth represent 57% and 11% respectively of overall UK landings (average 2000 to 2018). Landings from Brixham (Fig. 3) and Plymouth (Fig. 4) are both dominated by towed gears. Landings to Brixham are predominantly from beam trawls throughout the time series whereas landings to Plymouth have seen a shift from Beam trawl to Otter Trawl since 2014. In contrast, the Sussex cuttlefish fishery is dominated by the cuttlefish trap sector (Davis and Nelson, 2018).

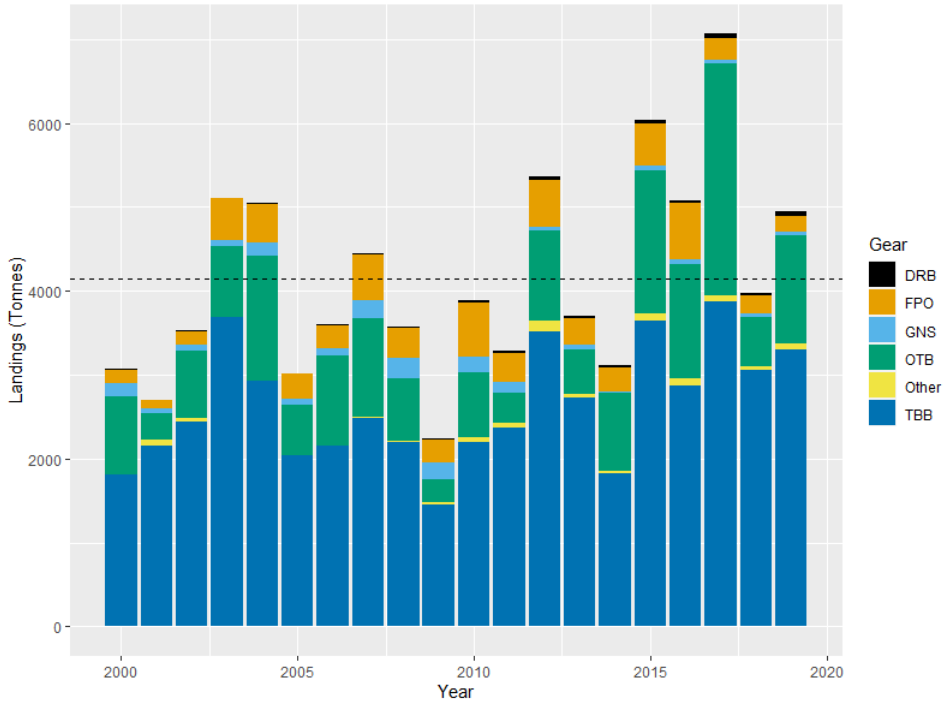

Figure 2: Landings from 2000 to 2019 by fishing gear across all ports of the United-Kingdom.
Dashed line represents mean landings. OTB: otter trawls, TBB: beam trawls, GNS: gill nets, FPO: pots, and DRB: dredges.

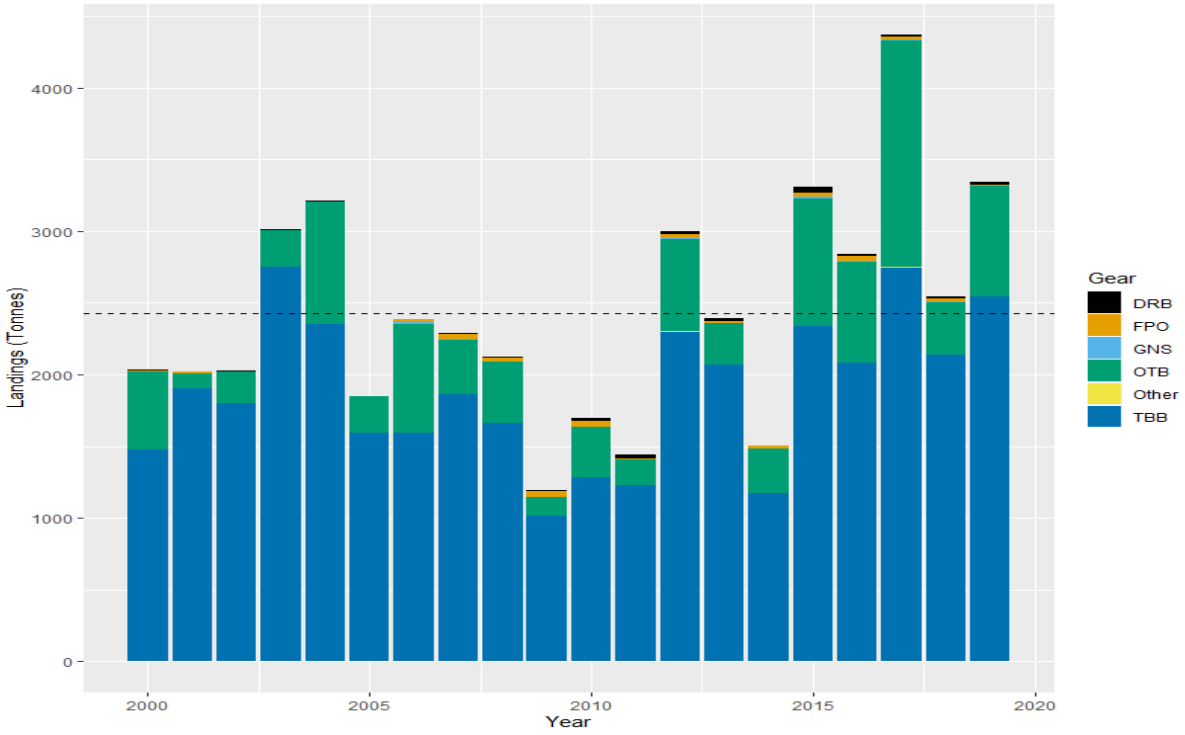

Figure 3: Landings from 2000 to 2019 by fishing gear from Brixham.
OTB: otter trawls, TBB: beam trawls, GNS: nets, FPO: pots, and DRB: dredges.

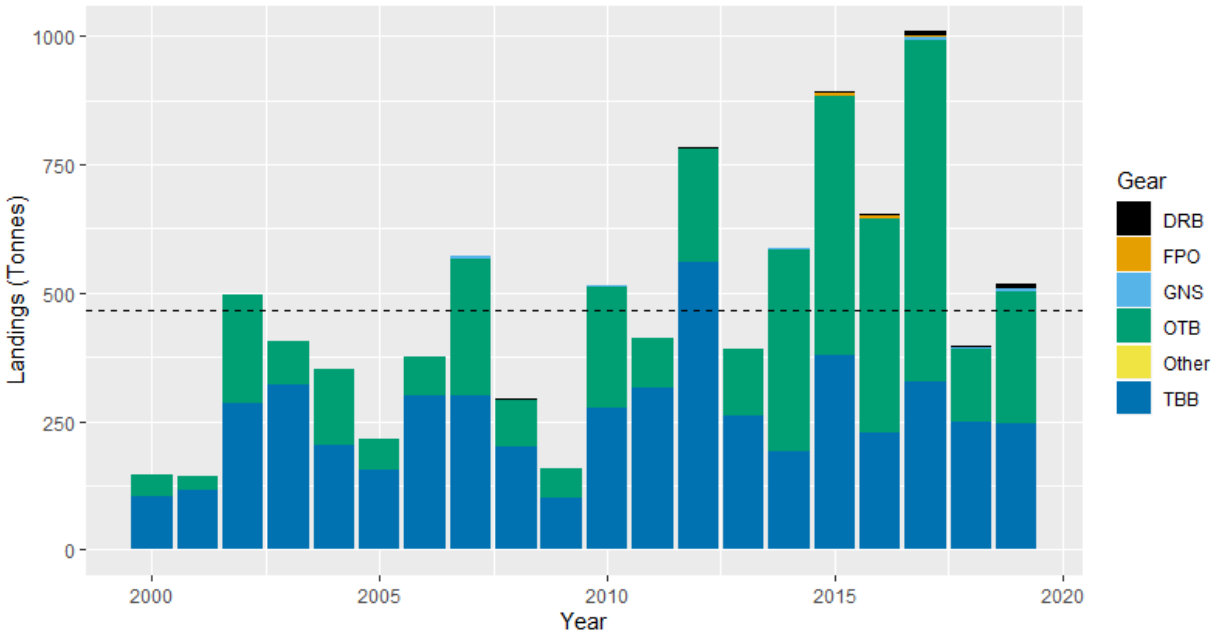

Figure 4: Landings from 2000 to 2019 by fishing gear from Plymouth
OTB: otter trawls, TBB: beam trawls, GNS: nets, FPO: pots, and DRB: dredges.

4 Sampling results

4.1 Plymouth

A total of 5,179 length measurements were used in the analysis, with samples landed using otter trawls being the majority (Table 2).

Table 2: Plymouth: Biomass (tonnes) of sampled and unsampled landings with total sample numbers by gear type at Plymouth Market from December 2018 to June 2019.
OTB: otter trawls, TBB: beam trawls, GNS: nets, FPO: pots, and DRB: dredges.

	OTB			TBB			Other			Total		
	Sampled	Un-sampled	% sampled	Sampled	Un-sampled	% sampled	Sampled	Un-sampled	% sampled	Sampled	Un-sampled	% sampled
Dec-18	31.5	5.6	85%	15.6	16.4	49%	0.0	1.9	0%	47.1	22.0	68%
Jan-19	134.9	11.5	92%	0.8	17.0	4%	0.0	9.2	0%	135.7	28.4	83%
Feb-19	15.6	0.5	97%	7.2	13.3	35%	0.0	0.5	0%	22.8	13.8	62%
Mar-19	7.8	1.0	88%	0.0	7.5	0%	0.0	0.2	0%	7.8	8.5	48%
Apr-19	3.9	1.2	76%	0.0	3.9	0%	0.0	0.1	0%	3.9	5.1	43%
May-19	15.7	4.7	77%	0.9	1.1	46%	0.0	0.0	0%	16.7	5.8	74%
Total	209	25	89%	25	59	29%	0	12	0%	233.9	83.6	74%
Number of samples	116			13			4 FPO 1 DRB 5 GNS					

Over the duration of this study, landings were dominated by Otter Trawls, followed by beam trawls, pots, dredges and nets (Table 2) which show a similar trend to the UK reported landings pattern reported by Davies and Nelson (2018) where towed gear dominate the cuttlefish fishery. Cuttlefish landings are characterised by two size classes one with a mean size of 10 cm and the larger class around 20 cm with a fairly clear split at around 15 cm. This corresponds well to the two age-classes found in cuttlefish populations. Landings from pots, nets and dredges are almost exclusively from the larger size class whereas landings from the otter and beam trawls are more evenly split between the size classes (in terms of number of animals).

The seasonality in length frequency for each gear was investigated to assess whether the length of individuals landed varied across the year (Fig. 5). There was insufficient data to explore whether nets, traps and dredges had a similar pattern. The proportion of small individuals varied throughout the timeseries in a relatively short time frame (December–June). The largest proportion of immature (<16cm mantle length) cuttlefish were caught by OTB during early spring to end of summer (this period coincides with the spawning season Wang *et al*., 2003). However, the largest proportion of immature caught by beam trawl were landed in late autumn/early winter. Figure 5 shows that for both OTB and TBB, two cohorts can be visualized (<16 and ≥16 cm ML) with the later cohort increasing in numbers from late winter. Thus, it

seems apparent that there is a constant pressure on immature cuttlefish throughout the year (Fig. 5, Table 3).

Although individuals were not identified to sex in this project, the results suggest that all gears are landing immature individuals with trawlers landing a significant number of immature individuals which could influence the potential spawning stock biomass and yield.

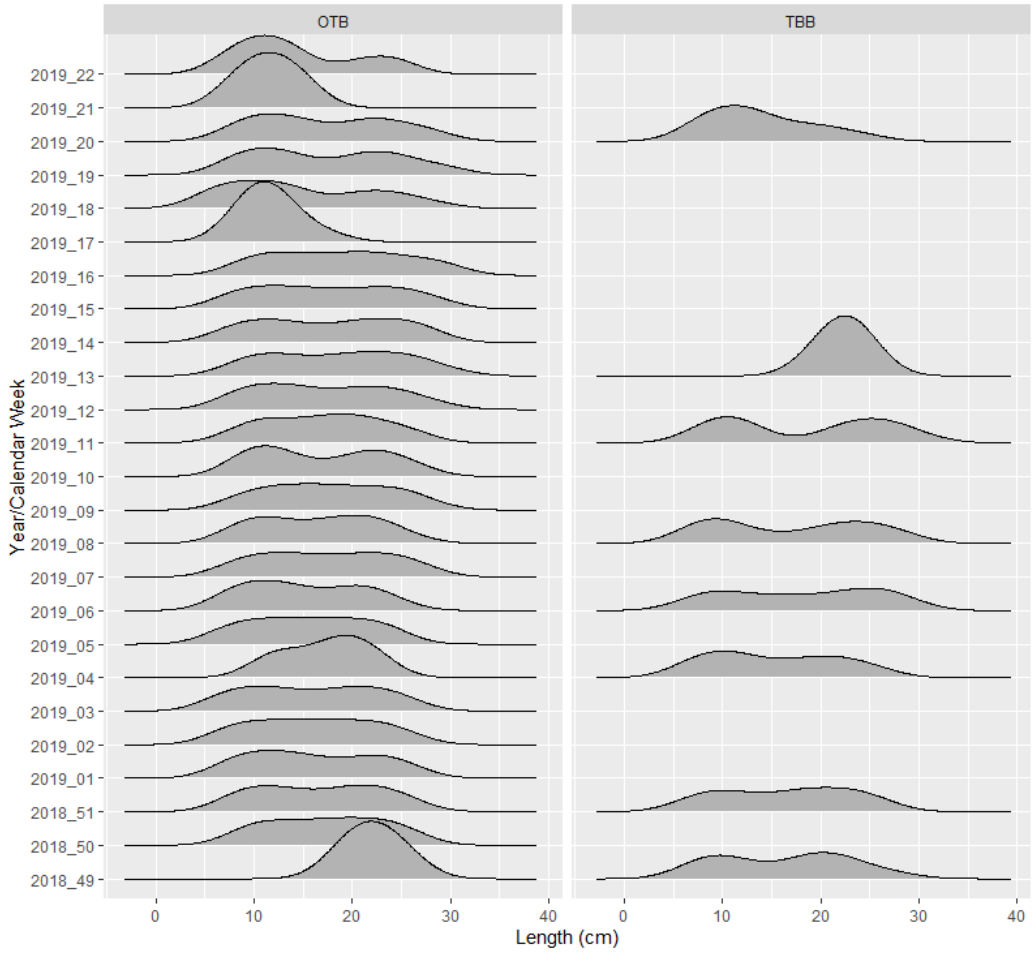

Figure 5: Plymouth: Length frequency for each gear type by week.
Note: Some gears are not represented each week due to a very limited amount of data being available. OTB: otter trawl, TBB: beam trawl.

As landings of Cuttlefish from otter trawls and beam trawls have increased in recent years, there is an interest in investigating where the immature and mature individuals are being caught.

The number of samples attributed to nets, pots and dredges were not sufficient to make any conclusions on the spatial variability. Over the time series, most landings from otter trawls were caught in the ICES rectangle 29E5 and had a higher proportion

of immature individuals (immature individuals accounted for 68% of the total landings in 29E5). Moreover, landings from beam trawls were reported from ICES rectangle 28E5 and accounted for the largest proportion of immature individuals (17% of the total landings in 28E5).

Table 3: Plymouth: Percentage of total individuals that were immature (<16cm) landed at Plymouth market by gear type from December 2018 to June 2019.
Week is the calendar week. Note: not all gear types were sampled each week.

Week	Dredge	Pots	Gill net	Otter trawl	Beam trawl
49					76%
50				37%	
51				59%	70%
1				85%	
2				76%	
3	<0.1%		<0.1%	87%	
4				30%	84%
5				69%	
6				89%	27%
7				58%	
8				52%	81%
9				40%	
10				97%	
11				63%	80%
12				73%	
13				72%	
14				78%	
15				66%	
16				36%	
17		3%		98%	
18				95%	
19				90%	
20				81%	100%
21				100%	
22				94%	
Season average (individuals)	<0.1%	2%	<0.1%	74%	75%
Season average (biomass)	<0.1%	<0.1%	<0.1%	28%	25%

The catch composition per fishing trip for TBB was quite binary – i.e. catch was either dominated by immature individuals or mature individuals. There were no TBB trips with anything more even than a 30:70 or 70:30 split in their immature:mature ratios (although there were only 13 TBB samples at this location). OTB trips saw a broader spread of proportions, around a third of trips being in the middle proportions that the TBB lack (Fig. 6).

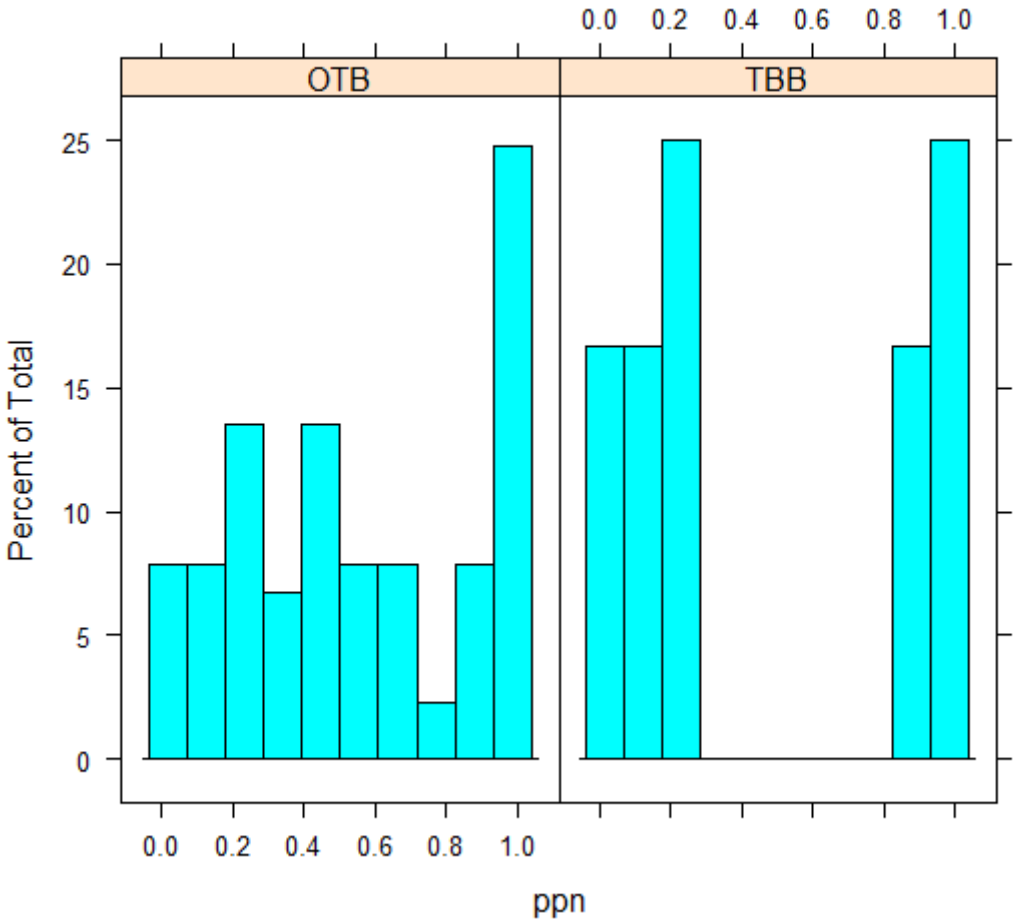

Figure 6: Plymouth: Proportion (ppn) of mature (>=16cm) individuals per fishing trip for both otter trawls (OTB) and beam trawls (TBB).

4.2 Brixham

All Individual measurements were cross referenced with the iFISH official landing database in order to gather information on the fishing area. Some discrepancies occurred between the gear type associated to that landing in the market sample and in iFISH. In the analysis gear type from iFISH was used (Table 4). The landings are dominated by beam trawls, followed by otter trawls, pots, nets and finally dredges

(Table 4) which show a similar trend with findings from Sussex IFCA (Davies, D. and Nelson, K., 2018).

Table 4: Brixham: Biomass (tonnes) of sampled and unsampled landings with total sample numbers by gear type at Plymouth Market from December 2018 to June 2019.
OTB: otter trawls, TBB: beam trawls, GNS: nets, FPO: pots, and DRB: dredges.

Brixham	OTB			TBB			Other			Total		
	Sampled	Un-sampled	% sampled	Sampled	Un-sampled	% sampled	Sampled	Un-sampled	% sampled	Sampled	Un-sampled	% sampled
Dec-18	0.0	10.0	0%	75.3	128.2	37%	0.0	2.9	0%	75.3	138.2	35%
Jan-19	120.1	6.4	95%	36.9	357.8	9%	0.0	0.0	0%	157.0	364.2	30%
Feb-19	0.1	2.0	3%	1166.6	156.2	88%	0.0	0.0	0%	1166.7	158.2	88%
Mar-19	1.0	0.0	95%	23.2	147.0	14%	0.0	0.2	0%	24.1	147.1	14%
Apr-19	8.8	0.2	98%	53.7	84.0	39%	0.5	1.8	21%	62.4	84.2	43%
May-19	8.0	1.8	82%	1.7	31.6	5%	0.1	4.2	2%	9.7	33.3	23%
Total	138	20	87%	1357	905	60%	1	9	6%	1495.2	925.2	62%
Number of samples	86			68			18 FPO 1 DRB 2 GNS					

Length of landed cuttlefish using beam trawls and otter trawls vary considerably, with sizes ranging from 4 to 31 cm (Fig. 7). Landings of immature individuals (≤16 cm ML) from otter trawls fluctuated throughout the time series, with a larger proportion being landed in winter and early summer. Landings from OTB had a higher proportion of mature individuals from late January to early March. Immature individuals caught by beam trawls were relatively stable throughout the time series. There was a peak of immature individuals landed in March (week 17) (Fig. 7, Table 5). The time series from the static gear was too short to assess seasonality.

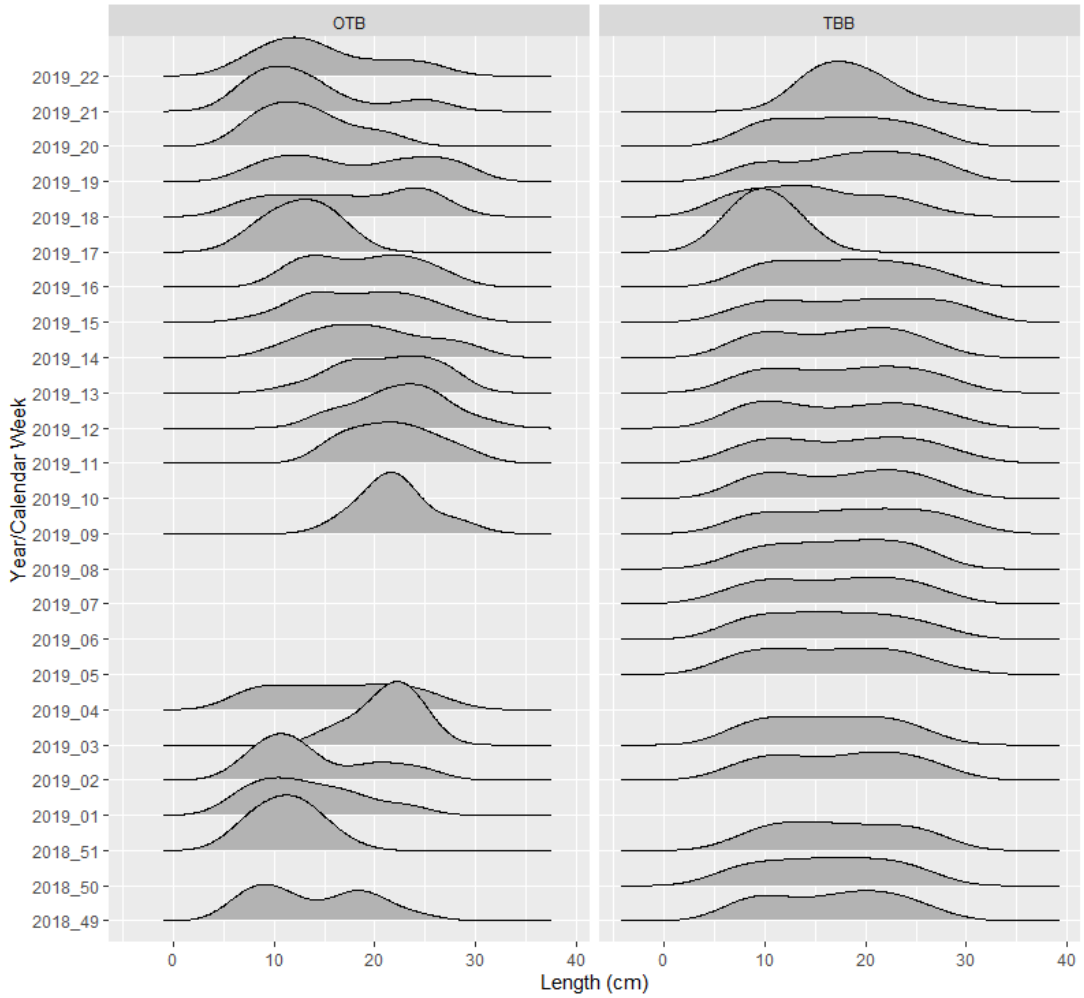

Figure 7: Brixham: Length frequency for each gear type by week for otter trawls (OTB) and beam trawls (TBB).

Over the time series, landings from otter trawls were reported from 29E6 and dominated by immature individuals (30E6 has the highest biomass of immature individuals caught by OTB). Moreover, the majority of landings from beam trawls are reported from 28E6, with a larger proportion of mature individuals being caught overall (Appendix 1, Fig. 10).

Table 5: Brixham: Percentage of total individuals that were immature (<16cm) landed at Brixham market by gear type from December 2018 to June 2019.
Week is the calendar week. Note: not all gear types were sampled each week.

Week	FPO	GNS	OTB	TBB
1			79%	
2			99%	69%
3			16%	71%
4			78%	
5				80%
6				71%
7				66%
8				54%
9				43%
10			53%	75%
11			8%	74%
12			14%	64%
13	67%		10%	81%
14	6%	<0.1%	30%	79%
15			29%	77%
16			27%	81%
17	6%	<0.1%	98%	100%
18	13%		83%	86%
19	21%	<0.1%	74%	95%
20	35%		98%	99%
21	52%		97%	26%
22	16%	<0.1%	96%	
49			72%	83%
50				86%
51			98%	18%
Season average (individuals)	21%	<0.1%	82%	75%
Season average (biomass)	7%	<0.1%	41%	27%

As with the results from Plymouth, the size composition of TBB trips was fairly binary, with trips being dominated by either immature or mature animals, few trips presenting a balance of the two sizes. The sample numbers in Brixham for TBB were much greater than in Plymouth, therefore the binary composition noted in Plymouth

is more likely to have been a genuine trait rather than a sampling artefact. OTB trips were dominated by mature animals (>50% of trips had >90% mature animals Fig.8).

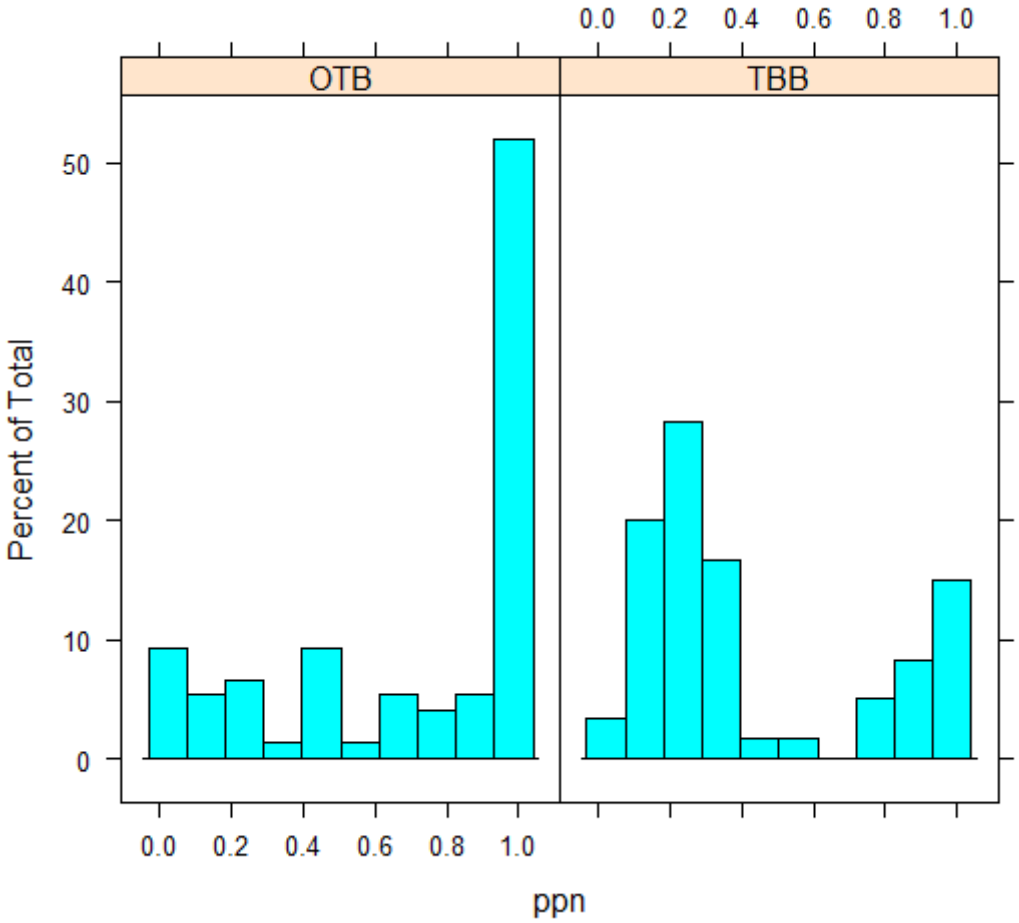

Figure 8: Brixham: Proportion (ppn) of mature individuals per fishing trip for both otter trawls (OTB) and beam trawls (TBB).

5 Conclusion

- The highest catches landed at Plymouth market are from ICES rectangle 29E5 and the lowest ICES rectangle 27E5. Similarly, the highest catches landed at Brixham market are from ICES rectangle 28E6 and the lowest ICES rectangle 29E4
- Static gears are catching a larger proportion of mature individuals, however the total amount landed is substantially lower than for active gears (Note: not many samples were collected from static gear landings).
- Over the fishing season, the proportion of immature individuals is substantially higher than the proportion of mature individuals for both active gears.

- During the part of the year when both size groups of animals are available, a day's catch from beam trawls is dominated by either mostly mature or mostly immature individuals rather than being an even split. This suggests that any aggregations of cuttlefish on the sea-bed are split by size. The available data, being just one year and at a relatively coarse spatial resolution (ICES rectangle is the legal precision of catch recording) is not sufficient to identify any specific patterns in catch composition which would indicate whether vessels target particular sizes or if the size of animal encountered is random. A revised sampling program involving recording of size composition at haul sites, preferably operating over several seasons would be required for such an analysis.

6 References

Davies, D. and Nelson, K. 2018. Supporting sustainable Sepia Stocks Report 2: The English Channel fishery for common cuttlefish (*Sepia officinalis*) Sussex IFCA.

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Wang, J., Pierce, G.J., Boyle, P.R., Denis, V., Robin, J.P., Bellido, J.M. 2003. Spatial and temporal patterns of cuttlefish (Sepia officinalis) abundance and environmental influences – a case study using trawl fishery data in French Atlantic coastal, English Channel, and adjacent waters. ICES Journal of Marine Science, Volume 60, Issue 5. https://doi.org/10.1016/S1054-3139(03)00118-8

7 Appendix 1:

7.1 Plymouth

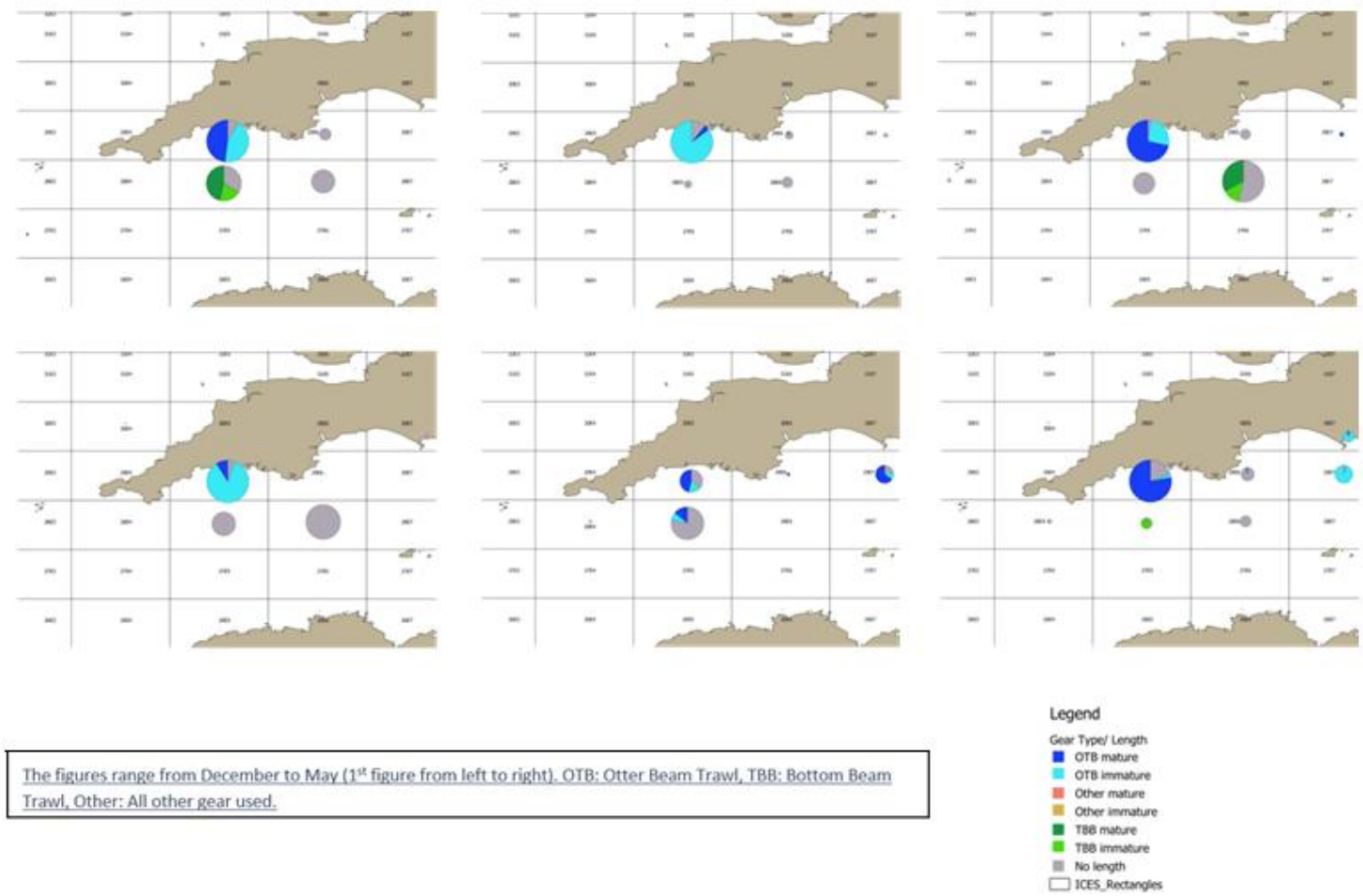

Figure 9: Plymouth: Landings of immature and mature (>16 cm) cuttlefish by gear type.

7.2 Brixham

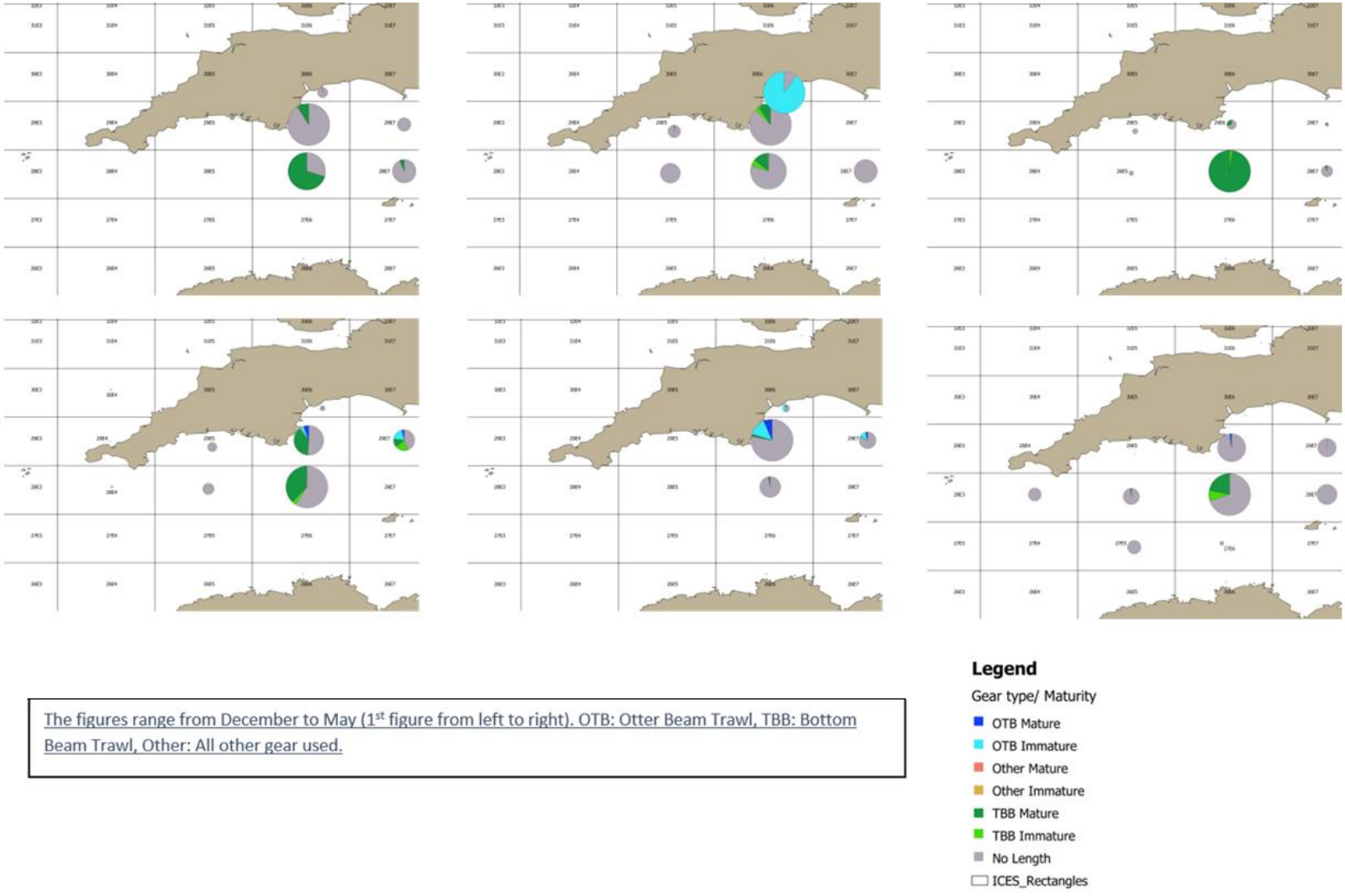

Figure 10: Brixham: Landings of immature and mature (>16 cm) cuttlefish by gear type.

About us

We are the Government's marine and freshwater science experts. We help keep our seas, oceans and rivers healthy and productive and our seafood safe and sustainable by providing data and advice to the UK Government and our overseas partners.

We are passionate about what we do because our work helps tackle the serious global problems of climate change, marine litter, over-fishing and pollution in support of the UK's commitments to a better future (for example the UN Sustainable Development Goals and Defra's 25 year Environment Plan).

We work in partnership with our colleagues in Defra and across UK government, and with international governments, business, maritime and fishing industry, non-governmental organisations, research institutes, universities, civil society and schools to collate and share knowledge.

Together we can understand and value our seas to secure a sustainable blue future for us all, and help create a greater place for living.

Innovative, world-class science is central to our mission. Our scientists use a breadth of surveying, mapping and sampling technologies to collect and analyse data that are reliable and valuable. We use our state-of-the-art Research Vessel Cefas Endeavour, autonomous marine vehicles, remotely piloted aircraft and utilise satellites to monitor and assess the health of our waters.

In our laboratories in Lowestoft and Weymouth we:

• safeguard human and animal health

• enable food security

• support marine economies.

This is supported by monitoring risks and disease in water and seafood; using our data in advanced computer models to advise on how best to manage fish stocks and seafood farming; to reduce the environmental impact of man-made developments; and to respond to serious emergencies such as fish disease outbreaks, and to respond to oil or chemical spills, and radioactivity leaks.

Overseas, our scientists currently work in Commonwealth countries, United Kingdom Overseas Territories, South East Asia and the Middle East.

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

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