

Crab Tile Surveys of Devon Estuaries 2016



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January 2017



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1. Introduction

Crab tiling, also known as crab potting, is a method of collecting shore crabs (*Carcinus maenas*) for use as fishing bait by anglers. Like all other crustaceans, shore crabs moult their shells at intervals during their life cycle, during which they seek a refuge from predators. Crab tilers exploit this behaviour, providing artificial shelters such as roof tiles, guttering, drainpipes, chimney pots and tyres. Whilst sheltering under the tiles, the crabs are in the 'soft shell' state i.e. the hard shell has been shed and the new shell has not yet hardened. It is in this state that the crabs are collected for bait during low water when the tiles are exposed (Black, 2014). This method of bait collection has been used throughout Devon for generations.

Devon and Severn Inshore Fisheries and Conservation Authority (D&S IFCA) has a duty to manage the exploitation of sea fisheries resources under the Marine and Coastal Access Act 2009 (MaCCA) and this includes crab tiling. Every four years, surveys are carried out to determine the number and location of crab tiles on the intertidal zone of estuaries in the D&S IFCA district. These surveys enable D&S IFCA to assess any potential impacts of crab tiling on sensitive estuary environments, and to inform the development of appropriate management. In particular, crab tiles have the potential to change habitat complexity, benthic infaunal diversity and abundance, and bird behaviour over large areas (Sheehan et al., 2010). The 2016 survey results will feed into a hand gathering byelaw which D&S IFCA will start to develop in 2017.

This report covers crab tiles on estuarine areas of the River Axe, Dart, Exe, Plym, Tamar, Teign and Salcombe and Kingsbridge Estuary. Crab tiles on the Taw Torridge Estuaries and Exe Estuary were surveyed using an Unmanned Aerial Vehicle (UAV), or drone as they are commonly referred to, and detailed information for the Taw Torridge Estuaries can be seen in Parkhouse (2016).

2. Methodology

2.1 Traditional Surveys

Fieldwork was conducted on spring low tides between August and December 2016. All fieldwork was carried out within a period of approximately two hours before and after low tide. Most of the surveys were carried out on foot for the River Axe, Sid, Otter, Avon, Erme, Plym, Tamar, and Teign, and by boat on the River Dart, Yealm, and Salcombe and Kingsbridge Estuary.

This survey followed the methodology of previous surveys (Noble, 2013a; Noble, 2013b; Lockett, 2008; Black, 2004) to ensure comparable data. Survey sheets were used to record numbers of tiles in distinct blocks or line formations, in addition to substrate, type of material used, orientation, epibiota and usage status (see Appendix 1 for a sample survey form). To assist in location of historic

crab tile areas, previous data layers were overlaid onto UKHO charts and/or Bing Maps to create field maps. Once areas of crab tiles had been located, GPS co-ordinates were taken around the perimeters, or at the start and end of each line. These coordinates were later plotted using MapInfo 15.0, and used to create polygons that stored all associated crab tile data in each layer.

Crab tiles were counted wherever possible, although estimations were necessary where extremely large numbers of tiles were encountered. In such cases, each team member would make an estimate, and a figure was agreed by consensus. In areas where full access was not possible, due to tidal conditions or deep mud, the size of the area covered by crab tiles was also estimated as accurately as possible for mapping purposes.

2.2 UAV Surveys

The aerial imagery company Vertical Horizons Media were chartered to carry out the work. Surveys were carried out over a four-hour time frame, two hours either side of low water on spring tides. Using the site maps produced from the past surveys, the operator programmed flight paths into the UAV for each location of the survey. The UAV then flew these pre-determined flight paths at an altitude of 20m, recording the GPS track, and taking photos every few seconds to achieve a target ground spacing distance of 1 pixel/cm. See Appendix 1 for the technical specifications of the UAV. The flight was monitored by the operator who was able to manually override the UAV to compensate for obstacles and wind drift.

The images from the survey were then processed by the UAV operator using the processing software; GPSBable, Geosetter, and Pix4D. The software Pix4D stitches together the imaging and creates geo-tiles. These geo-tiles can then be overlaid on Google Earth to give the exact location of the images. The Google Earth images are then used to count the crab tiles and pin the start and end of the rows of tiles or the perimeter to give the GPS co-ordinates. The co-ordinates were transferred to MapInfo to compare results with previous surveys.

3. Results

3.1 Overall Results

The overall results of the 2016 survey are compared to those of previous years in Table 1. Comparison in number of tiles and percentage differences can be seen in Tables 2-10. No crab tiles were found on the River Avon, Erme, Otter, Sid or Yealm and will therefore not be discussed further.

Table 1 – Comparisons of crab tile counts in each estuary in the Devon and Severn IFCA District.
¹Devon and Severn IFCA District only, ²For detailed results see Parkhouse (2016)

Estuary	2016	2012 (Noble, 2013a&b)	2011 (unknown)	2008 (Lockett, 2008)	2003/04 (Black, 2004)	2000/01 (Black, 2004)
Avon	0	-	-	-	50	0
Axe	263	-	-	-	0	0
Dart	5,484	-	-	-	11,904	11,794
Erme	0	-	-	-	0	0
Exe	23,835	20,997	-	26,488	30,302	26,796
Otter	0	-	-	-	0	0
Plym	2,019	1,710	-	-	2,729	2,956
Tamar ¹	3,570	4,929	-	-	2,646	3,412
Taw Torridge	3,704 ²	-	2,213	-	3,741	4,864
Teign	12,865	-	-	-	22,722	21,001
Salcombe & Kingsbridge	105	-	-	-	193	534
Sid	0	-	-	-	0	0
Yealm	0	-	-	-	0	0
Total:	51,845	-	-	-	74,287	71,357

3.2 River Axe

The first crab tiles were recorded in 2016 for the River Axe, with a total of 263. Figure 1 shows the location and counts of crab tiles on the River Axe. The crab tile survey was carried out on 15th November 2016 by two officers on foot. All tiles were deemed in use and made from plastic piping, terracotta roof tiles, corrugated iron and carpet.



Figure 1 - Crab tiles on the River Axe.

3.3 River Dart

Crab tile surveys on the River Dart were carried out over four days between August and November. A total of 5,484 crab tiles were counted. This was a 54% decrease from the 2003/04 survey (Table 2). Figure 2 to Figure 5 show the location of crab tiles on the River Dart. The majority of counts were carried out by boat, with three officers, on 3rd and 4th August 2016. Apart from at Higher Noss Creek, Galmpton Creek and Mill Point where access was restricted by boat so surveys were carried out on foot, by two officers, on 19th August and 16th November 2016. A total of 3,375 crab tiles were deemed to be in use, 1,934 were unsure and 185 not in recent use. Crab tiles were made up of a range of terracotta roof tiles, corrugated iron, plastic piping and chimney pots.

Table 2 –Comparison of crab tile counts from previous surveys on the River Dart

Survey	Number of crab tiles	Difference	Percentage difference
2016	5,484	-6,420	-54%
2003/04	11,904	+110	+1%
2000/01	11,794	-	-

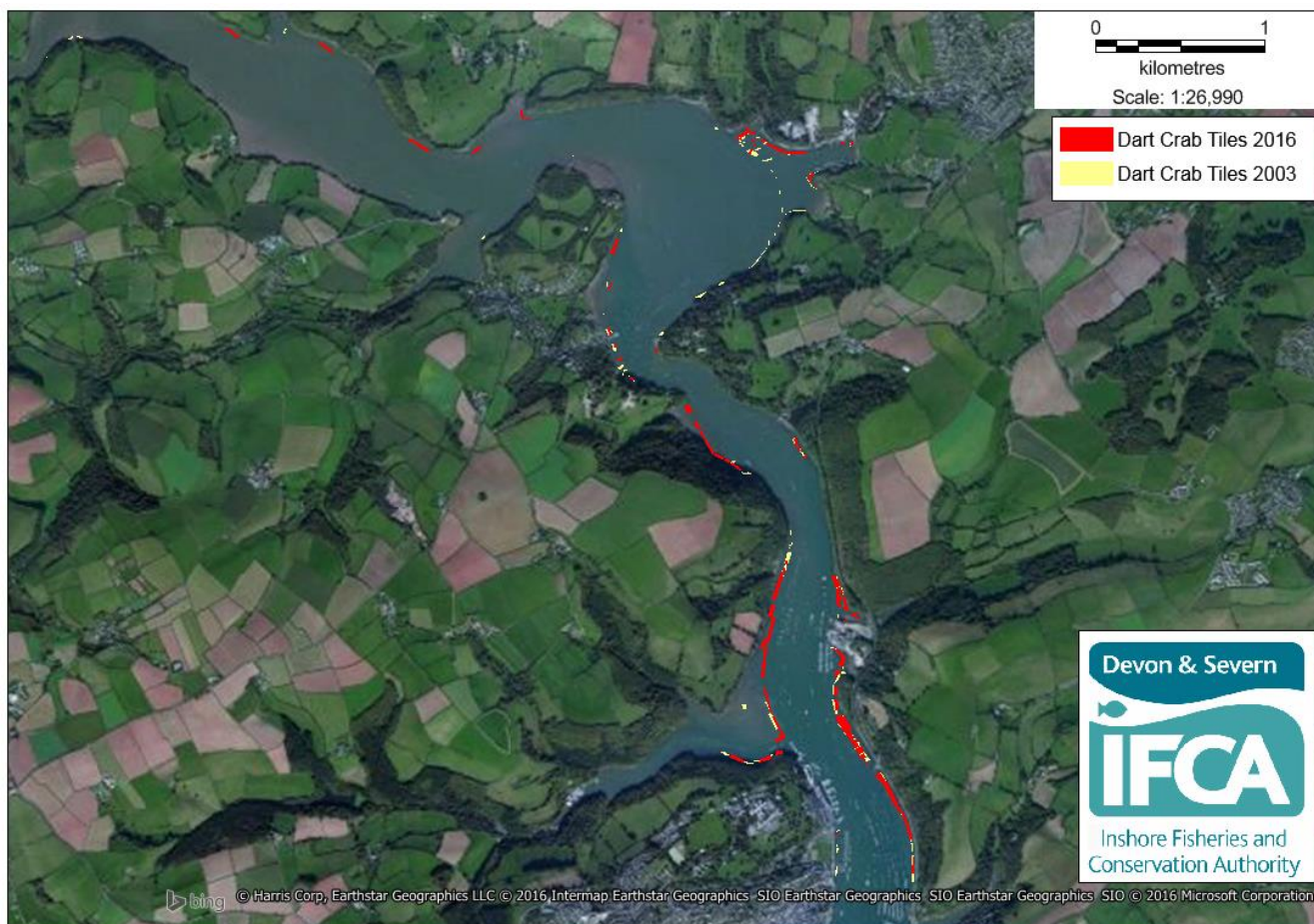


Figure 2 – Overview of crab tiles on the River Dart.



Figure 3 –Crab tiles on the upper Dart Estuary



Figure 4 - Crab tiles near Galmpton, Dart Estuary

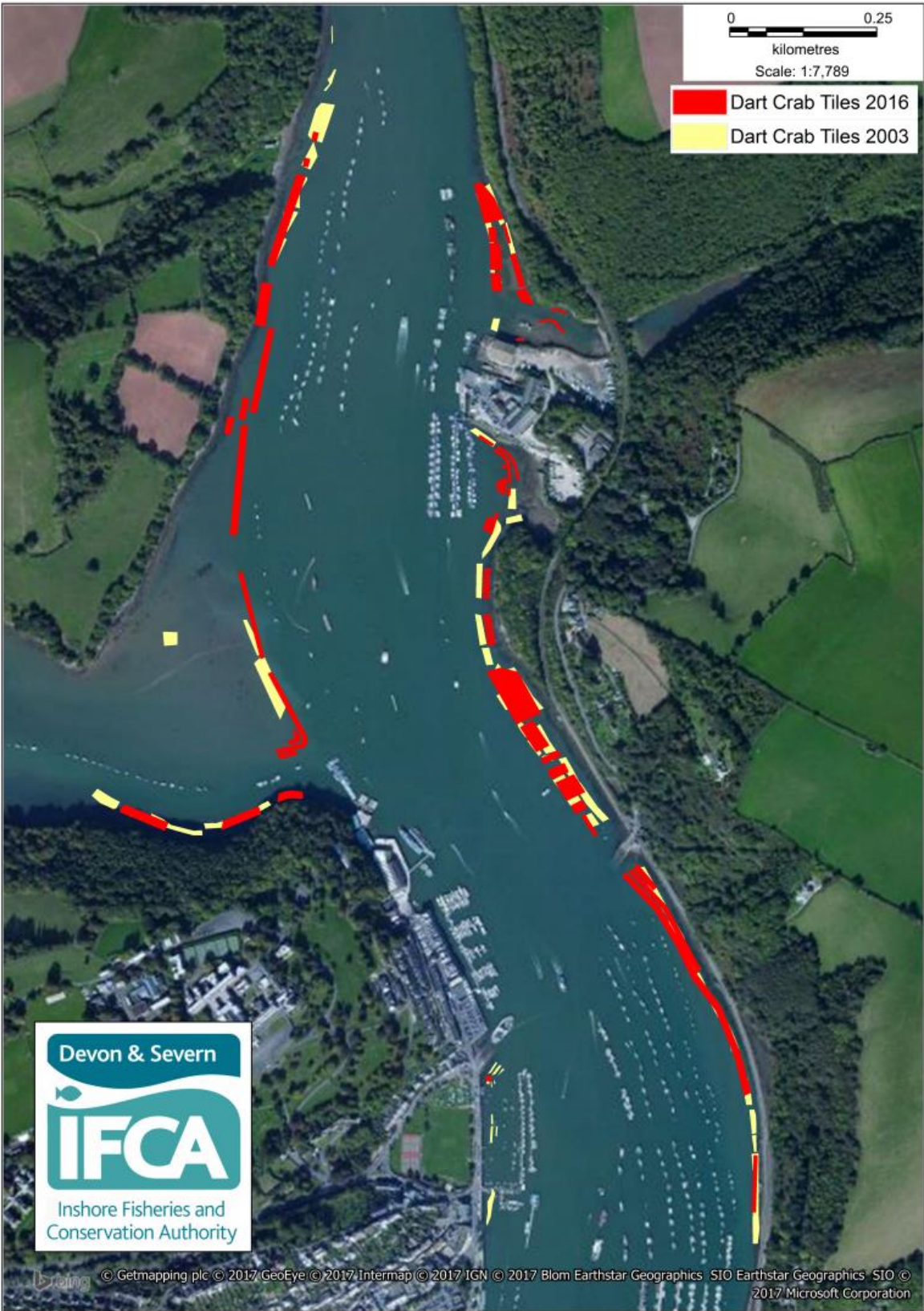


Figure 5 - Crab tiles on the lower Dart Estuary

3.4 Exe Estuary

Crab tiles were counted on the Exe Estuary using an UAV mostly in August, September and one day in November 2016. A total of 23,835 crab tiles were counted. This is a 14% increase since 2012 (Table 3). Table 4 shows the breakdown of crab tiles on the Exe Estuary compared to previous years. Figure 6 to Figure 14 show the location of crab tiles on the Exe Estuary, the 2008 layers were not available at the time of writing this report and so are not included in the maps.

Table 3 - Comparison of crab tile counts from previous surveys on the Exe Estuary

Survey	Number of crab tiles	Difference	Percentage difference
2016	23,835	+2,838	+14%
2012	20,997	-5,451	-21%
2008	26,488	-3,814	-13%
2003/04	30,302	+3,506	+13%
2000/01	26,796	-	-

Table 4 - Breakdown of crab tile numbers and distribution on the Exe Estuary

Location	Area	2016	2012	2008	2003/04	2000/01
Dawlish Warren	EXE 04	93	148	152	410	0
	EXE 05	5,073	4,406	6,054	4,573	1,135
Cockwood-Starcross	EXE 06	5,237	3,188	4,720	6,375	3,400
North of Starcross	EXE 07	6,760	7,338	6,313	8,468	8,450
South of Powderham	EXE 08	2,317	1,757	2,765	3,303	4,876
North of Powderham	EXE 09	0	0	0	0	150
North of Lympstone	EXE 17	584	330	384	420	1,165
South of Lympstone	EXE 18	1,231	1,123	1,472	1,580	900
Middle of Exmouth and Lympstone	EXE 19	2,226	2,463	4,022	4,218	5,820
Exmouth	EXE 20	314	244	606	955	900

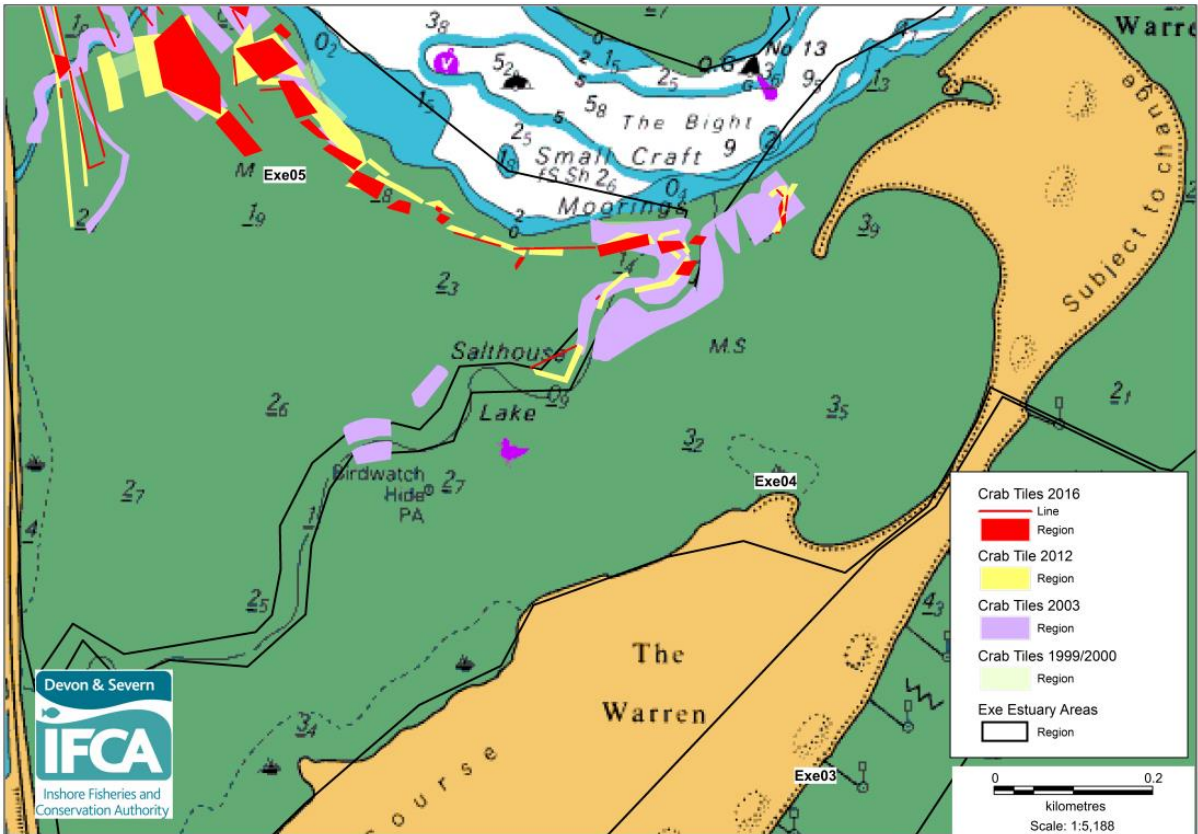


Figure 6 – Crab tiles on the Exe Estuary, Area Exe04

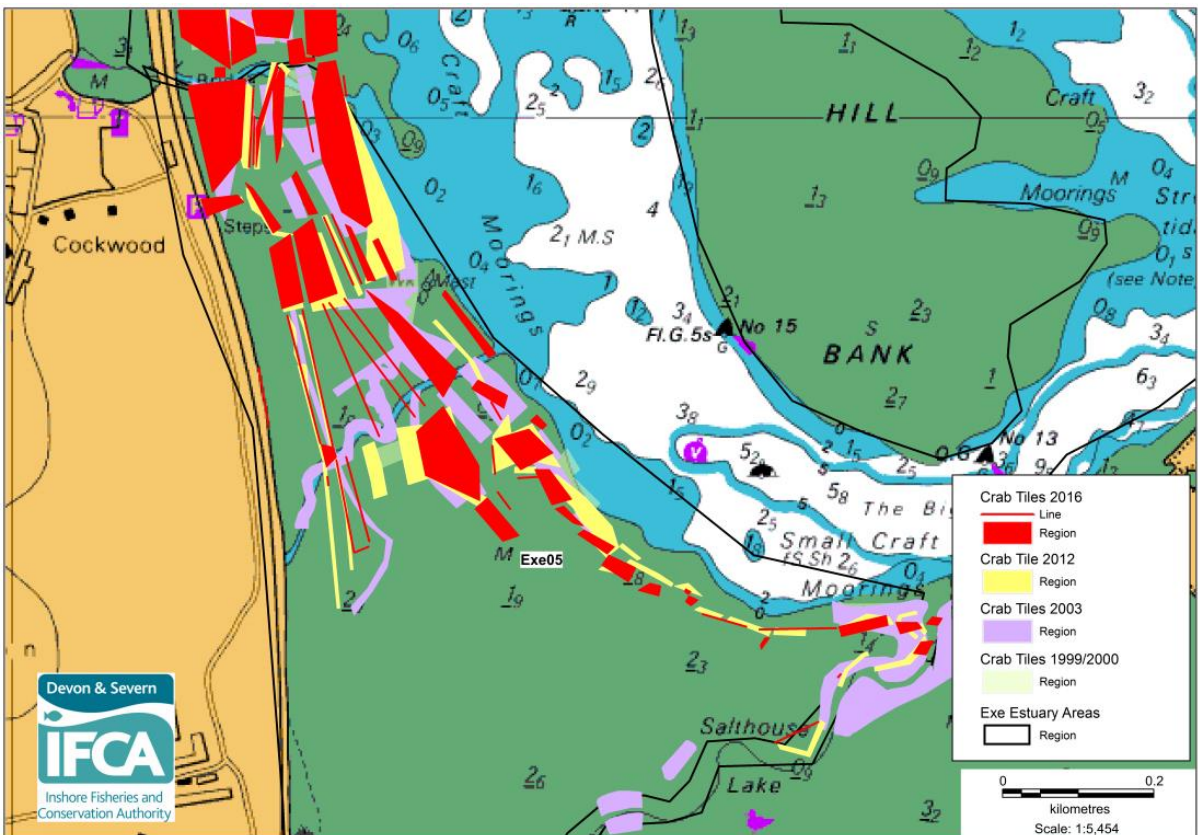


Figure 7 - Crab tiles on the Exe Estuary, Area Exe05

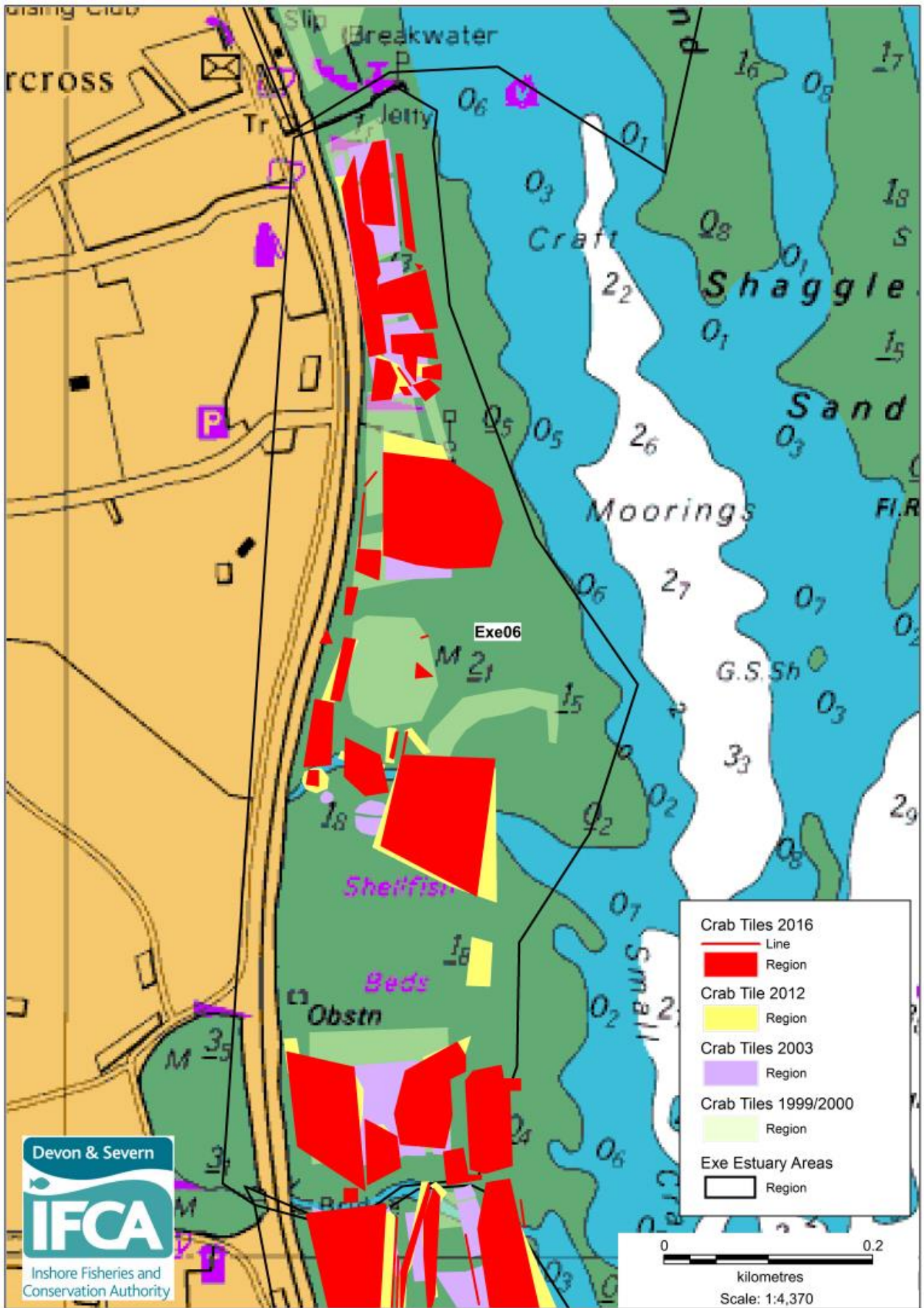


Figure 8 - Crab tiles on the Exe Estuary, Area Exe06

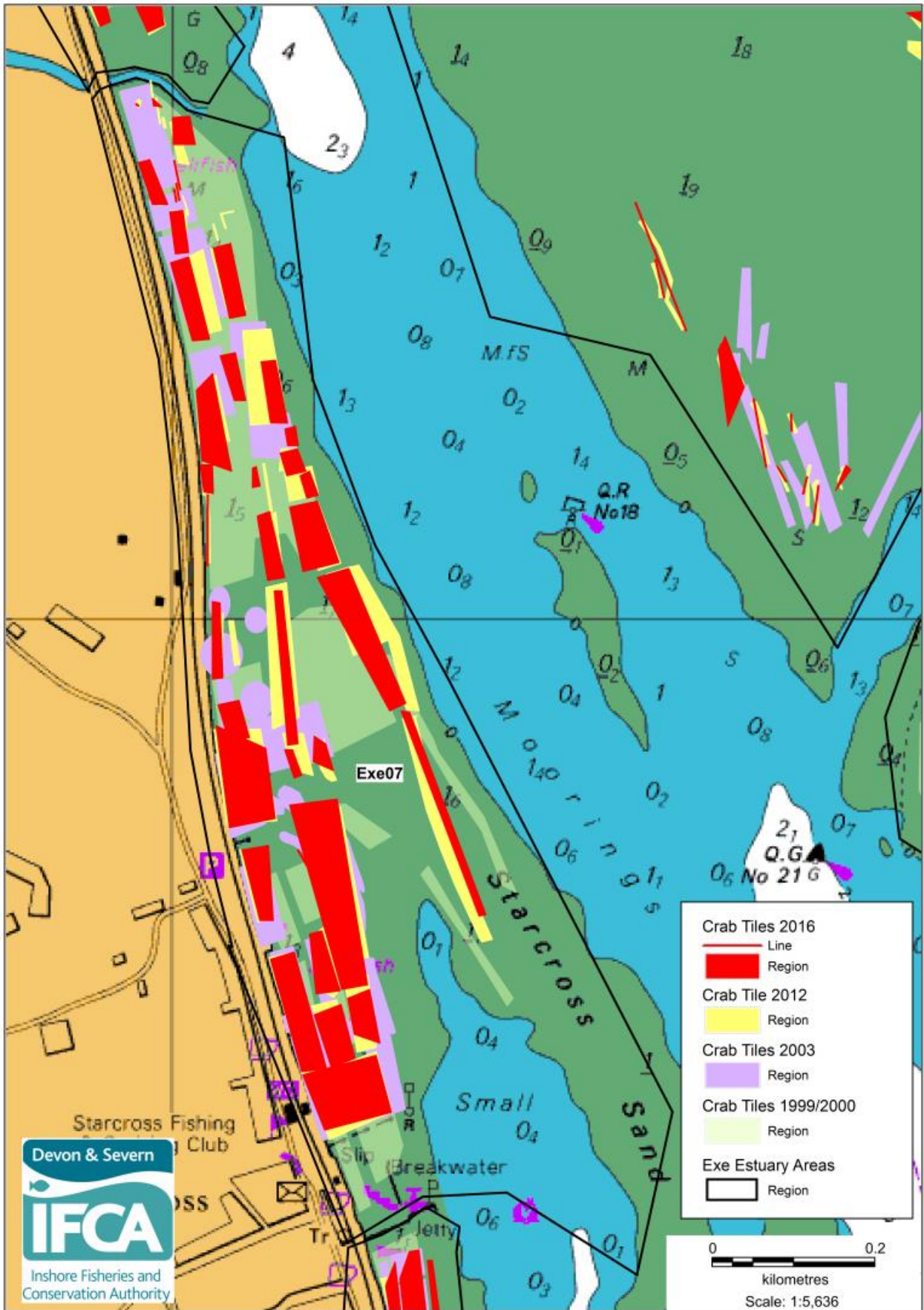


Figure 9 - Crab tiles on the Exe Estuary, Area Exe07

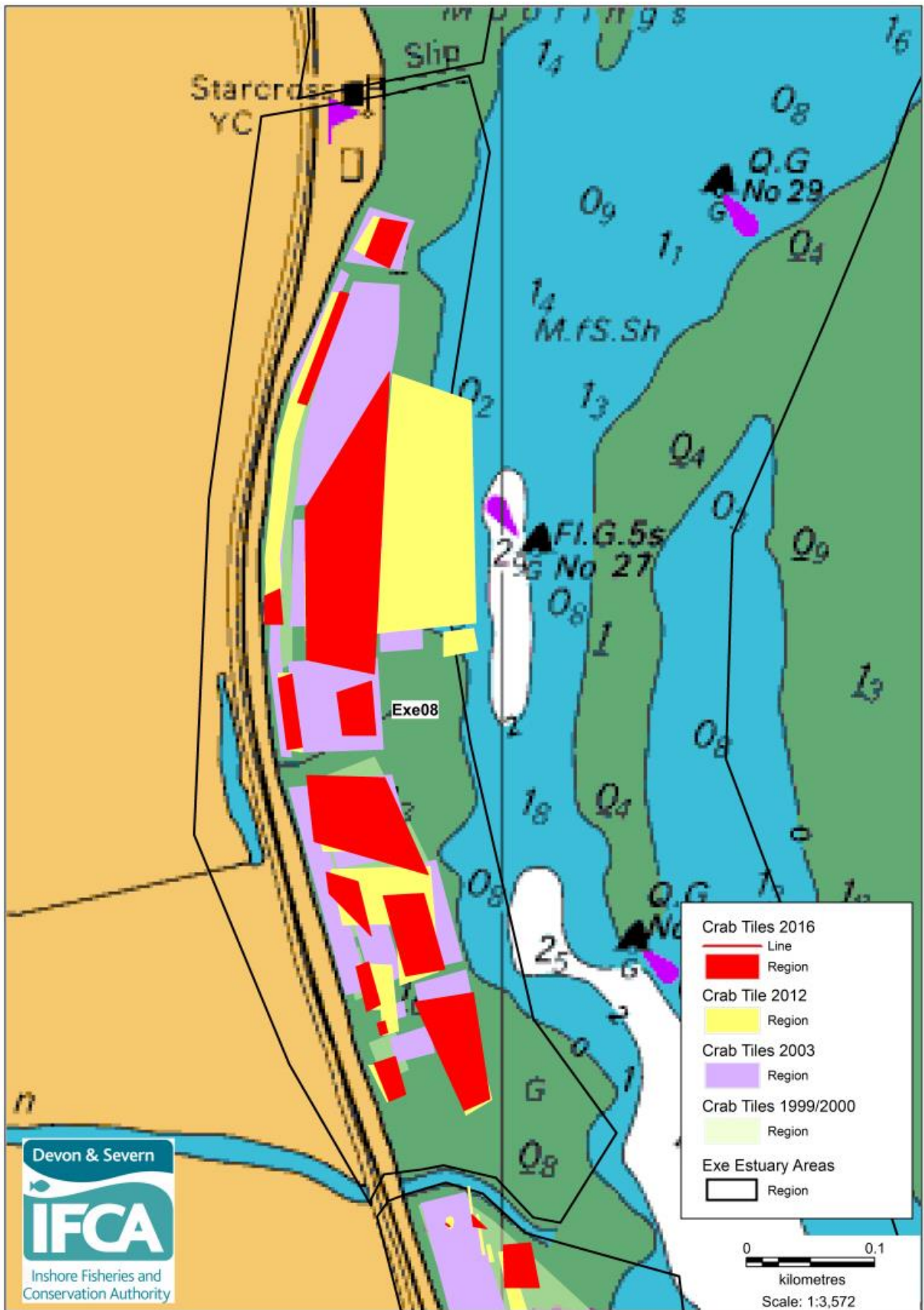


Figure 10 - Crab tiles on the Exe Estuary, Area Exe08

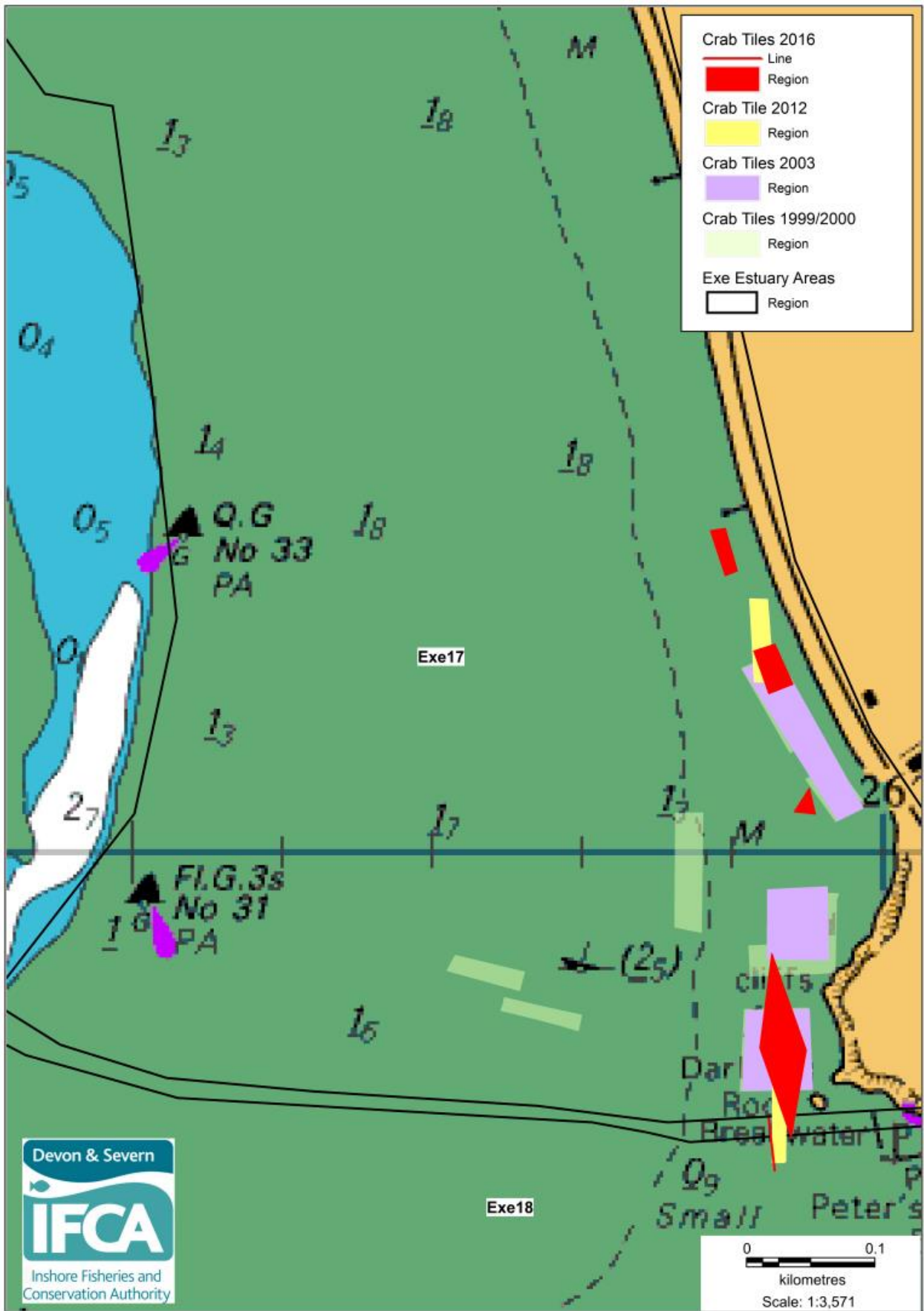


Figure 11 - Crab tiles on the Exe Estuary, Area Exe17

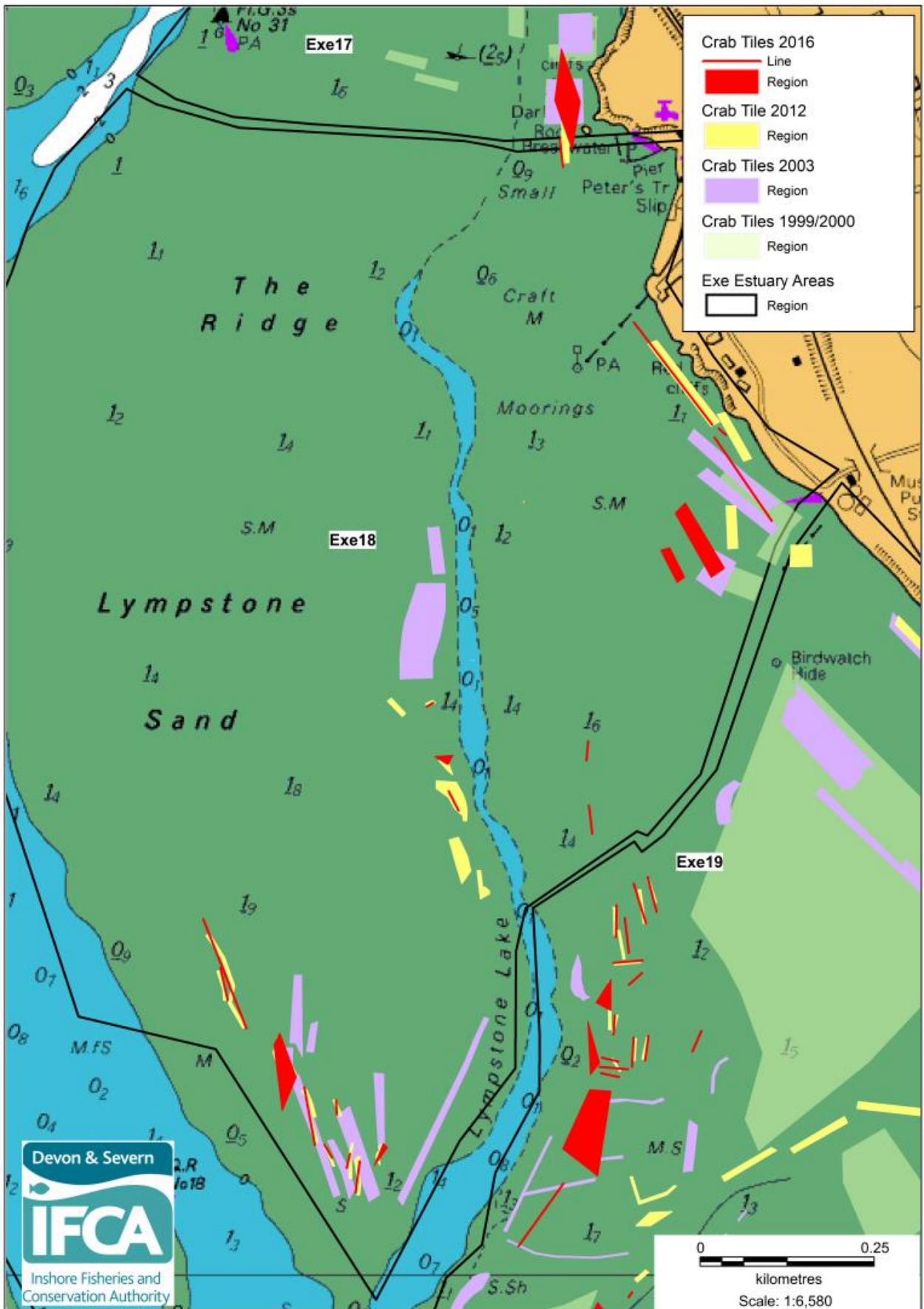


Figure 12 - Crab tiles on the Exe Estuary, Area Exe18

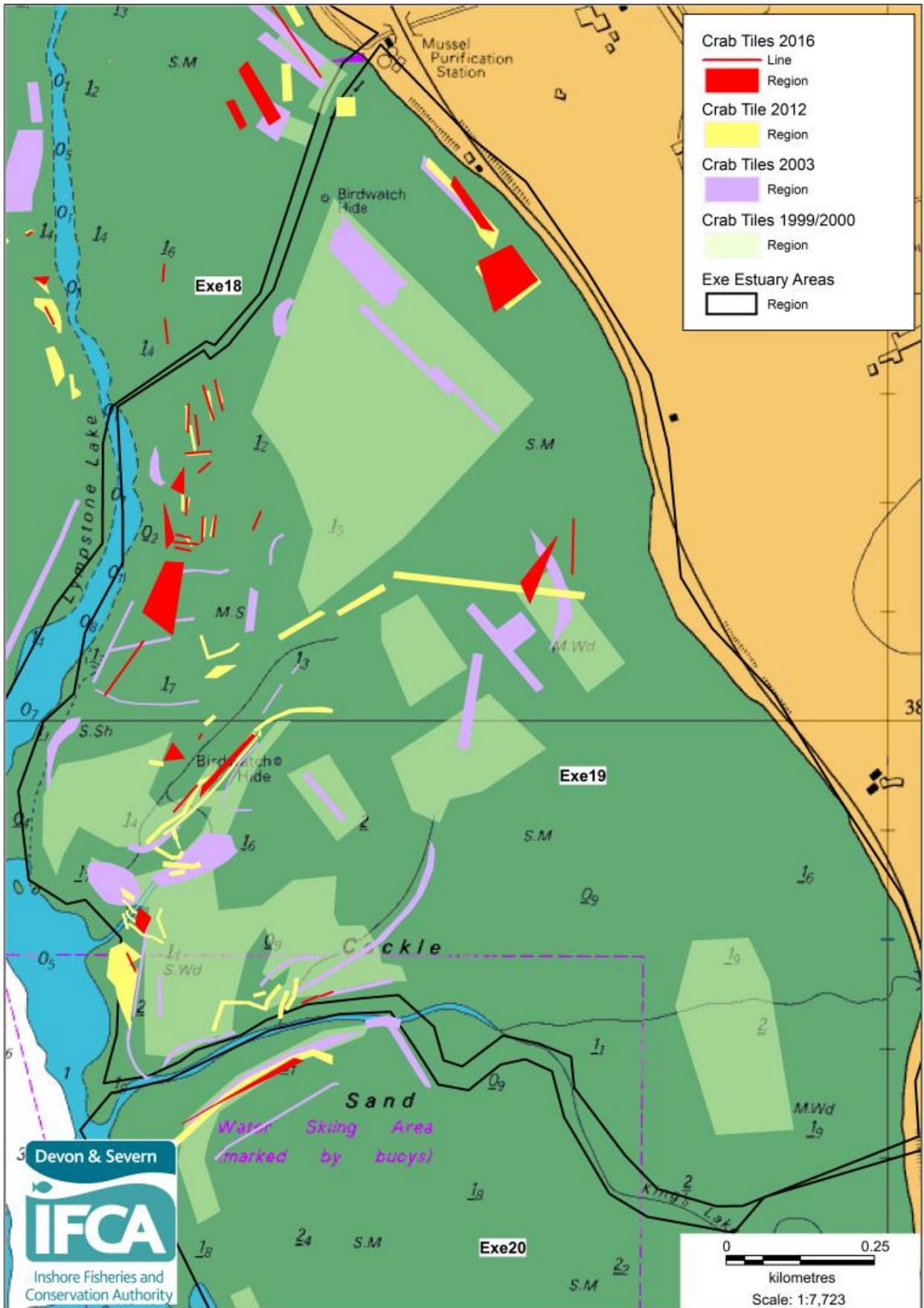


Figure 13 - Crab tiles on the Exe Estuary, Area Exe19

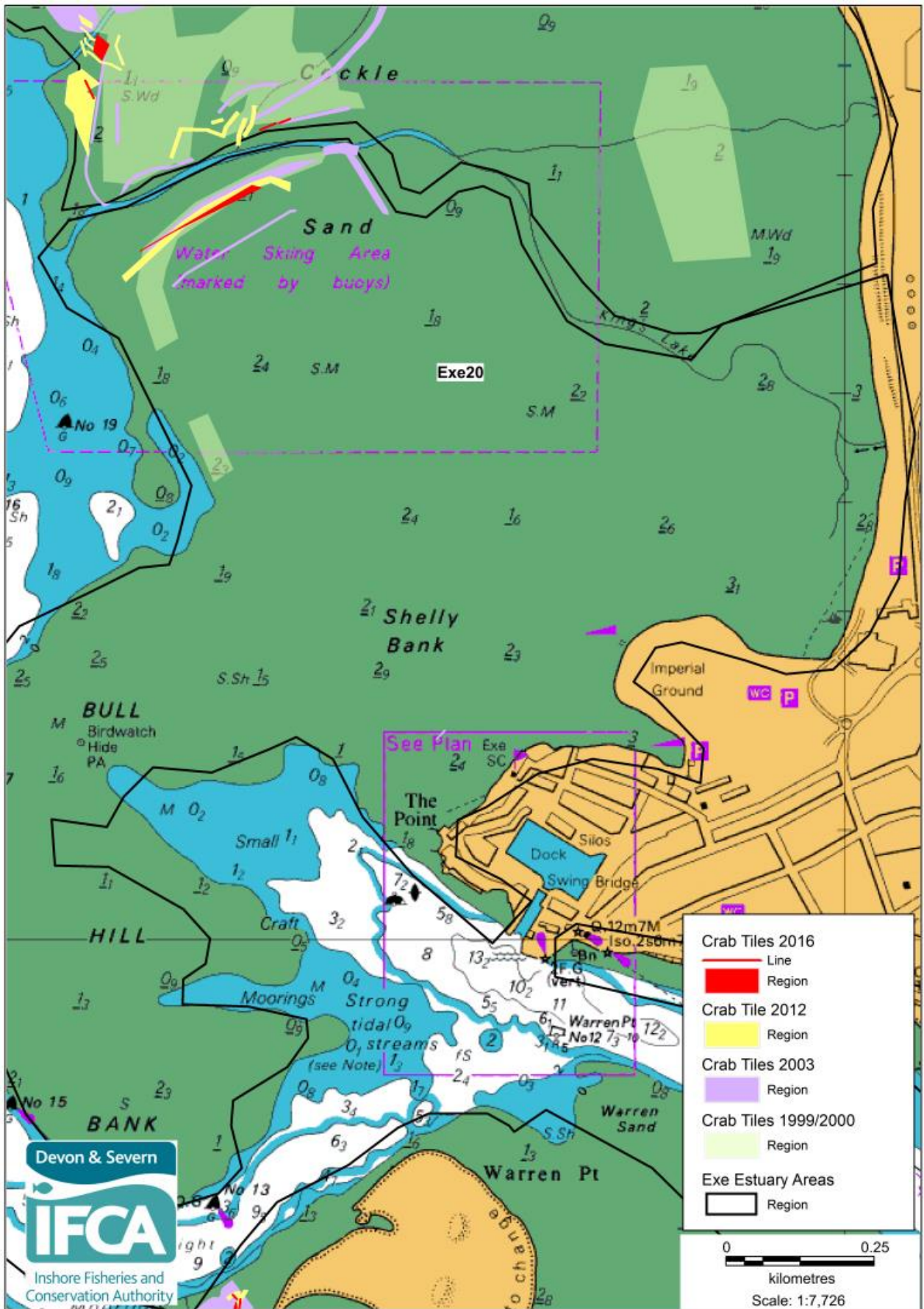


Figure 14 - Crab tiles on the Exe Estuary, Area Exe20

3.5 River Plym

Crab tile surveys on the River Plym were carried out on foot, over two days. One survey on 22nd August 2016 with two teams of two officers completing the main stretch and two officers on 17th October 2016 surveying Hooe Lake. A total of 2,019 crab tiles were counted. This was a 23% increase from the 2012 survey (Table 5). Figure 16 shows the location of crab tiles on the River Plym and Figure 15 shows crab tiles on Hooe Lake. All tiles were deemed in recent use and made up of terracotta roof tiles, plastic piping and corrugated iron. Table 6 shows the breakdown of crab tiles on the Plym compared to previous years. TAM19 contributed to most of the increase with an extra 402 crab tiles north of Laira Bridge compared to 2012.

Table 5 - Comparison of crab tile counts from previous surveys on the River Plym.

Survey	Number of crab tiles	Difference	Percentage difference
2016	2,104	+394	+23%
2012	1,710	-1,019	-37%
2003/04	2,729	-227	-8%
2000/01	2,956	-	-

Table 6 – Breakdown of crab tile numbers and distribution on the River Plym.

Location	Area	2016	2012	2003/04	2000/01
Plym (West side)	TAM18	60	50	560	176
	TAM19	897	495	1247	1125
Plym (East side)	TAM20	80	0	0	288
	TAM21	495	655	620	714
	TAM22	452	360	302	653
Hooe Lake	TAM36	120	150	0	0



Figure 15 - Crab tiles on Hooe Lake

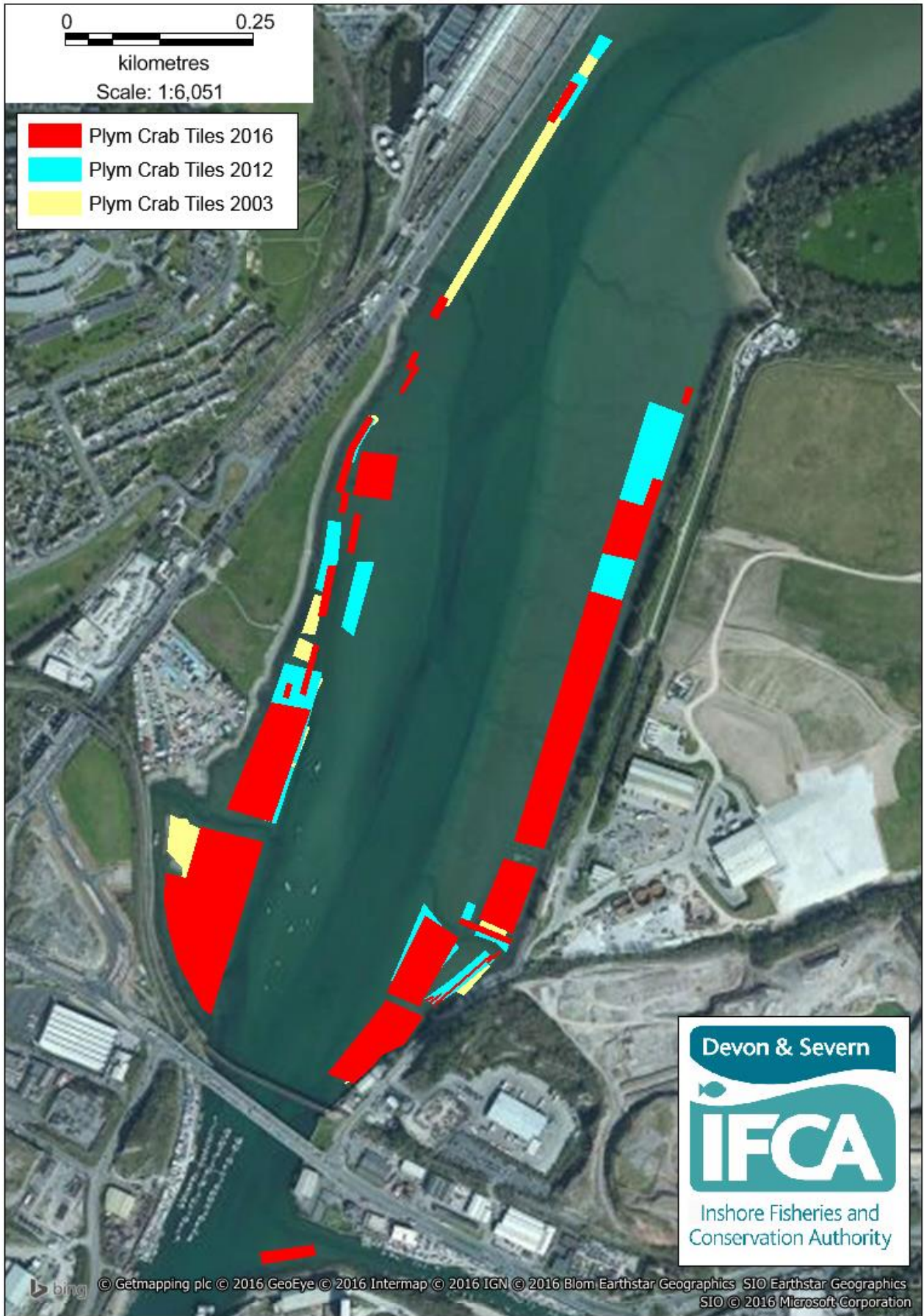


Figure 16 - Crab tiles on the River Plym.

3.6 River Tamar

Crab tile surveys on the River Tamar (D&S IFCA District only) were first carried out on boat, but for most areas this method was not accurate due to restricted access and poor visibility of the tiles. Surveys were subsequently carried out on foot over four days during September and October. These four days were split by three officers surveying from Tamerton Lake north to the River Tavy mouth (16/09/16), two officers surveyed from Tamerton Lake south to Ernesettle Pier (03/09/16), one officer surveyed from Ernesettle Pier south to Tamar Sailing Club (19/09/16) and two officers surveyed Kiln Bay (17/10/16). A total of 3,570 crab tiles were counted. This was a 28% decrease from the 2012 survey (Table 7). Figure 17 shows the location of crab tiles on the River Tamar. A total of 3,416 were deemed to be within recent use, 48 unsure and 106 not in recent use. Crab tiles were made up of a range of terracotta roof tiles, corrugated iron and plastic piping. Table 8 shows the breakdown of crab tiles on the Plym compared to previous years. A reduction of crab tiles were seen in all areas, apart from on Tamerton Lake.

Table 7 - Comparison of crab tile counts from previous surveys on the River Tamar.

Survey	Number of crab tiles	Difference	Percentage difference
2016	3,570	-1,359	-28%
2012	4,929	+2,283	+86%
2003/04	2,646	-766	-22%
2000/01	3,412	-	-

Table 8 - Breakdown of crab tile numbers and distribution on the River Tamar.

Location	Area	2016	2012	2003/04	2000/01
Tavy river mouth	TAM07	0	0	0	20
	TAM08	184	181	360	284
	TAM09	726	816	980	442
Tamerton Lake	TAM10	1,129	938	470	490
	TAM11	0	0	0	112
North of Ernesettle Pier to Tamerton Lake	TAM12	701	1,581	344	1068
North of Tamar Bridge to South of Ernesettle Pier	TAM13	425	810	281	475
South of Tamar Bridge	TAM14	78	191	211	227
Kiln Bay	TAM15	327	412	0	294

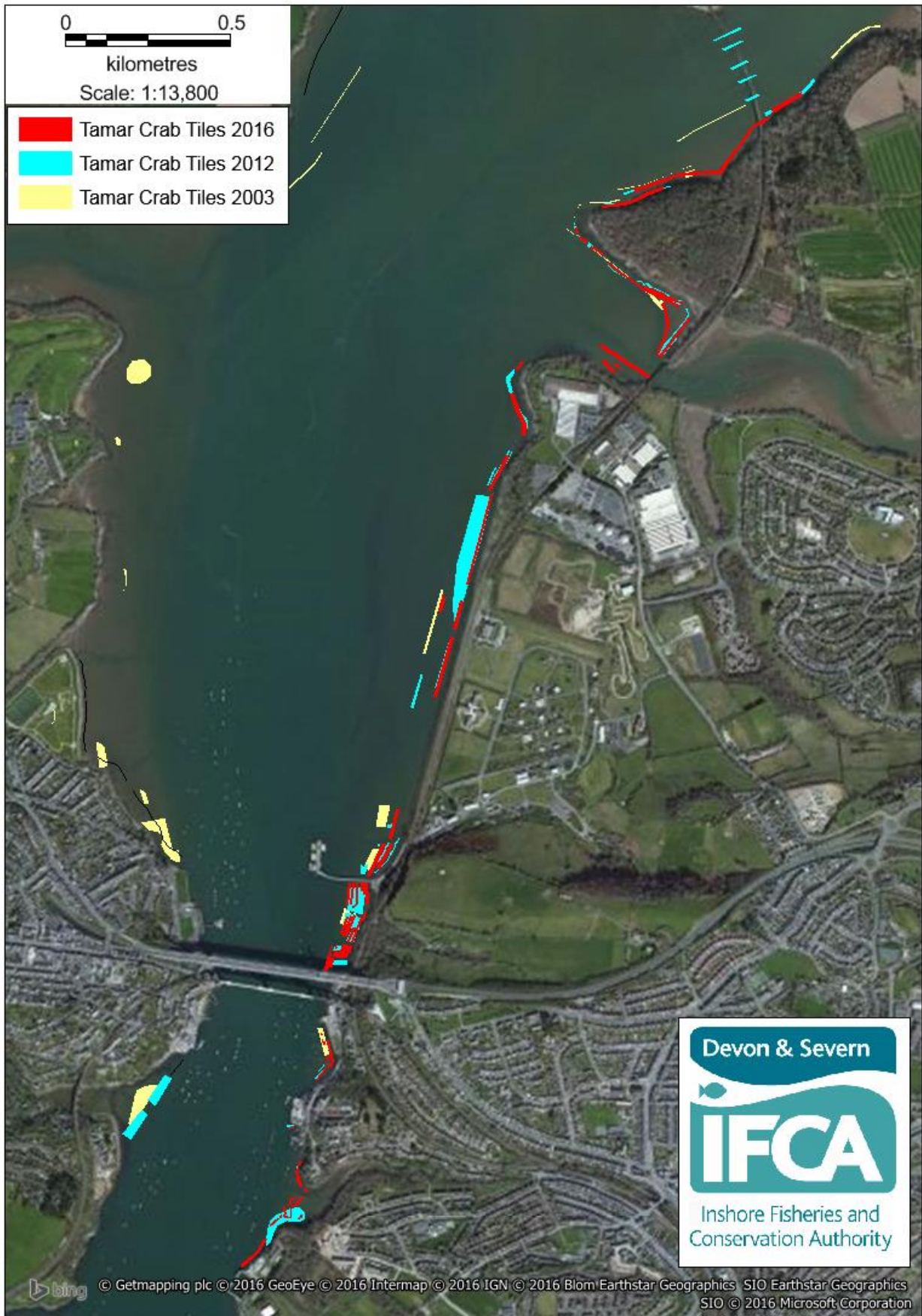


Figure 17 - Crab tiles on the River Tamar (N.B. Cornwall IFCA did not survey crab tiles in their District in 2016, so there is no data for the west side of the Tamar).

3.7 River Teign

Crab tile surveys on the River Teign were carried out on foot. Two teams of two officers split covering the south and north sides on 14th November 2016. The north side was not completed in one day, so two officers finished the survey the following day. A new area of tiles were discovered in the middle bank and only accessible by boat so on 16th December officers surveyed this area but access was hard and too shallow to get access by the IFCA boat, so the number of tiles were estimated from what could be seen. A total of 12,865 crab tiles were counted on the River Teign (Figure 18 to Figure 20). This was a 28% decrease from the 2012 survey (Table 9). Tiles were made from terracotta roof tiles, chimney pots, corrugated iron and plastic piping. A total of 12,670 crab tiles were deemed in recent use, 190 unsure and 5 not in use.

Table 9 - Comparison of crab tile counts from previous surveys on the River Teign.

Survey	Number of crab tiles	Difference	Percentage difference
2016	12,865	-9,857	-43%
2003/04	22,722	+1,721	+8%
2000/01	21,001	-	-

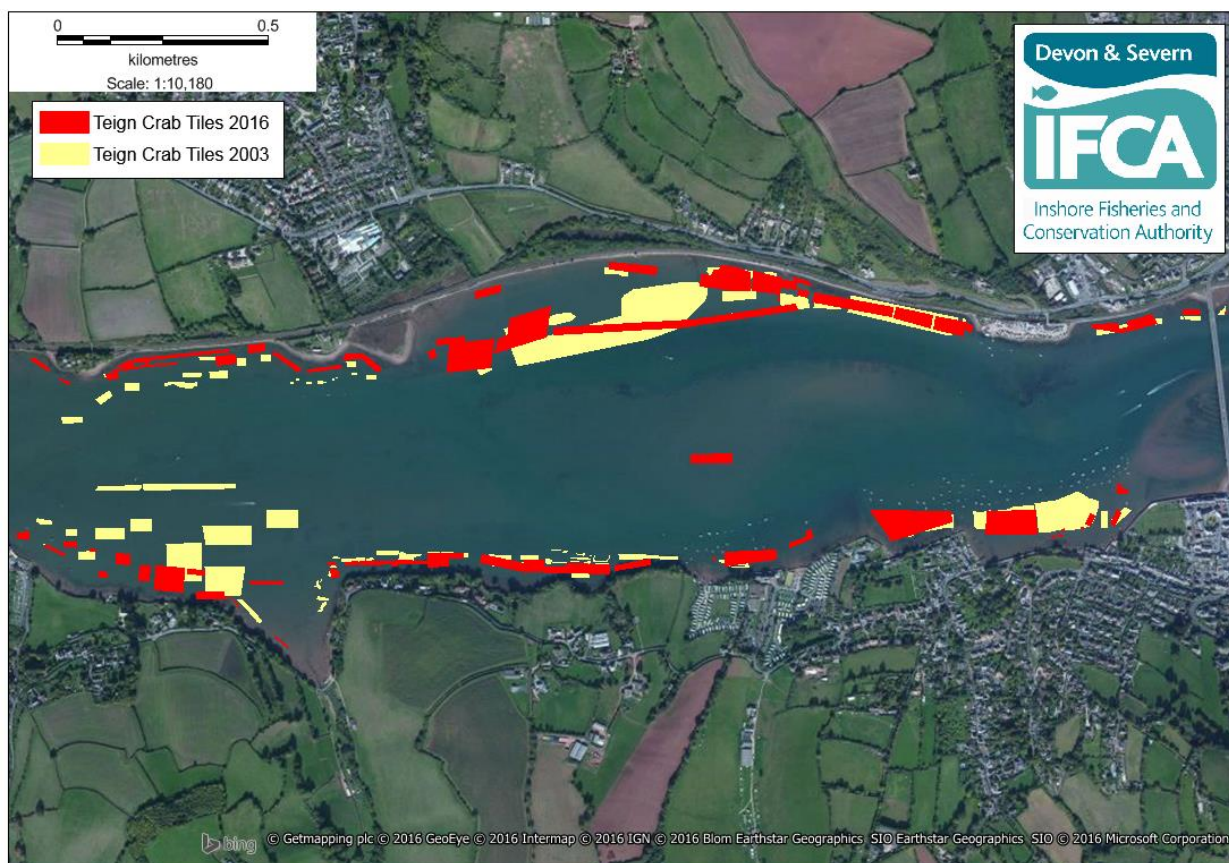


Figure 18 - Crab tiles on the River Teign.

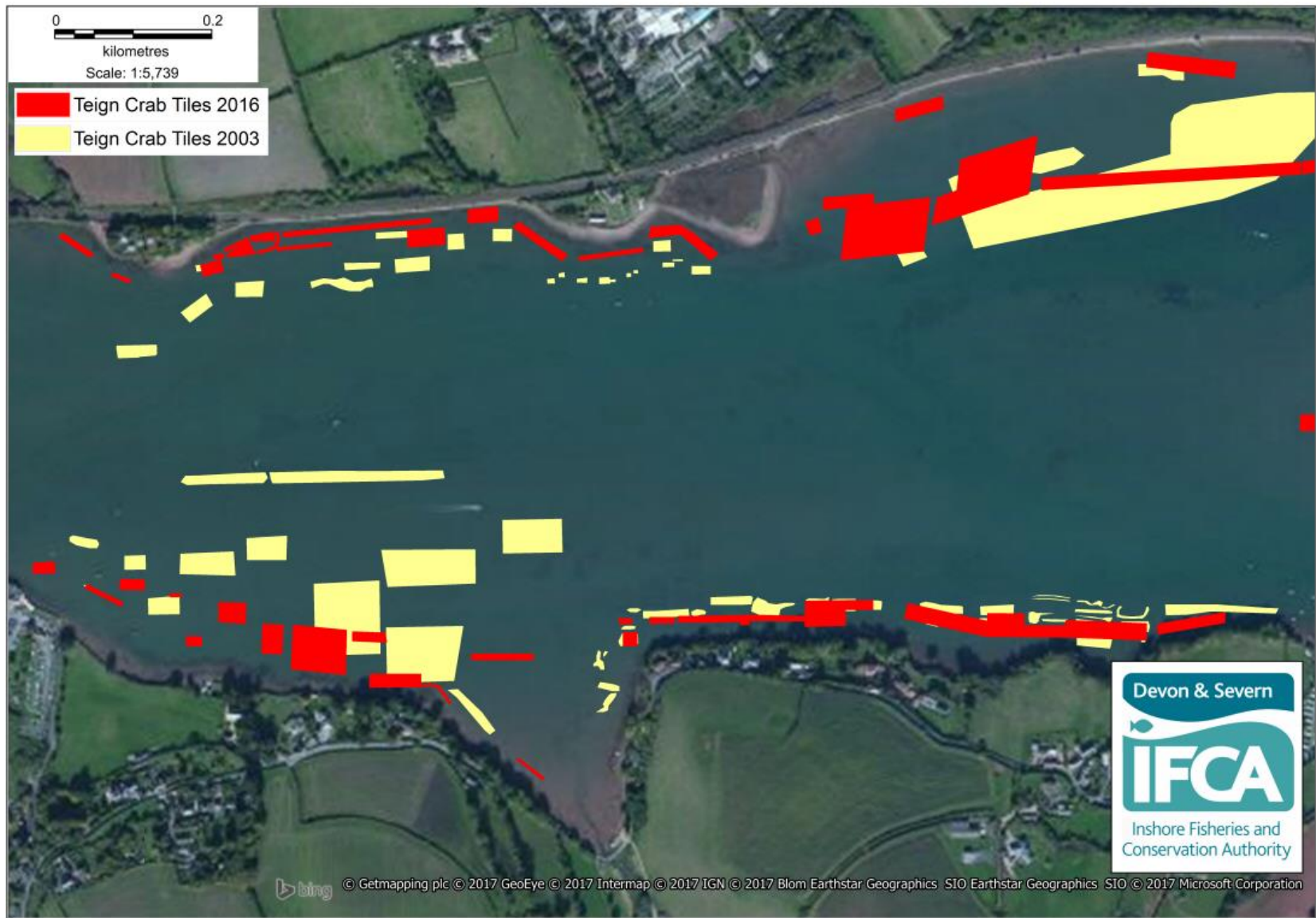


Figure 19 - Crab tiles to the west of Teign estuary

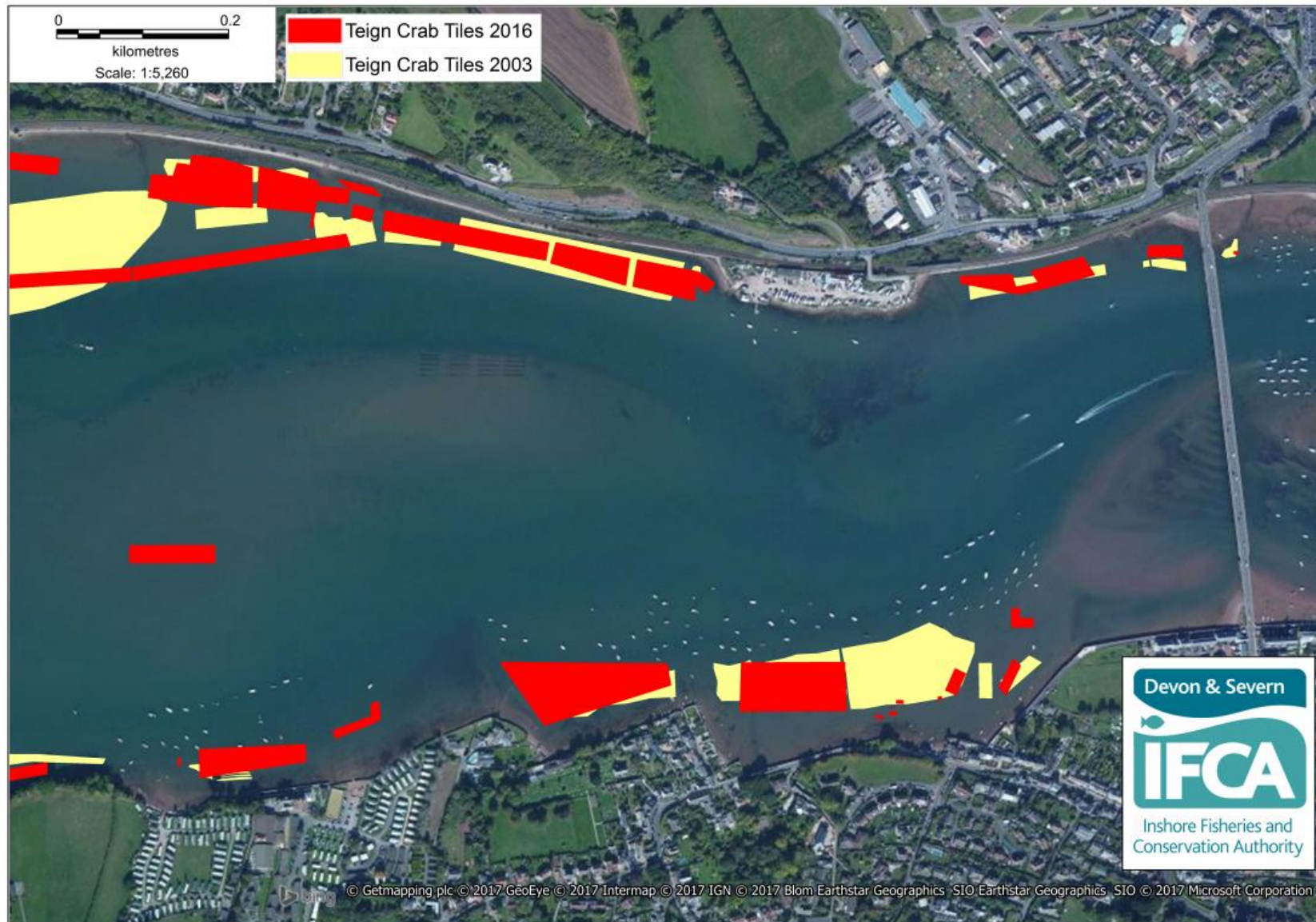


Figure 20 - Crab tiles to the east of Teign Estuary

3.8 Salcombe and Kingsbridge Estuary

Crab tiles in the Salcombe and Kingsbridge Estuary were surveyed by boat on 1st September 2016 by two officers. A total of 110 crab tiles were found. They were made up of terracotta roof tiles and plastic piping, 55 tiles in Salcombe were deemed to be within recent use and the remaining in Kingsbridge unsure. Crab tile counts and locations on Salcombe Estuary can be seen in Figure 21. Here, new crab tiles were found near The Bag. In 2003/04 survey, 46 crab tiles were identified on Southpool Creek but these were not found during this survey. Crab tile locations and counts on Kingsbridge Estuary can be seen in Figure 22. In the 2003/04 survey 147 crab tiles were located on Kingsbridge Estuary but these have reduced to 55 crab tiles in 2016.

Table 10 - Comparison of crab tile counts from previous surveys on Salcombe and Kingsbridge Estuary.

Survey	Number of crab tiles	Difference	Percentage difference
2016	105	-88	-46%
2003/04	193	-341	-64%
2000/01	534	-	-

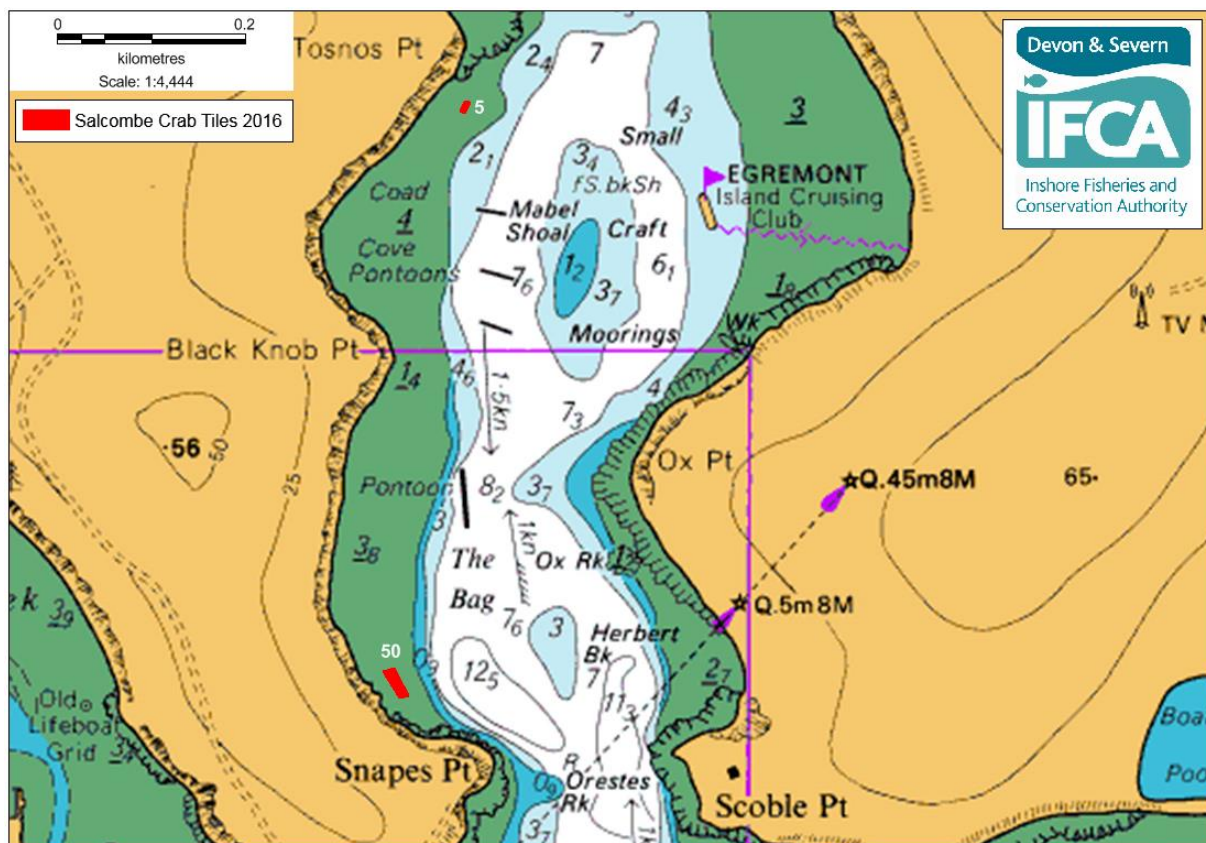


Figure 21 - Crab tiles on Salcombe Estuary.

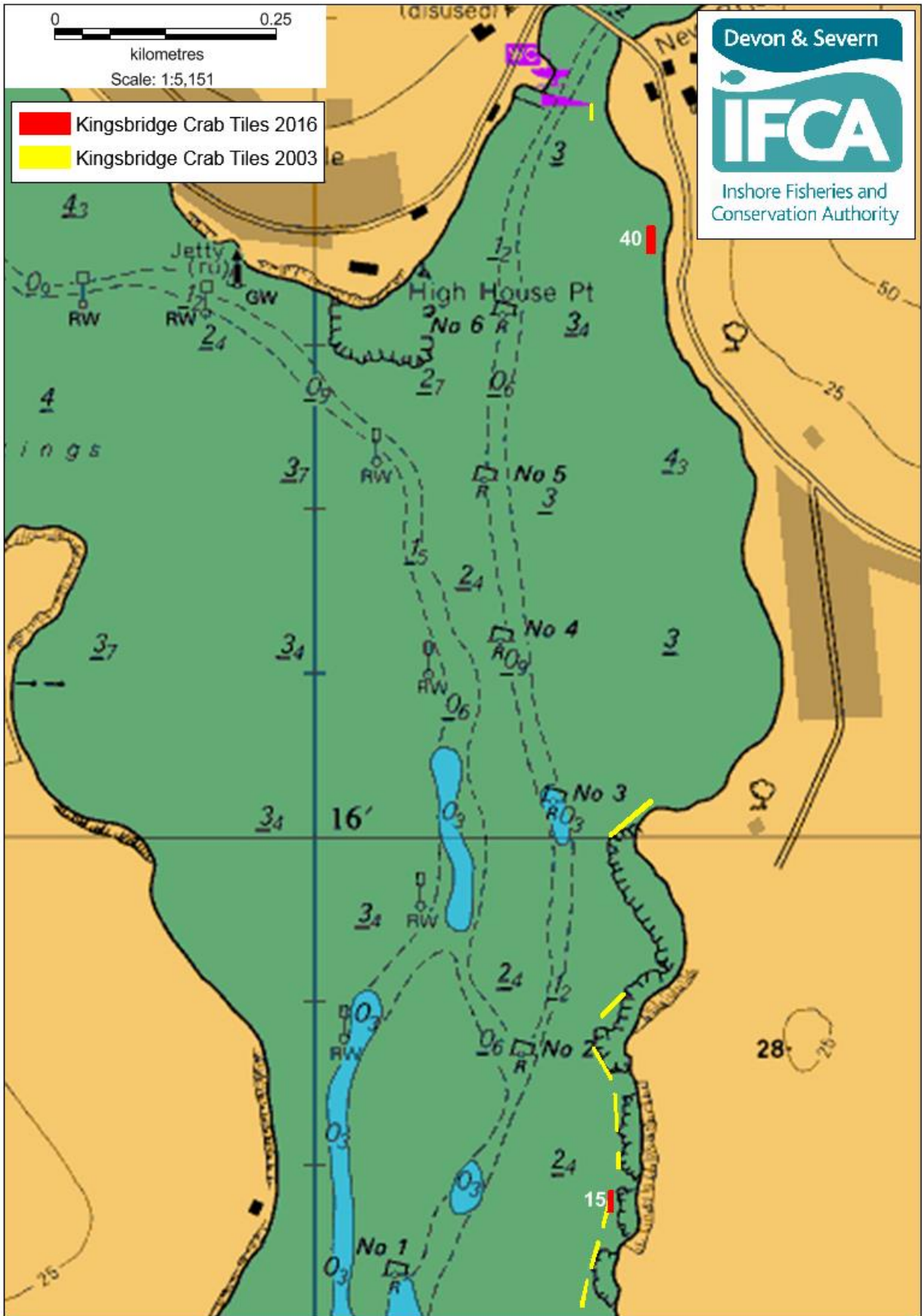


Figure 22 - Crab tiles on Kingsbridge Estuary

4. Discussion

4.1 Results

There is a territorial consensus between crab tilers, with a set area of crab tiles generally worked by one individual who owns them. Additionally, there is a limit to the number of crab tiles that can be placed on one estuary. This carrying capacity of the fishery may explain why there are no significant increases in the number of crab tiles year on year.

No crab tiles were found on the River Sid, Otter, Avon, Erme or Yealm. The River Yealm Harbour Authority has a byelaw prohibiting crab tiles within the harbour. The River Erme is a private estate and does not allow crab tiling on its premises. Crab tiles had previously been recorded on the Avon in the 2003/04 survey, but were not found during this survey. New crab tiles were found on the River Axe which had previously never been exploited. There was a slight reduction of crab tiles in Kingsbridge, and a new area tiled in Salcombe, with previous tiles being removed. Crab tile numbers had been steadily decreasing in the River Plym from 2000/01 to 2012, but numbers increased in 2016 by 23%. On the River Tamar a reduction of crab tiles were seen in all areas apart from on Tamerton Lake. There was a 14% increase in crab tiles overall on the Exe Estuary though levels of increases and decreases in numbers varied between sites. However, the overall increase may be due to the increased accuracy of surveying using an UAV.

There were significant reductions in the number of crab tiles on the River Dart (54%) and Teign (43%). The cause of a decline in crab tile numbers is unknown, although it may be that tilers have ceased fishing their tiles and therefore they have become buried by the sediment over time. Black (2004) states in the 2003/04 survey "It should be noted that the survey on the Dart and some areas in the Tamar Complex (Tamar, Tavy, Plym and Lynher) did not cover the entire estuary. In these cases it has been assumed that there have been no changes to numbers of crab tiles in areas not surveyed.", although the affected areas are not detailed. Considering this, it is possible that although a significant decrease occurred on the Dart, the rate at which numbers decreased may not have been as sharp as suggested.

4.2 Data limitations

Counts of large expanses of crab tiles are sometimes estimated and this can be down to personal judgement. Additionally, in areas that are difficult to reach due to soft mud or by boat, binoculars are used and crab tiles may be counted inaccurately as they can be mistaken for rocks, or vice versa, when covered with seaweed or sunk into the sediment. The process of crab tile mapping can also be subjective; for areas with restricted access the distance away and crab tile area coverage are estimated.

4.3 Future work

There are currently no statutory management measures for crab tiling in place on the rivers and estuaries (apart from a closed area on the Exe Estuary) in D&S IFCA District. Voluntary Codes of Conduct are in place on the Exe Estuary, Teign and Taw Torridge. D&S IFCA is looking to progress development on a hand gathering byelaw this year (2017) and regular surveys should continue to monitor the activity. The results of this and previous surveys have been used in Habitat Regulations Assessments (HRAs) for crab tiling in the Plymouth Sound and Estuaries Special Area of Conservation (SAC), Tamar Estuaries Complex Special Protection Area (SPA) and Exe Estuary SPA. Additionally, the activity has been assessed for the Tamar Estuary Marine Conservation Zone (MCZ). Therefore, as a management control and monitoring measure for these sites, it is important that future surveys of crab tile numbers and their distribution are continued.

The use of drones for crab tile surveys has been successful in the Taw Torridge (Parkhouse, 2016) and Exe Estuary with more accurate counts and locations of tiles, as well as being a safer method for surveying mudflats. For future surveys, if resources allow, using drones would be beneficial for surveying the estuaries with large amounts of crab tiles such as the River Teign.

5. References

Black, G. (2004) Report on Surveys in 2003/04 of Crab Tiling Activity on Devon's Estuaries and Comparison with 2000/01 Crab Tile Survey Data. Devon Biodiversity Records Centre.

Lockett, J. (2008) Exe Estuary crab tile survey 2008. Exe Estuary Management Partnership Report.

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Noble, T. (2013b) Tamar estuaries complex crab tile survey 2012. Devon and Severn IFCA Report.

Parkhouse, L. (2016) Taw Torridge crab tile survey 2015. Devon and Severn IFCA Report

River Yealm Harbour Authority Regulations (19th February 2015). Available from:

http://www.yealmharbourauthority.co.uk/downloads/RulesAndRegulationsIssue5_2015.pdf

[Accessed: 02/02/2017]

Sheehan, E.V., Coleman, R.A., Thompson, R.C., & Attrill, M.J. (2010) Crab tiling reduces the diversity of estuarine infauna. *Marine Ecology Progress Series* 411: 137 -148

Appendix 1 – Crab tile Survey Forms

FOR OFFICE USE ONLY Site No: Checked by EO <input type="checkbox"/> Checked by DBRC <input type="checkbox"/> Tide Times: MLW am pm MHW am pm	CRAB TILE SURVEY FORM
ESTUARY: TEMP. SITE No: GRID REF OF SITE: * Please mark location of site on copy of OS map (See guidance notes)	DATE OF SURVEY: START TIME AT THIS SITE: FINISH TIME AT THIS SITE: AMOUNT OF TIME AT THIS SITE:
SURVEYOR NAME/S: CONTACT PHONE No:	SITE DESCRIPTION: (See guidance notes)
NAME & ADDRESS OF CRAB TILER (If known):	
NUMBER OF TILES:	SPACING OF TILES: (1-5 scale): (See guidance notes)
SEDIMENT TYPE: FINE <input type="checkbox"/> MEDIUM <input type="checkbox"/> COARSE <input type="checkbox"/> OTHER <input type="checkbox"/> (Please specify)	SHORE POSITION: (See guidance notes) HIGH <input type="checkbox"/> MEDIUM <input type="checkbox"/> LOW <input type="checkbox"/>
MATERIAL OF TILE: PLASTIC PIPING <input type="checkbox"/> TERRACOTTA ROOF <input type="checkbox"/> TILE <input type="checkbox"/> TYRE <input type="checkbox"/> CORRUGATED IRON <input type="checkbox"/> CHIMNEY POT <input type="checkbox"/> OTHER <input type="checkbox"/> (Please specify)	TILES IN USE? YES <input type="checkbox"/> NO <input type="checkbox"/> UNSURE <input type="checkbox"/> (See guidance notes)
EPIFLORA & FAUNA ON TILES: (See guidance notes)	
SEAWEED <input type="checkbox"/> BARNACLES <input type="checkbox"/> NONE (Tiles clean) <input type="checkbox"/> OTHER <input type="checkbox"/> (Please specify)	COVERAGE 1=slight 2=medium 3=dense <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
ORIENTATION OF TILES: (See guidance) FLAT <input type="checkbox"/> 45° <input type="checkbox"/> UPRIGHT <input type="checkbox"/>	OTHER <input type="checkbox"/> (please specify)
EASE OF PUBLIC ACCESS: (See guidance notes)	

POTENTIAL CONFLICTS: Please list here
(See guidance notes)

SKETCH MAP OF SITE:
(Please include distribution and pattern of tiles)
(See guidance notes)

PLEASE RETURN FORM TO ESTUARY OFFICER BY date

THANK YOU