Fal Oyster Survey 2020

Final report for the 2020 Fal Oyster Survey
(2020_CIFCA_SAC_FAL_FOS)

Cornwall Inshore Fisheries and Conservation Authority (Cornwall IFCA)

Authors: Annie Jenkin, Colin Trundle, Steph Sturgeon and Kimara Street

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2020_CIFCA_SAC_FAL_FOS

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Cornwall IFCA
Office 2, Chi Gallos
Hayle Marine Renewables Business Park
North Quay
Hayle
Cornwall
TR27 4DD

Tel: 01736 336842
Email: enquiries@cornwall-ifca.gov.uk

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Glossary of Terms and abbreviations

Area A	North Bank, Mylor Bank and Parsons Bank
Area B	East Bank and St.Just Flats
Area C	North of a line drawn due east from Pill Point to the coast on Turnaware Point
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
FFMC	Fal Fishery Management Committee
FOS	Fal Oyster Survey
H	Harbour section
IFCA	Inshore Fisheries and Conservation Authority
MLS	Minimum Landing Size
OH	Outer harbour
R	River

1 Introduction

Cornwall Inshore Fisheries and Conservation Authority (IFCA) has been responsible for the management of the Fal Oyster Fishery since July 2014. Prior to this, Cornwall Council (Port of Truro), as the grantee under the Truro Port Fishery Order 1936 (as amended), was responsible for the management fishery until the Order expired in July 2014. Cornwall IFCA initially authorised access under the Closed Areas (European Marine Sites) Byelaw 2 then as Regulator of the Fal Fishery Regulating Order 2016. As part of the management of the fishery the Authority assumed responsibility for monitoring the stock of oysters by continuing the yearly surveys of the fishery. Previous Cornwall IFCA surveys have been reported on since 2015 (Jenkin *et al*., 2019; Jenkin *et al*., 2018; Jenkin *et al*., 2017; Latham *et al*., 2016; and Latham and Trundle, 2015).

The oyster stocks were monitored intermittently by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in the 1950s and 1960s. An annual survey was started in 1971 and continued until 1984, when they were discontinued due to low stock levels resulting from mortalities caused by the oyster parasite, *Bonamia ostrea*. Following recovery of the stock, joint CEFAS/ Cornwall Council Maritime Division oyster surveys were restarted in 2002 and have been undertaken annually since. These surveys initially targeted 95 sample sites, spread across the River (R), Harbour (H) and Outer Harbour (OH) sections (Annex Figure A). The abundance and size of the oysters were recorded, with oysters allocated into size classes that reflected recruitment to the fishery in future seasons. The size classes for this year's report have been updated so that the upper size class matches the minimum size of oysters (67 mm) which can be removed from the fishery[1].

In 2020, the analysis was done by Management Areas A, B and C so that the survey data corresponds with the Fal Fishery shellfish return statistics. Area A covers the North Bank, Area B covers East Bank and Area C covers the river section (Figure 5). Areas A and B cover the area from the southern boundary of the fishery to Turnaware Point and are fished predominantly by sail and Area C covers the area from Turnaware Point to Malpas and is fished by oyster punts using haul tow methods.

The number of sites which are surveyed has decreased over time. This is because some sites were located where sensitive habitats such as maerl were found and some of the sites in Area C (north of Turnaware Point) were set up as clusters, with three sites located very close to each other, so these have been replaced with just one location being surveyed.

A number of changes were made to the Fal Fishery Order 2016 Regulations prior to the 2016 fishing season starting due to expressions of interest made through the Fal Fishery Management Committee (FFMC). Previously under the regulatory order, a person that retained on board or landed native species of bivalve or gastropod shellfish had to ensure that the combined weight of species other than oysters (*Ostrea edulis*) and mussels (*Mytilus edulis*) (bycatch) did not exceed 20% of the weight of all the native species retained on board or landed. In the Fal Fishery Order 2016 Regulations this was removed which has changed the previously non-target species such as the queen scallop,

[1] Regulations under the Fal Fishery Order 2016 https://secure.toolkitfiles.co.uk/clients/17099/sitedata/Fal_Fishery/2017-Regulations-under-the-FFO-2018-09-04-161532.pdf

Aequipecten opercularis[2] and the variegated scallop, *Mimachlamys varia*[3] (queenie scallops) to a target species. It is thought that the species referred to as 'queenies' within the Fal Fishery Area are thought to be primarily the variegated scallop (*M. varia*) as opposed to the queen scallop (*A. opercularis*). The queenie scallops have been included as part of the survey since 2016. For the remainder of this report they are referred to as scallops.

The minimum size of native oysters (*O. edulis*) which can be removed from the fishery is 67 mm and the minimum size of queen scallops (*Chlamys* spp.) is 40 mm under Council Regulation 850/98 Annex XII.

In 2018, an addition to the survey was made to record the number of individual slipper limpets (*Crepidula fornicata*) at each site instead of the subjective broad approach of a SACFOR style recording system which was used prior to this. This has been continued as part of the survey since 2018.

In 2020, a list of bycatch was recorded across the whole survey area and not per dredge sample due to time constraints.

1.1 Aims and objectives

1.1.1 Aims

- To investigate the relative abundance and distribution of native oysters, *O. edulis*, within the Fal Oyster Fishery located in the Fal Estuary, Cornwall.
- To investigate the relative abundance and distribution of scallops (queen scallop, *A. opercularis*; variegated scallop, *M. varia*) within the Fal Oyster Fishery.
- To investigate the relative abundance and distribution of slipper limpets (*C. fornicata)* within the Fal Oyster Fishery.
- To investigate the distribution of substrate types across the fishery.
- To investigate the species of bycatch present across the survey area.

1.1.2 Objectives

- To re-survey Fal oyster survey sites, as previously surveyed by Cornwall Council/ CEFAS, recording abundance and size of native oysters (*O. edulis)*.
- To record the abundance and size of scallops (queen scallop, *A. opercularis*; variegated scallop, *M. varia*).
- To count the number of slipper limpets per site (*C. fornicata)*.
- To record bycatch across the survey area.
- To record the volume of each dredge sample.
- To record the composition of each dredge sample.
- To record and retain any invasive species observed during the survey.
- To provide recommendations for future survey work.

[2] Synonymised name: *Chlamys opercularis* (unaccepted) http://www.marinespecies.org/aphia.php?p=taxdetails&id=152997 [Accessed 18/02/2020]

[3] Synonymised name: *Chlamys varia* (unaccepted) http://www.marinespecies.org/aphia.php?p=taxdetails&id=140696 [Accessed 18/02/2020]

2 Methodology

2.1 Survey Area

The survey was carried out within the Fal Oyster Fishery Area (Figure 5), in the Fal Estuary on the south coast of Cornwall.

2.2 Vessel Specifications

Research vessel (R/V) Tiger Lily VI is Cornwall IFCA's research survey vessel (Figure 1). She is a South Boats 11 m Island MkII catamaran with twin IVECO 450hp engines; her Callsign is MRWR7. The survey methodology for the first few samples was the same as previous years, with the use of the hydraulic anchor winch on the starboard side providing towing capabilities and the use of the A frame on her stern from which the dredge was towed (outlined in section 2.5). However in 2020, the hydraulic controls broke at the fifth site so the vessels speed was used to haul the dredge. The minimum speed in gear of Tiger Lily VI is approximately 4 knots which is too fast so the skipper put the vessel in and out of gear along the line of tow to slow the vessel down. The general layout of Tiger Lily VI is shown in Annex 1.

Tiger Lily VI has been refitted for survey work and includes a purpose built survey station within the wheelhouse, fitted with an uninterruptable power supply (UPS) and a dedicated Global Positioning System (GPS) with NMEA outputs.

Figure 1: R/V Tiger Lily VI – Cornwall IFCA's research survey vessel.

2.3 Personnel

The crew during the surveys consisted of the skipper and up to three scientific officers. The crew roles rotated during the surveys and included data recording, operating the winch, deploying and recovering the dredge, measuring bivalves and the identification of bycatch species.

2.4 Personal Protective Equipment (PPE)

Life jackets, steel toe capped waterproof boots and waterproofs were worn while working on deck. Hard hats were worn whilst the A frame was being used. Thick, waterproof gloves provided protection against sharp shell edges and any anthropogenic debris whilst sorting through the dredge sample. There were no reported accidents or near misses during the survey.

2.5 Survey methodology

Each survey station was transferred to the vessel's Olex navigation plotter for navigation purposes and into HYPACK MAX 2019 software for data logging. The dredge used was a 72 cm blade, Essex-style oyster dredge, rigged with 34 mm diameter steel belly rings and a 45 mm (twin 3 mm nylon twine) mesh back. It varies slightly from those used within the fishery but was used previously by Cornwall Council and CEFAS for the survey work within the fishery. The dredge was deployed and recovered using the A frame on the stern of Tiger Lily VI.

For the first few sites, a tow haul method was adopted, similar to that used by the oyster punts. This allowed the dredge tow to be of a known distance and to be easily and consistently replicated. At each survey site the survey vessel was anchored and 60 m of anchor line was let out. The dredge was shot by hand and the vessel's slave hauler winch was used to take up 50 m of marked anchor line, resulting in a 50 m dredge tow at a steady 0.5 to 1 knots. The towing warp was run via the A frame mounted hydraulic winch. The towing warp was marked off so that the length (m) of cable deployed at any time was known; this was generally fixed for an average depth and altered only if a depth change was sufficient to cause the dredge to fish too heavily or lightly.

Previous surveys prior to 2016 used a towing method where the dredge was towed for approximately 1 minute at around 1.6 knots (3 kph). This equates to a tow distance of 50 m, the same as the new method, but with less consistency over speed and direction.

The hydraulic control broke at the fifth site on the first day of the survey and no repair could be carried out during the survey so the vessels speed was used to tow the dredge for the remaining sites. The skipper put the vessel in and out of gear to slow the vessel below the minimum speed of 4 knots. A circle with a radius of 50 m was put around all survey sites in Olex to ensure the tow was 50 m in length.

During recovery, the dredge was lifted using the hydraulic winch and/ or A frame, then tilted and emptied into the sorting table which was positioned beneath the frame. A deck wash was available to aid in clearing muddier samples, particularly from sites within the upper reaches of the Fal (Area C). The set up for the dredge tow, A frame and sorting table is shown in Figure 2 below and the methodology discussed in Section 2.5.

A target was created in HYPACK MAX 2019 to indicate the start of line (SOL); this was repeated at the end of line (EOL). All positions were recorded using WGS84 projection and sourced from the dedicated survey GPS (Furuno GP-32). All times are recorded as Coordinated Universal Time (UTC) and taken from the same source as the position data. The data was transferred to a WD passport hard drive at the end of each survey day.

If the dredge did not fish, due to being blinded or flipped over, or the sample appeared smaller than it should be for particular areas, the dredge haul was repeated.

During the survey, photographs were taken using an Olympus Tough TG-5 digital camera and a printed image identification plate ('clapper' board) was used for sample identification. All measurements (mm) were taken using Vernier callipers.

Figure 2: Survey set-for the Fal Oyster Survey 2020 on the deck of R/V Tiger Lily VI.

Each sample was photographed on the sorting table alongside the clapper board prior to sorting. Live native oysters, scallops (queen/ variegated scallop) and slipper limpets were removed and set aside as the sample was sorted (Figure 3).

Figure 3: Samples sorted into buckets containing native oysters, scallops and slipper limpets from the 2019 Cornwall IFCA Fal Oyster Survey.

All live oysters were then counted and measured across the widest point, to the nearest mm using callipers. All queen or variegated scallops were counted and measured along the length of the valve (from the hinge to the outer edge), to the nearest mm using callipers. All slipper limpets were counted, this included live individuals or live individuals which were part of a chain (Figure 4). The weight (g) was recorded for oysters where possible. This was done alongside in Mylor, at anchor or on floating pontoons to stabilise the scales. If shell or stone was attached to the individual or they were joined, a weight was not taken.

Figure 4: Examples of slipper limpets (*Crepidula fornicata)* growing on substrate as individuals or chains of two or a longer chain of individuals as observed on the 2019 Cornwall IFCA slipper limpet survey.

Observations of the catch composition (substrate) were recorded for each dredge sample. A clapper board was filled out per site for the volume of the dredge as a percentage (25%, 50%, 75% and 100%) of how 'full' the dredge was when it was at the surface and the percentage composition for the following categories; mud, shell (live and dead), weed, gravel, vegetation (sticks and leaves), dead maerl and stone in increments of 5% so that the catch composition per dredge equalled 100%. Live maerl was recorded as the number of fragments.

A list of previously recorded bycatch was made and species were ticked off as they were observed and previously unrecorded species were added. The bycatch recording in 2020 was a fairly minor part of the oyster survey. Photographs were taken of species when it wasn't possible to identify them on the spot.

The values for all measurements recorded were relayed verbally to a member of staff in the wheelhouse who was recording the data into a Microsoft Excel spreadsheet.

2.6 Data handling

Data was entered *in situ* into a recording sheet which was set up in Microsoft Excel. This enabled data to be easily transferred into data analysis Excel spreadsheets in the office.

The measurements for oysters were tallied into four size ranges (≥ greater than or equal to, ≤ less than or equal to);

- ≥ 67 mm

  Oysters of a size to be fished this season. Currently oysters removed from the fishery must not pass through a ring of 67 mm.
- ≥ 51 to ≤ 66 mm

  Oysters of a size likely to enter the fishery within the next two seasons.
- ≥ 36 to ≤ 50 mm

  Small oysters unlikely to attain fishable size within the next two seasons.
- ≤ 35 mm

  Spat, oysters spawned within the last 18 months. It is acknowledged that oysters of this size are not efficiently sampled using this method.

These categories have changed from the previous surveys as it was thought it would be more beneficial to record the data so the larger size category matched the minimum landing size of oysters in the fishery. The previous categories were ≤ 35 mm, ≥ 35 to ≤ 49 mm, ≥ 50 to ≤ 64 mm and ≥ 65 mm.

The measurements for scallops were tallied into four size ranges (≥ greater than or equal to, ≤ less than or equal to);

- ≥ 60 mm
- ≥ 40 to ≤ 59 mm

  Scallops of a size to be fished this season.
- ≥ 21 to ≤ 39 mm

  Scallops of a size likely to enter the fishery within the next two seasons.
- ≤ 19 mm

  Juvenile scallops. It is acknowledged that scallops of this size are not efficiently sampled using this method.

These categories have changed from the reporting from previous years as it was thought it would be more beneficial to record in four categories instead of seven. The previous categories were ≤ 29 mm, ≥ 30 to ≤ 39 mm, ≥ 40 to ≤ 49 mm, ≥ 50 to ≤ 59 mm, ≥ 60 to ≤ 69 mm, ≥ 70 to ≤ 79 mm and ≥ 80 mm.

2.7 Data analysis

From the oyster and scallop tally data, abundances (actual and as a proportion of the total) were calculated, and size frequency distributions for the three areas were calculated and graphed. The average size (mm) and the average number of oysters and scallops for each of the three areas were calculated. The analysis was split into management areas; Areas A, B and C. The reports from the survey in previous years split the analysis into geographic sections (H, OH and R) as well but it was thought that it would be more beneficial if the sections represented those in the fishery and are compatible with how the licence holder monthly shellfish statistics are reported.

All photographs taken as part of the survey were transferred to Cornwall IFCA's servers, labelled with the survey name, date, site number and replicate, [Name]_[Date]_[Site]_[*Replicate*]_[Photograph Reference].jpg, e.g. FOS_20200119_H45_P1191481.JPG and filed. To compare the dredge sample photographs from 2014 to 2020, a folder was created per site with the photos from each year alongside one another, for all sites surveyed in at least one of those years. This was used for a visual comparison of the site characteristics and sample volume.

The GPS derived locations of all sample sites were plotted in MapInfo Pro Advanced Version 17.0 over hydrographic charts of the area. For sites within Areas A and B where dredge samples were arranged in a dense grid, density maps were created for oysters, scallops and slipper limpets to enable a visual comparison from 2016 to 2020. Density maps were not created for sites within Area C (except the sites around Turnaware Point which were included in Area B sites) as the sites are randomly spaced along the stretch of river between Turnaware and Malpas and not in a grid pattern which is used in other sections of the survey area. The mooring areas around Mylor were deliberately excluded from the density maps as they are not fished, or sampled and it is not classified as a bivalve mollusc production area. Oyster, scallop and slipper limpet densities per sample were converted to densities per 10 m^2. MapInfo Pro Advanced Version 17.0 was used to create a colourised grid of the selected values from each sample station. The colourised grid was generated by using the Natural Neighbour interpolation function. A pre-generated

standardised .vcp colour palate was applied to the grid to allow the density contouring to be viewed using different colour palates for oysters, scallops and slipper limpets. This was used across all density grids. From this modified colourised grid, it was possible to estimate the distribution of oyster and scallop size-classes within the fishery, identify hotspots and make a comparison with previous years.

The oyster and scallop size composition charts were produced using the Thematic Mapping function in MapInfo Pro Advanced Version 17.0. The size frequency data for each sample station were grouped into four size ranges for oysters (≥67 mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35 mm) and four size ranges for scallops (≥60 mm, ≥40-≤59 mm, ≥21≤39 mm and ≤20 mm). This data was then used to calculate the proportion of each size range of the whole sample at each site. The data was displayed as pie charts with the size of the pie chart being indicative of the overall oyster abundance at each station.

The same approach was applied to the substrate composition data to create pie charts showing the percentage volume of the dredge as the size of the pie (25%, 50%, 75% and 100%) and the composition of mud, shell, weed, gravel, vegetation (sticks and leaves), dead maerl and stones.

3 Results

3.1 Survey metadata

The time of year that previous surveys have been carried out has varied (Table 1) but they are usually completed in the second half of the oyster fishery season. The timing of the 2020 survey was consistent with surveys since 2016 and carried out in mid-January. The survey is normally planned over consecutive days for consistency.

A number of the original 95 sample sites have been dropped during recent years due to sensitive habitats or sample replication. The dropped sites are located in the southern section of the fishery where live maerl has been recorded and in the river where sites were originally clustered together. A total of 82 sites were completed in 2020 (Table 1) as site H 22 was dropped from the survey as over five fragments of live maerl were recorded in 2019. The positions of the survey stations surveyed during the 2020 survey are shown in Figure 6 and in more detail in Annex Table A.

Table 1: The dates of previous Fal oyster surveys and the number of sites surveyed from 2015 to 2020 during the Fal oyster survey.

Year	Dates of surveys	Number of sites surveyed
2020	19th to 22nd January	82
2019	15th to 18th January	83
2018	9th to 13th January	83
2017	22nd to 24th January	80
2016	17th to 19th January	89
2015	11th to 18th February	79

A summary of the dates of the survey, the sites sampled and the members of staff on each survey day are shown in Table 2. The daily logs are shown in Annex Table B, Annex Table C, Annex Table D and Annex Table E.

Table 2: A summary of the dates, sites completed and the staff involved in the Fal oyster survey 2020.

Date	Sites Completed		Number of completed sites	CIFCA staff	Skipper	Visitors
19/01/2019	A_16 B_18 A_19 A_20 A_21 A_23_1 A_23_2 A_50 A_49	A_48 A_47 A_46 A_45 B_44 A_56 A_55 A_54 A_53	17	Colin Trundle, Annie Jenkin, Steph Sturgeon, Hilary Naylor	Chris Lowe	None
20/01/2019	A_52 A_58 A_59 A_60 A_61_1 A_61_2 A_66 A_67 A_68 A_69 A_70 A_71 A_82	A_81 A_83 A_84 A_89 C_88 C_24 B_87 B_85 B_86 B_94 B_93 B_92	24	Colin Trundle, Annie Jenkin, Steph Sturgeon	Chris Lowe	Mark Kaczmarek, Meg Hayward-Smith
21/01/2019	B_80 B_97 B_72 B_103 B_65 B_10 B_110 B_57 B_123 B_51 B_111	B_62 B_76 B_100 B_77 B_78 B_79 B_98 B_99 B_75 B_74	21	Colin Trundle, Steph Sturgeon, Hilary Stidwell	Chris Lowe	Meg Hayward-Smith
22/01/2020	B_64 B_63 B_106 B_105 B_104 B_73 C_26 C_27 C_28 C_29 C_30	C_31_1 C_31_2 C_32 C_33 C_43_1 C_43_2 C_42 C_41 C_40 C_36 C_43	20	Colin Trundle, Annie Jenkin, Steph Sturgeon	Chris Lowe	Meg Hayward-Smith

An invitation to join the survey was sent out to Natural England and the ITV Westcountry news crew. A member of the Cornwall IFCA committee also joined the survey for one day.

A chart showing the management areas A, B and C is shown in Figure 5. Area A represents North Bank, Mylor Bank and Parsons Bank, Area B represents East Bank and St Just Flat and Area C represents the area north of a line drawn due east from Pill Point to the coast on Turnaware Point.

A total of 82 sites were surveyed, 31 were in Area A, 35 were in Area B and 16 were in Area C, as shown in Figure 6.

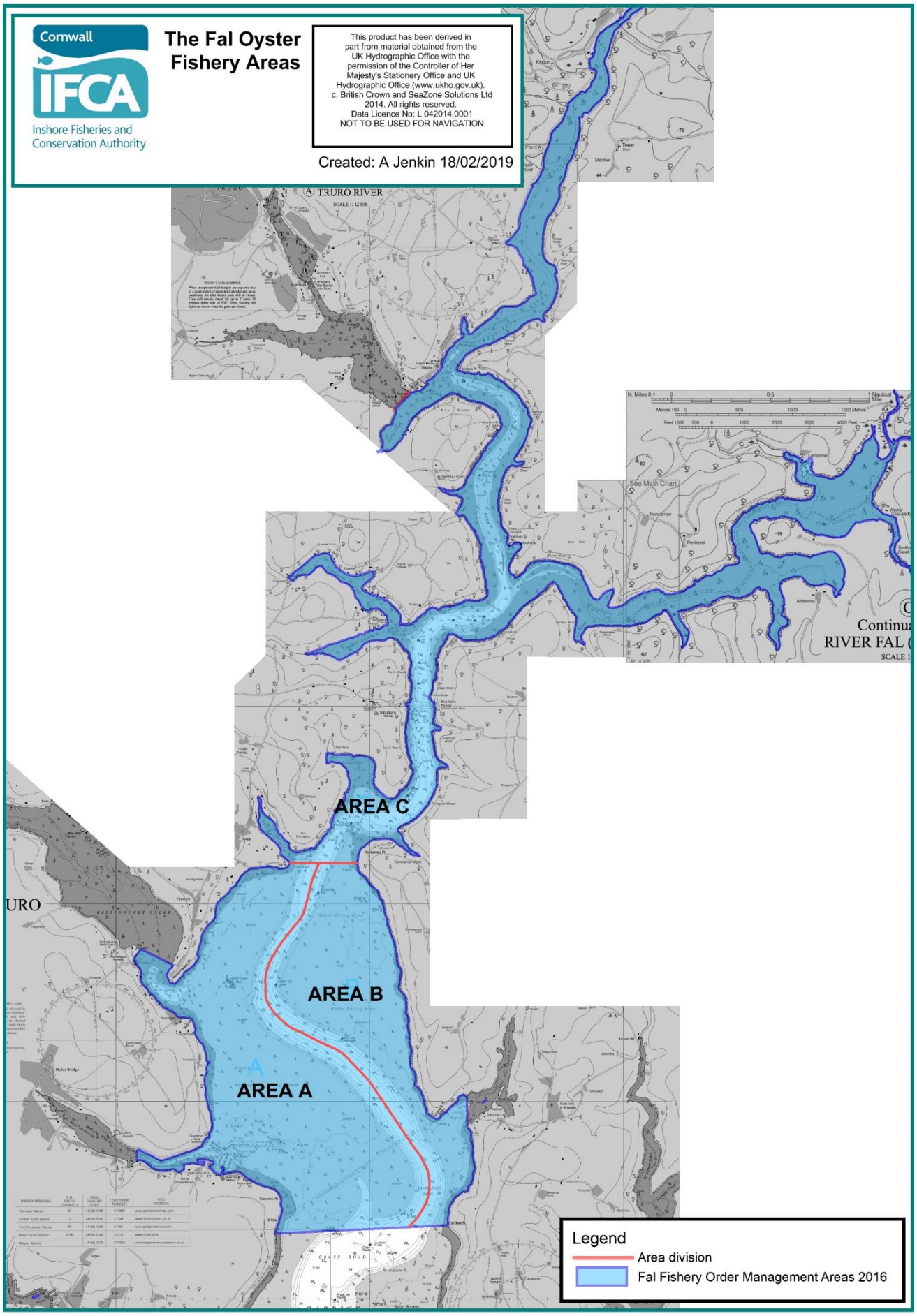


Figure 5: The management areas, Area A, B and C of the Fal oyster survey.

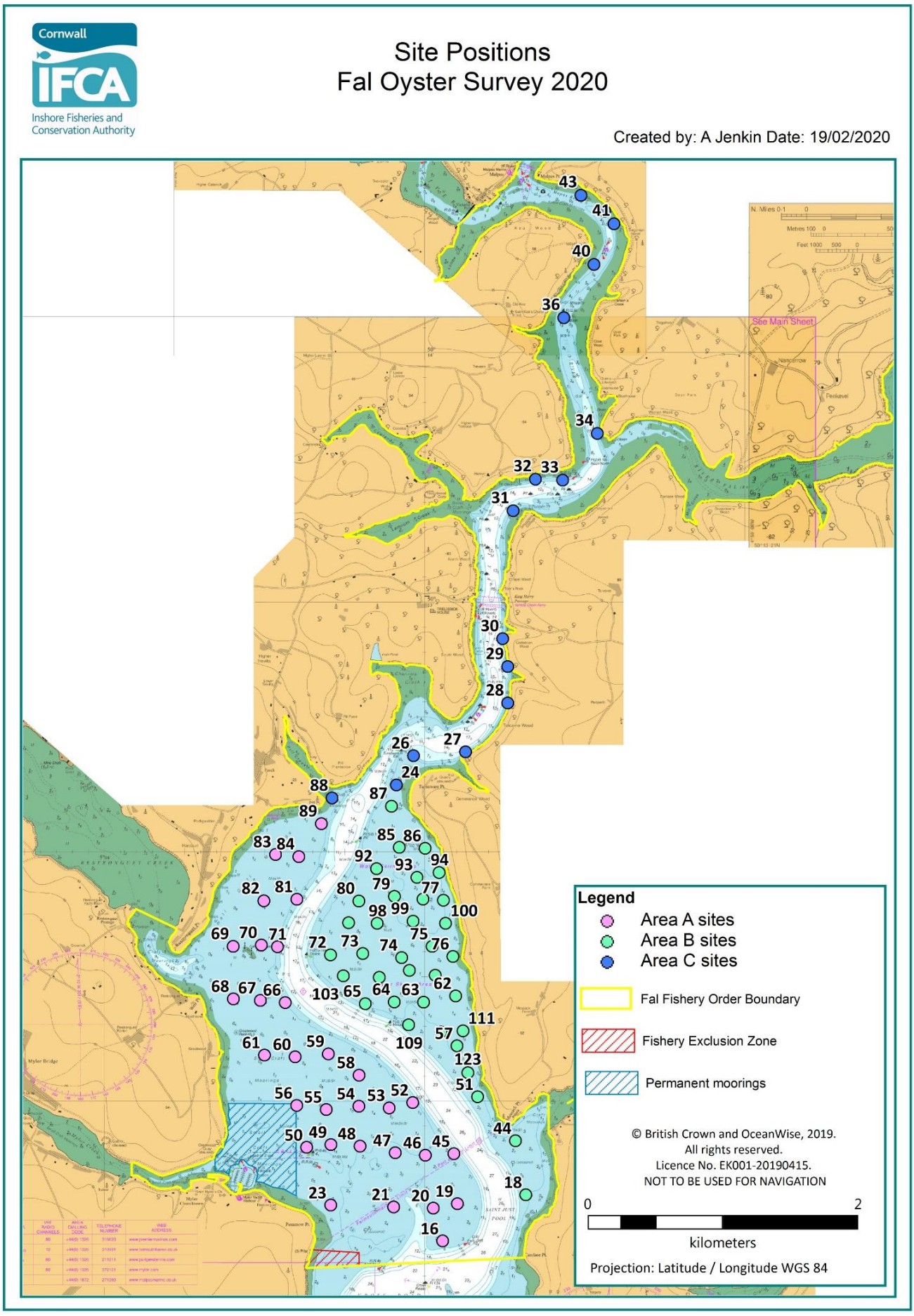


Figure 6: The Fal Oyster Survey area and survey sites in the Fal, split by management areas A, B and C from the 2020 survey.

Of the 82 sites, valid tows were completed at all sites. Four of the tows were repeated (sites H 23, H 61, R 31, and R 43), due various reasons including small sample size, the dredge flipping and turns on the line.

Visual comparison of the survey photos from 2014 to 2020 indicates that the dredged volumes for samples are reasonably consistent between the surveys, despite the slight change in dredging method between 2014 and 2015 and the revised method in 2017.

3.2 Native oysters (*Ostrea edulis*)

In total, 1,265 oysters were measured and recorded. Previous oyster counts are shown in Table 3. The number of survey stations changed year on year so the numbers recorded across the years are not directly comparable. The 2014 data has not been included for further analysis because the method was different and the results are not comparable.

Table 3: The number of native oysters (*Ostrea edulis)* recorded during the Fal oyster survey between 2015 and 2020

Year	Number of sites sampled	Number of native oysters	Difference	Percentage difference
2020	82	1,265	-445	-26%
2019	83	1,710	+209	14%
2018	83	1,501	+20	1%
2017	80	1,481	-184	-11%
2016	89	1,665	+896	117%
2015	79	769	-	-

3.2.1 Oyster Size Class Composition

The following analysis is for the years 2016 to 2020 to enable a five year temporal comparison of the fishery. The total number of native oysters has varied by size class (≤ 35 mm, ≥36 to ≤50 mm, ≥51 to ≤66 mm and ≥67 mm) from to 2016 to 2020 (Figure 7 and Figure 8). The predominant size class for all years was the ≥51 to ≤66 mm, except for 2016 when the number of oysters in each size classes were relatively similar. The number of oysters in the ≥67 mm size class had steadily increased from 2017 to 2019 but decreased in 2020. The number of oysters in the smaller size classes were comparable from 2018 to 2020. The greatest difference in 2020 from 2019 was a decline in the number of oysters in the ≥51 to ≤66 mm size class from 832 to 541.

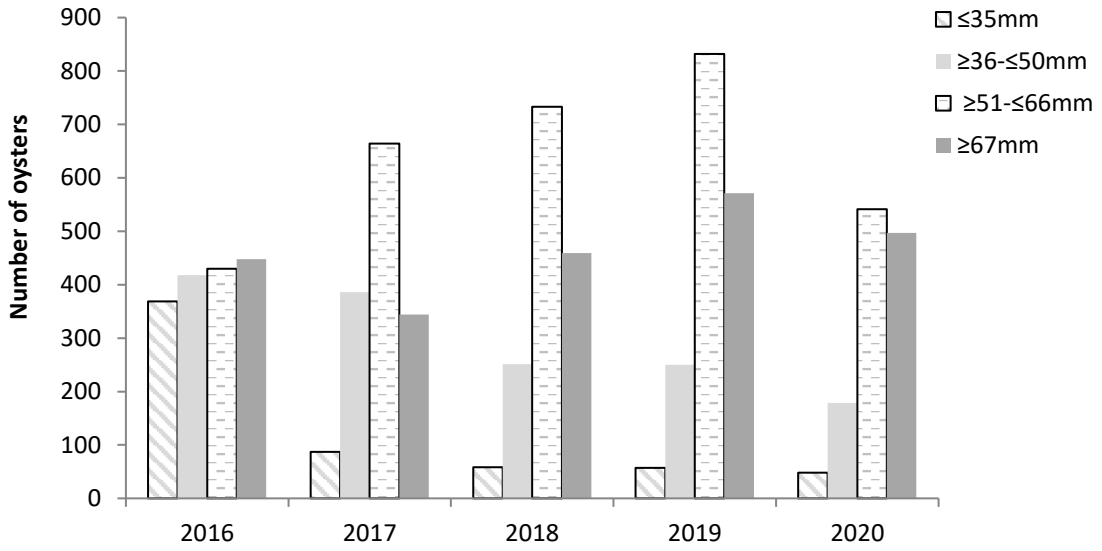


Figure 7: The total number of native oysters (*Ostrea edulis)* per size class (≥67 mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35 mm) from 2016 to 2020.

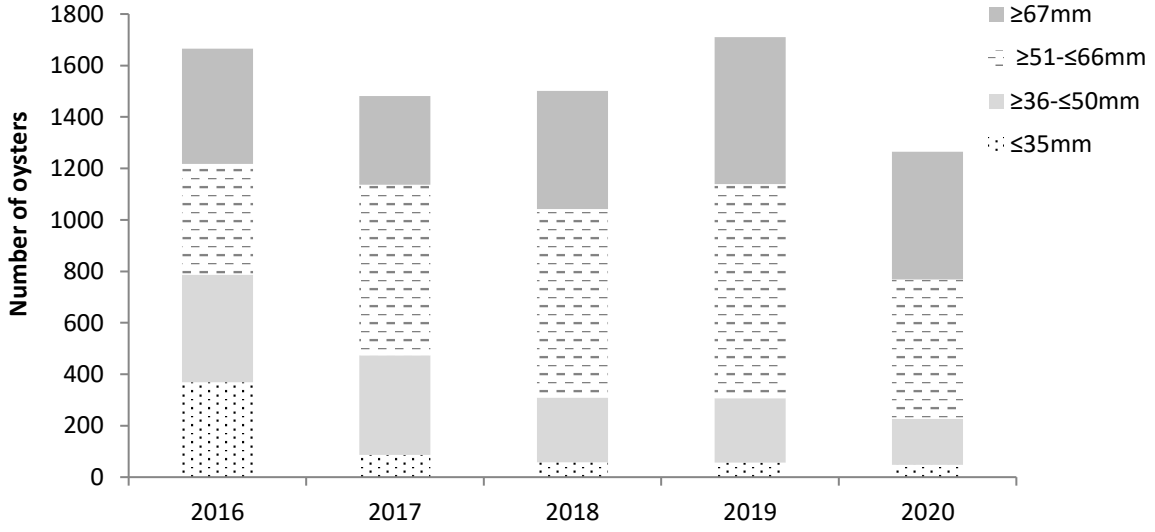


Figure 8: The composition of native oysters (*Ostrea edulis)* per size class (≥67 mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35 mm) from 2016 to 2020.

The size distribution of native oysters from 2016 to 2020 is shown in Figure 9. The largest oyster recorded during the survey was 135 mm and the smallest was 13 mm. The greatest proportion of oysters from 2017 to 2020 was the ≥51 to ≤66 mm size class, followed by the ≥67 mm size class. The smallest proportion for these four years was the ≤35 mm size class with percentages of 3 % to 6 %. In 2016 the distribution of oysters by size class was more evenly spread. The total number of oysters per size class per site is shown in Annex Table F.

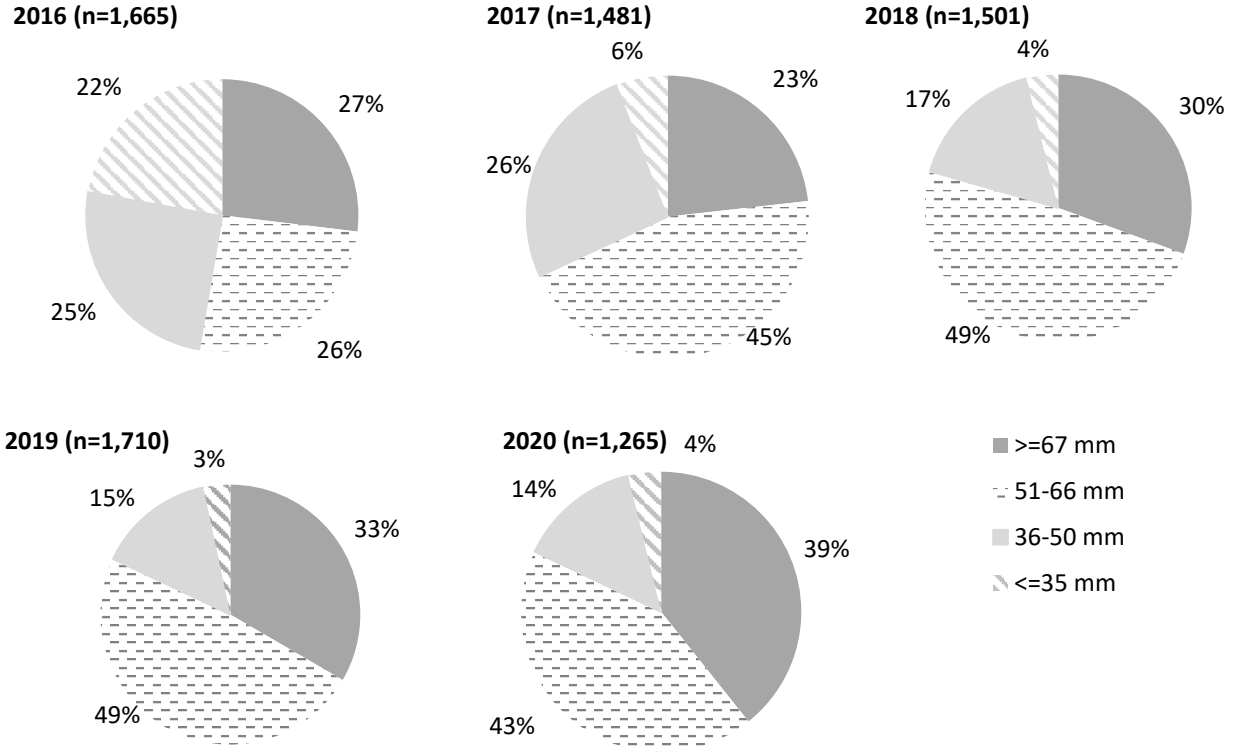


Figure 9: The size class distribution (≥67 mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35 mm) of native oysters (*Ostrea edulis)* from the Fal Oyster Survey from 2016 to 2020.

The composition of size classes of oysters at each site in Areas A, B and C has varied from 2016 to 2020 (Figure 10 and Figure 11) with most sites composed of a range of size classes. In 2016, the oyster size class composition for most samples consisted of all four size classes including a large proportion of oysters in the ≤35 mm size class, especially on the East bank in Area B. The samples in 2016 and 2017 had a greater number of oysters recorded compared to sites from 2018 onwards. From 2017, the size class composition per site has been dominated by the ≥51 to ≤66 mm. For all five years a very low number of oysters were recorded in the 'basin', an area of deeper water on the East Bank, this is likely due to be large amounts of red weed (*Soliera chordalis*) in this area reducing the number of oysters. In 2020, the number of oysters in the ≤35 mm was low compared to previous years.

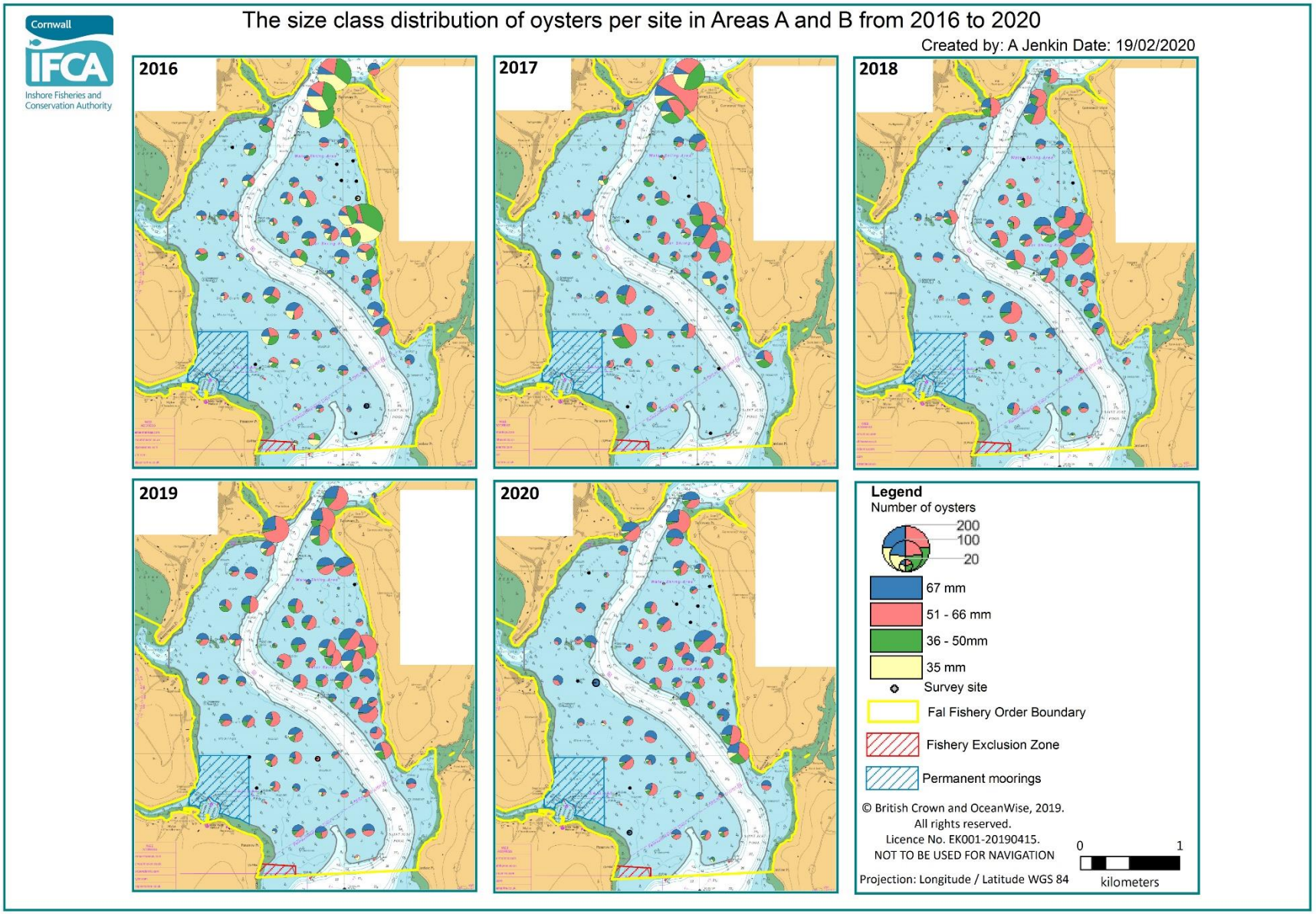


Figure 10: The composition of size classes (≥67 mm, ≥51 to ≤66 mm, ≥36 to ≤50 mm and ≤35 mm) of native oysters (*Ostrea edulis*) per survey station within Areas A and B from 2016 to 2020.

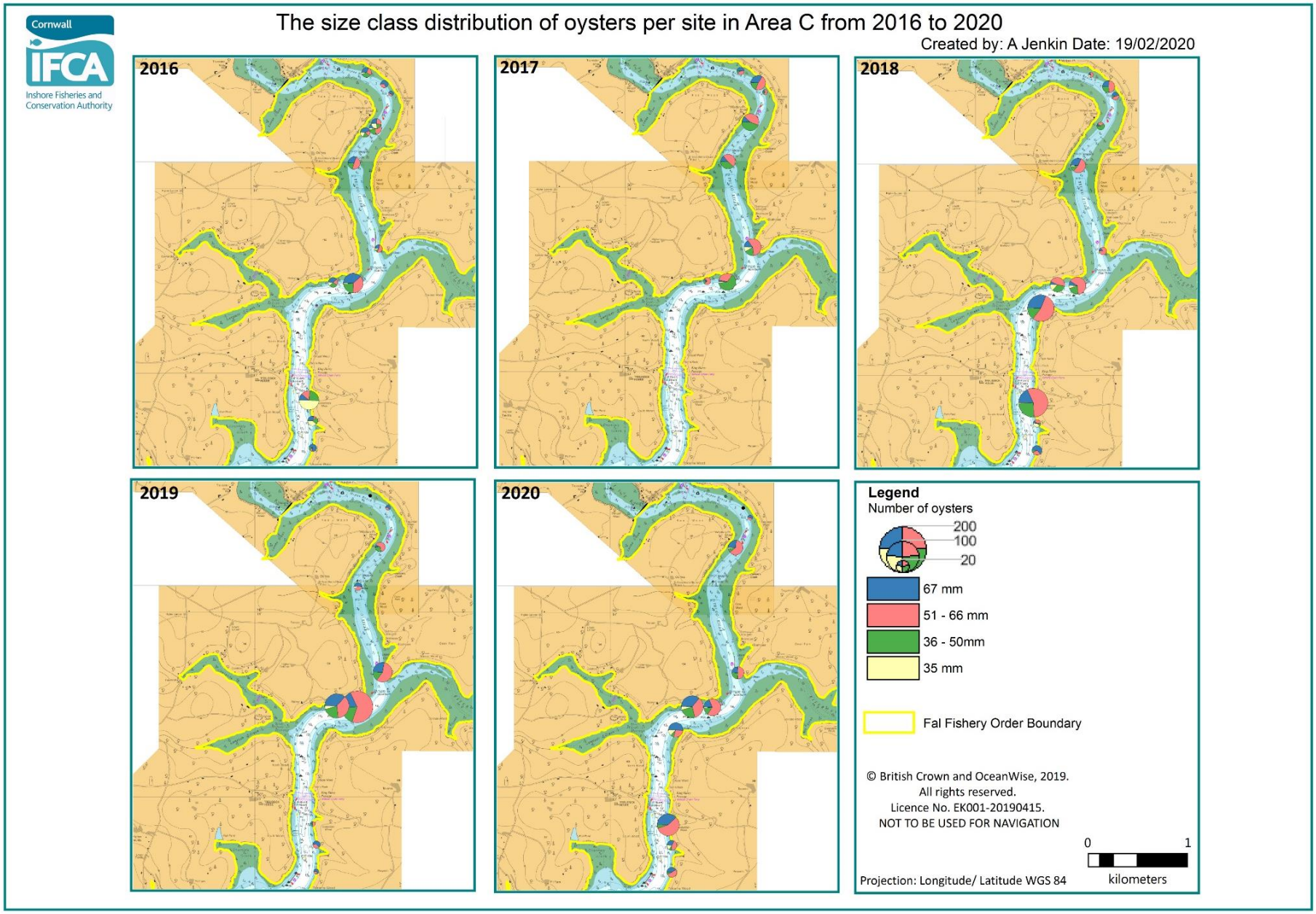


Figure 11: The composition of size classes (≥67 mm, ≥51 to ≤66 mm, ≥36 to ≤50 mm and ≤35 mm) of native oysters (*Ostrea edulis*) per survey station within Area C as surveyed from 2016 to 2020.

3.2.2 Density plots

Density plots were created for the total number of oysters per 10 m^2, the number of oysters ≥67 mm per 10 m^2 and the number of oysters between ≥51 to ≤66 mm per 10 m^2 for Areas A and B. Density plots of Area C, the upper reaches above Turnaware Point were not mapped by density due to the lack of samples and their scattered distribution which could lead to misleading interpolation.

Total number of oysters per 10m^2

The distribution of the total number of oysters per 10 m^2 is shown in Figure 12. The distribution of the total number of oysters per 10 m^2 from 2016 to 2020 shows similar areas with a higher density of oysters, around Turnaware Point, the central part of East Bank and the central part of North Bank directly to the north-east of the moorings in Mylor, however the density of oysters has decreased over five years from 20 – 40 oysters/ 10m^2 to 8 to 12 oysters/ 10m^2 in some parts. Areas with a low density of oysters were the southern part of the survey area, the area just to the south of Turnaware Point where the 'basin' exists and the west side of North Bank.

Oysters ≥ 67 mm per 10 m^2

The distribution of oysters ≥67 mm per 10 m^2 is shown in Figure 13. In 2020, the density of oysters was low across most of the survey area from 0.1 to 2 oysters per 10 m^2 to 2 to 4 oysters per 10 m^2). The distribution of the slightly higher density patches was scattered across the survey area at Turnaware Point and parts of North and East Bank. This distribution is similar to that recorded for this size class in previous years with a low density and a patchy distribution of slightly higher density patches across the survey area except in 2017 when a lower density of oysters was recorded on East Bank with (0 to 0.1 oysters/ 10 m^2).

Oysters ≥51 to ≤66 mm per 10 m^2

The distribution of pre-recruits between ≥51 and ≤66 mm per 10 m^2 is shown in Figure 14. The distribution of oysters in this size class was similar to previous years from 2017 onwards however the density of oysters has decreased over time with fewer areas with a high distribution of oysters between 10 to 40 oysters per 10m^2. The areas with a higher density in 2020 were Turnaware Point and central parts of East Bank. The remainder of the survey site had a low distribution of oysters from 0.1 to 2 oysters per 10 m^2.

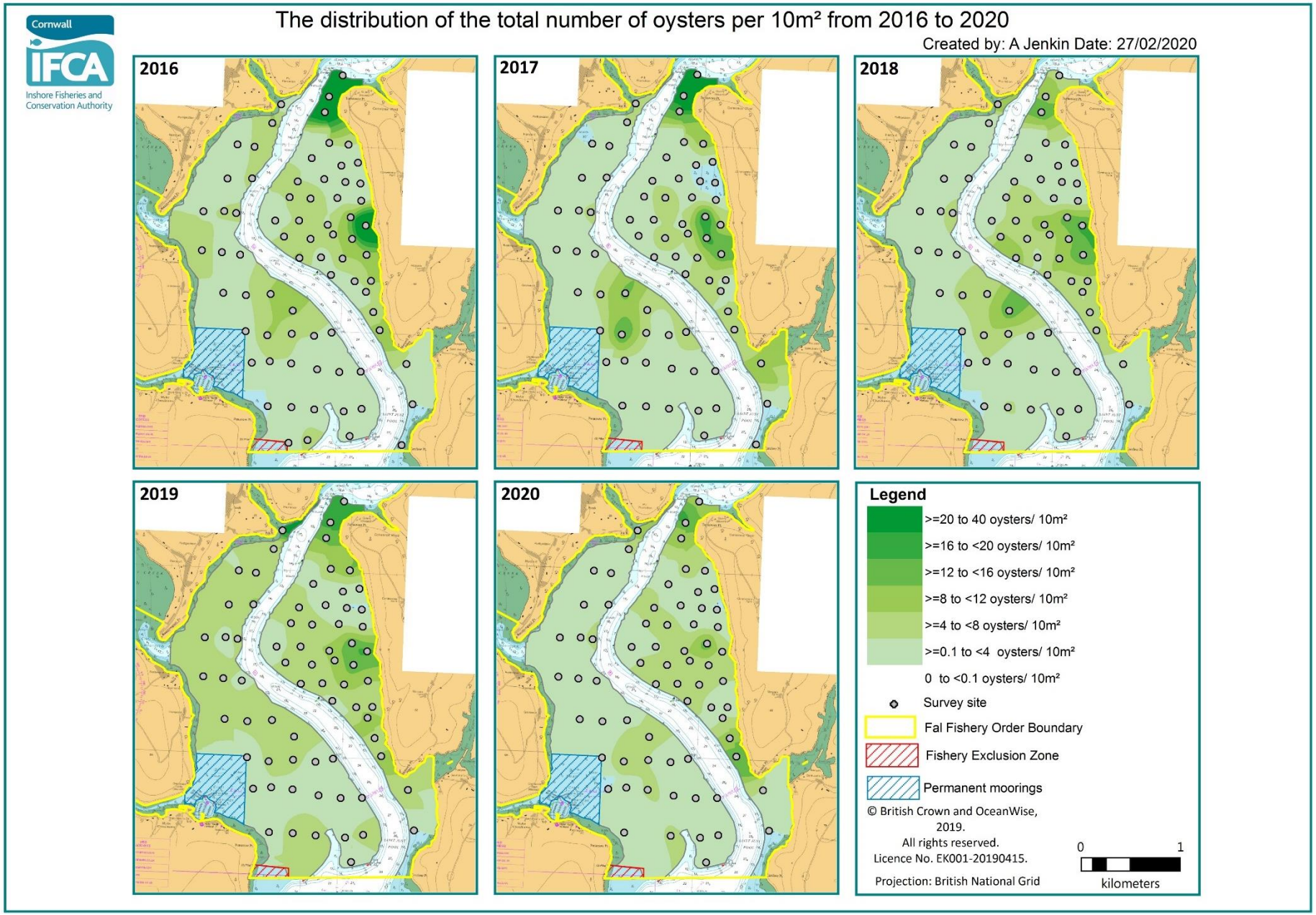


Figure 12: Oyster density map displaying the total number of native oysters (*Ostrea edulis)* per 10 m² within Areas A and B from 2016 to 2020.

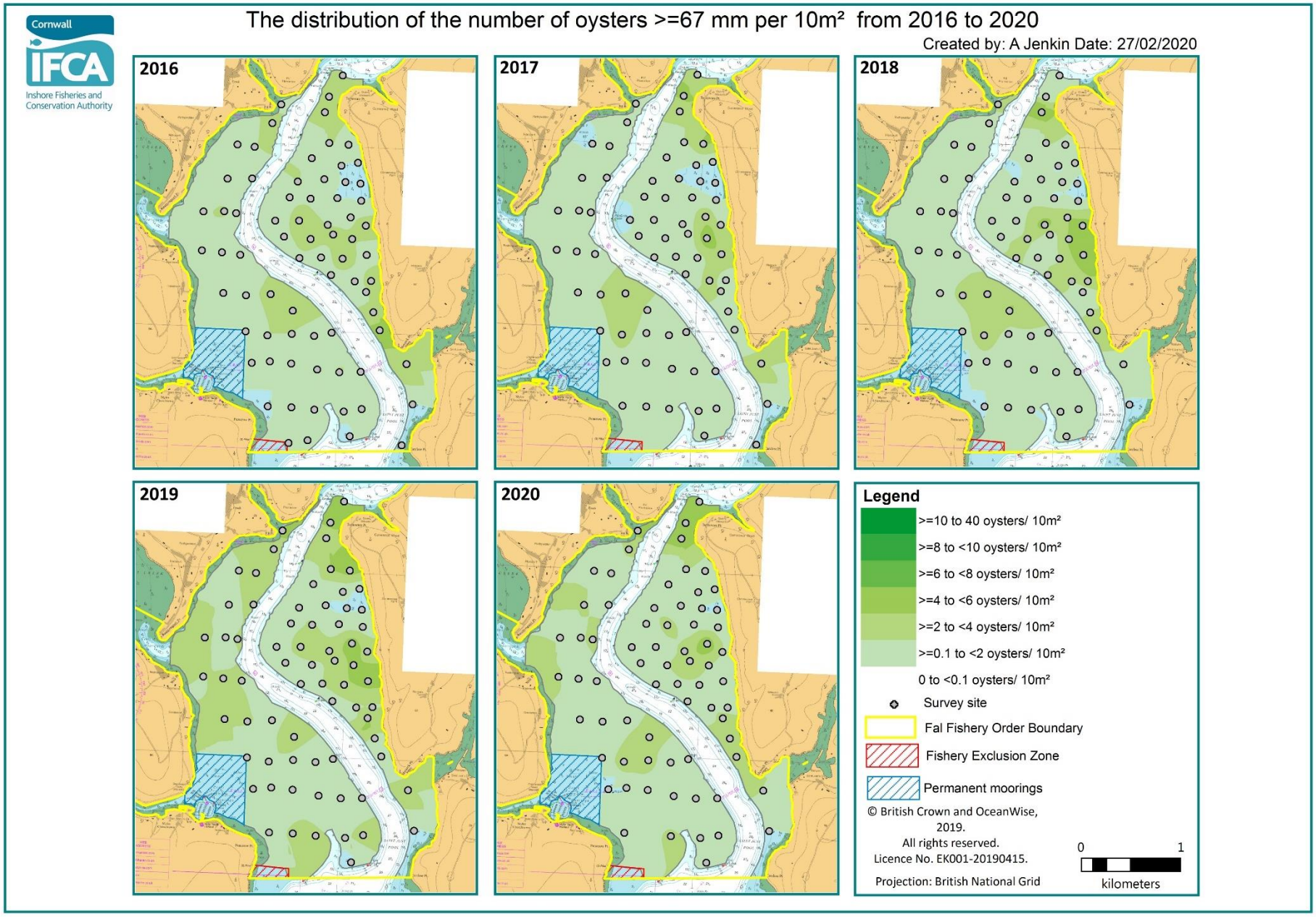


Figure 13: Oyster density maps displaying native oysters (*Ostrea edulis)* ≥67 mm per 10 m² within Areas A and B from 2016 to 2020.

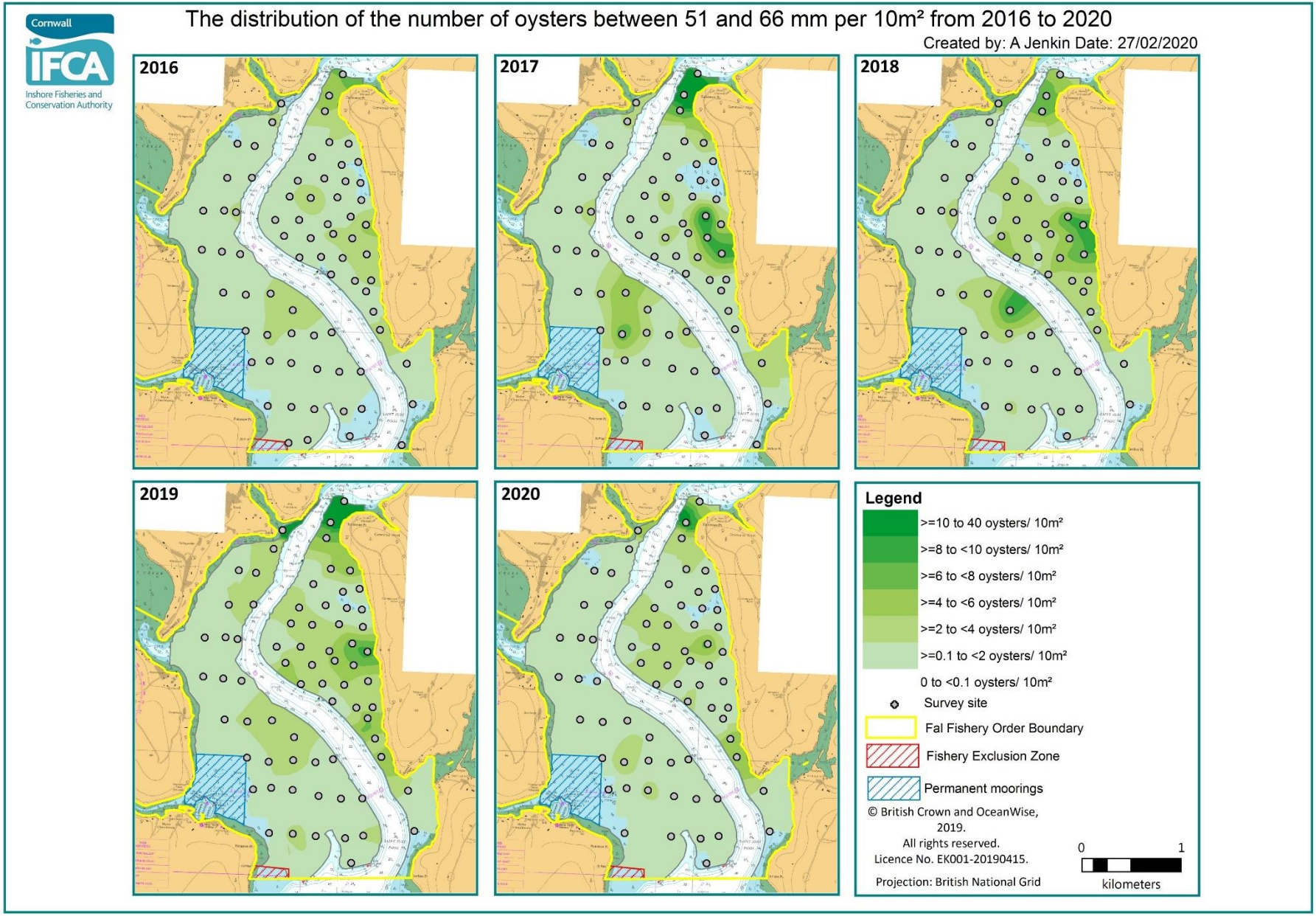


Figure 14: Oyster density maps showing native oysters (*Ostrea edulis)* between ≥51 and ≤66 mm per 10m² within Areas A and B from 2016 to 2020.

3.2.3 Management sections

Of the total number of oysters, 304 were from Area A, 573 from Area B and 388 from Area C. The total number of oysters per site is shown in Annex Table F.

3.2.3.1 Average sizes

Table 4 and Figure 15 show the average length (mm) of native oysters recorded in Areas A, B and C from 2016 to 2020. For all sections of the survey, the average size (mm) of native oysters has increased in all three areas from 2016 to 2020 from 57.9 to 65.4 mm in Area A, from 51.8 to 61.6 mm in Area B and from 51.1 to 62.9 mm in Area C.

Table 4: The average size (mm) ± standard error of native oysters (*Ostrea edulis)* in the Area A, B and C management areas from 2016 to 2020.

Year	Area A	Area B	Area C
2020	65.4 mm ± 0.87 mm	61.6 mm ± 0.58 mm	62.9 mm ± 0.70 mm
2019	62.8 mm ± 0.72 mm	61.3 mm ± 0.46 mm	60.8 mm ± 0.54 mm
2018	61.9 mm ± 0.79 mm	60.5 mm ± 0.49 mm	59.1 mm ± 0.62 mm
2017	59.7 mm ± 0.78 mm	58.8 mm ± 0.58 mm	52.7 mm ± 0.57 mm
2016	57.9 mm ± 0.96 mm	51.8 mm ± 0.66 mm	51.1 mm ± 0.89 mm

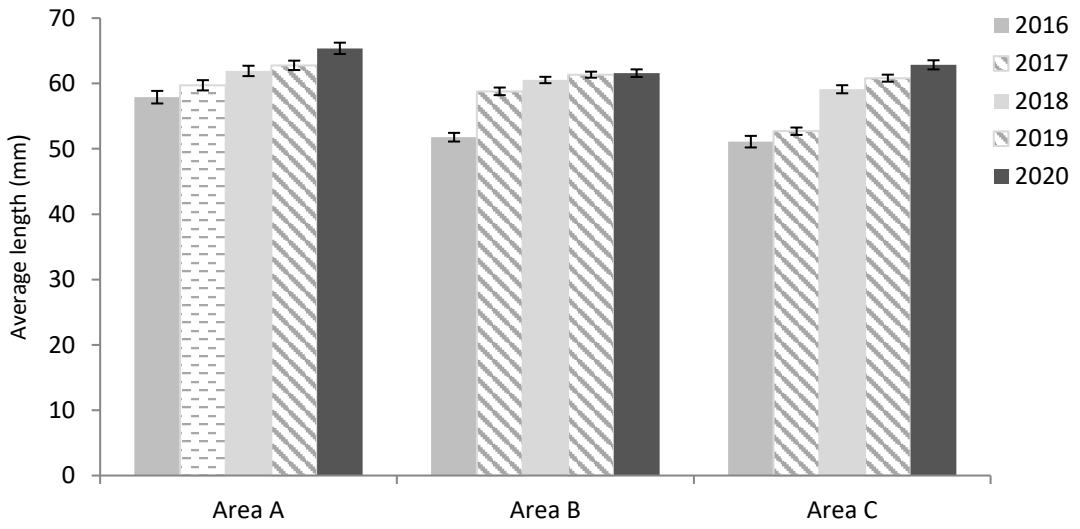


Figure 15: The average size (mm) of native oysters (*Ostrea edulis)* ± standard error for the management areas (Area A, B and C) of the survey for the years 2016 to 2020.

The total length frequency for all oysters sampled from 2016 to 2020 in shown in Figure 16.

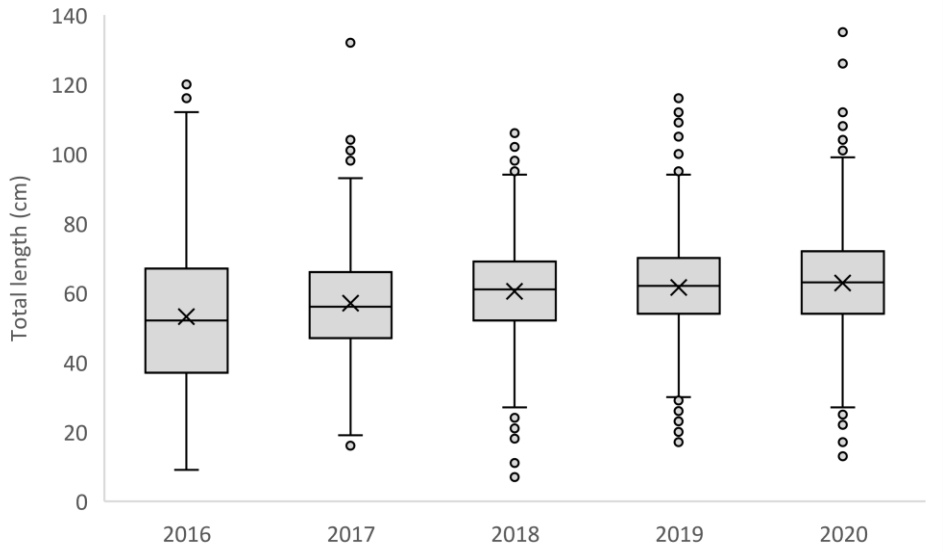
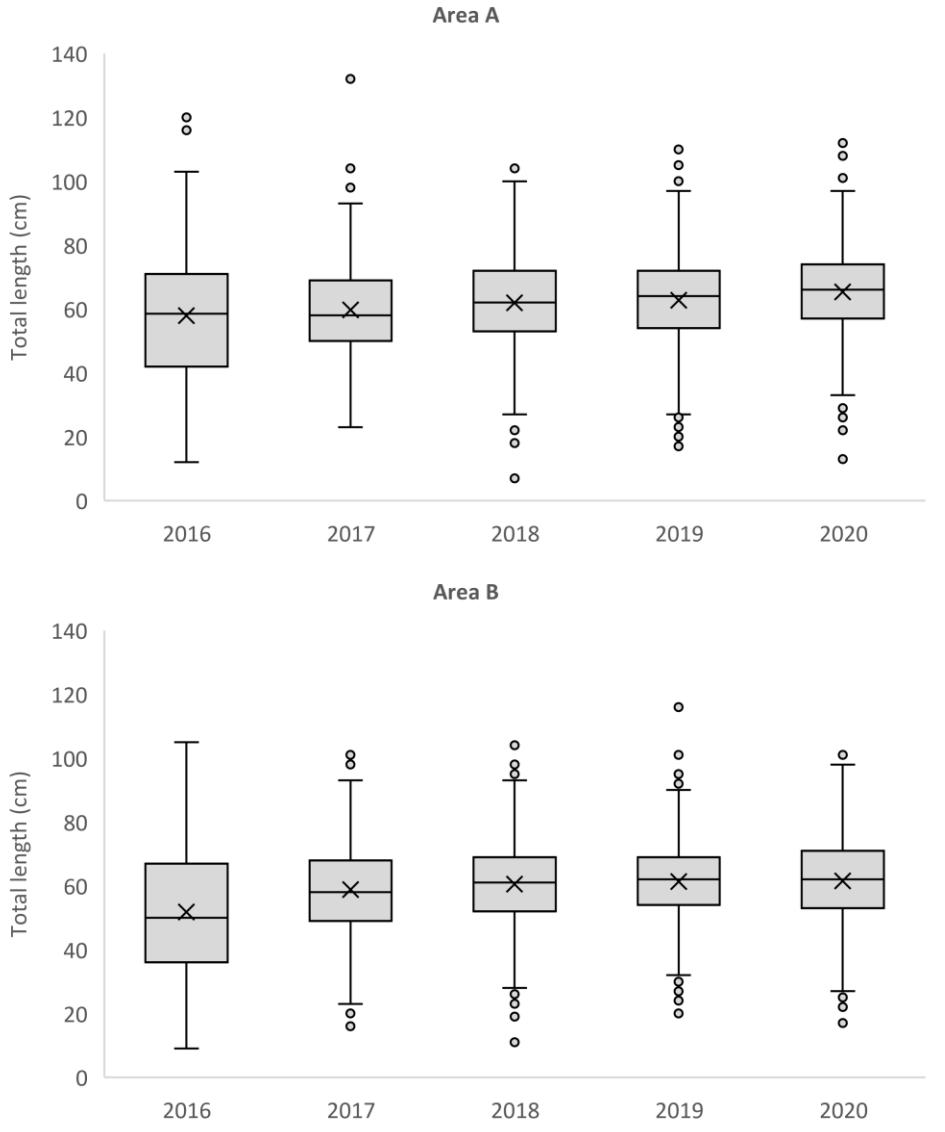


Figure 16: Total length frequency plot for all native oysters (*Ostrea edulis)* from 2016 to 2020. Date is grouped by year. The X represents the mean, the line represents the median, boxes represent the inter-quartile range, error bars represent the range, and the filled circles represent outliers.

The total length frequency for all oysters sampled in Areas A, B and C from 2016 to 2020 are shown in Figure 17.



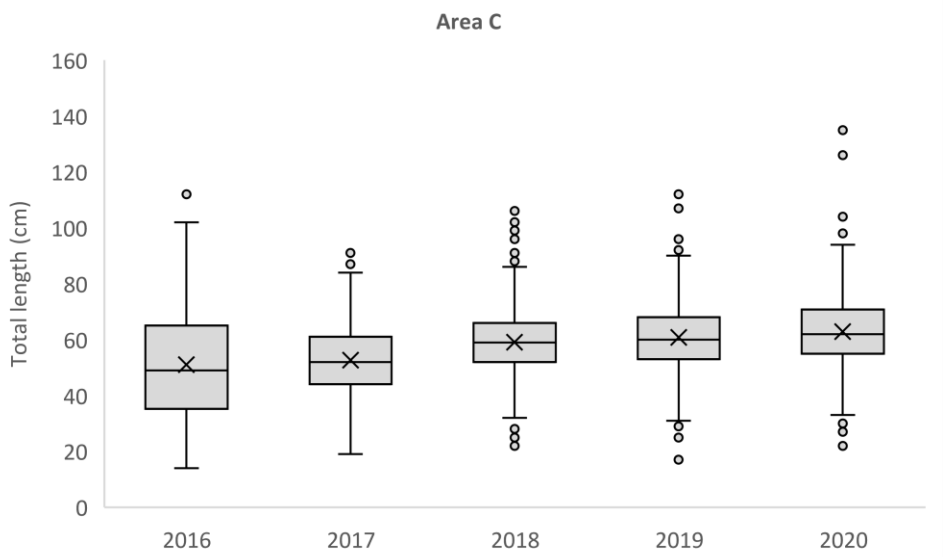


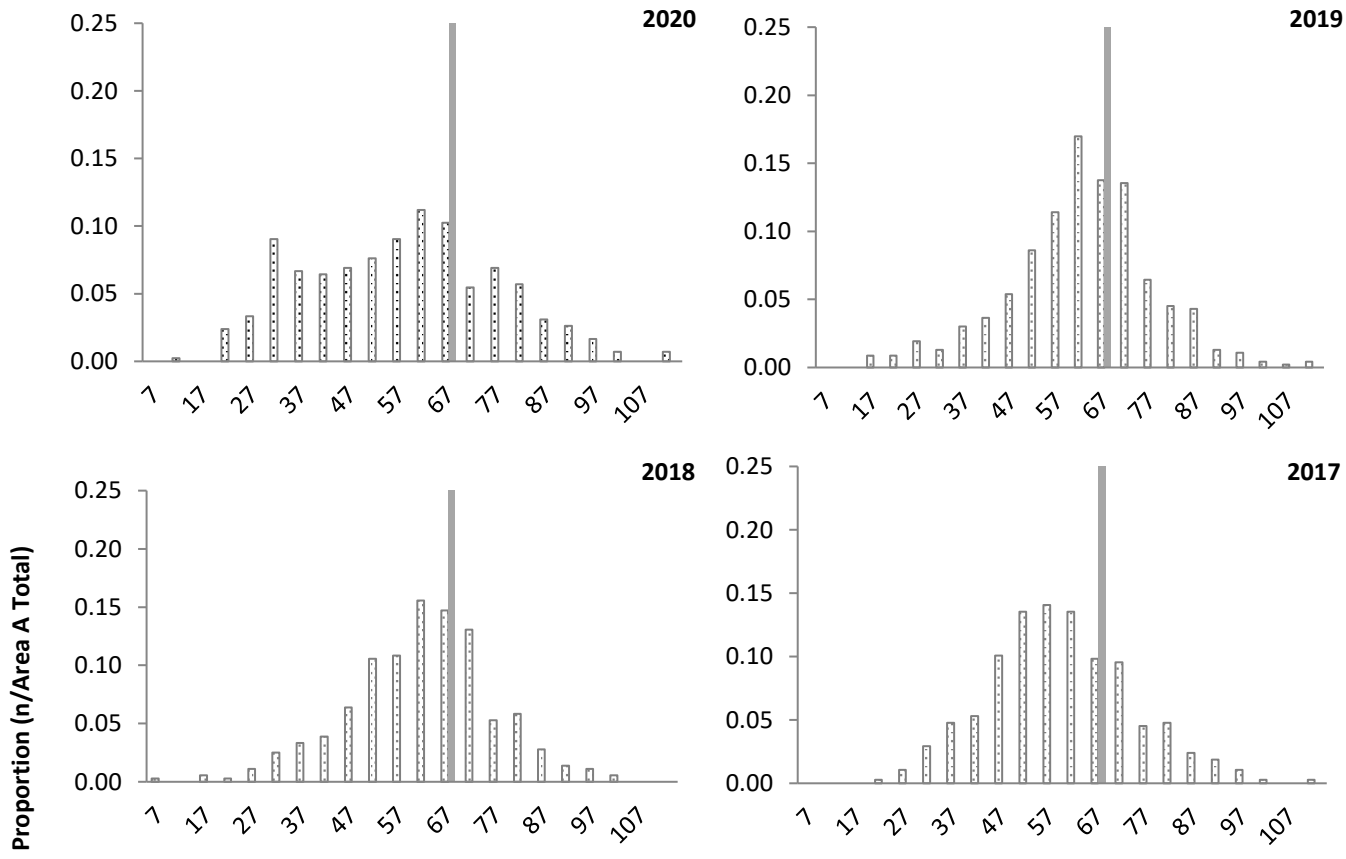
Figure 17: Total length frequency plot for all native oysters (*Ostrea edulis)* in Areas A, B and C from 2016 to 2020. Date is grouped by year. X represents the mean, the line represents the median, boxes represent the inter-quartile range, error bars represent the range, and the filled circles represent outliers.

3.2.3.2 Size frequency plots

Size frequency plots for the management areas A, B and C are shown in Figure 18.

The distribution for Area A was the same for all years of the survey with a unimodal distribution, except in 2016 when the distribution was uneven and irregular. The peak in 2020 was 67 mm which was slightly larger than 62 mm in 2019 and 2018.

Area A



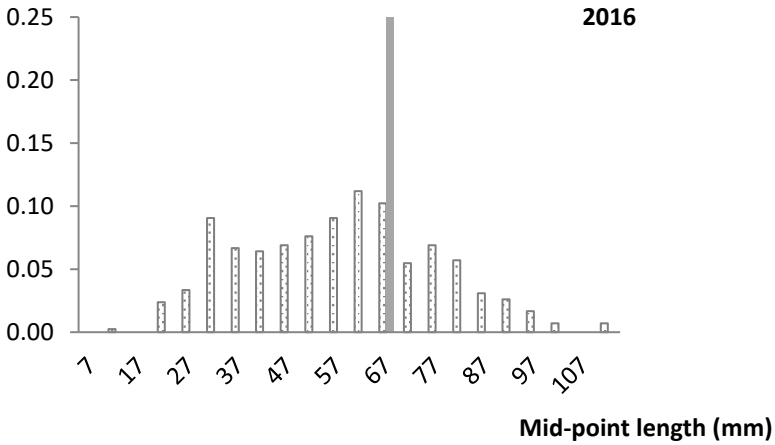
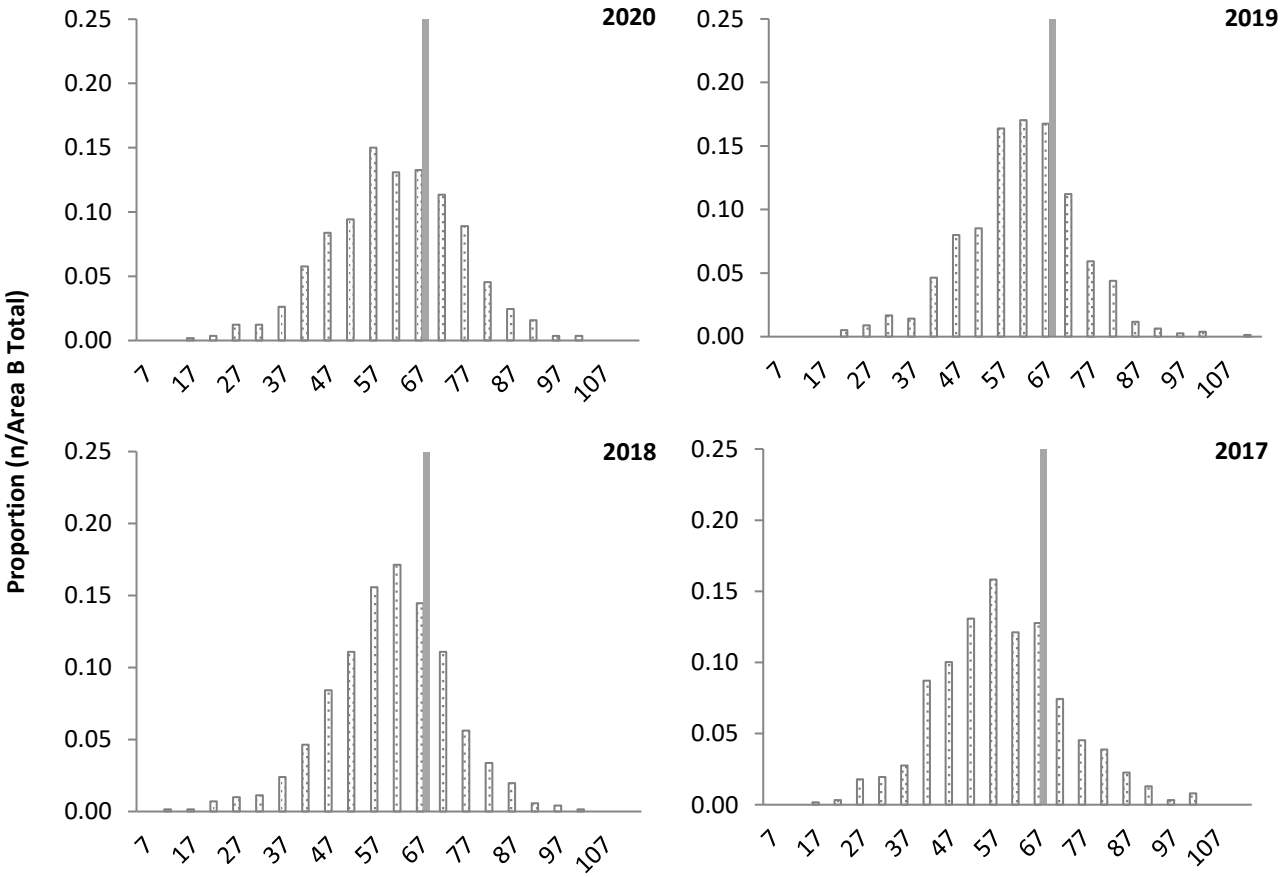


Figure 18: Size frequency distributions of native oysters (*Ostrea edulis)* for the management area, Area A of the fishery for 2016, 2017, 2018, 2019 and 2020. The minimum landing size for native oysters from the fishery is shown with the grey line (67 mm).

Area B

The distribution for Area B in 2020 was unimodal with a peak at 57 mm (Figure 19). The distribution in 2015, 2017-2019 was similar, with a unimodal distribution and peaks of either 62 mm or 57 mm. As in Area A, in 2016 the distribution was uneven and irregular.



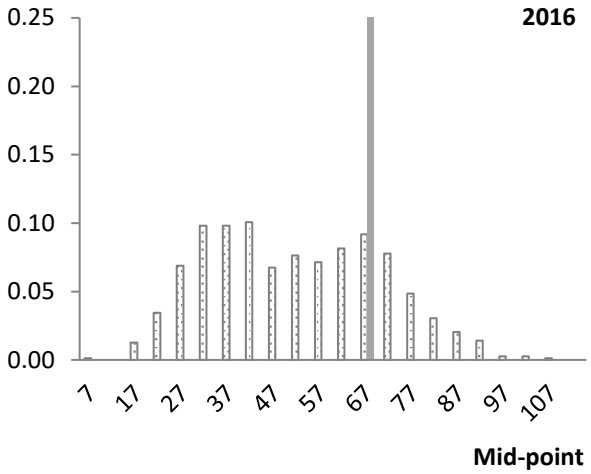
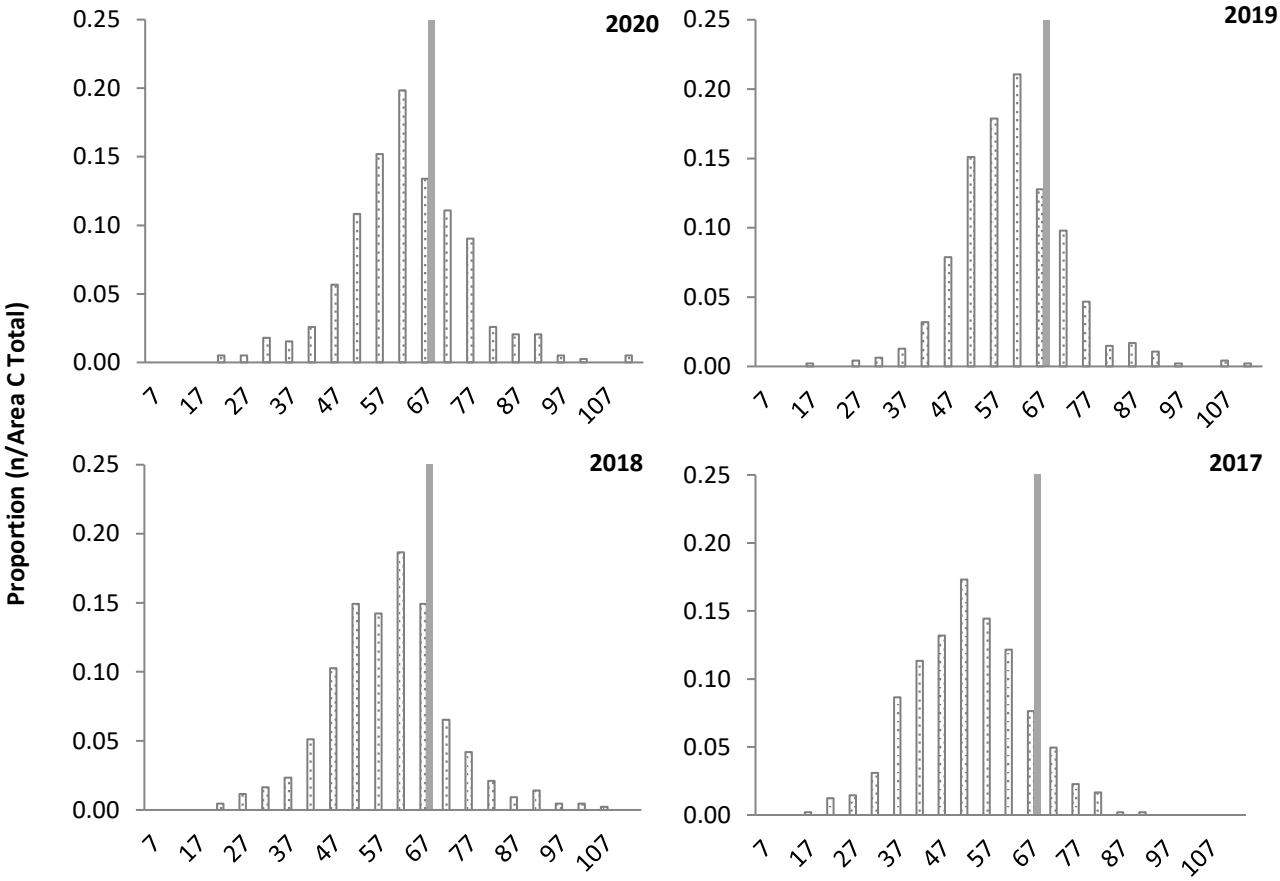


Figure 19: Size frequency distributions of native oysters (*Ostrea edulis)* for the management area, Area B of the fishery for 2016, 2017, 2018, 2019 and 2020. The minimum landing size for native oysters from the fishery is shown with the grey line (67 mm).

Area C

The distribution for Area C in unimodal with a peak at 62 mm, the same as 2018 and 2019 (Figure 20). The distribution was also unimodal in 2017 however the peak was 52 mm. As in areas A and B, in 2016 the distribution was uneven and irregular.



2020_CIFCA_SAC_FAL_FOS

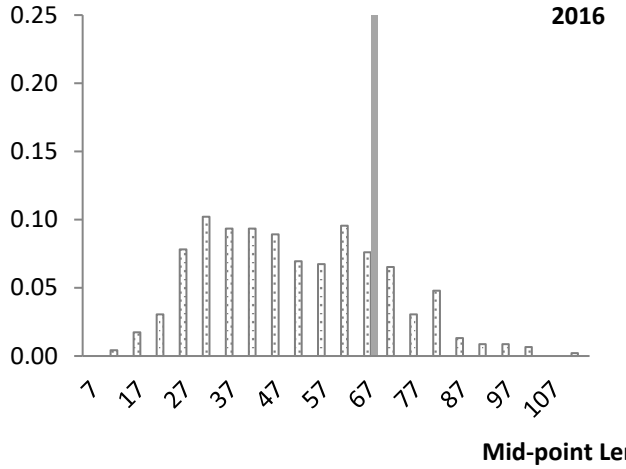


Figure 20: Size frequency distributions of native oysters (*Ostrea edulis)* for the management area, Area C of the fishery for 2016, 2017, 2018, 2019 and 2020. The minimum landing size for native oysters from the fishery is shown with the grey line (67 mm).

3.2.3.3 Average number per site

Table 5 and Figure 21 show the average number of native oysters per site by management areas A, B and C from 2016 to 2020.

The average number of oysters per site by management area from 2016 to 2020 was highest in Area C. In Area A the average number of oysters was highest in 2019 at 14.5 and decreased in 2020 to 9.8 oysters. In Area B the value increased from 2017 to a peak in 2019 of 22.1 and then decreased in 2020 to 16.4 oysters. In Area C the average number was highest in 2017 at 40.4 oysters, then decreased in 2018 and has fluctuated steadily with 24.3 oysters recorded in 2020.

Table 5: The average number per site ± standard error of native oysters (*Ostrea edulis)* for the management areas (Area A, B and C) of the survey from 2016 to 2020.

Year	Area A	Area B	Area C
2020	9.8 ± 1.2	16.4 ± 2.3	24.3 ± 5.2
2019	14.5 ± 1.4	22.1 ± 2.9	29.4 ± 8.7
2018	11.3 ± 1.9	20.3 ± 3.0	26.8 ± 6.4
2017	11.8 ± 2.4	17.2 ± 3.4	40.4 ± 15.7
2016	12.4 ± 1.6	21.8 ± 4.8	24.2 ± 7.2

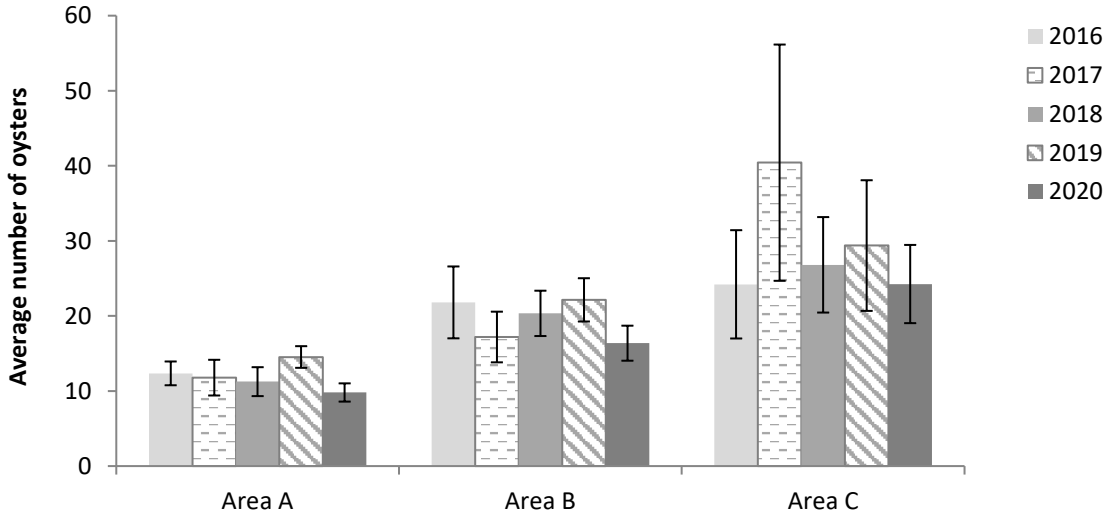


Figure 21: The average number of native oysters (*Ostrea edulis)* ± standard error for the management areas (Area A, B and C) of the survey from 2016 to 2020.

3.2.3.4 Density

The density of oysters per 10 m^2 for 2020 for all three management areas is shown in Figure 22. The density of oysters was lowest in Area A and highest in Area C. The density has decreased in all three areas from 2019 to 2020.

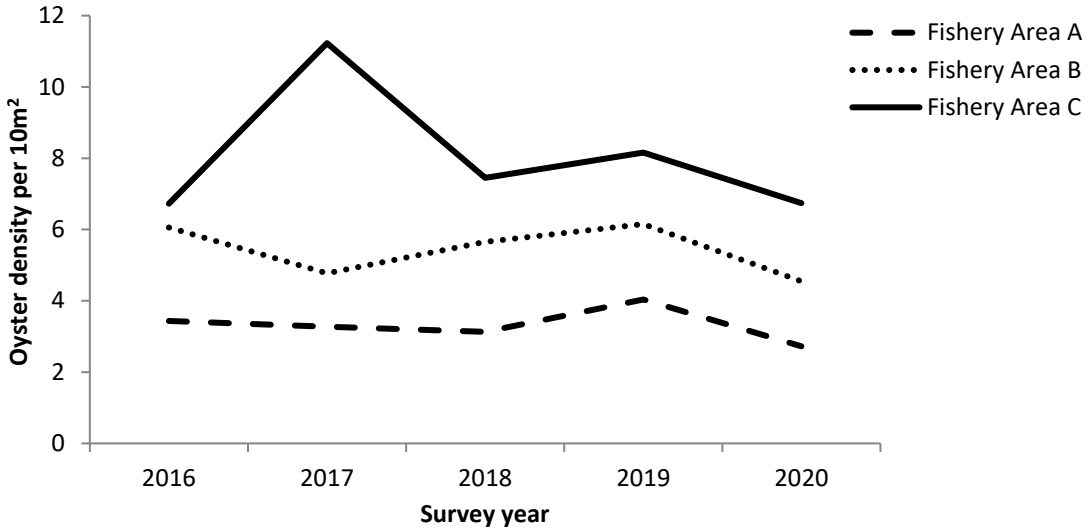
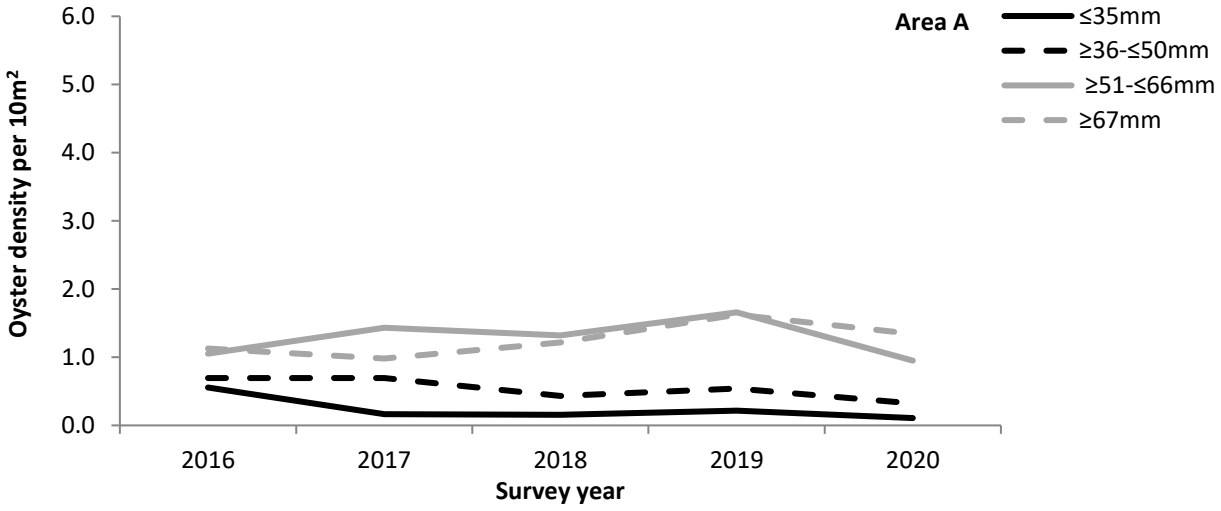


Figure 22: The density of native oysters (*Ostrea edulis)* per 10 m^2 for the three management areas (Area A, B and C) from 2016 to 2020.

The density of oysters per 10 m^2 From 2016 to 2020 for all three management areas per size class is shown in Figure 23.



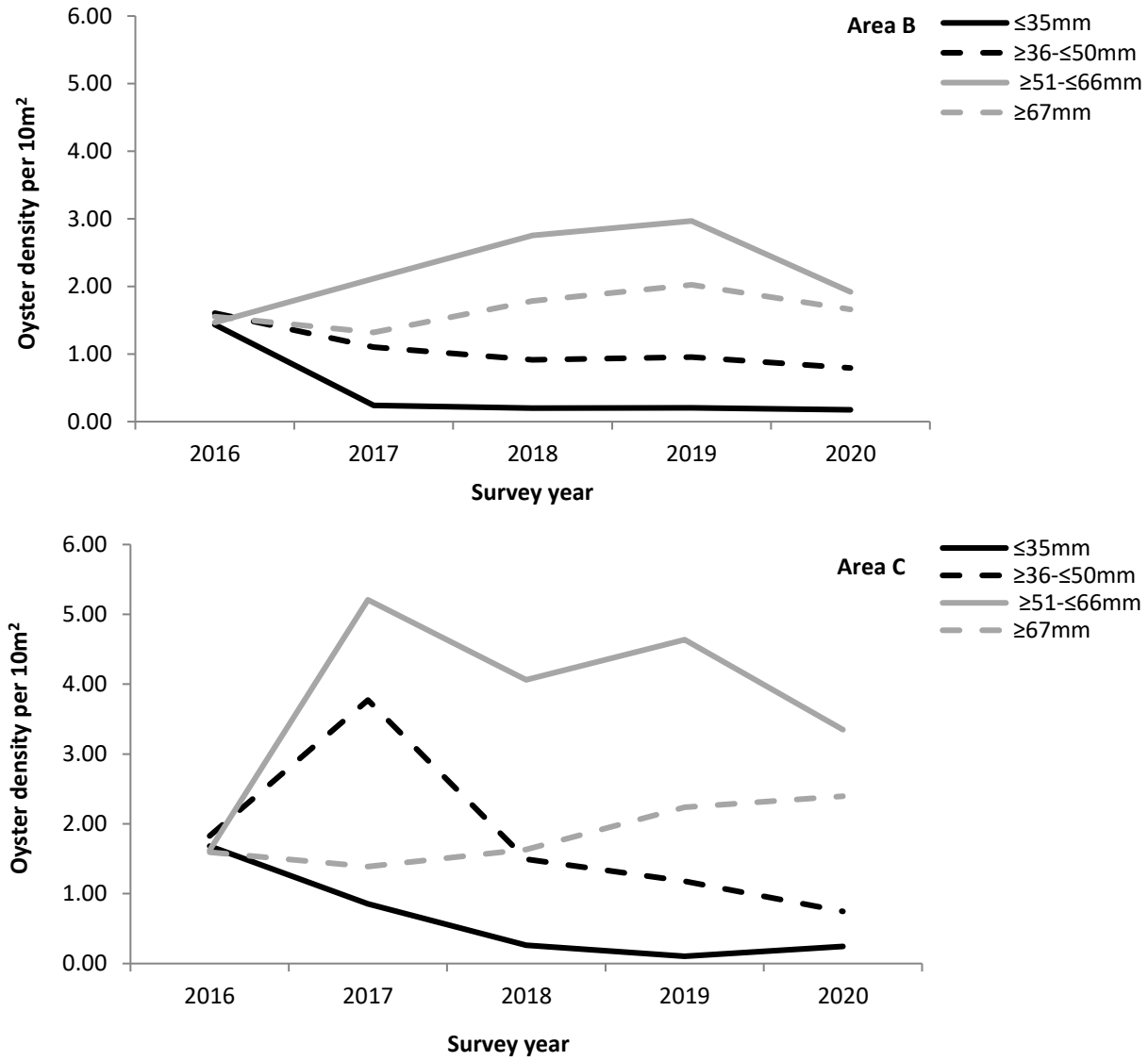


Figure 23: The density of native oysters (*Ostrea edulis)* per 10 m² for the three management areas (Area A, B and C) per size class from 2016 to 2020.

3.2.3.5 Oyster Size Class Composition

When split by size class and management area, the total number of oysters for all of the size classes was highest in Area B (Table 6) and lowest in Area A except for the ≥65 mm size class which was lowest in Area C.

Table 6: The number of native oysters (*Ostrea edulis)* recorded in the three management sections (Area A, B and C) recorded by total number, total number of oysters ≥67 mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35mm during the Fal oyster survey 2020.

Section	The total number of oysters	≥67 mm	≥51-≤66 mm	≥36-≤50 mm	≤35 mm
A	304	150	106	36	12
B	573	209	242	100	22
C	388	138	193	43	14

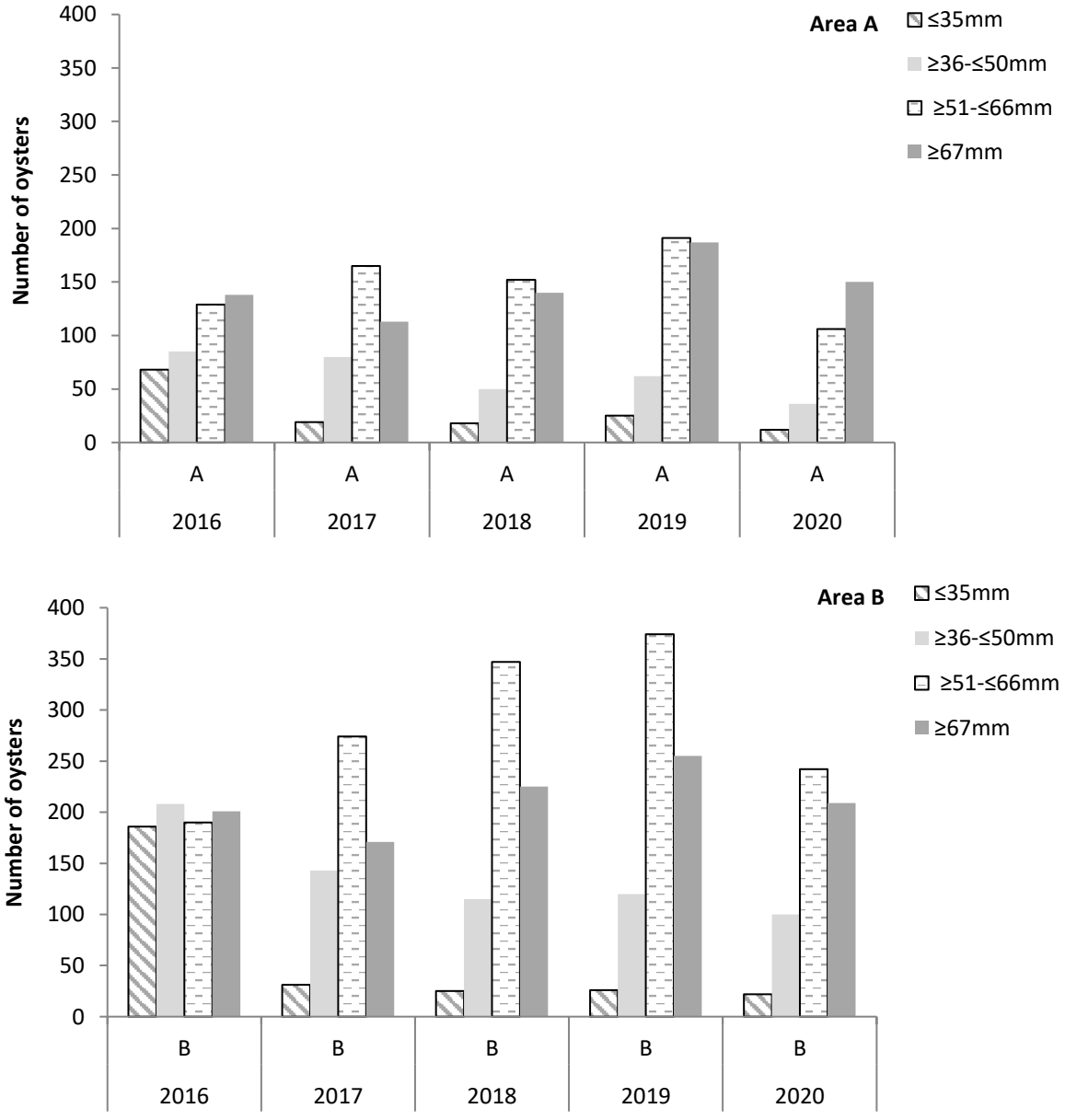
When split by size class and management area, the average number of oysters by section was highest in Area C and lowest in Area A (Table 7) except for the ≥36-≤50 mm size class which was highest in Area B. The average

number of oysters per section by size class was highest in Area C for the ≥51-≤66 mm size class (12.1) and lowest in Area A for the ≤35 mm size class (0.4).

Table 7: The average number of native oysters (*Ostrea edulis)* recorded in the three management sections (Area A, B and C) by each size class ≥67mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35mm during the Fal oyster survey 2020.

Section	The average number of oysters	≥67 mm	≥51-≤66 mm	≥36-≤50 mm	≤35 mm
A	9.8	4.8	3.4	1.2	0.4
B	16.4	6.0	6.9	2.9	0.6
C	24.2	8.6	12.1	2.7	0.9

The total number of native oysters per management area by size class varied by size class year by year (Figure 24). The number of oysters in the ≥51-≤66mm size class dominated in Areas B and C and remained low in the smallest size class (≤35 mm) from 2017 to 2020.



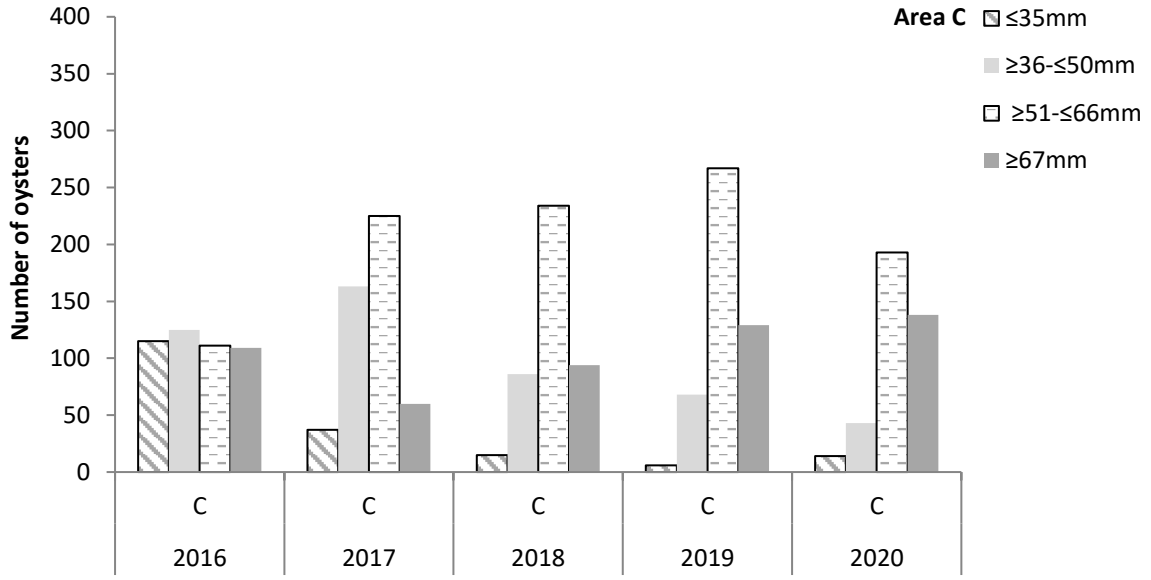
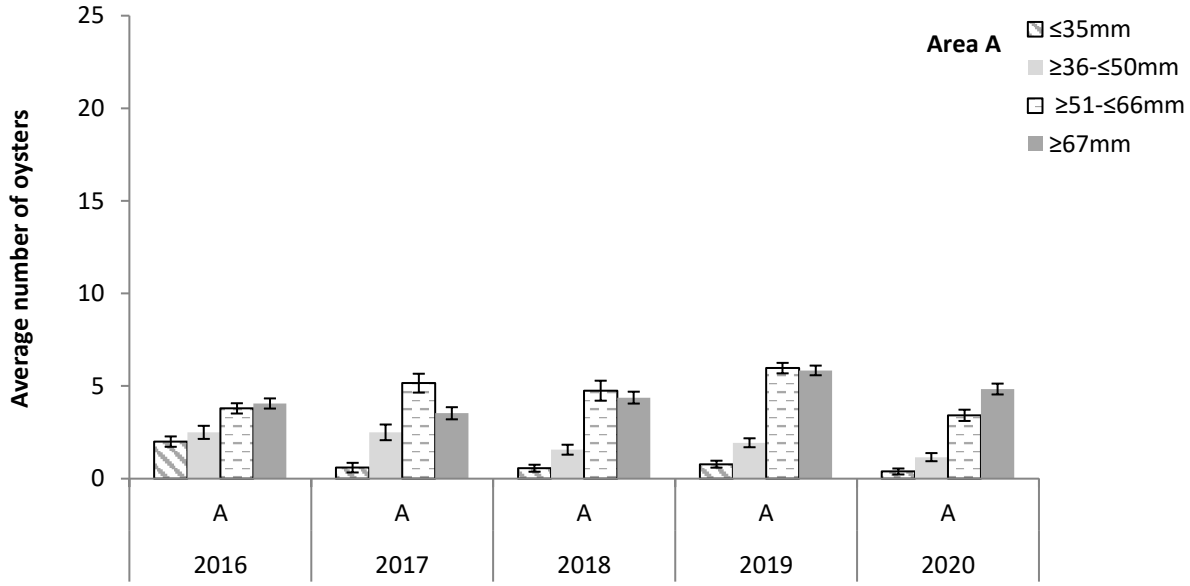


Figure 24: The total number of native oysters (*Ostrea edulis)* per size class (≥67mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35mm) for the management areas (Area A, B and C) from 2016 to 2020.

The average number of native oysters per area (Figure 25) varied for all three areas year by year with a greater number in the ≥51-≤66mm size class for all three areas from 2017 to 2020, except in 2020 in Area A when the ≥67mm size class had a slightly larger number. The average number of oysters in the ≤35 mm size class remained low.



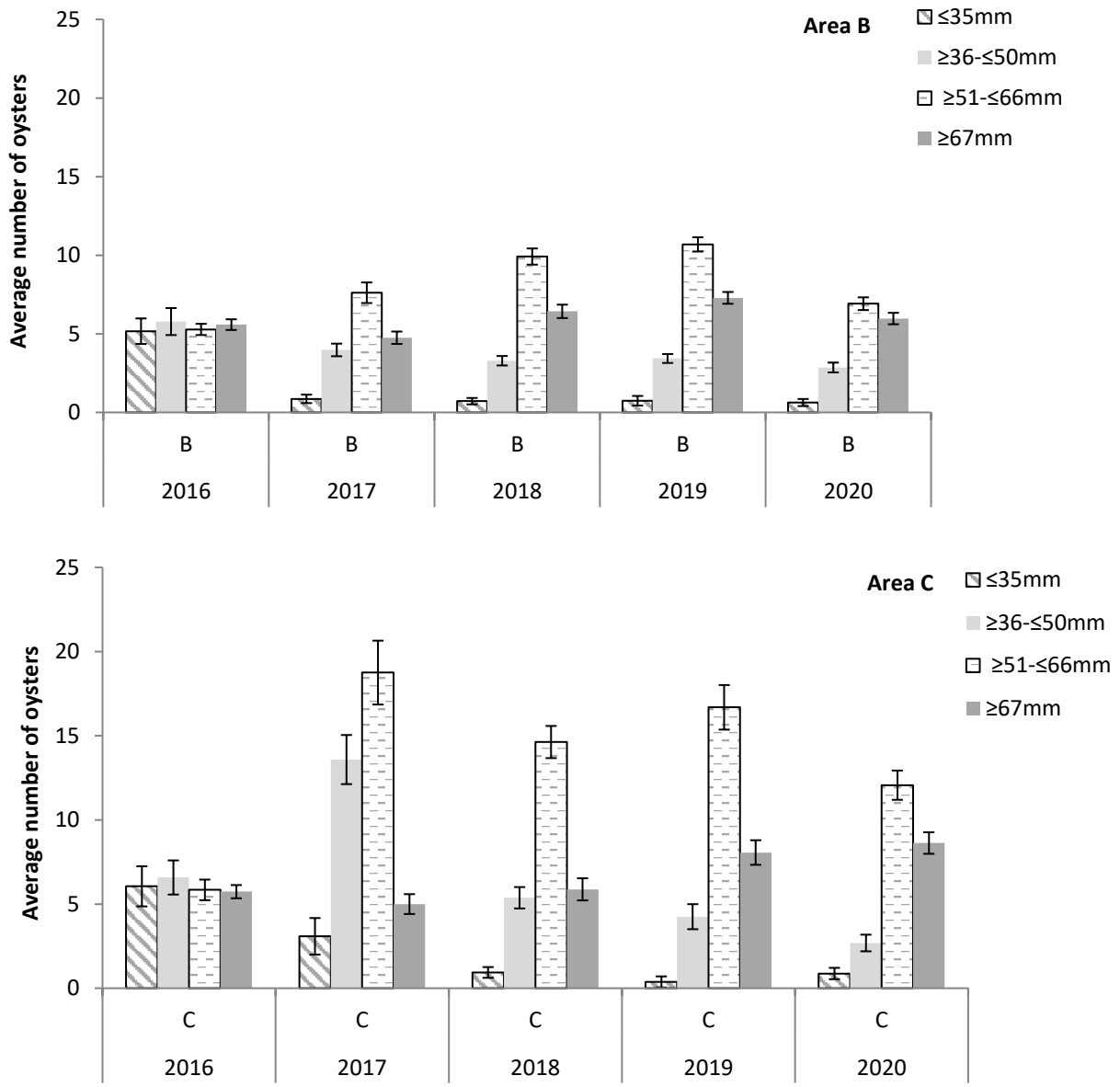


Figure 25: The average number of native oysters (*Ostrea edulis)* per size class (≥67 mm, ≥51-≤66 mm, ≥36-≤50 mm and ≤35 mm) from 2016 to 2020 for the management areas (Area A, B and C.

3.2.3.6 Minimum landing size (MLS)

As mentioned previously, the MLS for oysters from the fishery is 67 mm. The percentage of oysters over and under the MLS for the management areas, A, B and C is shown in Table 8. For all three areas in all years the percentage under the MLS was greater than over the MLS.

Table 8: The percentage (%) of native oysters (*Ostrea edulis*) over and under the minimum landing size (67 mm) for all three management areas (Area A, B and C) of the Fal Oyster Survey area from 2016 to 2020.

	Area A % under 67 mm	Area A % over 67 mm	Area B % under 67 mm	Area B % over 67 mm	Area C % under 67 mm	Area C % over 67 mm
2020	50.66	49.34	63.53	36.47	64.43	35.57
2019	59.78	40.22	67.10	32.90	72.55	27.45
2018	61.11	38.89	68.40	31.60	78.09	21.91
2017	70.03	29.97	72.37	27.63	87.63	12.37
2016	67.14	32.86	74.39	25.61	76.30	23.70

3.2.3.7 Length weight comparison

The total number of oysters weighed, the average weight and the number of oysters ≥67 mm for 2019 and 2020 are shown in Table 9 and Figure 26. The average weight of oysters (g) has increased across the whole fishery and the three management areas since 2019.

Table 9: The number of native oysters (*Ostrea edulis*) weighed, the average weight of native oysters (g), the number of oysters ≥67mm weighed and the average weight of oysters ≥67mm.

	Number of native oysters weighed	Average weight (g) of native oysters	Number of oysters ≥67 mm weighed	Average weight of oysters ≥67 mm (g)
Total 2019	787	51.07	298	74.74
Total 2020	1108	54.00	466	79.16
Area A 2019	154	56.51	71	80.42
Area A 2020	266	57.18	143	76.26
Area B 2019	583	49.93	213	72.79
Area B 2020	493	50.39	195	75.10
Area C 2019	50	47.56	14	75.71
Area C 2020	349	56.69	128	88.57

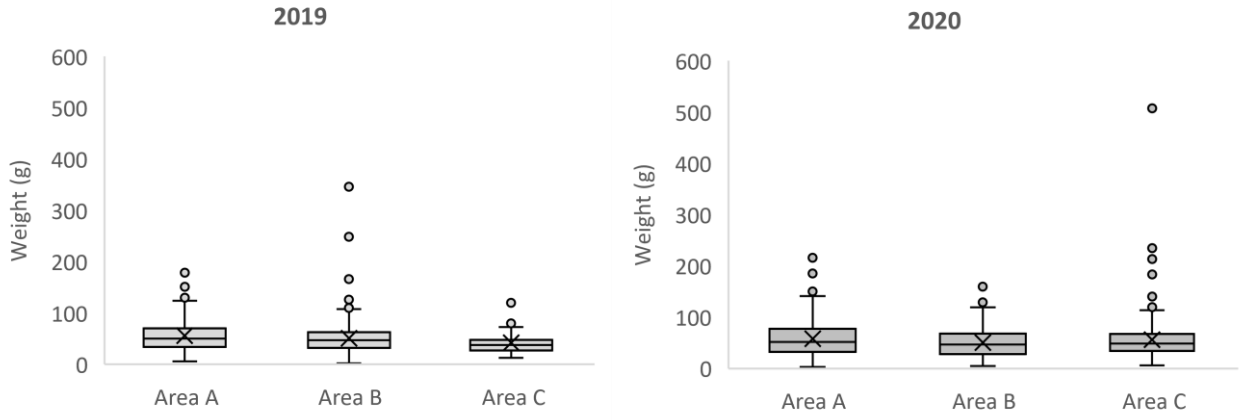
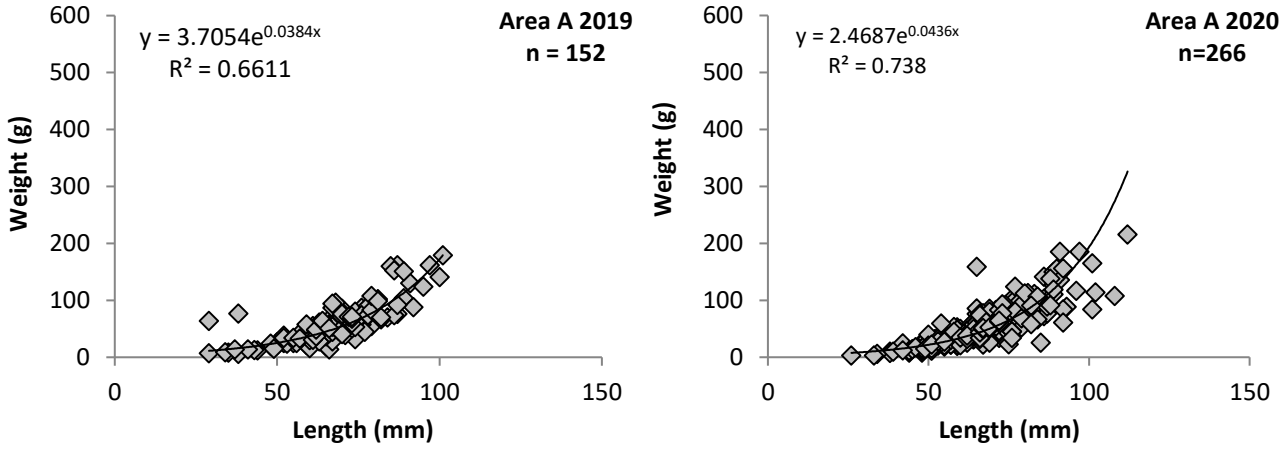


Figure 26: Total weight (g) frequency plot for all native oysters (*Ostrea edulis)* in Areas A, B and C from 2019 to 2020. Date is grouped by year. X represents the mean, the line represents the median, boxes represent the inter-quartile range, error bars represent the range, and the filled circles represent outliers.

The length weight relationship of oysters for areas A, B and C from 2019 to 2020 is shown in Figure 27. A total of 1,108 oysters were measured in 2020 compared to 787 in 2019 with the majority measured in Area B for both years.



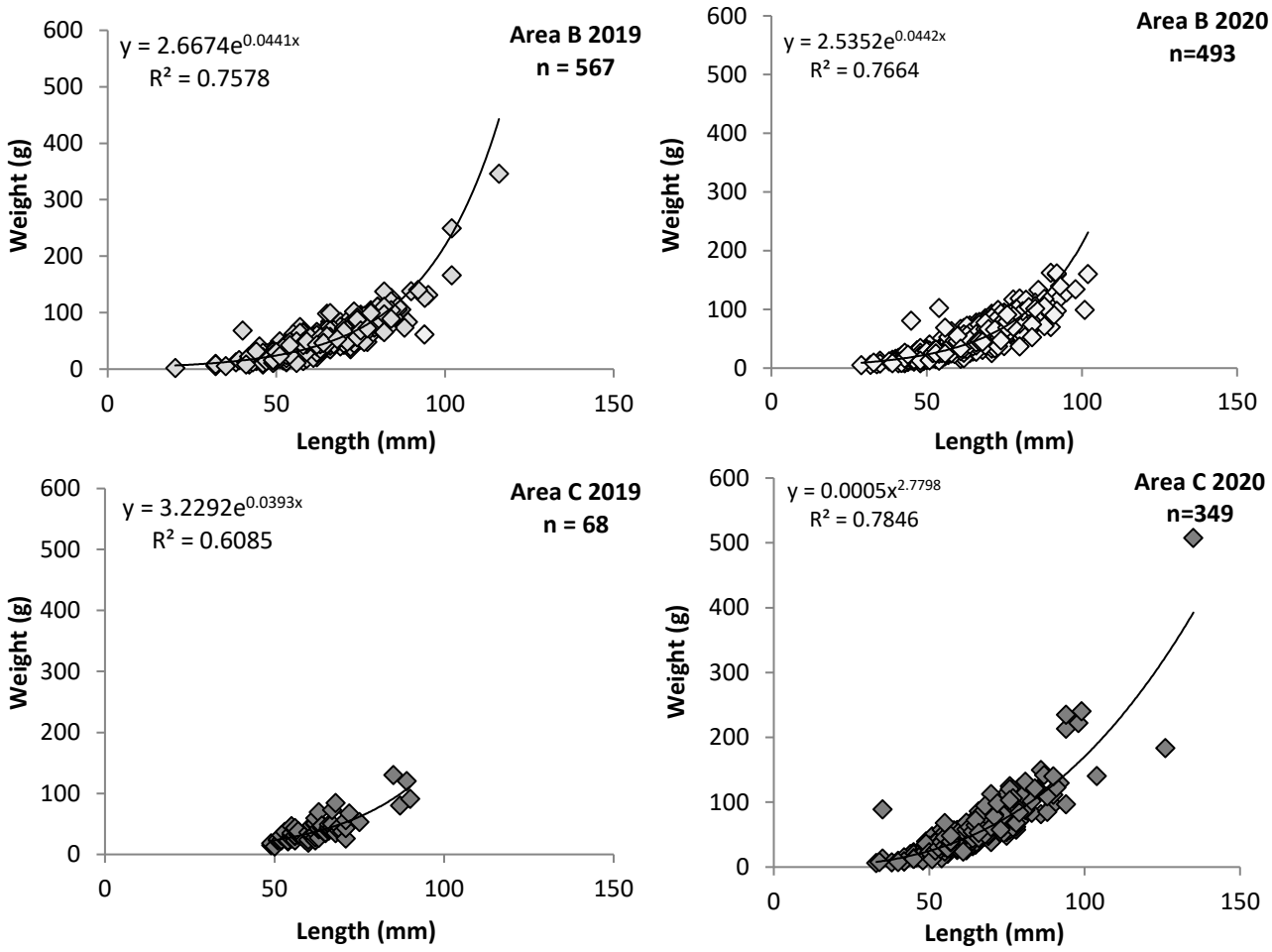


Figure 27: The length (mm) weight (g) relationship of native oysters (*Ostrea edulis)* in the management sections, Area A, B and C of the FaL Oyster Survey from 2019 to 2020.

3.3 Scallops (queen or variegated scallop)

In total, 4,977 scallops were measured and recorded. Previous scallop counts including the number of sites sampled, the average number of scallops per site and the difference per year are shown in Table 10. The number of survey sites changed year on year so the total number of scallops recorded across the years are not directly comparable.

Table 10: The number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) recorded during the Fal oyster survey between 2016 and 2020

Year	Number of sites sampled	Number of scallops	Average number of scallops per site	Difference	Percentage difference
2020	82	4,977	60.7	-2038	-29.05%
2019	83	7,015	84.5	2870	69.24%
2018	83	4,145	49.9	1193	40.41%
2017	80	2,952	36.9	-305	-9.36%
2016	89	3,257	36.6	-	-

3.3.1 Scallop Size Class Composition

The total number of scallops has varied by size class from 2016 to 2020 (Figure 28 and Figure 29). The size classes used were ≤ 19 mm, ≥20 to ≤39 mm, ≥40 to ≤59 mm and ≥60 mm. The number of scallops in the lowest two size classes has declined since 2019, from 2,011 in 2019 to 143 in the ≤ 19 mm size class and from 992 in 2019 to 367 in 2020. The dominant size class since 2018 was the ≥40-≤49 mm size class. The ≥60 mm size class has fluctuated since 2016 and decreased since 2019; 1,634 compared to 1,574 in 2020.

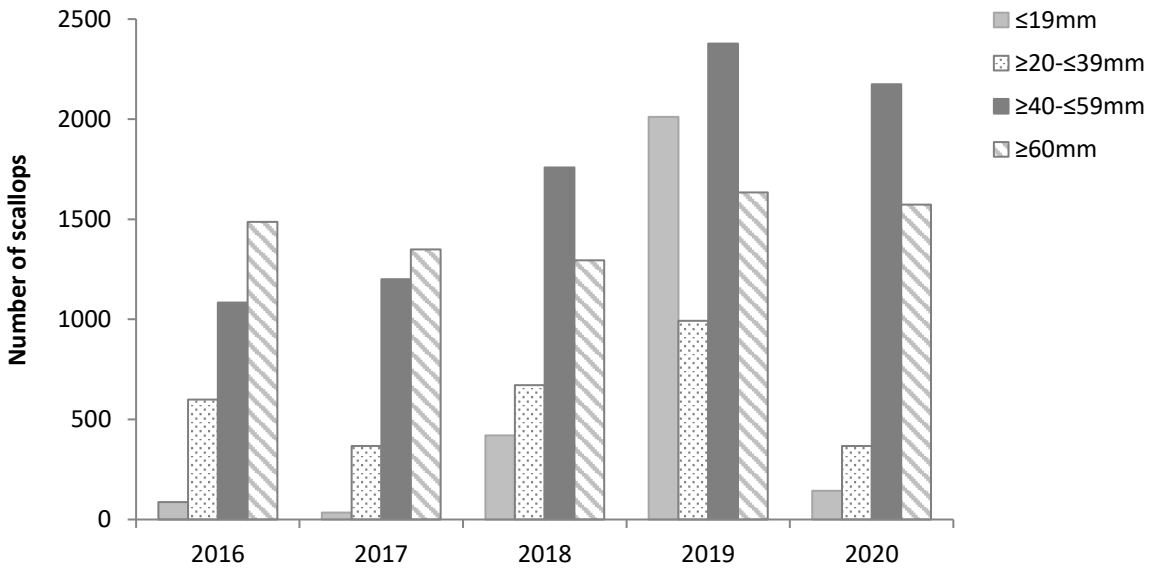


Figure 28: The total number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per size class (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm and ≤19 mm) from 2016 to 2020.

2020_CIFCA_SAC_FAL_FOS

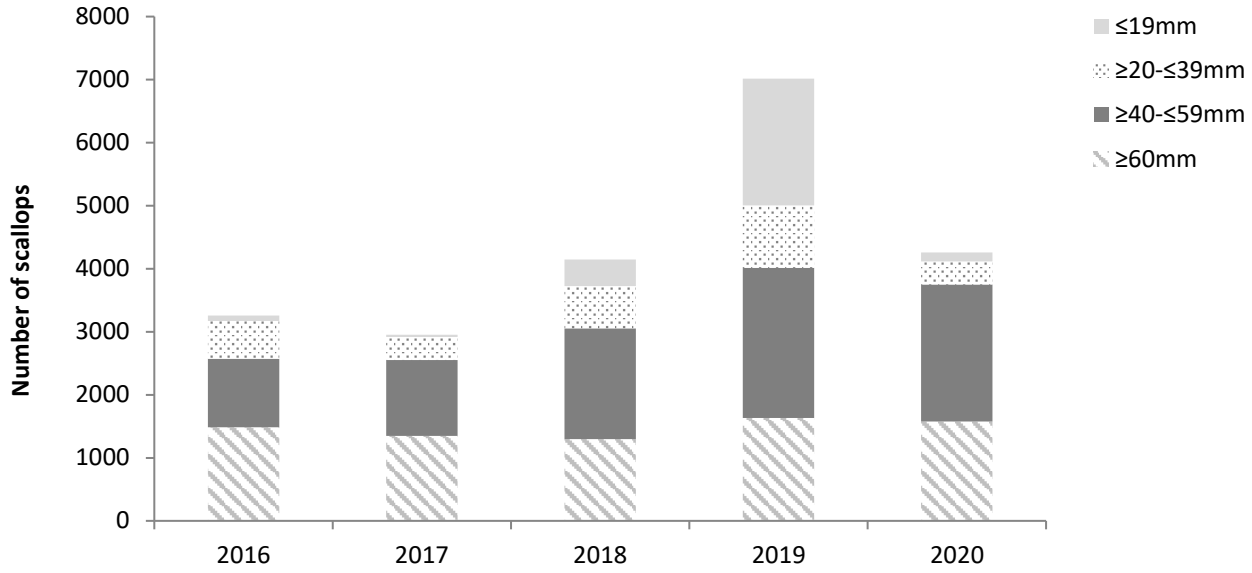


Figure 29: The composition of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per size class (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm and ≤19 mm) from 2016 to 2020.

The distribution of size classes is shown in Figure 30. The size class distribution was for the years 2016, 2017, 2018 and 2020 with a small proportion of small scallops. In 2019, the proportion of size classes was more even with a greater number of smaller scallops ≤19 mm. The proportion of scallops in the ≥40-≤49 mm size class has remained high, varying between 33% to in 2016 to 44 % in 2020. The total number of scallops per size class per site is shown in Annex Table F.

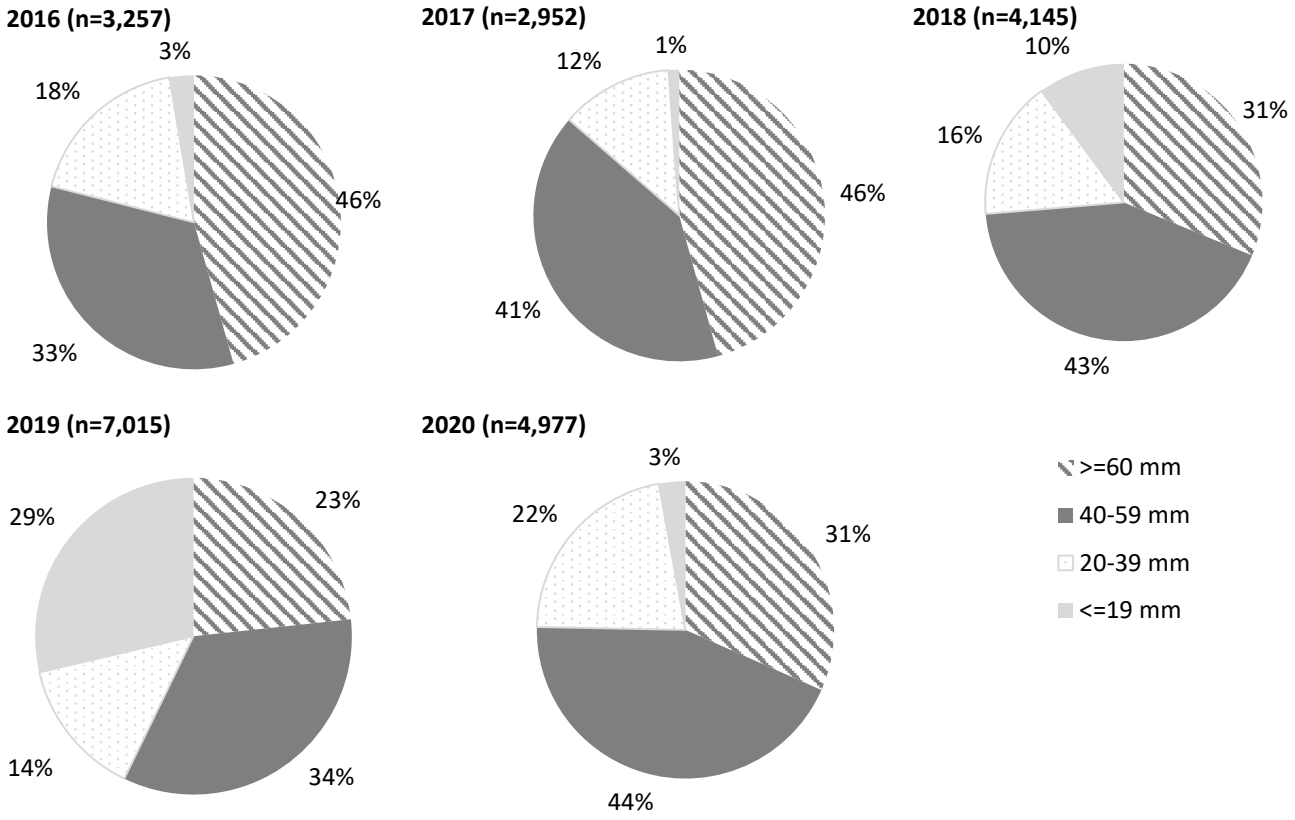


Figure 30: The size class distribution (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm, and ≤19 mm) of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) from the Fal oyster survey from 2016 to 2020.

The size composition and distribution of size classes (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm and ≤19 mm) of scallops for each site is shown in Figure 31 and Figure 32. The plots show the distribution of scallops was fairly similar between 2016 to 2018, with a greater number of scallops recorded in 2019 with a larger proportion of the smaller size classes (≤19 mm) and a decrease in the number of scallops recorded across the samples in 2020 and a smaller proportion of the smaller size class compared with 2019.

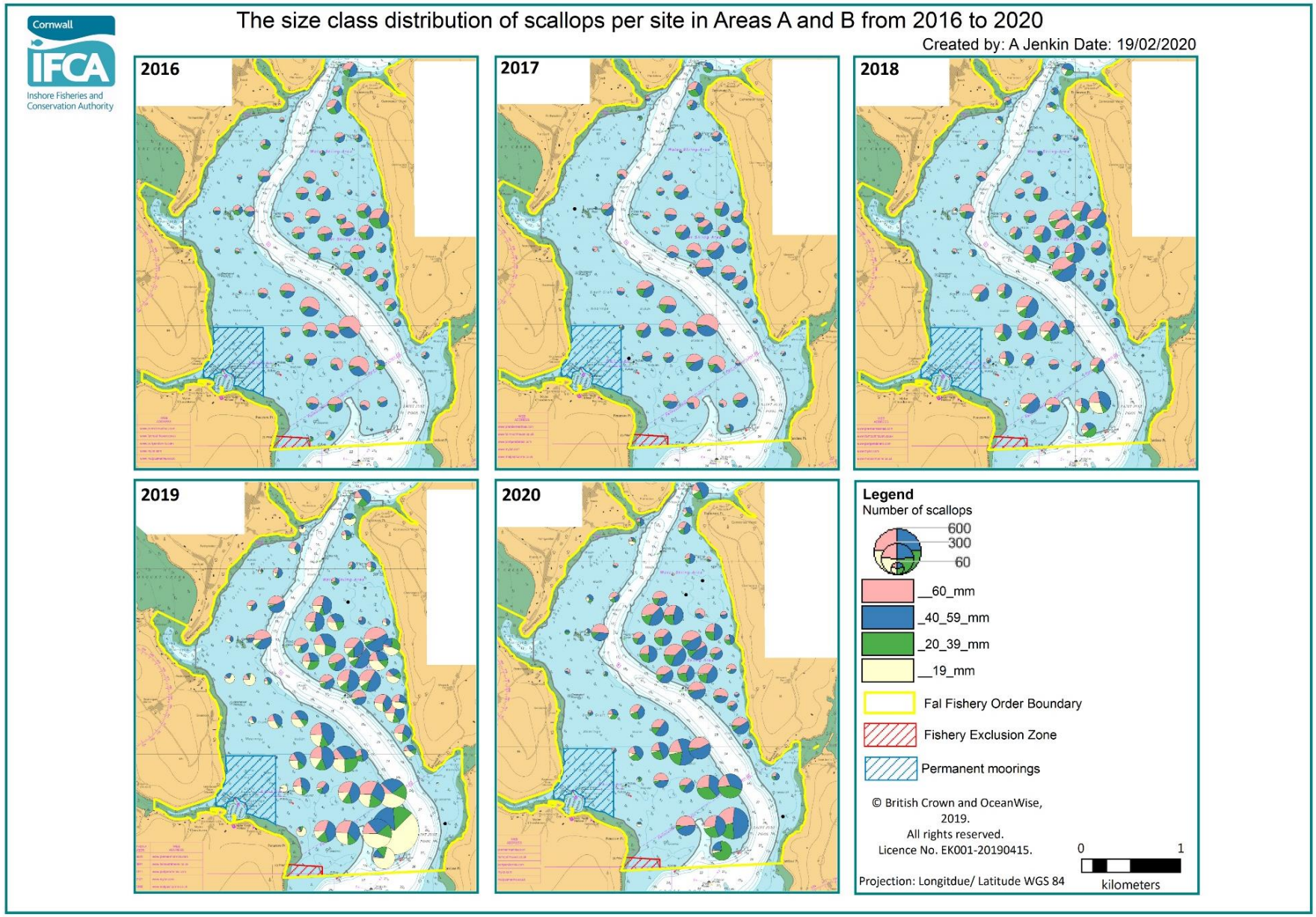


Figure 31: The size composition and distribution of size classes (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm and ≤19 mm) of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) for each site within the Outer Harbour and Harbour from 2016 to 2020.

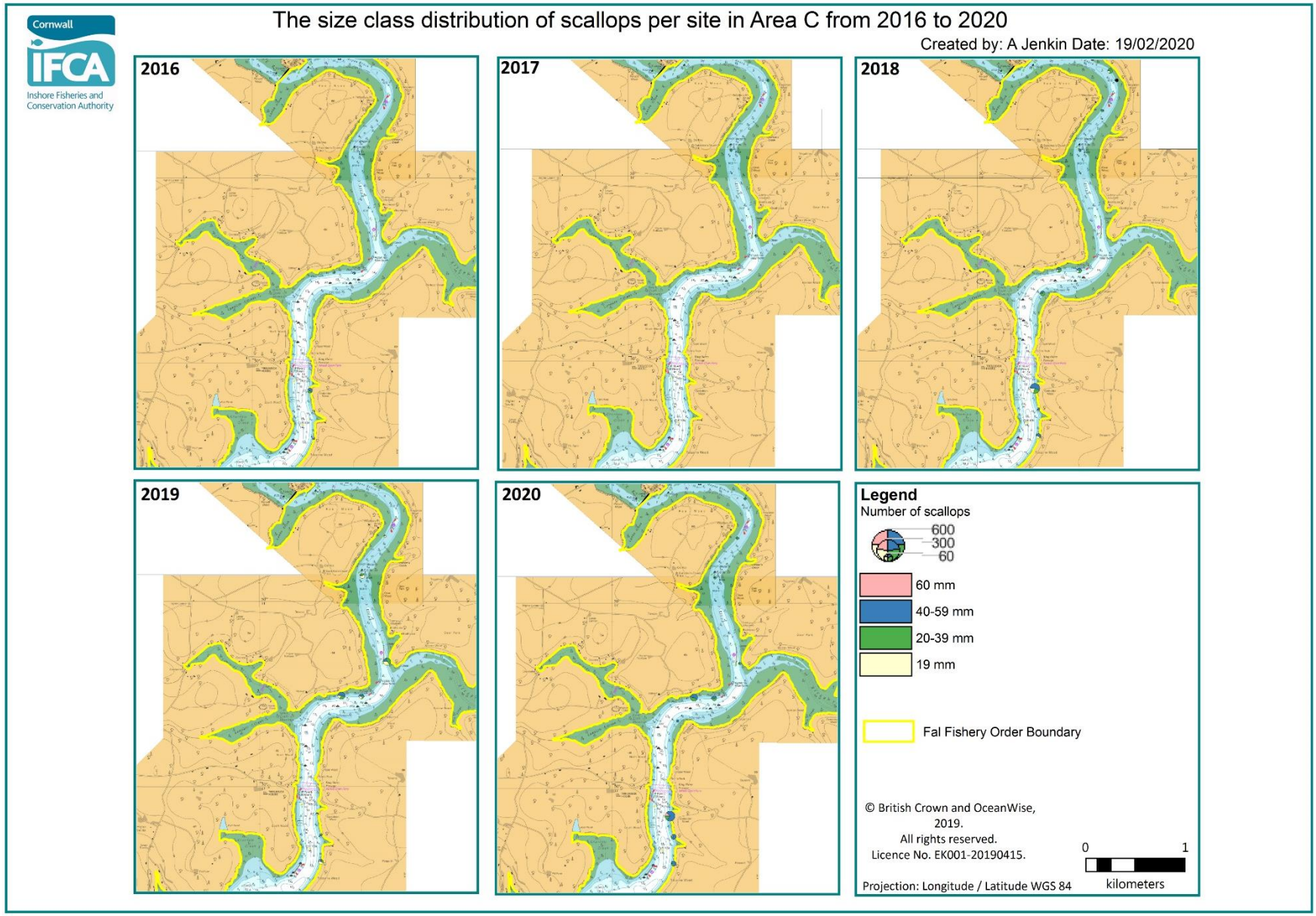


Figure 32: The size composition and distribution of size classes (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm and ≤19 mm) of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) for each site within Area C from the 2016 to 2020.

3.3.2 Density plot

Density plots were created for the total number of scallops per 10 m^2, the number of scallops ≥60 mm per 10 m^2 and the number of scallops between ≥40 to ≤59 mm per 10 m^2 for Areas A and B. Density plots of Area C, the upper reaches above Turnaware Point were not mapped by density due to the lack of samples and their scattered distribution which could lead to misleading interpolation.

Total number of scallops per 10m^2

The distribution of the total number of scallops recorded from 2016 to 2020 is shown in Figure 33. This shows that the density of scallops has steadily increased from 2016 to 2020. The areas with a high density of scallops between 60 to 200 scallops per 10 m^2 were the central part of the survey area either side of the channel. The size of this area had decreased slightly since 2019 but remains higher than 2016 to 2018. The density in the remained of the survey area was low, between 0.1 to 12 scallops per 10 m^2.

Scallops ≥ 60 mm per 10 m^2

The distribution of the total number of scallops ≥60 mm recorded from 2016 to 2020 is shown in
Figure 34. This shows that the density of scallops has steadily increased from 2016 to 2020. The areas with a high density of scallops varying from the 4 to 8 scallops per 10 m^2 category to the 20 to 120 scallops per 10 m^2 category were the central part of the survey area either side of the channel. The areas with a high density of 20 to 120 scallops per 10 m^2 have shifted since 2016, from the central part of the survey area either side of the channel to the southern part. The density in the remained of the survey area was low, between 0.1 to 4 scallops per 10 m^2.

Oysters ≥40 to ≤59 mm per 10 m^2

The distribution of the total number of scallops for the ≥40 to ≤59 mm size class recorded from 2016 to 2020 are shown in
Figure 34. This shows that the density of scallops in this size class has steadily increased from 2016 to 2020. As with the total number of scallops and the number of scallops ≥60 mm, the areas with a high density of scallops varying from the 4 to 8 scallops per 10 m^2 category to the 20 to 120 scallops per 10 m^2 category were the central part of the survey area either side of the channel. The areas with a high density of 20 to 120 scallops per 10 m^2 have shifted since 2016, from the central part of the survey area either side of the channel to the southern part. The density in the remained of the survey area was low, between 0.1 to 4 scallops per 10 m^2.

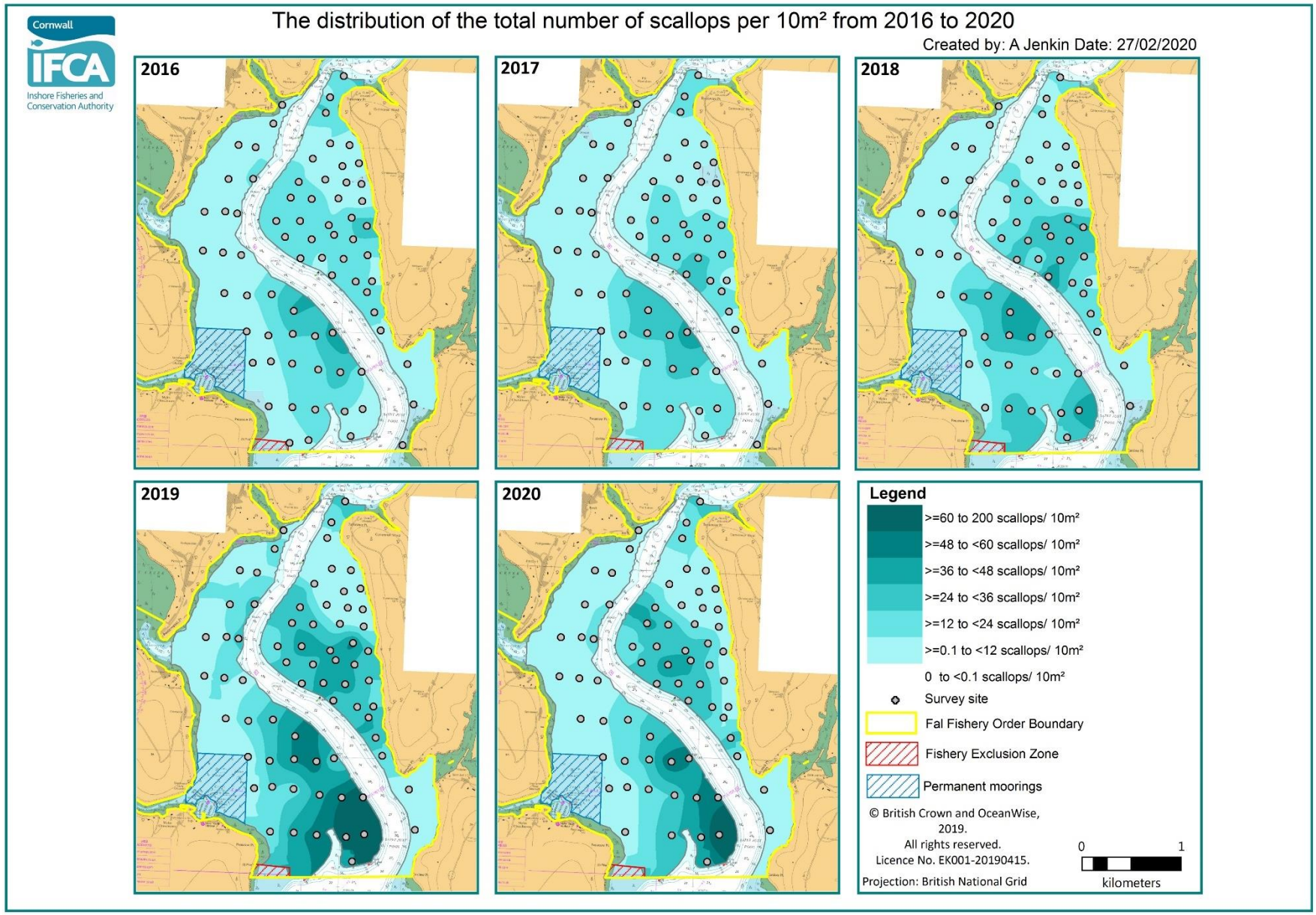


Figure 33: Density map displaying the total number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per 10 m² recorded within Areas A and B from 2016 to 2020.

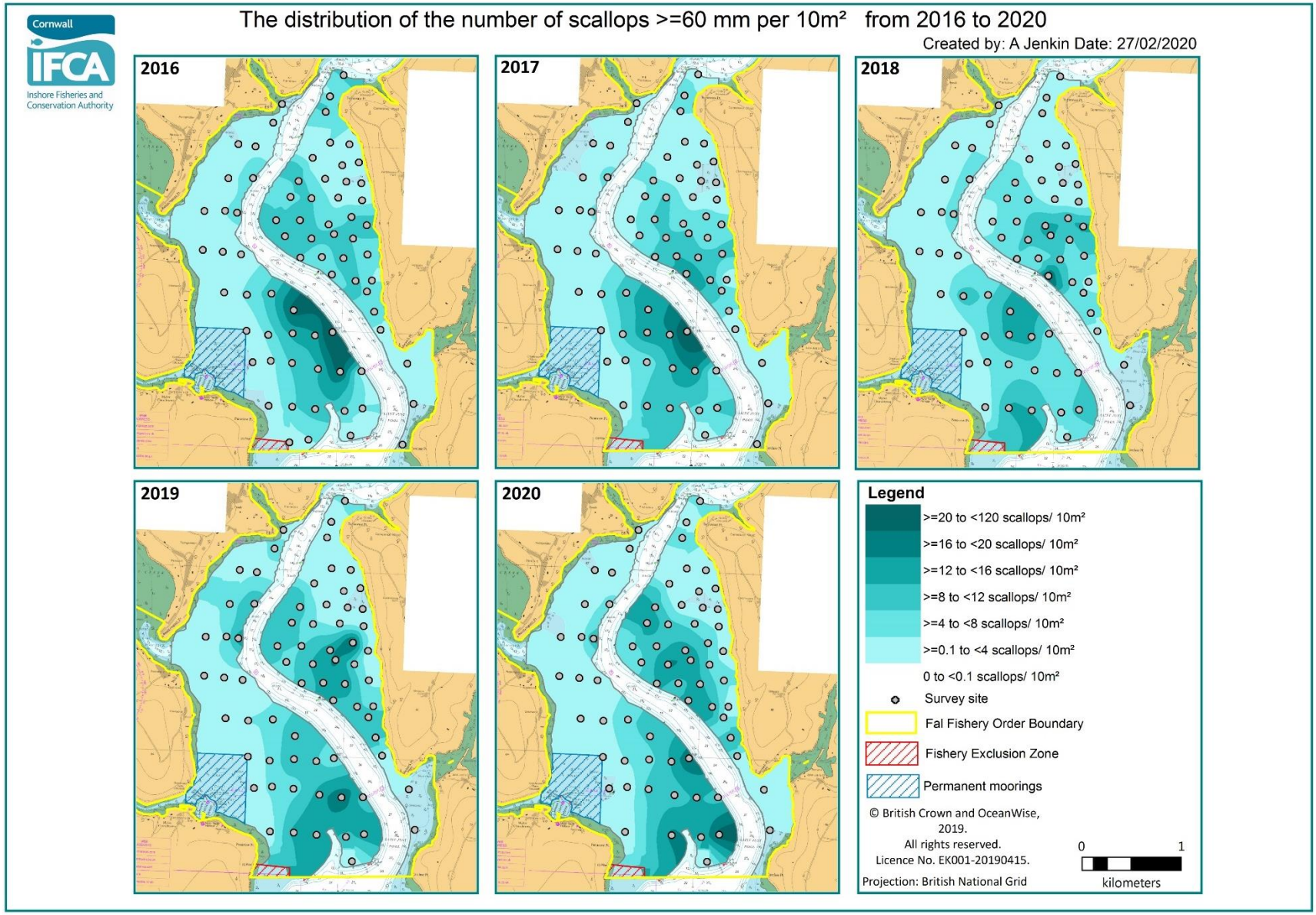


Figure 34: Density map displaying the total number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) ≥60 mm per 10 m² recorded within Areas A and B from 2016 to 2020.

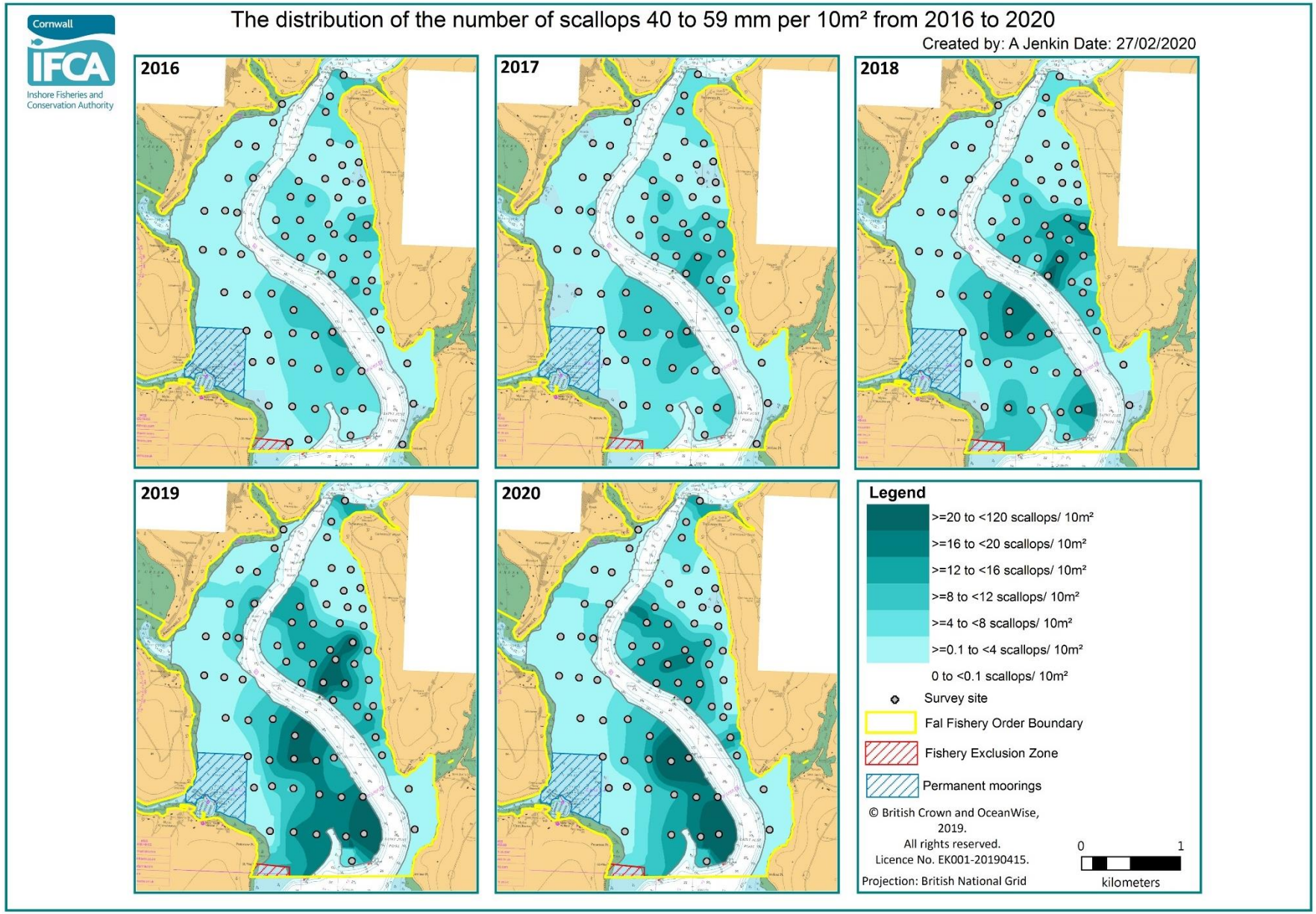


Figure 35: Density map displaying the total number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*), ≥40-≤59 mm per 10 m² recorded within Areas A and B from 2016 to 2020.

3.3.3 Management sections

Of the total number of scallops (4,977), 2,322 were from Area A, 2,235 from Area B and 420 from Area C. The total number of scallops per site is shown in Annex Table F.

3.3.3.1 Average sizes

Table 11 and Figure 36 show the average size (mm) of scallops recorded in the A, B and C management areas from 2016 to 2020.

For the management areas of the survey, the average size (mm) of scallops has varied yearly. In all three areas the average size of scallop has increased from 2019 to 2020 which is likely to be due to less smaller scallops being recorded during the survey.

Table 11: The average size (mm) ± standard error of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) in the management areas, Area A, B and C from 2016 to 2020.

Year	Area A	Area B	Area C
2020	48.5 mm ± 0.3 mm	52.9 mm ± 0.3 mm	45.1 mm ± 0.7 mm
2019	36.6 mm ± 0.4 mm	44.4 mm ± 0.4 mm	34.0 mm ± 1.0 mm
2018	47.8 mm ± 0.5 mm	50.4 mm ± 0.4 mm	38.6 mm ± 0.9 mm
2017	56.5 mm ± 0.3 mm	54.9 mm ± 0.3 mm	44.7 mm ± 1.2 mm
2016	55.3 mm ± 0.4 mm	51.8 mm ± 0.4 mm	47.6 mm ± 1.1 mm

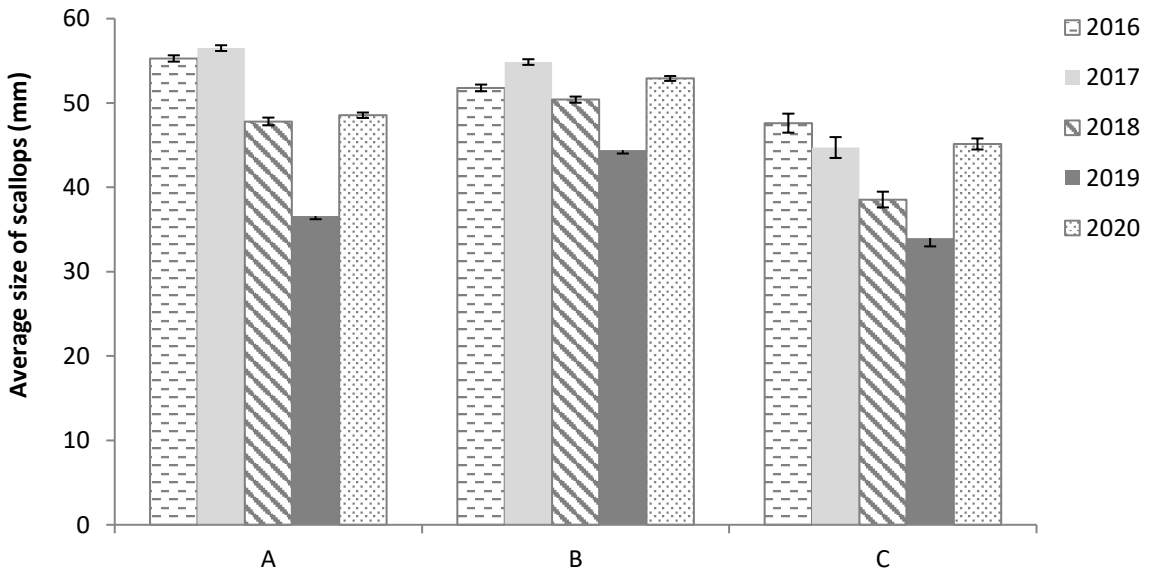


Figure 36: The average size (mm) of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) ± standard error for the management areas (Area A, B and C) of the survey for the years 2016 to 2020.

The total length frequency for all scallops sampled from 2016 to 2020 in shown in Figure 37.

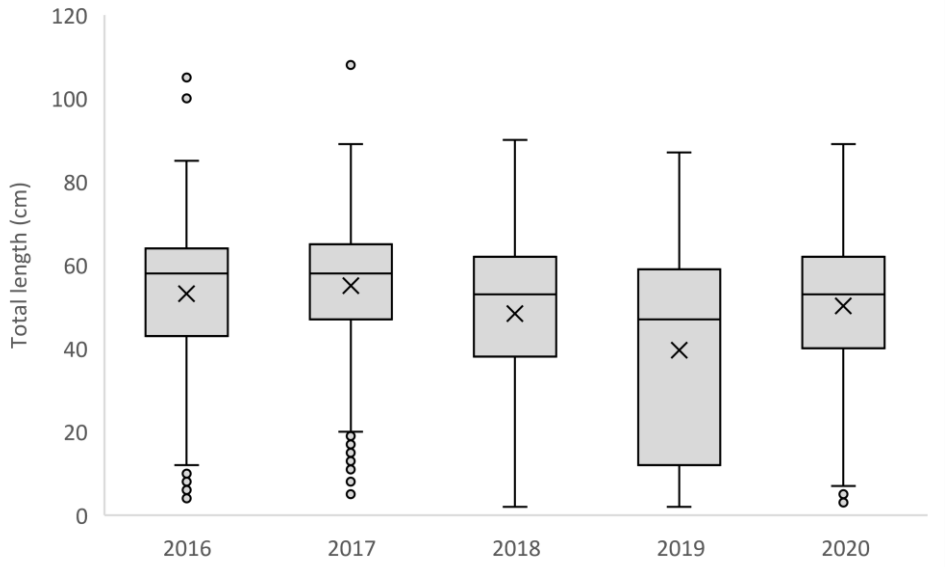
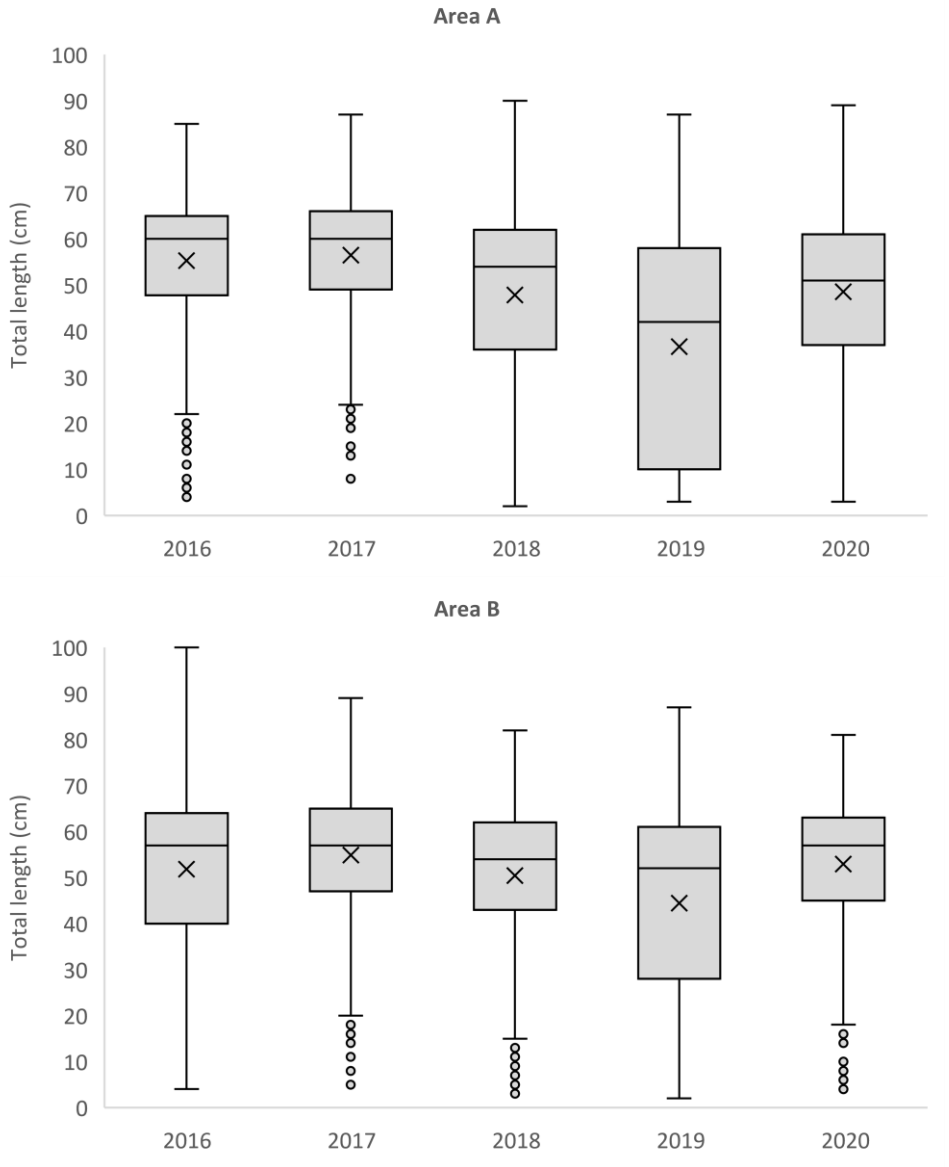


Figure 37: Total length frequency plot for all queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) from 2016 to 2020. Date is grouped by year. The X represents the mean, the line represents the median, boxes represent the inter-quartile range, error bars represent the range, and the filled circles represent outliers.

The total length frequency for all scallops sampled in Areas A, B and C from 2016 to 2020 are shown in Figure 38.



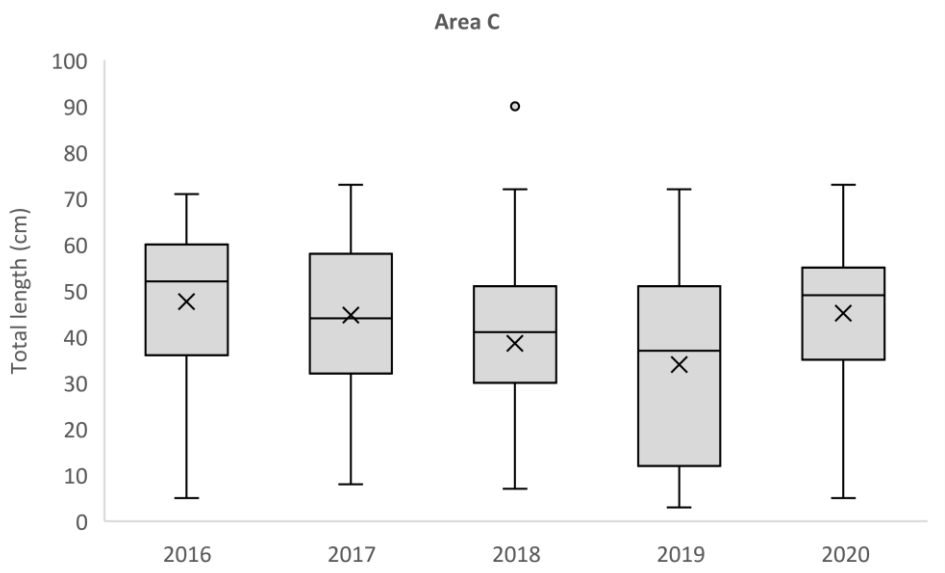


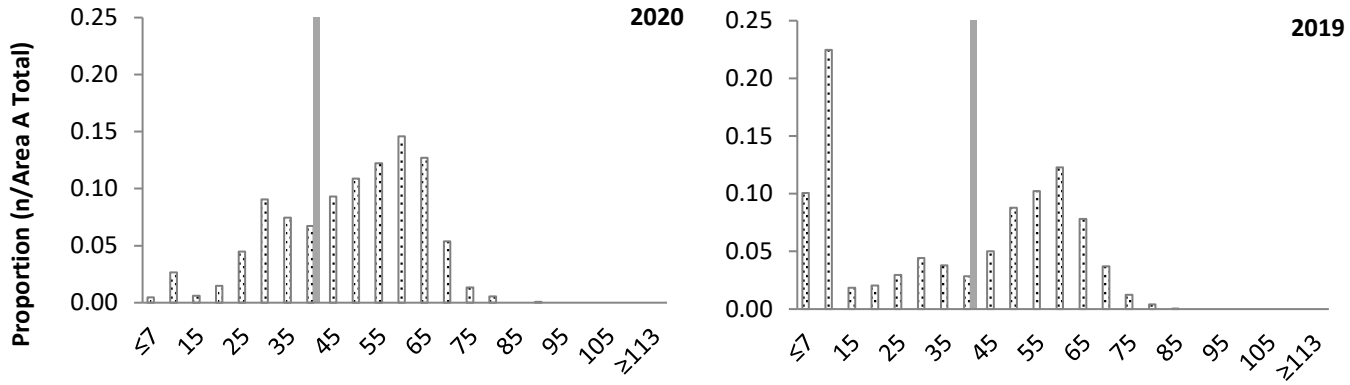
Figure 38: Total length frequency plot for all queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) in management areas A, B and C from 2016 to 2020. Date is grouped by year. The X represents the mean, the line represents the median, boxes represent the inter-quartile range, error bars represent the range, and the filled circles represent outliers.

3.3.3.2 Size frequency plots

The size distribution of scallops in Areas A, B and C were graphed for the management areas; Area A (Figure 39), B (Figure 40) and C (Figure 41).

Area A

The frequency distribution in Area A is shown in Figure 39. The frequency distribution for Area A was similar to the normal distribution in 2016 and 2017 with a peak at 62 mm. In 2018 and 2019 the distribution was uneven and widespread with a large number of scallops over 57 mm and small scallops recorded, with 9% of the scallops in the 7 mm size class in 2018 and 22 % in 2019.



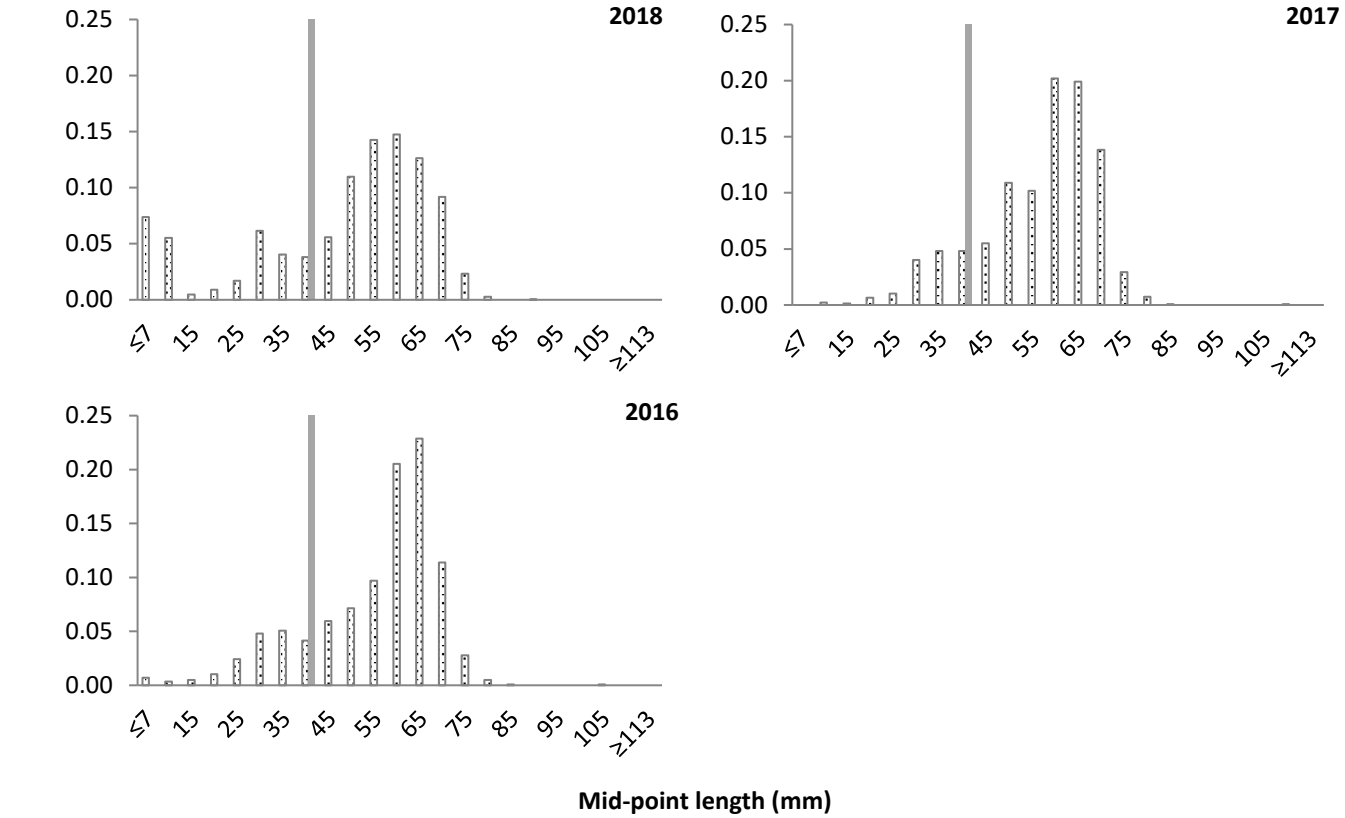
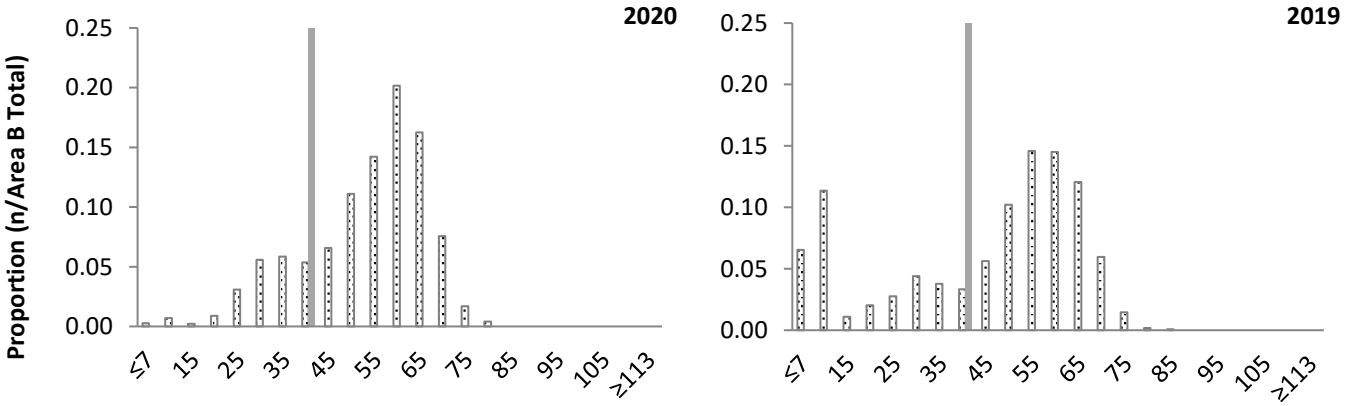


Figure 39: Size frequency distributions for queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) for the management section Area A of the fishery from 2016 to 2020. The minimum landing size for queen scallops (*Chlamys* spp.) from the fishery is shown with the grey line (40 mm).

Area B

The frequency distribution in Area B is shown in Figure 40. The frequency distribution for Area B in 2020 was similar to the normal distribution recorded in 2016 and 2017 with a peak at 62 mm. In 2018 and 2019 the distribution was uneven and widespread with a large number of scallops over 57 mm and small scallops recorded, with 4% of the scallops in the 7 mm size class in 2018 and 12 % in 2019.



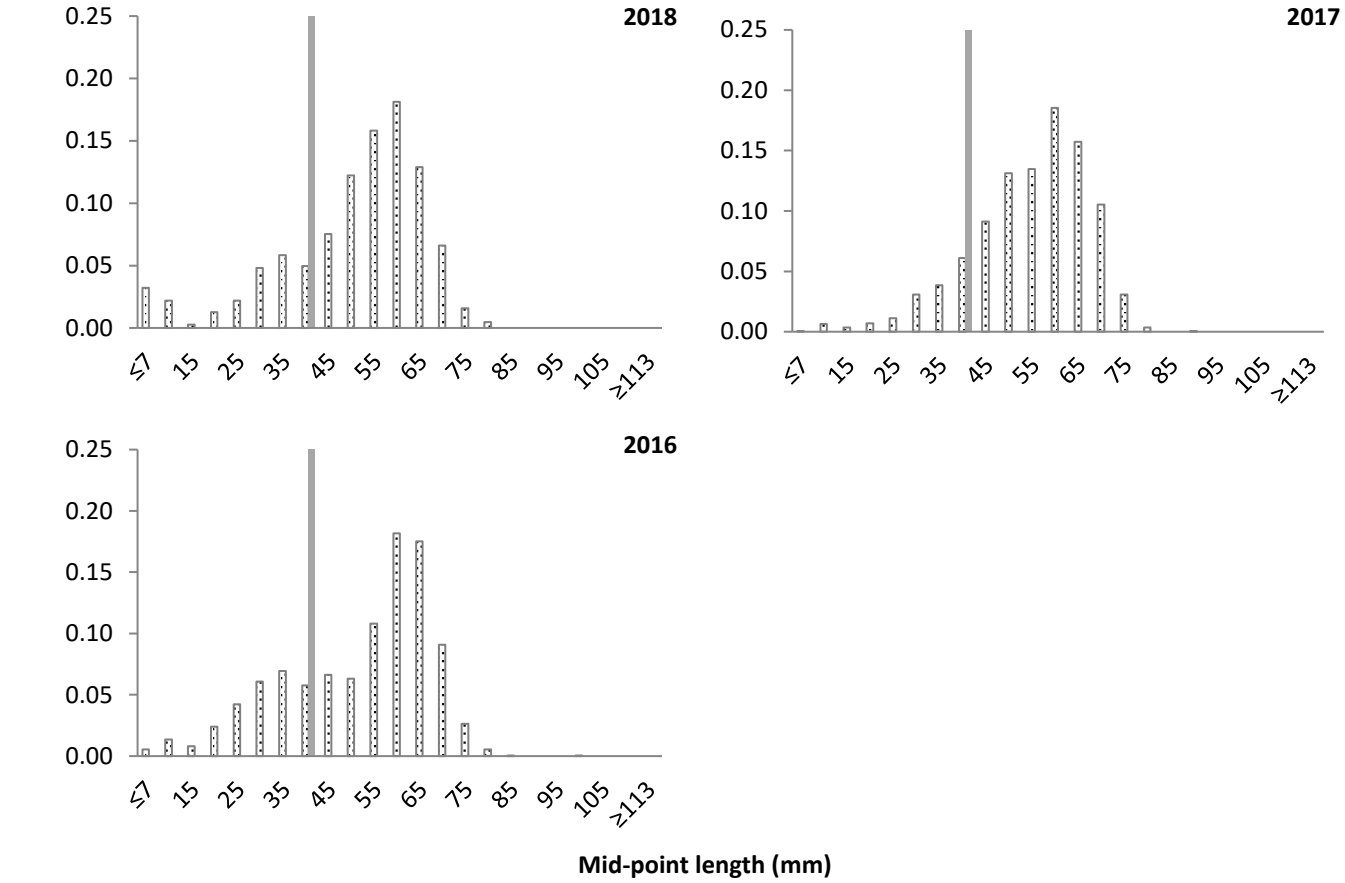
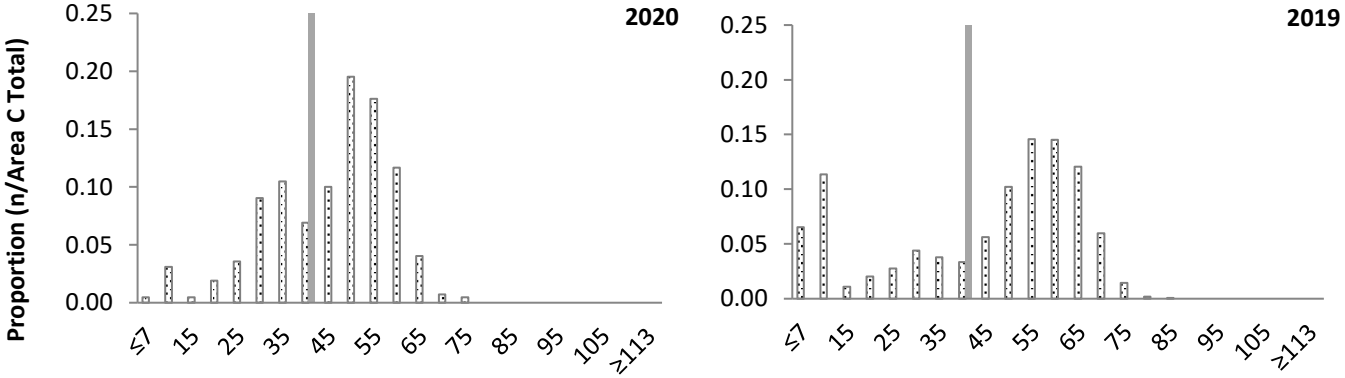


Figure 40: Size frequency distributions for queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) for the management section Area B of the fishery from 2016 to 2020. The minimum landing size for queen scallops (*Chlamys* spp.) from the fishery is shown with the grey line (40 mm).

Area C

The frequency distribution in Area C is shown in Figure 41. In 2020, the frequency was bi-modal with peaks at 52 mm and 32 mm and a very low proportion of scallops in the smaller size classes compared to 2019. The frequency distribution for Area C was uneven in 2016 and 2017 with a peak at 62 mm in 2016 and 32 mm in 2017. In 2018 and 2019 the distribution was widespread with a lower number of scallops of 57 mm compared to previous years and a much larger number of scallop spat with high proportions in the 7 mm and 12 mm size classes.



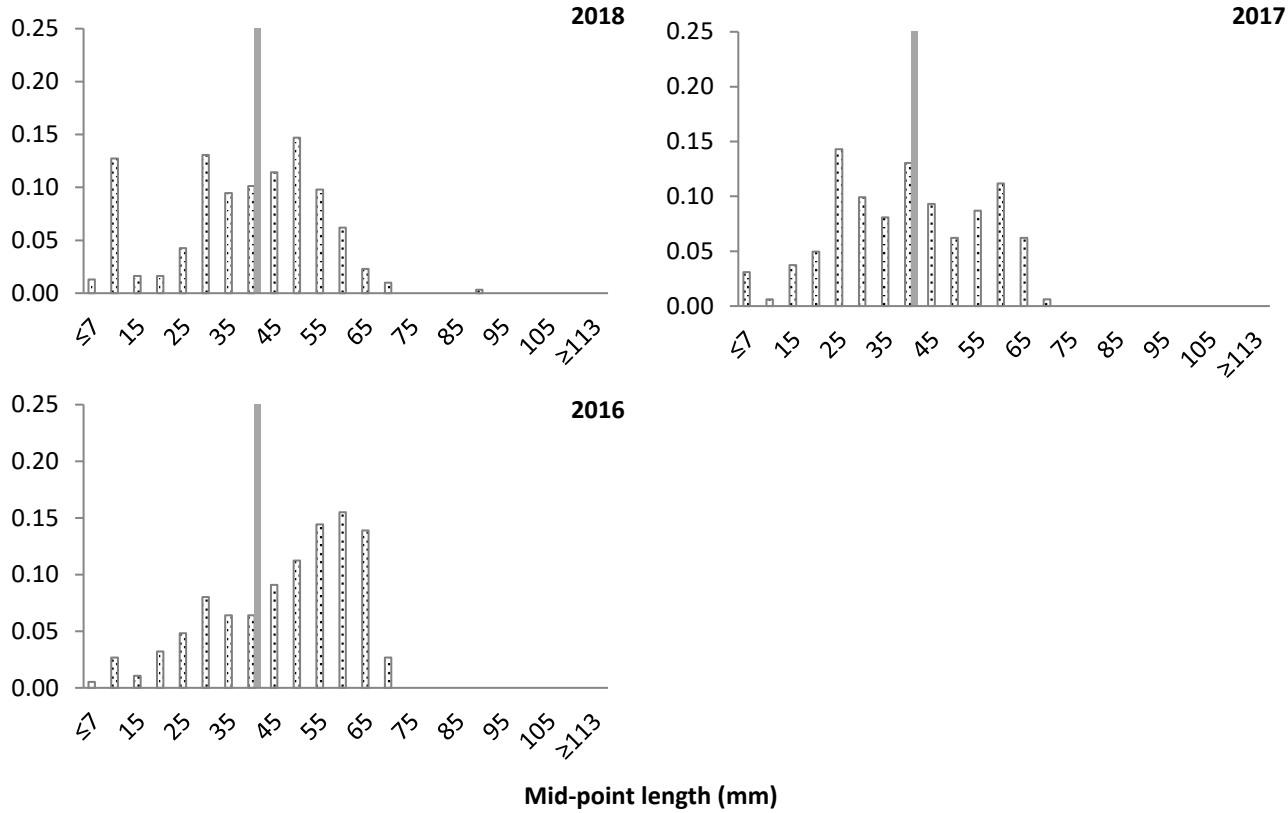


Figure 41: Size frequency distributions for queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) for the management section, Area C of the fishery from 2016 to 2020.The minimum landing size for queen scallops (*Chlamys* spp.) from the fishery is shown with the grey line (40 mm).

3.3.3.3 Average number per site

Table 12 and Figure 42 show the average number of scallops per site recorded in the management areas (Area A, B and C) from 2016 to 2020.

The average number of scallops per site increased for all three areas from 2016 to 2019, then decreased in Areas A and B and increased slightly in Area C. The largest decrease was recorded in Area A, from 119 scallops in 2019 to 74.9 scallops in 2020.

Table 12: The average number per site ± standard error of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*)s in the management areas (Area A, B and C) of the survey from 2016 to 2020.

Year	Area A	Area B	Area C
2020	74.9 ± 13.8	63.9 ± 8.5	26.3 ± 7.8
2019	119 ± 21.8	80.3 ± 10.1	24.8 ± 7.6
2018	58.9 ± 8.7	55.8 ± 8.3	19.1 ± 5.0
2017	42.7 ± 7.7	39.6 ± 5.7	13.4 ± 6.6
2016	42.4 ± 7.0	45.2 ± 5.5	9.8 ± 5.00

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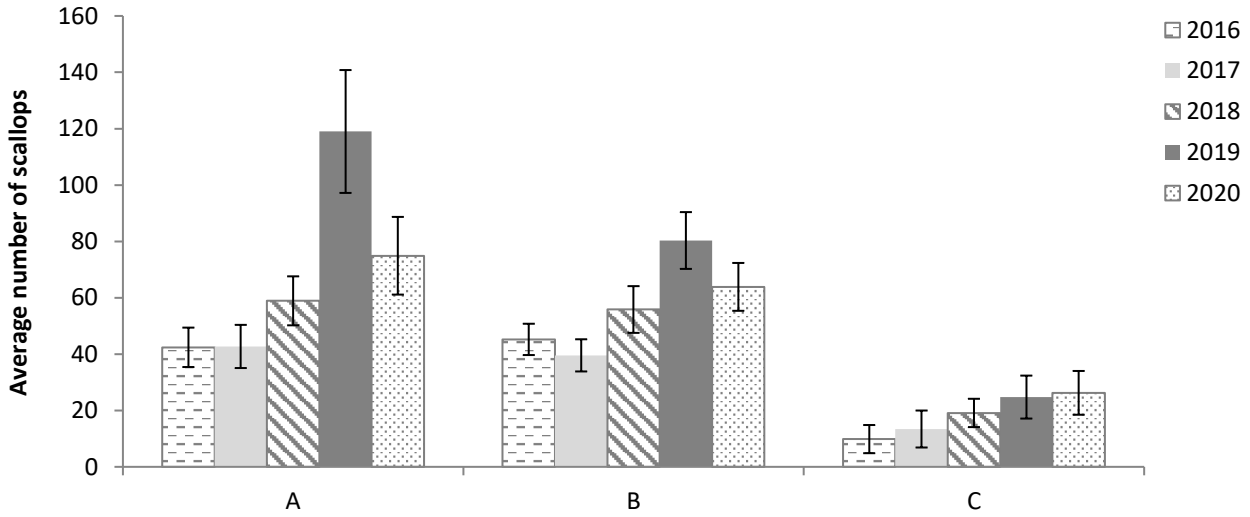


Figure 42: The average number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) ± standard error for the management areas (Areas A, B and C) of the survey for the years from 2016 to 2020.

3.3.3.4 Density

The density of scallops per 10 m^2 for 2019 for all three management areas is shown in Figure 43. The density of scallops was highest in Area A and lowest in Area C from 2016 to 2020. The density of scallops per 10 m^2 has steadily increased in Area C, whereas in Areas A and B, the density peaked in 2019 (33.06 and 22.31 respectively) and has dropped off in 2020.

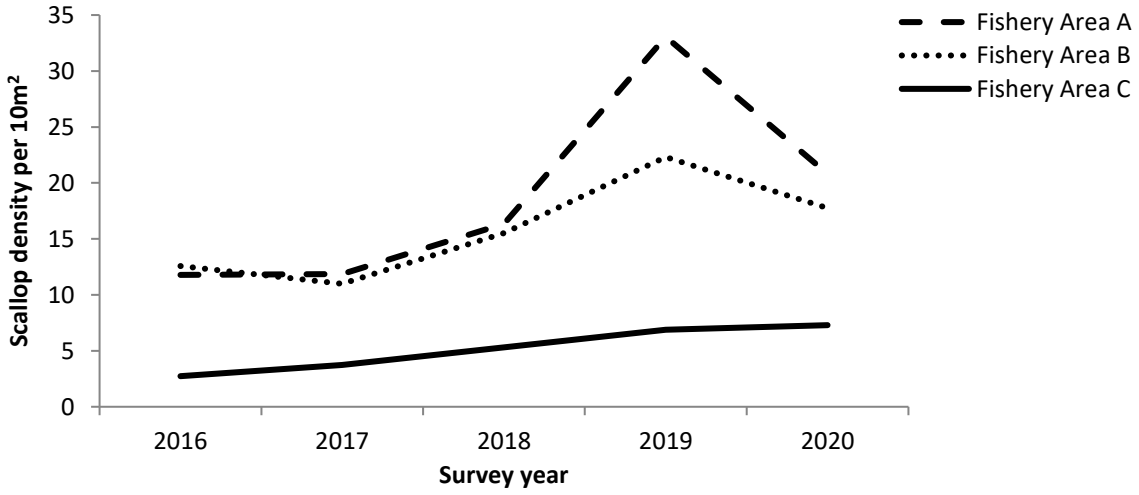


Figure 43: The density of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per 10 m^2 for the three management areas (Area A, B and C) from 2016 to 2020.

The density of scallops per 10 m^2 for 2019 for areas A, B and C per size class is shown in Figure 44. The density of scallops for all size classes has varied for all three areas and remained lowest in Area C. The ≥40-≤59mm size class had the highest density of scallops / 10m^2 in all three overs over the five years except in Area A in 2019 when the ≤19 mm size class peaked at 11.56 scallops 10m^2.

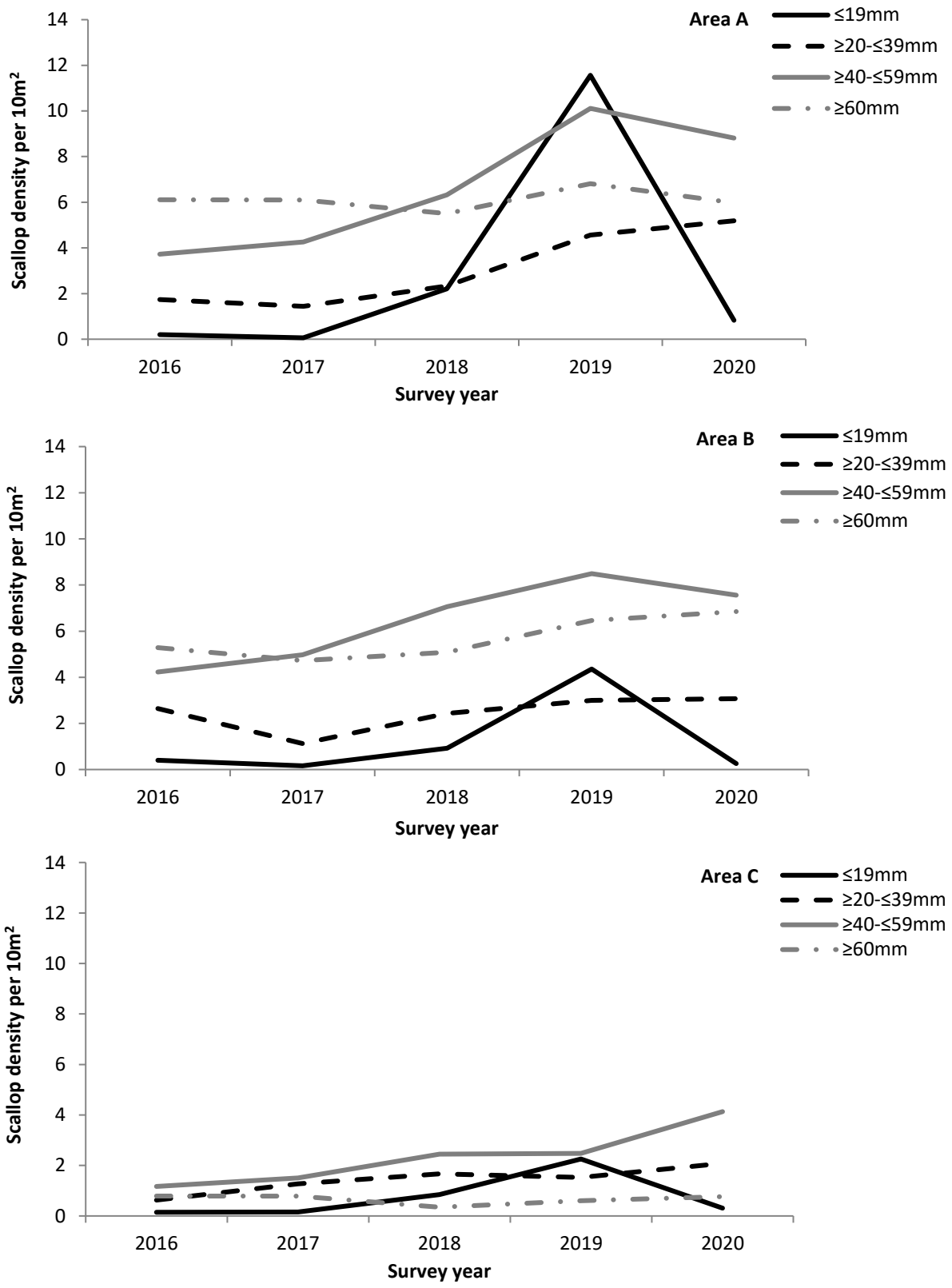


Figure 44: The density of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per 10 m² for the three management areas (Area A, B and C) per size class from 2016 to 2020. N.B All scales are identical.

3.3.3.5 Scallop Size Class Composition

When split management area and size, the total number of scallops for all the size classes was highest in Area A, except for the ≥60 mm size class which was highest in Area B (Table 13). The total number of scallops by

management area by size class was highest in Area A for the ≥40 ≤49 mm size class (984 scallops) and lowest in Area C for the ≤19 mm size class (18 scallops).

Table 13: The number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) recorded in the management areas (Areas A, B and C) recorded by total number of scallops, total number of scallops ≥60 mm, ≥40-≤49 mm, ≥21-≤39 mm and ≤20 mm during the Fal oyster survey 2020.

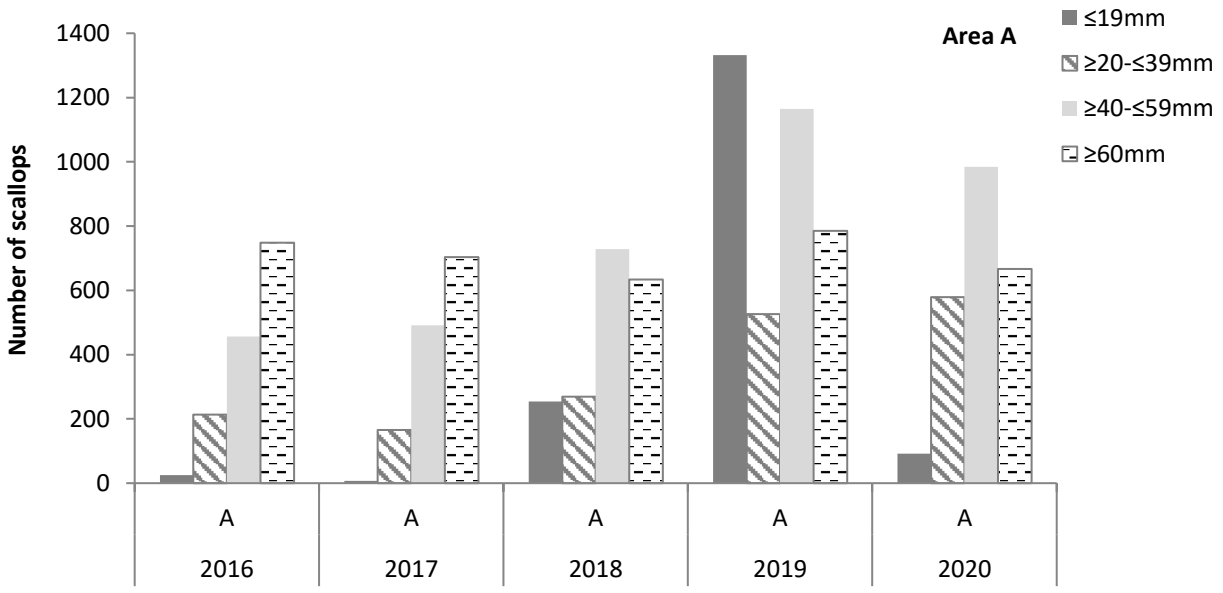
Section	Total number of scallops	≥60 mm	≥40-≤49 mm	≥20-≤39 mm	≤19 mm
A	2,322	667	984	579	92
B	2,235	863	952	387	33
C	396	44	238	120	18

The average number of scallops per size class by management area is shown in Table 14. When split by size class and management area, the average number of scallops for all the size classes was highest in Area A for all size classes except the ≥40-≤59 mm size class which was highest in Area B and lowest in Area C (Table 14). The total number of scallops by management area by size class was highest in Area A for the ≥40 ≤59 mm size class (an average of 31.7 scallops) and lowest in Area B for the ≤19 mm size class when no scallops were recorded.

Table 14: The average number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) recorded in the management areas (Areas A, B and C) recorded by total number, total number of scallops ≥60 mm, ≥40-≤59 mm, ≥21-≤39 mm, and ≤20 mm during the Fal oyster survey 2020.

Section	Average number of scallops	≥60 mm	≥40-≤59 mm	≥20-≤39 mm	≤19 mm
A	74.9	21.5	31.7	18.7	3.0
B	63.9	24.7	27.2	11.1	0.9
C	26.3	2.8	14.9	7.5	1.1

The total number of scallops per section by size class has varied between 2016 and 2020 (Figure 45). Few scallops in the ≤19 mm size class scallops were recorded except in 2019 in Areas A and B with a maximum of 1,332 in Area A in 2019. The number of scallops in the ≥40-≤59 mm and ≥60 mm size classes have decreased since 2019.



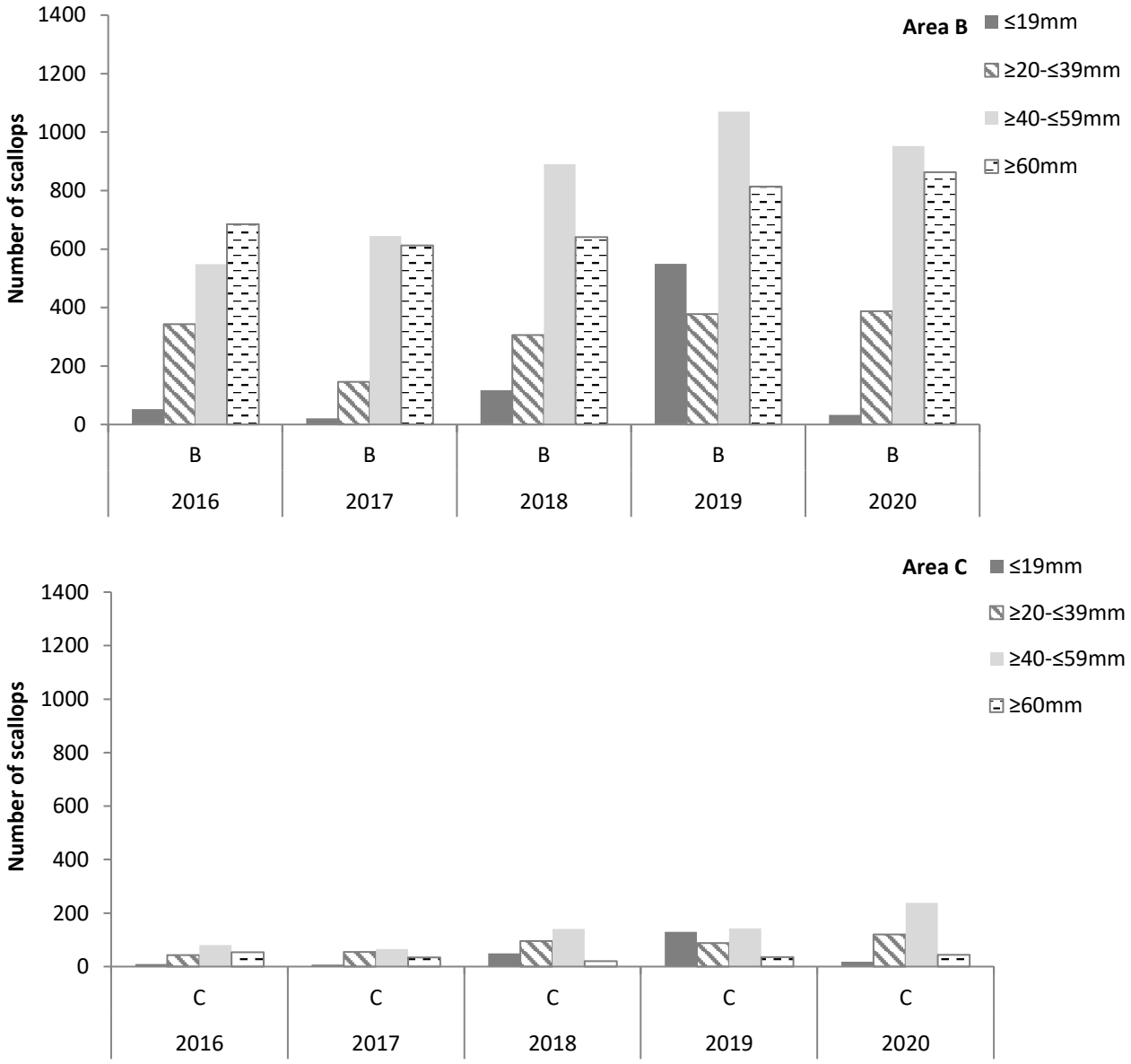


Figure 45: The total number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per size class (≥60 mm, ≥40-≤59 mm, ≥21-≤39 mm and ≤20 mm) from 2016 to 2020 for the management areas, Area A, B and C.

The average number of scallops per area by size class varied between 2016 and 2020 (Figure 46). The average number of scallops was generally lower in the smaller size classes (≤19 mm and ≥20-≤39 mm) and greatest in the ≥40-≤59 mm size class except in area A in 2019 the ≤19 mm size class peaked at 41.6 scallops.

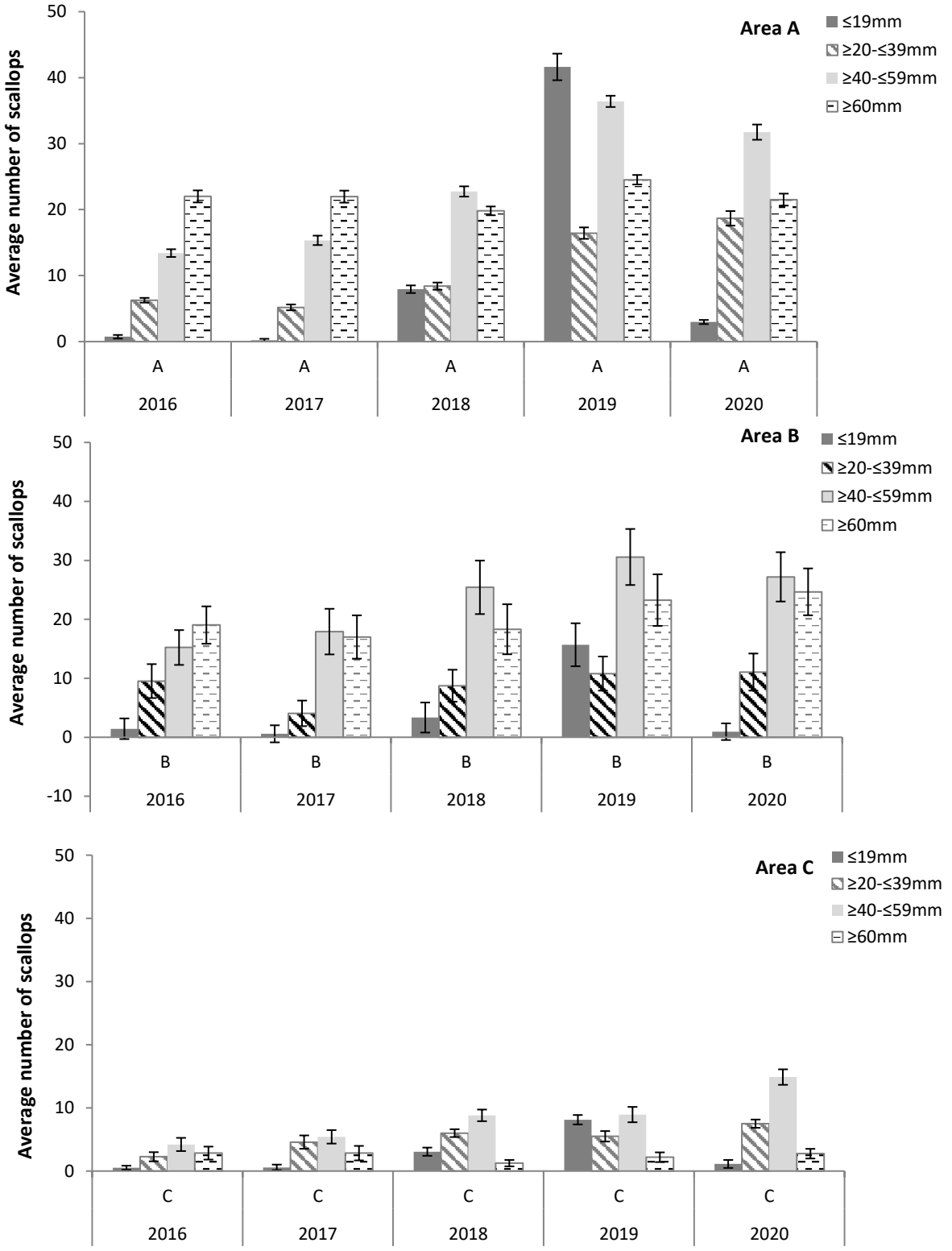


Figure 46: The average number of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per size class (≥60 mm, ≥40-≤59 mm, ≥20-≤39 mm and ≤19 mm) from 2016 to 2020 for the management areas, Area A, B and C.

3.3.3.6 Minimum landing size

As mentioned previously, the MLS for queen scallops (*Chlamys* spp.) is 40 mm. The percentage of scallops over and under the MLS is shown in Table 15. The percentage of scallops over 40 mm was greater for all years and all areas except in Area C in 2019. The area with the largest percentage of scallops over 40 mm in 2020 was Area B (81%), followed by Area A (71%).

Table 15: The percentage (%) of queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) over and under the minimum landing size (40 mm) for all three management areas (Area A, B and C) of the Fal oyster survey area from 2016 to 2020.

	Area A % under 40 mm	Area A % over 40 mm	Area B % under 40 mm	Area B % over 40 mm	Area C % under 40 mm	Area C % over 40 mm
2020	28.90	71.10	18.79	81.21	32.86	67.14
2019	48.79	51.21	32.98	67.02	55.05	44.95
2018	27.75	72.25	21.65	78.35	47.39	52.61
2017	12.66	87.34	11.73	88.27	38.51	61.49
2016	16.50	83.50	24.26	75.74	28.34	71.66

3.4 Slipper limpets

The number of slipper limpets per dredge sample were recorded again during the 2020 survey. A total of 8,753 slipper limpets were recorded during the survey which is a decrease from previous years (Table 16).

Table 16: The number of slipper limpets (*Crepidula fornicata*) recorded during the Fal oyster survey between 2018 and 2020

Year	Number of slipper limpets	Area A	Area B	Area C
2020	8,753	3,929	2,313	2,511
2019	11,412	6,364	3,166	1,882
2018	11,525	5,295	3,830	2,400

All slipper limpets recorded during the survey were retained onboard Tiger Lily VI in sacks and not returned to the fishery.

3.4.1 Management sections

The total number of slipper limpets recorded from 2018 to 2020 by management area is shown in Figure 47. The numbers of slipper limpets decreased in Areas A and B from 2019 to 2020 with the biggest difference in Area A from 6,364 to 3,929 in Area B, but increased in Area C.

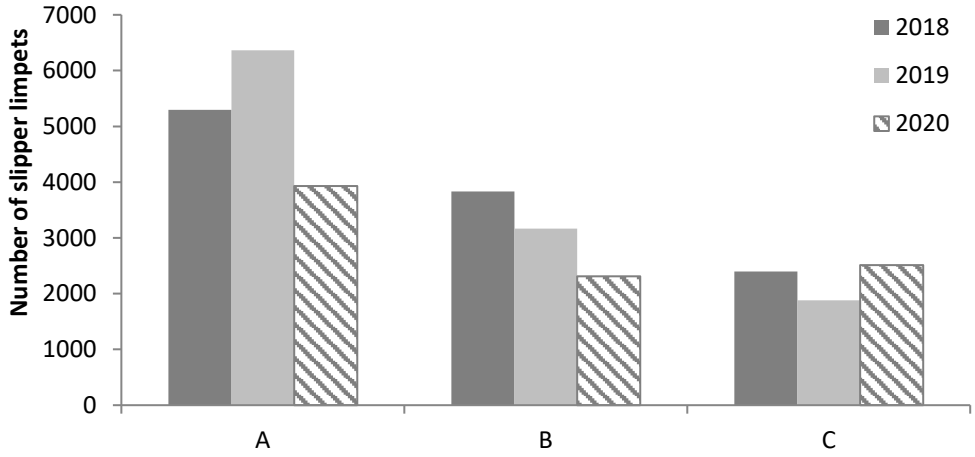


Figure 47: The total number of slipper limpets (*Crepidula fornicata*) for the management areas, Area A, B and C of the survey for the years 2018 to 2020.

The average number of slipper limpets per site by management area is shown in Figure 48. The average number of slipper limpets decreased from 2019 to 2020 in Areas A and B, from 199 to 127 and from 90 to 66 respectively and increased in Area C from 118 to 157.

2020_CIFCA_SAC_FAL_FOS

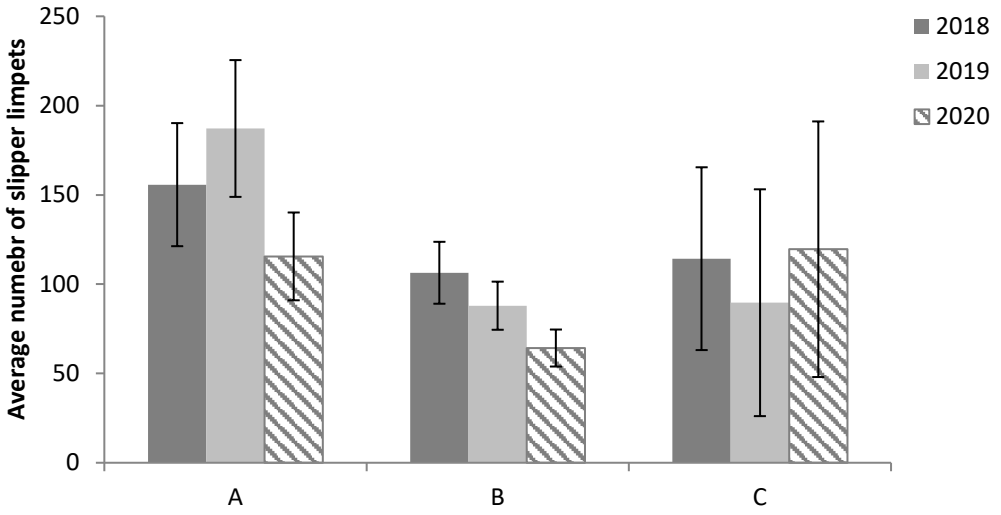


Figure 48: The average number ± standard error of slipper limpets (*Crepidula fornicata*) for the management areas, Area A, B and C of the survey for the years 2018 to 2020.

The distribution of slipper limpets is shown in Figure 49. The distribution of slipper limpets observed in 2020 was similar to 2018 and 2019. Areas with a high density, greater than 80 slipper limpets per 10 m^2 were either side of the channel running between the East Bank and North Bank. In 2019, the central of the southern extent had a high density of 160 to 200 slipper limpets per 10 m^2 but the density and size of this area had decreased in 2020. The density of slipper limpets was lowest (0.1-40 slipper limpets per 10 m^2) to the west of North Bank along the section closest to the shore, the area to the south of Turnaware Point and a small area in the south-east of the survey area.

It should be noted that areas with a higher density were recorded in Area C in the upper reaches of the Fal but a density map was not created due to the sparsity between sites.

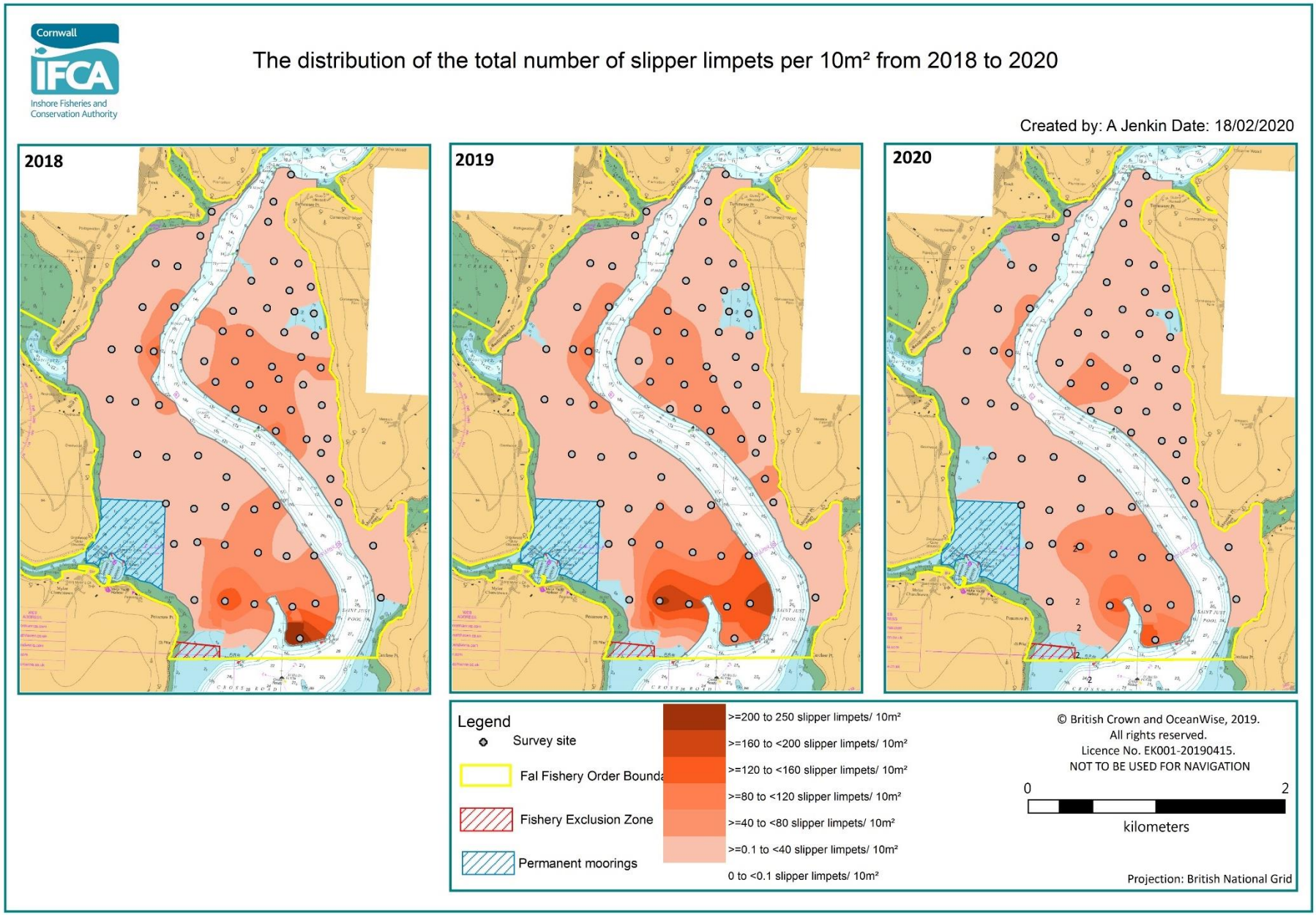


Figure 49: The distribution of slipper limpets (*Crepidula fornicata*) within Areas A and B from 2018 to 2020.

3.5 Bycatch

Bycatch species were present in all 82 dredge samples. A total of 81 species were identified, with the majority down to species level and the reminder identified to genus, or family level. This number is likely to be an underestimate as unidentified species were often grouped to family level, e.g. unidentified Polychaete spp. species were recorded as Polychaete pp. The species identified are listed in full in Annex Table G. Due to the light footprint of the dredge and short tow durations bycatch species were good condition and returned alive to the water straight away.

Arthropods and molluscs were the most commonly observed families in the bycatch (Figure 50). Two fish species were recorded in 2020 which hadn't been recorded before, including three bearded rockling (*Gaidropsarus vulgaris*) and butterfish (*Pholis gunnellus*). As in previous years, commonly observed molluscs included; slipper limpets (*Crepidula fornicata*), saddle oysters (*Anomia ephippium)*, topshells (*Gibbula* spp.), chitons (*Lepidochitona cinerea)*, and spiral shells (*Turitella / Bittium* sp.). Additional mollusc species which were recorded in 2020 were the pelican foot shell (*Aporrhais pespelecani*) recorded five times and the oyster drill shell (*Ocenebra erinaceus).* Regularly recorded crab species were similar to those observed in 2019; common shore crab (*Carcinus maenas*), navigator crab (*Liocarcinus navigator*), harbour crab (*Liocarcinus depurator*), long-legged spider crab (*Macrapodia* sp.), hermit crab (*Pagurus bernhardus)* and long-clawed porcelain crab (*Pisidia longicornis)*. Two species of red algae; coralline algae (*Lithophyllum* sp.) (which was likely under-recorded) and red string weed (*Soliera chordalis*) were also commonly seen. Sponges were noticeable throughout the survey, but often couldn't be identified to species level and will therefore be under-reported in Figure 50. This shows that the Fal Oyster Fishery supports a high number of other species and they were distributed across the fishery.

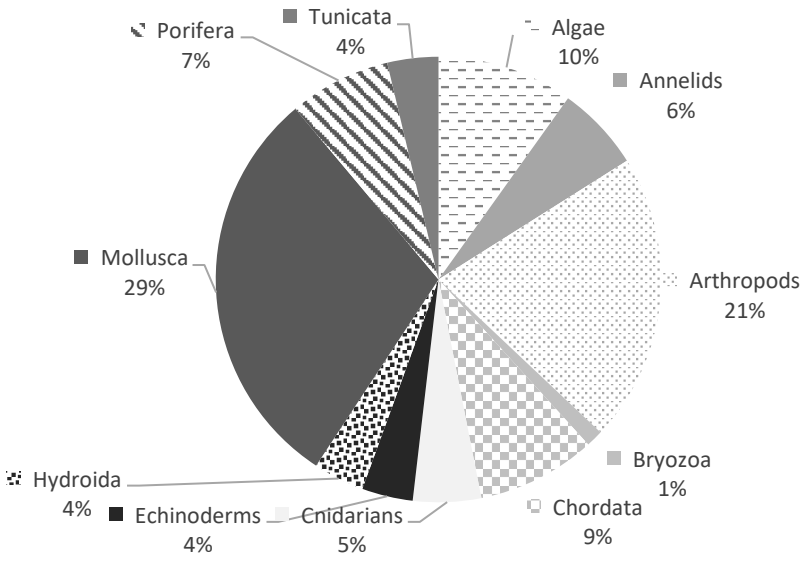


Figure 50: Percentage composition of identified bycatch across the whole Fal oyster survey 2020, shown by biological family. NB. This data has been calculated on the number of different species recorded from each family and not the number of individuals of each species present.

In previous years a species of red alage, *Solieria chordalis* was recorded in abundance at many sites. In 2020, this species was present in larger quantities than in 2019. It has been reported that the weed is most prolific after southerly swells when the weed is pushed up the estuary. Figure 51 shows sites with a great abundance of the red weed in 2020. The distribution of *S. chordalis* as a composition of the dredge sample can be seen in Figure 52. The

area with a high abundance of red weed was the central part of East Bank where a basin exists but it was also recorded in scattered samples across the survey area.

Figure 51: A species of red weed (*Solieria chordalis)* in a recovered sample recorded during the Fal oyster survey 2020.

3.6 Non-native species

Three non-native species were found during the survey; slipper limpets, *C. fornicata*, leathery sea-squirts, *Styela clava* and one pacific oyster (*Magallana gigas* - previously *Crassostrea gigas*). The distribution and abundance of slipper limpets is explained in more detail in section 3.5. All non-native species recorded during the survey were kept onboard and removed from the fishery and were collected by a biological waste company.

3.7 Dredge composition

The percentage volume of each dredge and the distribution of mud, shell (live and dead), weed, gravel, vegetation (sticks and leaves), dead maerl and stone is shown in Figure 52. Shell was prevalent across the central part of the survey area with large quantities of mud present in the northern part of Areas A and B and in the river (Area C) above Turnaware Point. The visual comparison plot showed that the dredged volumes for samples were relatively consistent at each site for all years from 2014 to present.

Maerl

- Live maerl

Live maerl was recorded at site A 16 (seven fragments). Cornwall IFCA will consider discontinuing this site from future surveys due to the number of live fragments recorded.

- Dead maerl

Fragments of dead maerl were recorded at ten sites (A 16, A 20, A 45, A 46, A 47, B 51, A 53, B 62, B 106, B 111). Dead maerl was recorded as a percentage as part of the substrate composition with a maximum of 30% recorded at site H 51.

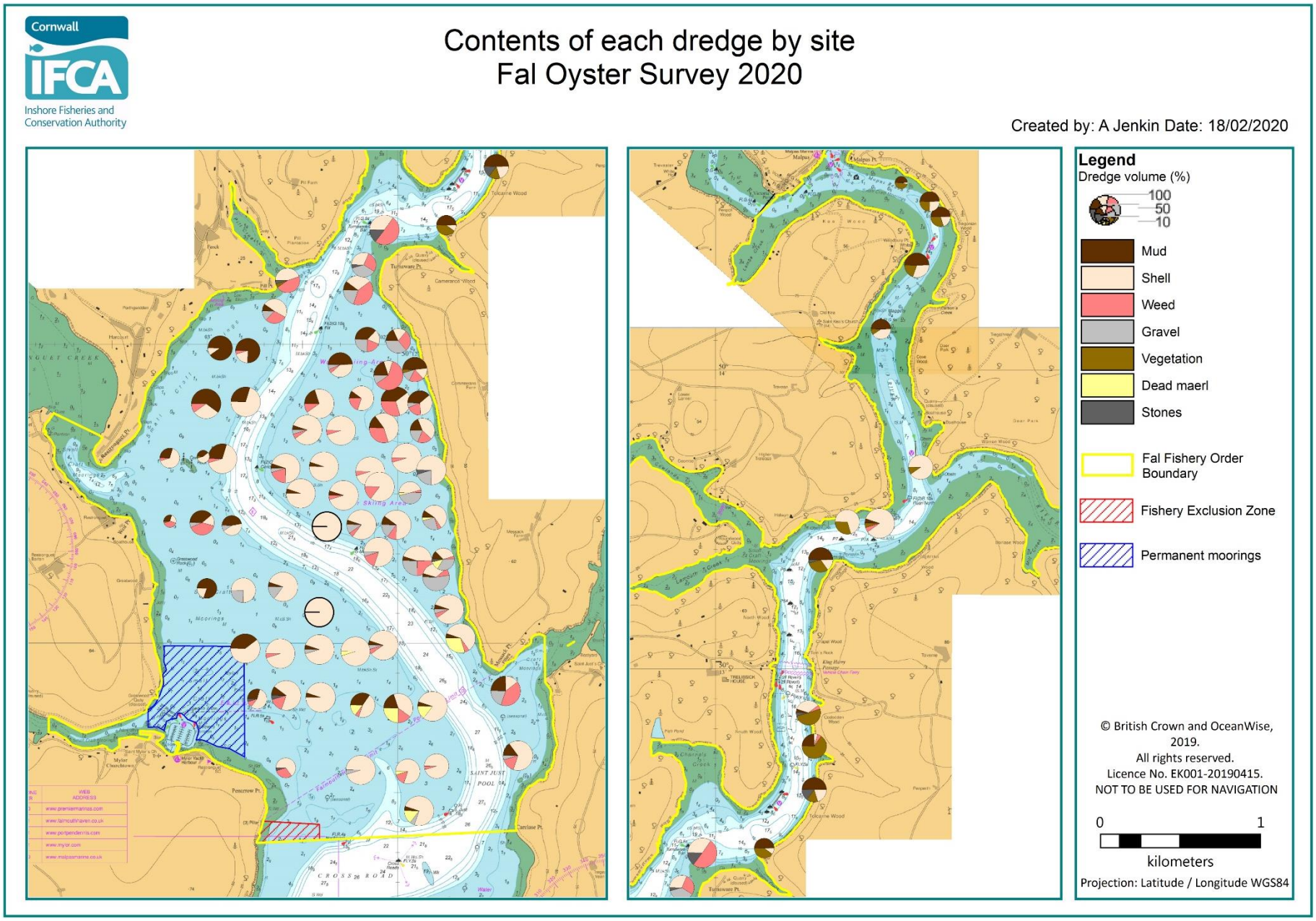


Figure 52: The dredge volume and the contents of each dredge per site recorded during the Fal oyster survey 2020.

3.8 Fishery as a whole

The density of oysters, scallops, slipper limpets and the contents of the dredge (%) recorded in 2020 are shown in Figure 53. The areas with a high density of oysters, scallops and slipper limpets corresponds with areas of samples with a high shell content.

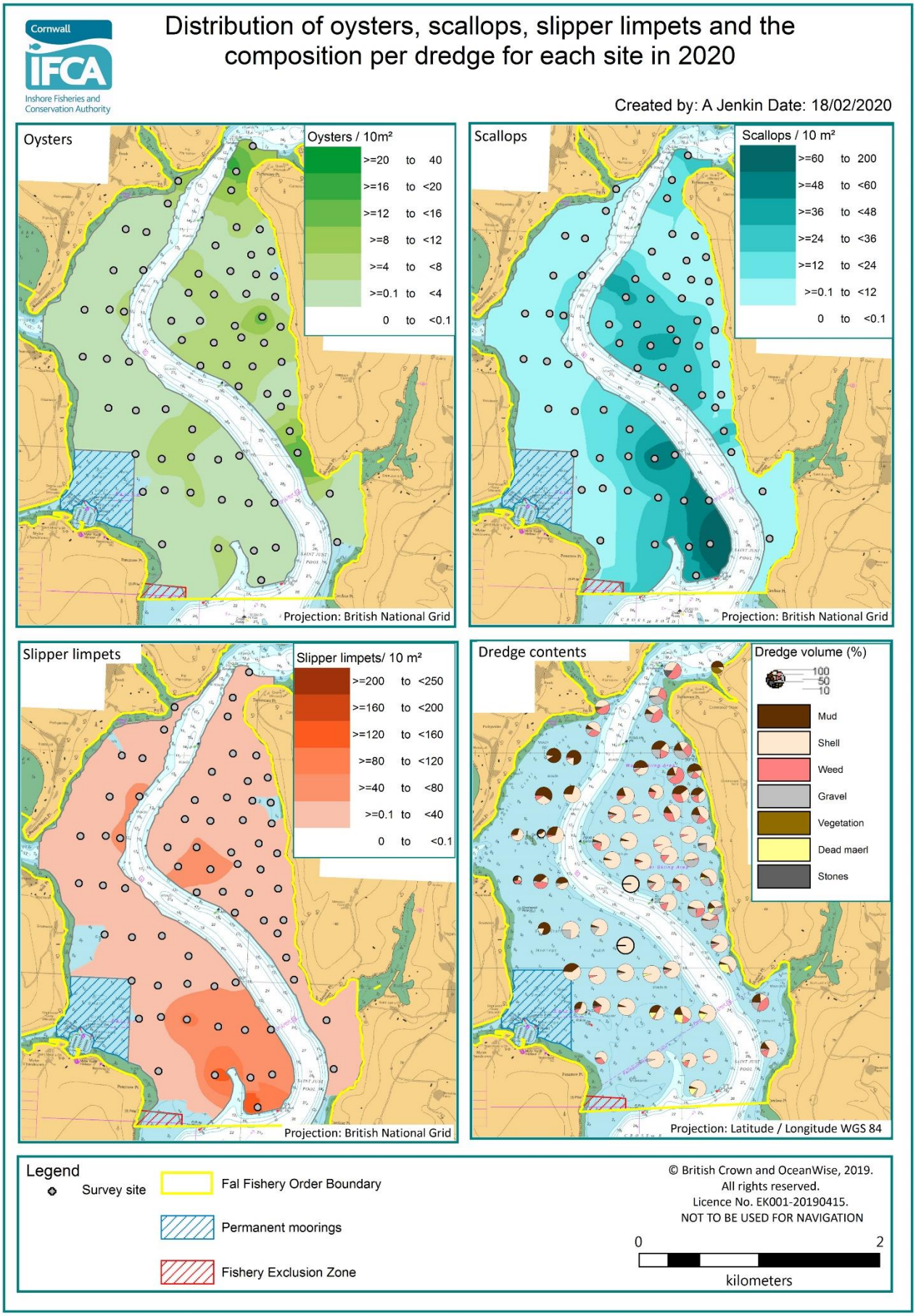


Figure 53: Density maps displaying the total number of native oysters (*Ostrea edulis)* per 10 m², the total number of scallops queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) per 10 m², the total number of slipper limpets (*Crepidula fornicate)* per 10 m² and the dredge volume and the contents of each dredge per site recorded within Areas A and B from 2020.

3.9 Anthropogenic impact

Anthropogenic impact was recorded at seven sites with glass bottles, pieces of glass and a metal bar coming up in the dredge. These were all removed from the fishery.

4 Discussion

Cornwall IFCA has completed yearly surveys of the Fal Oyster Fishery since the 2013-14 season. This data has enabled a temporal comparison to be made to assess the abundance and distribution of oysters and queen scallops, the distribution of slipper limpets since 2018, the composition of the dredge contents and an assessment of the bycatch species.

Overall, the 2019-20 season has been a frustrating year for the fishery with very little market for oysters locally which is similar to the situation in the 2018-19 season. Production in Europe, mainly in France has been very successful over the last couple of years meaning that supply is good which has weakened the demand for English oysters and their value is low. This is coupled with an apparent 70 g minimum weight applied by all merchants, presumably because their only markets are restaurants as opposed to relay markets. As a result, some fishermen and are focusing solely on scallops and have stopped fishing for oysters since the 2017-18 season when there were no restrictions on the number of scallops which could be removed from the fishery. Poor marketing ability is leading to increased amounts of oysters being put on the 'lays' (>10 tonnes during the 2018/19 season).

4.1 Oysters

The number of oysters recorded during the 2020 survey was lower than 2019. It is possible that the change in method in 2020 due to a hydraulic issue affected the results as the numbers were lower for scallops and slipper limpets as well. There was a decline in the number of large oysters (≥51 to ≤66 mm and ≤67 mm) from 2019 and the amount of adult spawning oysters on the ground was lower which could have an impact on the stock in 2020. A number of clean, dead oyster shells were recorded during the survey and mortality of adult oysters in the fishable stock can be caused by natural mortality, fishing pressure, disease and change in habitat and environmental conditions (Loughs Agency, 2018). A decrease in the number of breeding adults will have an associated effect on larval production and is directly related to the biomass of the oyster stock (Korringa, 1940). The number of small oysters class (≤ 35 mm and ≥36 to ≤50 mm) remained low.

Fluctuations in the abundance of shellfish are mostly caused by variations in recruitment (spat fall) (Sissenwine, 1984) which is caused by several factors including the size of the spawning stock (Shepherd, 1982; Beverton and Holt, 1957; Ricker, 1954) and environmental conditions (Le Pennec *et al*., 2003; Hofmann and Powell, 1998; Neill *et al*., 1994; Caputi, 1993). Past studies investigating recruitment in invertebrates have proposed that variation is often independent of the abundance of high spawners and is mainly influenced by variability in environmental conditions (Hancock, 1973; Drinkwater and Myers, 1987; Caputi, 1993). A number of previous studies have investigated abiotic factors including temperature (Dickie, 1955; Fogarty, 1988; Mackenzie and Köster, 2004), salinity (Nell and Holliday, 1988; Laing, 2002), suitability of habitat (Stokesbury and Himmelman, 1995), and biotic factors, including food availability (Jackson *et al*., 1995), indirect fishing mortality (Shepard and Auster, 1991), and predator abundance and

competition (Thouzeau, 1991). All of these factors vary spatially and temporally, which can explain why recruitment is often inconsistent (Vause *et al*., 2007).

Oyster settlement is highly sporadic, and native oyster spat can suffer up to 90% mortality (Cole, 1951). Factors which affect mortality include, but are not limited to; temperature, food availability, suitable settlement areas, and the presence of predators (Lancaster, 2014; Kennedy and Roberts, 1999; Cole, 1951; Spärck, 1951). The larvae respond to environmental signals which lead them to settling within the most suitable locations (Woolmer *et al.,* 2011; Walne, 1974).

Cefas undertook disease surveillance sampling of 150 *0. edulis* individuals within the Fal Estuary in 2020. Of these seven individuals tested positive for *Bonamia ostreae* (five from Messack, one from Truenaware point and one from Ruan Creek). *B. ostreae* is a microscopic single-celled parasite from the phylum Haplosporidia. It has no impact on other shellfish or on human health and does not affect the taste of oysters in anyway or pose a health risk to a consumer. However, it can result in significant mortalities in affected oyster stocks of up to 90% mortality when initially introduced (Culloty and Mulcahy, 2007). It is transmitted through proximity and there is currently no known treatment (Cefas, 2005). The samples were negative for *Marteilia refringens* and *Bonamia exitiosa.*

4.2 Scallops

The number of large scallops ≥40 mm has decreased slightly but remained high in 2020 and the number of small scallops ≤39 mm have decreased since in 2019. A widespread spat settlement occurred in 2019 with a notable increase in scallops ≤19 mm in all three areas of the survey. One of the dredge samples in 2019 was fished heavier than normal and a total of 405 scallops ≤19 mm were recorded from site A 19. This size class wasn't observed the following year in the data and only a low number of scallops ≤19 mm were present despite the team checking each shell (dead or alive) individually or scallop spat.

Scallop stocks are known for being temporally and spatially variable, and the main causes of this can be put into three groups; recruitment variability, catastrophic mortality and the longevity of species; (Vause *et al.,* 2007) scallops are a short lived species with rapid early growth and they have no buffer zone if there is a period of poor recruitment (Vause *et al.,* 2007).

The scallops have been a target species of the fishery since the 2017/18 season and are no longer subject to bycatch restrictions so effort within the fishery is now mostly directed at queen scallops rather than oysters and a higher number of larger scallops are being removed from the fishery. Queen scallops are broadcast spawners, therefore a decrease in density is likely to rapidly reduce the fertilisation efficiency of the larger scallops (Stoner and Ray-Culp, 2000). A study carried out in the northern Irish Sea queen scallop fishery showed that the fishery there is heavily reliant on recruiting two year olds and less so on three year olds making the fishery potentially vulnerable to recruitment overfishing (Vause *et al*., 2007).

The market for native oysters is currently so low that some fishermen are only fishing for scallops and last year there was an oversupply of scallops on the market. A survey carried out in the Isle of Man found that there was a significant relationship between the density of one year olds caught on survey and the commercial catch rates the following year

(Vause *et al*., 2007). Monitoring of a fishery by assessing the juvenile scallop density therefore allows the prediction of recruitment and differences in the fishery at least one year in advance (Vause *et al*., 2007). Cornwall IFCA will continue to monitor the abundance of scallops to ensure the scallop fishery is sustainable.

4.3 Slipper limpets

The number of slipper limpets recorded in 2020 was lower than in 2019. This could be due to licence holders continually removing them from the fishery (Table 17) and Cornwall IFCA removing a total of 11,412 from the fishery in 2019.

Table 17: Total weight (kg) of slipper limpets (*Crepidula fornicata*) removed by dredging from the Fal Fishery between October to March each season.

Season	Slipper limpets removed (kg's)
2014-2015	5,111
2015-2016	2,363
2016-2017	1,863
2017-2018	2,429
2018-2019	2,497
2019-2020	1,045

Areas with a high density were either side of the channel running between East Bank and North Bank as well as the southern part of Area C. The distribution is similar to what was reported by Fitzgerald in 2006.

All slipper limpets recorded during the survey in 2020 were removed from the fishery by Cornwall IFCA. The presence of slipper limpets are a threat to native oysters as they compete with oysters by reducing the amount of food available which can slow oyster growth, and overcrowding which traps suspended silt, faeces and pseudo faeces which can smother oysters (Invasive Species Ireland, 2019; Cornwall Good Seafood Guide, 2017; Naylor, 2011). It is for this reason that Cornwall IFCA will continue to remove all slipper limpets recorded during the survey in 2021.

4.4 Bycatch

In 2020, due to time constraints, a comprehensive bycatch study was not carried out but a record was made of the bycatch species observed using a list made from the comprehensive survey in 2019. A total of 81 species were recorded which demonstrates that the Fal Oyster Fishery area provides a habitat for a diverse number of species. Oyster beds have been known to support a diverse epifauna consisting of protozoa, sponges, hydroids, the benthic stages of *Aurelia* sp., flatworms, ribbon worms, nematodes polychaetes, amphipods and ostracod crustaceans, crabs, sea spiders, gastropod molluscs, ascidians, bryozoans, starfish and sea urchins (Yonge, 1960; Korringa, 1951). Dead shells which are present on the oyster beds make up a substantial portion of the substratum. The clumps of dead shell can support a large number of sponges, polychaetes and seaweeds, as well as scavengers such as hermit crabs and common whelks ((Perry and Tyler-Walters, 2016) – all of which were recorded during the survey. A number of predators also feed on the oyster beds including starfish, slipper limpets, dog whelks and some species of crab (Perry

and Tyler-Walters, 2016). A survey carried out in the early 1900's found that lots of the cultch in the fishery was overgrown with marine organisms, including sponges and *Lithothamnion* (a genus of thalloid red algae) (Orton, 1927).

Live maerl was recorded in one site (A 16) with seven fragments of live maerl recorded. Cornwall IFCA will consider dropping this site from the survey in 2021. Dead maerl was present at ten of the sites. Maerl thalli are frequently loose and mobile, which is how they were recorded in the Fal Oyster survey. This form of maerl prevents colonisation by other species (Perry and Tyler-Walters, 2018).

All non-native species recorded during the survey were removed from the fishery, the most dominant non-native species recorded during the survey was the slipper limpet (*Crepidula fornicata*). One pacific oyster was recorded during the survey (site C 30) which was removed from the fishery.

4.5 Dredge composition

Native oysters have a planktonic dispersal stage, therefore suitable substratum is a key habitat feature which influences settlement and recruitment (Bromley *et al*., 2016; Caddy and Stamatopolous, 1990). The oyster larvae will only settle out and metamorphose where suitable hard substratum is available (Brown *et al*., 2010; Walne, 1974; Waugh, 1972). The fishery is composed of a mix of substrates including shell (live and dead), mud, gravel and stone. The shell and mixed sediment recorded will provide a hard substratum for plankton to settle. However, in areas with a high number of slipper limpets there was often an accumulation of mud, as recorded during the survey. Mud can prevent spat from settling out as there is no surface to settle on.

The red macroalgae (*S. chordalis*) was much less abundant than in previous years. The red macroalgae is normally present after windy conditions from the south which blows this weed straight up the Fal. The calmer conditions during the early part of winter in 2020 are likely to explain why this species was less abundant.

5 Recommendations

5.1 Recommendations for 2021

- Use a set of scales that are stabilised to weigh the oysters on site instead of having to return to Mylor.
- Consider dropping site A 16 from the survey in 2020 due to the presence of seven fragments of live maerl which were recorded in 2020.
- Review survey sites within area C (the upper reaches of the Carrick roads) with the aim of achieving better coverage. The river reaches are important fishery areas for tow haul fishing and a more consistent approach to cover this section is needed. Due to the low number of sites within this area it is not possible to create accurate density maps for this part of the fishery.
- The Cornwall IFCA research team are hoping to carry out a plankton survey within the oyster fishery in 2020 to provide an indication of the level of *O. edulis* and *M. varia* larvae in the water column. Spawning occurs in the summer months of June to September and coincides with new or full moons (Yonge, 1960; Korringa, 1952). This data would be collected in collaboration with monitoring the temperature to assess the optimum spawning period. The sampling would be carried out by weekly plankton tows from fixed sampling points in the

fishery. An addition to this survey might be the analysis of mature native oysters for gonad stage analysis. Both of these pieces of information will help inform Cornwall IFCA's management of the fishery.

- Analyse the data from the temperature logger which was in the fishery in 2019.
- Deploy spat collectors within the fishery to enable an assessment of the settlement rate and recruitment within the fishery of both native oysters and queen scallops.
- Make a note of any fresh dead oyster shells as a measure of recent mortality. These shells will show no fouling on the inner surface of the shell.
- Measure salinity and water quality within the fishery as water quality is a key component of healthy shellfish beds (Allison, 2017).
- Assess the efficiency of the dredge across the Fal fishery. The method used by Allison (2017) is recommended which assessed the number of oysters from a grab survey and a dredge survey then uses an equation to calculate the dredge efficiency which can vary depending on the size class and location (Powell *et al,*. 2002). This is difficult to assess with such light gear and would be a separate project.
- Carry out a survey prior to the fishery starting to record the biomass of the fishery before it is fished each year although the banks are reported to have prolific weed earlier in the year therefore it's impossible to carry out consistent dredging.
- Habitat mapping of the area - The Fal Fishery area comprises a diverse array of habitats, which are part of the Fal and Helford Special Area of Conservation (SAC). Mapping the distribution of these habitats within the Fal Fishery may help to determine their influence on the distribution of oysters.
- Carry out a drop-down video survey of the southern extent of the fishery to assess the presence of live maerl.

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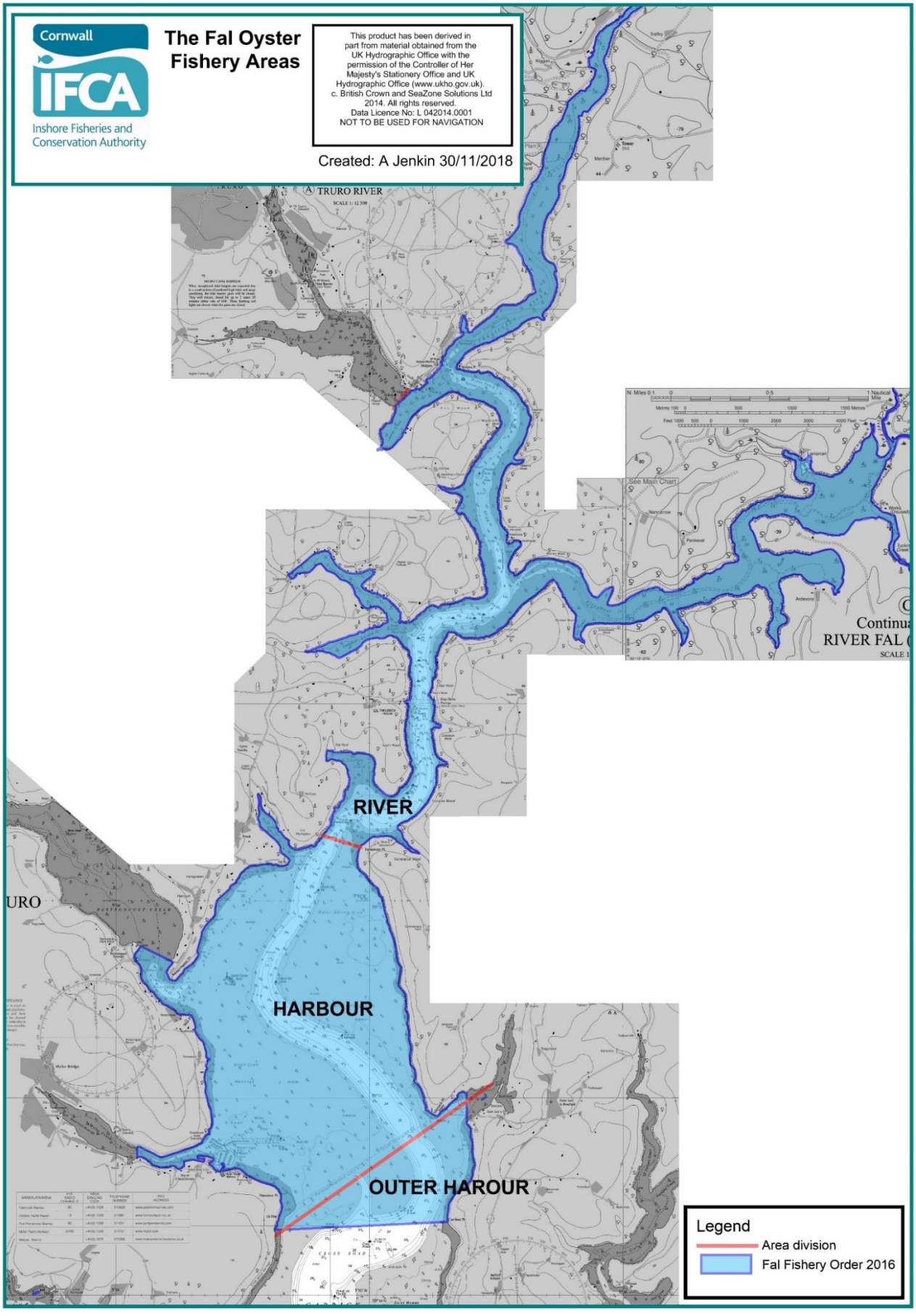
7 Appendices

Annex 1 – Fal Oyster Fishery Areas

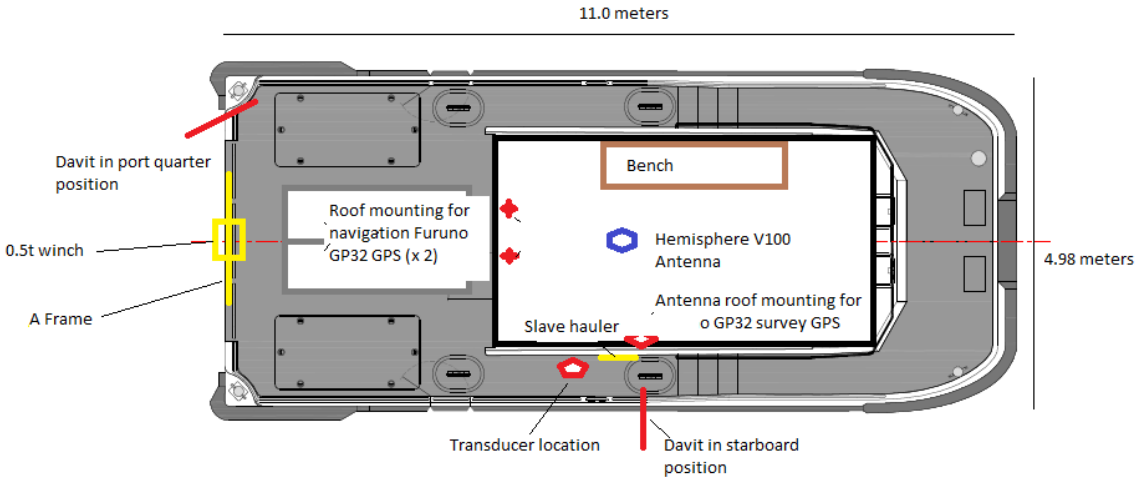


Annex Figure A: The Harbour, Outer Harbour and River areas of the Fal oyster survey.

Annex 1 – R/V Tiger Lily VI Deck Plan & Offsets

Builder	South Boats Ltd
Model	Island MkII
Built	2007
LOA	11.0m
Beam	4.98m
Draught	1.1m (aft)
Tonnage	c.10 tonnes
Area of operation	MCA Category 2
Call sign	MRWR7
MMSI Number	235054954
MECAL Certification number	M07WB0111059
Complement	14 (including min 2 crew)
Propulsion	2 x 450hp Iveco NEF series
Speed	Cruising: 16 – 18 knots Top: 24 – 26 knots
Range	c. 400 nautical miles
240v AC supply	Victron 3Kw power inverter 5KvA Volvo-Perkins generator (All 240 AC power is accessed via APC Smart UPS C1500)
Stern Gantry	500kg SWL
Winch (on stern gantry)	Spencer Carter 0.5t with scrolling level wind
Slave hauler	Sea Winch 200m dia.
Electric line hauler	12v Spencer Carter Bandit
Positioning	Hemisphere V100 GNSS 3 x Furuno GP32
NMEA data outputs	4 x USB 4 x Serial 4 x banjo
Navigation	Olex with data export Knockle Hypack Max

Tiger Lily VI General Layout - Plan view



			Offset (m)		
NMEA Device	**Make/Model**	**Offset Name**	**X (f'wd)**	**Y (port)**	**Z (+/-)**
Sounder	Furuno Navnet	Transducer	7.0	4.2	-0.5
GPS	Furuno GP32	GPS 1	4.8	3.48	+2.2
GNSS	Hemisphere V100	GNSS 1	5.0	2.5	+2.35

Annex 3 – Site positions

Annex Table A: Positions of sites surveyed in 2020

Site	Latitude (decimal degrees)	Longitude (decimal degrees)
A 16	50.173978	-5.031488
A 19	50.176465	-5.029952
A 20	50.176168	-5.032460
A 21	50.176247	-5.036592
A 23	50.176368	-5.043145
A 45	50.179802	-5.030308
A 46	50.179703	-5.033298
A 47	50.179862	-5.036422
A 48	50.180305	-5.040093
A 49	50.180412	-5.043107
A 50	50.180223	-5.045637
A 52	50.183213	-5.034612
A 53	50.182862	-5.037042
A 54	50.182973	-5.040197
A 55	50.182748	-5.043608
A 56	50.183025	-5.046680
A 58	50.185048	-5.040190
A 59	50.186470	-5.043378
A 60	50.186272	-5.046840
A 61	50.186385	-5.050032
A 66	50.189895	-5.047862
A 67	50.190042	-5.050450
A 68	50.190138	-5.053260
A 69	50.193653	-5.053283
A 70	50.193740	-5.050357
A 71	50.193622	-5.048685
A 81	50.196792	-5.046645
A 82	50.196685	-5.050100
A 83	50.199788	-5.048873
A 84	50.199640	-5.046462
A 89	50.201840	-5.044115
B 18	50.177060	-5.022842
B 44	50.180667	-5.023915
B 51	50.183602	-5.027855
B 57	50.187008	-5.030000
B 62	50.190340	-5.030140
B 63	50.189923	-5.033478
B 64	50.189940	-5.036523
B 65	50.189818	-5.039537
B 72	50.193082	-5.043152
B 73	50.193172	-5.039795
B 74	50.192898	-5.035747
B 75	50.193650	-5.032587
B 76	50.192972	-5.030413
B 77	50.196727	-5.031410
B 78	50.196808	-5.033525
B 79	50.196983	-5.036513
B 80	50.196677	-5.040213
B 85	50.200267	-5.036005
B 86	50.200190	-5.033302
B 87	50.203010	-5.036805
B 92	50.198842	-5.038367
B 93	50.198260	-5.034167
B 94	50.198582	-5.031860
B 97	50.195227	-5.041267
B 98	50.195185	-5.038300
B 99	50.195333	-5.034557
B 100	50.195182	-5.031192
B 103	50.191677	-5.041825
B 104	50.191575	-5.038087
B 105	50.192048	-5.034942
B 106	50.191717	-5.032258
B 109	50.188407	-5.035025
B 110	50.187922	-5.031647
B 111	50.188012	-5.029367
B 123	50.185215	-5.028865
C 24	50.204430	-5.036310
C 26	50.206380	-5.034517
C 27	50.206640	-5.029107
C 28	50.209903	-5.024713
C 29	50.212337	-5.024710
C 30	50.214193	-5.025233
C 31	50.222742	-5.024147
C 32	50.224850	-5.021825
C 33	50.224778	-5.018992
C 34	50.227903	-5.015393
C 36	50.235623	-5.018880
C 40	50.239188	-5.015732
C 41	50.241897	-5.013652
C 42	50.242745	-5.014617
C 43	50.243805	-5.017103
C 88	50.203555	-5.042988

Annex 4 – Daily logs

Daily log 1

Annex Table B: Daily log for 19th January 2020.

Project information			
Project	Fal Oyster Survey 2020		
Survey code	2020_CIFCA_SAC_FAL_FOS		
Location	Fal Estuary		
Date	19th January 2019		
Vessel	Tiger Lily VI		
Staff			
Survey role	**Company**	**Name**	
Principal Scientific Officer	Cornwall IFCA	Colin Trundle	
Scientific Officer	Cornwall IFCA	Annie Jenkin	
Scientific Officer	Cornwall IFCA	Stephanie Sturgeon	
Scientific Officer	Cornwall IFCA	Hilary Naylor	
Skipper	Independent	Chris Lowe	
Weather and tides			
High water time:	12:13		
High water (m)	4.30m		
Wind direction	E		
Wind speed	5mph		
Beaufort scale	1		
Cloud coverage	0/8		
Time weather recorded	08.00		
Safety			
Toolbox talk time	07:30		
Induction	None required		
Summary of operations			
Time start (UTC)	**Time end (UTC)**	**Type**	**Activity**
07:15			Onboard setting up
08:13			Depart Mylor
08:32:17	08:34:00	Dredge	A_16_OH
09:20:43	09:22:04	Dredge	B_18_OH
09:41:31	09:42:50	Dredge	A_19_OH
10:15:48	10:17:00	Dredge	A_20_OH
11:08:11	11:12:37	Dredge	A_21_0H
11:48:11	11:50:11	Dredge	A_23_H_1. Sample too small due to kelp blocking the dredge
11:54:49	11:56:40	Dredge	A_23_H_2
12:11:19	12:14:19	Dredge	A_50_H
12:30			Measuring/ weighing oysters alongside. Break
13:39:32	13:41:16	Dredge	A_49_H
13:54:14	13:57:01	Dredge	A_48_H
14:15:09	14:17:44	Dredge	A_47_H
14:37:00	14:39:26	Dredge	A_46_H
15:08:43	15:10:21	Dredge	A_45_H
15:37:28	15:40:17	Dredge	B_44_OH
16:00:57	16:04:28	Dredge	A_56_H
16:16:05	16:18:24	Dredge	A_55_H
16:37:54	16:40:30	Dredge	A_54_H
17:02:56	17:05:21	Dredge	A_53_H
17:45			Arrive Mylor
Overall progress			
Action	**Sites total**	**Sites completed**	**Remaining sites**
Dredge	82	17	65

Daily log 2

Annex Table C: Daily log for 20th January 2020.

Project information		
Project	Fal Oyster Survey 2020	
Survey code	2020_CIFCA_SAC_FAL_FOS	
Location	Fal Estuary	
Date	20th January 2020	
Vessel	Tiger Lily VI	
Staff		
Survey role	**Company**	**Name**
Principal Scientific Officer	Cornwall IFCA	Colin Trundle
Scientific Officer	Cornwall IFCA	Annie Jenkin
Scientific Officer	Cornwall IFCA	Stephanie Sturgeon
Skipper	Independent	Chris Lowe
Visitor		Mark Kaczmarek
Visitor		Meg Hayward-Smith
Weather and tides		
High water time:	13:30	
High water (m)	4.2m	
Wind direction	N	
Wind speed	3mph	
Beaufort scale	1	
Cloud coverage	0/8	
Time weather recorded	07:45	
Safety		
Toolbox talk time	07:30	
Induction	07:45	

Summary of operations			
Time start (UTC)	**Time end (UTC)**	**Type**	**Activity**
08:00			Depart Mylor
08:11:19	08:13:17	Dredge	A_52_H
08:40:18	08:43:17	Dredge	A_58_H
09:01:43	09:05:31	Dredge	A_59_H
09:30:45	09:34:49	Dredge	A_60_H
09:51:55	09:53:29	Dredge	A_61_H_1
10:00:01	10:02:47	Dredge	A_61_H_2
10:11:30	10:13:50	Dredge	A_66_H
10:24:33	10:26:57	Dredge	A_67_H
10:43:40	10:47:04	Dredge	A_68_H
10:57:18	11:00:44	Dredge	A_69_H
11:13:27	11:15:25	Dredge	A_70_H
11:28:50	11:31:21	Dredge	A_71_H
12:00	xx		Measuring/ weighing oyster alongside. Break
13:26:15	13:28:57	Dredge	A_82_H
13:46:11	13:48:23	Dredge	A_81_H
14:04:16	14:05:51	Dredge	A_83_H
14:16:07	14:18:39	Dredge	A_84_H
14:29:19	14:31:57	Dredge	A_89_H
14:44:45	14:45:52	Dredge	C_88_H
15:01:17	15:03:34	Dredge	C_24_H
15:22:29	15:25:05	Dredge	B_87_H
15:42:40	15:45:17	Dredge	B_85_H
16:08:31	16:11:12	Dredge	B_86_H
16:26:27	16:28:29	Dredge	B_94_H
16:38:19	16:40:41	Dredge	B_93_H
16:51:57	16:55:02	Dredge	B_92_H
17:25			Arrive Mylor

2020_CIFCA_SAC_FAL_FOS

Overall progress			
Action	**Sites total**	**Sites completed**	**Remaining sites**
Dredge	82	24	41

Daily log 3

Annex Table D: Daily log for 21st January 2020.

Project information			
Project	Fal Oyster Survey 2020		
Survey code	2020_CIFCA_SAC_FAL_FOS		
Location	Fal Estuary		
Date	21st January 2020		
Vessel	Tiger Lily VI		
Staff			
Survey role	**Company**	**Name**	
Principal Scientific Officer	Cornwall IFCA	Colin Trundle	
Scientific Officer	Cornwall IFCA	Stephanie Sturgeon	
Scientific Officer	Cornwall IFCA	Hilary Stidwell	
Skipper	Independent	Chris Lowe	
Visitors		Meg Hayward-Smith ITV Westcountry news crew	
Weather and tides			
High water time:	14:39		
High water (m)	4.32m		
Wind direction	NE		
Wind speed	5mph		
Beaufort scale	1		
Cloud coverage	0/8		
Time weather recorded	07:45		
Safety			
Toolbox talk time	07:30		
Induction	None required		
Summary of operations			
Time start (UTC)	**Time end (UTC)**	**Type**	**Activity**
08:00			Depart Mylor
08:26:31	08:28:00	Dredge	B_80_H
08:50:55	08:52:22	Dredge	B_97_H
09:15:11	09:17:25	Dredge	B_72_H
09:46:41	09:49:21	Dredge	B_103_H
11:02:20	11:05:09	Dredge	B_65_H
11:22:06	11:24:11	Dredge	B_109_H
11:43:22	11:46:28	Dredge	B_110_H
12:03:35	12:05:32	Dredge	B_57_H
12:18:41	12:21:32	Dredge	B_123_H
12:40			Measuring/ weighing oysters. Break
13:13:15	13:15:28	Dredge	B_51_H
11:43:22	11:46:28	Dredge	B_111_H
13:43:43	13:46:40	Dredge	B_62_H
13:59:41	14:03:39	Dredge	B_76_H
14:14:36	14:16:50	Dredge	B_100_H
14:33:00	14:34:42	Dredge	B_77_H
14:45:04	14:46:53	Dredge	B_78_H
14:57:08	14:59:15	Dredge	B_79_H
15:10:47	15:12:37	Dredge	B_98_H
15:34:48	15:37:15	Dredge	B_99_H
15:50:08	15:51:58	Dredge	B_75_H
16:20:53	16:22:52	Dredge	B_74_H

16:45			Arrive Mylor
Overall progress			
Action	**Sites total**	**Sites completed**	**Remaining sites**
Dredge	82	21	20

Daily log 4

Annex Table E: Daily log for 22nd January 2019.

Project information		
Project	Fal Oyster Survey 2020	
Survey code	2020_CIFCA_SAC_FAL_FOS	
Location	Fal Estuary	
Date	22nd January 2019	
Vessel	Tiger Lily VI	
Staff		
Survey role	**Company**	**Name**
Principal Scientific Officer	Cornwall IFCA	Colin Trundle
Scientific Officer	Cornwall IFCA	Annie Jenkin
Scientific Officer	Cornwall IFCA	Stephanie Sturgeon
Skipper	Independent	Chris Lowe
Visitor		Meg Hayward-Smith
Weather and tides		
High water time:	15:36	
High water (m)	4.5m	
Wind direction	E	
Wind speed	12-18mph	
Beaufort scale	3	
Cloud coverage	0/8	
Time weather recorded	07:45	
Safety		
Toolbox talk time	None required	
Induction	None required	

Summary of operations			
Time start (UTC)	**Time end (UTC)**	**Type**	**Activity**
08:00			Depart Mylor
08:16:58	08:18:45	Dredge	B_64_H
08:37:15	08:40:14	Dredge	B_63_H
08:59:27	09:02:05	Dredge	B_106_H
09:15:00	09:17:52	Dredge	B_105_H
09:36:01	09:37:59	Dredge	B_104_H
09:45			Sorting out turns on winch
10:13:53	10:16:06	Dredge	B_73_H
10:30			Measuring/ weighing oysters
11:10:06	11:12:08	Dredge	C_26_R
11:29:46	11:31:18	Dredge	C_27_R
11:41:06	11:42:37	Dredge	C_28_R
11:57:04	11:59:46	Dredge	C_29_R
12:12:34	12:14:18	Dredge	C_30_R
13:00			Measuring/ weighing oysters. Break
13:45:42	13:46:19	Dredge	C_31_R_1
13:51:44	13:53:26	Dredge	C_31_R_2
14:08:09	14:09:48	Dredge	C_32_R
14:25:22	14:26:36	Dredge	C_33_R
14:54:40	14:57:06	Dredge	C_43_R_1
15:00:22	15:01:54	Dredge	C_43_R_2
15:08:17	15:10:16	Dredge	C_42_R
15:18:04	15:20:00	Dredge	C_41_R

15:26:08	15:28:46	Dredge	C_40_R
15:39:37	15:40:49	Dredge	C_36_R
15:00:22	15:01:54	Dredge	C_43_R
17:15			Arrive Mylor
Overall progress			
Action	**Sites total**	**Sites completed**	**Remaining sites**
Dredge	82	20	0

Annex 5 – Survey data

Annex Table F: Native oysters (*Ostrea edulis)*, queen scallop (*Aequipecten opercularis*) and variegated scallop (*Mimachlamys varia*) and slipper limpet (*Crepidula fornicata*) counts for the Fal oyster survey 2020.

Area	Site Code	Date	No. of Oysters				Total Oyster Count	No. of Scallops				Total Scallop Count	Total Slipper Limpet Count
			≥67 mm	≥51-≤66 mm	≥36-≤50 mm	≤35mm		≥60 mm	≥59-≤40 mm	≥21-≤39 mm	≤20 mm		
Area A	A 16		1	0	1	1	3	3	30	104	7	144	450
	A 19		5	3	2	1	11	80	138	70	9	297	231
	A 20		5	6	2	1	14	41	61	40	6	148	262
	A 21		8	6	1	1	16	63	54	9	1	127	510
	A 23		4	0	0	0	4	1	4	0	5	10	5
	A 45		2	1	0	0	3	35	68	79	3	185	283
	A 46		4	2	2	0	8	46	68	62	3	179	189
	A 47		4	3	2	1	10	33	39	14	1	87	201
	A 48		5	10	2	1	18	36	28	5	2	71	352
	A 49		0	1	0	0	1	1	3	5	2	11	122
	A 50		0	0	0	0	0	0	0	0	0	0	0
	A 52		3	6	3	0	12	73	89	9	0	171	130
	A 53		3	4	2	1	10	44	128	43	7	222	144
	A 54		10	2	1	1	14	22	47	28	4	101	55
	A 55		12	14	3	1	30	14	31	19	7	71	64
	A 56		1	2	1	0	4	5	7	1	2	15	3
	A 58		10	7	0	0	17	33	45	15	0	93	77
	A 59		5	5	2	0	12	27	30	19	4	80	67
	A 60		1	2	0	2	5	7	12	11	5	35	25
	A 61		6	3	1	0	10	5	5	3	0	13	0
	A 66		7	0	0	0	7	3	7	4	1	15	67
	A 67		2	0	0	0	2	3	2	1	0	6	13
	A 68		8	4	0	0	12	5	3	0	0	8	5
	A 69		7	3	0	0	10	0	5	5	0	10	19
	A 70		3	4	0	0	7	2	7	2	2	13	85
	A 71		13	3	6	0	22	51	36	11	0	98	249
	A 81		2	5	2	0	9	20	14	9	5	48	246

	A 82	8	4	1	0	13	3	15	6	6	30	35
	A 83	1	0	0	0	1	0	1	0	0	1	0
	A 84	1	1	1	0	3	6	3	1	0	10	16
	A 89	9	5	1	1	16	5	4	4	10	23	24
Area A Sub-total	**31**	150	106	36	12	304	667	984	579	92	2322	3929
	B 18	0	0	0	0	0	0	4	0	0	4	4
	B 44	7	6	0	0	13	9	14	7	0	30	34
	B 51	14	19	14	5	52	13	15	6	1	35	125
	B 57	13	2	2	0	17	15	17	6	0	38	25
	B 62	5	4	5	1	15	17	9	3	4	33	12
	B 63	6	7	6	1	20	47	54	27	4	132	116
	B 64	6	5	2	1	14	38	45	31	2	116	107
	B 65	5	8	6	1	20	45	49	16	0	110	126
	B 72	2	6	0	0	8	26	28	13	0	67	78
	B 73	2	7	0	1	10	35	34	22	1	92	158
	B 74	8	15	3	0	26	51	55	13	1	120	121
	B 75	22	27	7	0	56	28	48	27	0	103	121
Area B	B 76	7	7	4	1	19	8	14	9	1	32	24
	B 77	0	0	0	0	0	0	0	1	0	1	0
	B 78	0	0	1	0	1	0	0	0	0	0	0
	B 79	1	0	0	0	1	0	4	0	0	4	14
	B 80	6	7	5	0	18	41	30	16	0	87	67
	B 85	8	9	4	2	23	12	22	9	2	45	15
	B 86	3	5	2	1	11	10	3	3	1	17	3
	B 87	19	12	5	0	36	18	23	9	5	55	28
	B 92	1	1	0	0	2	5	0	1	0	6	15
	B 93	3	3	1	0	7	0	2	0	0	2	2
	B 94	1	0	0	0	1	1	0	0	0	1	2
	B 97	2	10	0	3	15	57	63	26	4	150	125
	B 98	10	12	3	1	26	36	54	28	2	120	118
	B 99	2	0	0	0	2	22	12	2	0	36	7

	B 100	2	3	0	0	5	10	12	1	0	23	0
	B 103	6	9	2	0	17	28	48	28	0	104	164
	B 104	7	13	3	1	24	62	67	31	1	161	191
	B 105	12	5	3	0	20	59	62	19	0	140	143
	B 106	7	7	4	2	20	25	25	10	1	61	24
	B 109	7	9	7	0	23	50	48	7	1	106	148
	B 110	3	3	3	0	9	47	35	6	1	89	82
	B 111	1	1	0	0	2	5	6	0	0	11	3
	B 123	11	20	8	1	40	43	50	10	1	104	111
Area B Sub-total	**35**	209	242	100	22	573	863	952	387	33	2235	2313
	C 24	16	41	3	0	60	7	17	13	5	42	11
	C 26	17	13	4	1	35	18	57	23	10	108	17
	C 27	0	0	0	0	0	0	0	0	0	0	0
	C 28	5	6	1	0	12	0	14	4	1	19	191
	C 29	4	5	1	2	12	3	18	3	0	24	144
	C 30	20	29	3	0	52	10	59	13	0	82	67
	C 31	15	8	2	4	29	0	11	2	0	13	414
	C 32	20	19	13	3	55	1	31	20	1	53	147
Area C	C 33	7	24	5	1	37	0	13	14	0	27	1289
	C 34	5	10	5	0	20	0	2	8	0	10	21
	C 36	0	0	0	0	0	0	2	7	0	9	28
	C 40	7	16	2	1	26	0	3	6	0	9	142
	C 41	3	2	0	0	5	0	0	0	0	0	0
	C 42	1	0	0	0	1	0	1	1	0	2	4
	C 43	1	0	1	0	2	0	0	1	0	1	6
	C 88	17	20	3	2	42	5	10	5	1	21	30
Area C Sub-total	**16**	138	193	43	14	388	44	238	120	18	420	2511
Total	**82**	**497**	**541**	**179**	**48**	**1265**	**1574**	**2174**	**1086**	**143**	**4977**	**8753**

Annex 6 – Bycatch

Annex Table G: List of bycatch species recorded during the Fal oyster survey 2020 and in previous years. Species recorded in previous years which were unidentified have been removed from this list.

Species Name	Common Name / Descriptions	Species recorded in 2020	Species recorded in previous years	Non-native species
ALGAE - CHLOROPHYTA				
Ulva sp.	Sea lettuce	Y	Y	
ALGAE – OCHROPHYTA				
Ascophyllum nodosum	Knotted wrack	Y	Y	
Fucus serratus	Serrated wrack	Y	Y	
Fucus vesiculosus	Bladder wrack		Y	
Laminaria hyperborea and *Laminaria ochroleuca*	Kelp		Y	
Laminaria saccharina	Sugar kelp	Y	Y	
ALGAE – RHODOPHYTA				
Chondrus crispus	Irish Moss		Y	
Lithothamnion corallioides	Maerl	Y	Y	
Lithophyllum sp.	Encrusting coralline algae	Y	Y	
Phymatolithon calcareum	Maerl	Y	Y	
Solieria chordalis	Red string weed		Y	
RHODOPHYTA spp.	Red seaweed (unidentified)	Y	Y	
ANNELIDA				
Amphitritides spp.	Strawberry Terebellid worm	Y	Y	
Chaetopterus variopedatus	Parchment tube worm	Y	Y	
Lanice conchilega	Sand mason worm		Y	
Nereis spp.	Ragworms (unidentified)		Y	
POLYCHAETA spp*. unidentified*	Polychaete (unidentified)	Y	Y	
POLYNOIDAE spp*. unidentified*	Scale worms (unidentified)	Y	Y	
Pomatoceros triqueter	Keel worm	Y	Y	
Prostheceraeus vittatus	Candy striped flatworm		Y	
Sabella pavonica	Peacock worm tubes		Y	
Serpula vermicularis	Fan worm / red tube worm		Y	
Spirorbis spirorbis	Spiral worm		Y	
ARTHROPODA				
Athropoda spp.			Y	
Austrominius modestus	Darwins barnacle		Y	
Balanus crenatus	Leaning barnacle		Y	
Cancer pagurus	Edible crab	Y	Y	

Species Name	Common Name / Descriptions	Species recorded in 2020	Species recorded in previous years	Non-native species
Carcinus maenas	Common shore crab	Y	Y	
Crangon crangon	Brown shrimp	Y	Y	
Galathea squamifera	Squat lobster	Y	Y	
Inachus spp.	Spider crabs	Y	Y	
Liocarcinus navigator	Navigator crab / Arch	Y	Y	
Liocarcinus depurator	Harbour crab	Y	Y	
Liocarcinus holsatus	Flying crab		Y	
Liocarcinus spp.			Y	
Necora puber	Velvet swimming crab	Y	Y	
Portumnus latipes	Pennant swimming crab		Y	
Macropodia spp.	Long legged spider crabs	Y	Y	
MALACOSTRACA spp.		Y		
Pagurus bernhardus	Hermit crab	Y	Y	
Pagurus prideaux	Hermit crab (with anemone)	Y	Y	
Palaemon serratus	Common prawn	Y	Y	
Pilumnus hirtellus	Hairy crab		Y	
Pisidia longicornis	Long clawed porcelain crab	Y	Y	
Porcella platycheles	Broad Clawed porcelain crab	Y	Y	
Sacculina carcini	Crab hacker barnacle		Y	
Semibalanus balanoides	Acorn Barnacle		Y	
Xantho pilipes	Risso's crab (distinctive hair on legs)	Y	Y	
Xantho hydrophilus	Montagu's crab	Y	Y	
BRYOZOA				
BRYOZOA spp.	An encrusting bryozoan	Y	Y	
Flustrellidra hispida	Fleshy bryozoan		Y	
CHORDATA				
Callionymus lyra	Common dragonet	Y	Y	
Gaidropsarus vulgaris	Three bearded rockling	Y		
GOBIIDAE spp.	Goby (species unidentified)	Y	Y	
Hippocampus hippocampus	Short snouted seahorse		Y	
Lepadogaster lepadogaster	Shore clingfish		Y	
Nerophis lumbriciformis	Worm pipefish	Y	Y	
Pholis gunnellus	Butterfish	Y		
Scyliorhinus canicula	Mermaid purse – dog fish	Y		
Solea solea	Sole	Y	Y	

Species Name	Common Name / Descriptions	Species recorded in 2020	Species recorded in previous years	Non-native species
Syngnathus acus	Greater pipefish		Y	
Taurulus bubalis	Long-spined sea scorpion		Y	
CNIDARIA				
ACTINARIA spp.			Y	
Actinia equina	Beadlet anemone		Y	
Adamsia carciniopados	Cloak anemone	Y	Y	
Anemonia viridis	Snakelocks anemone	Y	Y	
Calliactis parasitica	Parasitic anemone	Y	Y	
ECHINODERMS				
ASTEROIDEA sp.	Starfish sp (unidentified)		Y	
Asterina gibbosa	Cushion star	Y		
Marthasterias glacialis	Spiny starfish	Y	Y	
Psammechinus miliaris	Green sea urchin		Y	
Ophiura spp.	Brittle star	Y	Y	
HYDROIDA				
Hydractinia echinata	Hermit crab fir (hydroid which grows on hermit crab shells)	Y	Y	
HYDROIDA *spp.*	Hydroids (unidentified)	Y	Y	
Nemertesia/Hydractinia antennia)	Often found with sponges on shells	Y	Y	
MOLLUSCA				
Anomia ephippium	Saddle oyster	Y	Y	
Acanthorcardia aculeata	Spiny cockle	Y	Y	
Acanthocardia tuberculata	Rough cockle	Y	Y	
Aporrhais pespelecani	Pelican foot shell	Y		
Buccinum undatum	Common whelk (or whelk eggs)	Y	Y	
Calyptraea chinensis	Chinaman's hat shell	Y	Y	
Chamelia gallina	Striped venus		Y	
Chlamys varia	Variegated scallop		Y	
Cerastoderma edule	Common cockle	Y	Y	
Crepidula fornicata	Slipper limpet (count)	Y	Y	Y
Calliostoma zizyphinum	Painted top shell	Y	Y	
Gibbula cineraria	Grey top shell	Y	Y	
Gibbula magus	Turban topshell	Y	Y	
Hiatella arctica (probable)	Wrinkled rock borer		Y	
Lepidochitona cinerea	Chiton	Y	Y	

Species Name	Common Name / Descriptions	Species recorded in 2020	Species recorded in previous years	Non-native species
Littorina obtusata	Flat periwinkle	Y	Y	
MOLLUSCA sp.	Angular small cockle (species unidentified)	Y	Y	
Mytilus edulis	Mussels	Y	Y	
Nucella lapillus	Dog whelk (or dog whelk eggs)		Y	
Ocenebra erinaceus	European sting winkle	Y	Y	
Pecten maximus	Great scallop	Y	Y	
Tectura virginea	White tortoiseshell limpet		Y	
Tritia reticulate	Netted dog whelk	Y	Y	
Turitella / Bittium sp. (Possibly retuculatum)	Spiral shell	Y	Y	
Urosalpinx cinerea,	Oyster drill	Y		
MOLLUSCA – sea slugs/ sea hares				
Acanthodoris pilosa	White fluffy nudibranch		Y	
Aeolidia papillosa	Sheep sea slug		Y	
Akera bullata	Sea slug with shell	Y	Y	
Aplysia punctate	Sea hare	Y	Y	
Aplysia punctate eggs	Sea hare eggs		Y	
Archidoris pseudoargus	Sea lemon	Y	Y	
Berthella plumula	Yellow sea slug		Y	
Goniodoris nodosa	Small white nudibranchs		Y	
Lamellaria perspicua (probable)	Sea snail		Y	
Onchidoris bilamellata	Rough mantled doris nudibranch		Y	
Onchidoris bilamellata / Pleurobranchus membranaceus	Sea slug		Y	
Rostranga rubra	Red sea slug	Y	Y	
Nudibranch sp. unidentified		Y	Y	
Nudibranch egg			Y	
PORIFERA				
Amphilectus fucorum	Shredded carrot sponge	Y	Y	
Cliona celata	Yellow boring sponge	Y	Y	
Dysidea fragilis	Goosebump sponge		Y	
Porifera *sp*. 1	Sponge associated with *Nemertesia* hydroids (Photo H83)	Y	Y	
Grantia compressa	Purse sponge		Y	
Haliclona sp.			Y	
Hymenaciodon perlevis			Y	

Species Name	Common Name / Descriptions	Species recorded in 2020	Species recorded in previous years	Non-native species
PORIFERA spp.		Y	Y	
Sycon cilliatum	Purse sponge		Y	
*Suberites carnosus (*probable)		Y	Y	
Suberites ficus	Orange sponge on queens	Y	Y	
Suberites spp.			Y	
*Ulosa stuposa (*probable)			Y	
TUNICATA				
Ascdiella aspersa	European sea squirt	Y	Y	
ASCIDIACEA spp. unidentified		Y	Y	
Ascidia mentula	Red sea squirt		Y	
Botrylloides leachi	Orange colonial ascidian (photo H58)		Y	
Ciona intestinalis	Sea vase (sea squirt)		Y	
Styela clava	Leathery sea squirt	Y	Y	Y