Cornwall IFCA
Inshore Fisheries and Conservation Authority

Crab Tiling Survey within the River Tamar 2017

Final report for the 2017 Crab Tiling Survey within the Tamar Estuary (20170612_CIFCA_Crab Tiling Survey in Tamar Estuaries)

Completed by: Cornwall Inshore Fisheries and Conservation Authority (CIFCA)
Authors: Annie Jenkin, Stephanie Davies, Colin Trundle, Kimara Street and Hilary Naylor

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This document has been produced by Cornwall Inshore Fisheries and Conservation Authority (CIFCA)

Cornwall IFCA
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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1 Introduction

Crab tiling, or crab potting as it is sometimes referred to locally, is a method of collecting shore crabs (*Carcinus maenas*) which are hiding underneath crab tiles so they can be used as bait for anglers. Like all other crustaceans, shore crabs moult their shells at regular intervals throughout their lives and will seek shelter when they go through this process. Bait collectors, known as 'crab tilers' exploit this behaviour by providing artificial habitats using hard, man-made structures, such as pieces of half round guttering, drain pipes, tyres and roof tiles, examples of crab tiles within the Tamar Estuary are shown in Figure 1. The crabs are collected at low tide (preferably spring low tide) when the tiles are accessible. Crab tiling has been documented within the Tamar Estuary since the 1990s (Godden, 1995). Crab tiles have the potential to change habitat complexity, benthic infaunal diversity and abundance, as well as bird behaviour over large areas (Sheehan *et al*., 2010).

An informal chat with a crab tiler during the survey provided further information about the fishery. The crab tiles are visited during spring low tides (approximately once a fortnight), within Thanckes Lake and the area surrounding this, some of which are visited during the summer and some during the winter. Berried crabs are not taken by the fishermen but are left to protect future stocks. The tiles are laid angled, so the open end faces the higher shore as the tide recedes. The holes left behind after tiles have been moved are naturally re-filled, this can occur overnight depending on the wind direction. The majority of the crabs are used by the fishermen themselves but any excess crabs are sold.

Figure 1: Crab tiles within the Tamar Estuary. (Source: Cornwall IFCA)

Cornwall Inshore Fisheries and Conservation Authority (CIFCA) have a responsibility to manage the exploitation of sea fisheries resources under the Marine and Coastal Access Act 2009 (MaCCA) which includes crab tiling. The Tamar Estuary falls within the jurisdiction of both Cornwall IFCA and Devon and Severn IFCA. Currently no statutory or voluntary measures have been implemented for crab tiling on the Tamar Estuary.

Cornwall IFCA aim to carry out a crab tiling survey within the Tamar Estuary every four years. This is to enable the number and location of crab tiles to be assessed over time. The crab tiles within CIFCA District, in the Tamar Estuary, were last surveyed in 2012 (Noble, 2013) and a repeat survey was due in 2016 but, due to other work commitments, this was not carried out. This survey of the Tamar Estuary only covers Cornwall IFCA District, namely the River Tamar and River Lynher, see Davies (2017) for crab tiles within the Devon & Severn IFCA District of the Tamar Estuary.

The project was run in partnership with Plymouth City Council who provided funding for the survey to be carried out and the Tamar Estuaries Consultative Forum (TECF).

A number of designations exist in the Tamar Estuary which includes the Tamar Estuary Marine Conservation Zone (MCZ) (Annex 2), the Plymouth Sound and Estuaries Special Area of Conservation (SAC) (Annex 3), Tamar Estuaries Complex Special Protection Area (SPA) (Annex 4), St. John's Lake Site of Special Scientific Interest (SSSI), Lynher Estuary SSSI and the Tamar – Tavy Estuary SSSI (Annex 5).

2 Aims and objectives

2.1 Aims

- Monitor the number of crab tiles within the Tamar Estuary.
- Assess the effectiveness of using aerial methods of remote sensing for data collection in intertidal areas.

2.2 Objectives

- Repeat areas surveyed in 2012 to assess the number of crab tiles.
- Verify crab tiles from aerial imagery.
- Count crab tiles on foot in areas inaccessible to the drone.
- Compare results from this survey with previous years.

3 Methodology

The survey was carried out in two phases; a drone survey for the majority of the sites and an on foot survey for one section which the drone was not allowed to be flown in, around Thanckes Lake. The areas surveyed were based on locations from the previous survey in 2012.

3.1 Foot survey

The foot survey was conducted in the area around Thanckes Lake during the daytime period of a low spring tide which allowed the mud flats where the crab tiles are located to become fully exposed. The foot survey was carried out on 5th December 2017. Cornwall IFCA personnel included Colin Trundle, Annie Jenkin and Hilary Naylor. They were joined on the day by Beth Siddons from Plymouth City Council. All fieldwork was carried out within two hours before and after low tide. Low tide on the day as recorded at Devonport was at 12:57 and 0.61m.

A chart with the previously located tiles was used in the field to relocate previous surveyed areas. The survey officers located 'patches' or lines of tiles and one member of staff would walk the perimeter of the patch with the GPS or record the start and end of the line taking note of the way points, one member of staff would count the number of tiles within each patch/line and the other member of staff would record the information in a waterproof notepad (Figure 2). Maps were drawn in the field to identify the patches and lines of tiles.

Figure 2: A member of staff from Cornwall IFCA counting the number of crab tiles within the area around Thanckes Lake during a survey on 5th December 2017. (Source: Cornwall IFCA)

Other observations which were noted down were non-native species, tracks to identify if the crab tiles had been accessed recently and informal comments from a crab tiler that was out collecting crabs on the day of the survey.

The survey followed the same methodology as the survey Cornwall IFCA carried out in 2012 to ensure comparable data (Noble, 2013; Black 2004).

Data was recorded in waterproof notebooks. It was then uploaded back in the office into a Microsoft Excel spreadsheet for analysis. GPS waypoint positions were extracted from the handheld GPS using Garmin Mapsource (Version 6.12) software and exported as a text file. The text file was then opened in Excel and manipulated to enable it to be used in Mapinfo. The data was then uploaded into MapInfo Pro (Version 15.2) where they were used to create display lines and polygons of crab tiles within the area surveyed. The GIS plots were also overlaid onto charts to verify that previous areas surveyed had been accurately followed.

3.2 Drone Survey

An Unmanned Aerial Vehicle (UAV) or drone, as they are commonly referred to, was used to collect images to map the areas of crab tiles. This was operated by Duncan Hine of Vertical Horizons Media. The survey was carried out over a four hour time frame, two hours either side of low water, on spring tides between late September and early October 2017. Site maps were provided by Cornwall IFCA from past surveys which showed the areas to be surveyed. The UAV operator programmed flight paths into the drone for each location of the survey. The drone was flown at an altitude of 20m, recording the GPS track and taking a still image every few seconds to achieve a target ground spacing distance of 1 pixel/cm. The technical specification of the drone can be found in Annex 1. The drone could be manually overridden by the operator when necessary to avoid obstacles or during windy periods.

The images from the survey were then processed by the drone operator using the processing software; GPSBable, Geosetter, and Pix4D. The software Pix4D stitches together the imaging and creates geo-tiles. These geo-tiles were imported and overlaid into MapInfo Pro (Version 15.2) to give the exact location of

the raster images which were then used to count the crab tiles. To do this, where possible, a polyline was drawn from the start to the end of each row of tiles or a polygon was created to show the perimeter of patches and the total numbers of tiles were counted for each vector feature. Attribute data including location, site identification, number of tiles, number of rows, usage and any other comments were recorded within the layer table. This layer was used to compare results with previous survey layers.

3.3 PPE

All staff working in the field were equipped with properly fitting chest waders, waterproof jackets and manual inflate lifejackets.

3.4 Equipment

The equipment used during the foot survey included;

- 1 x Garmin GPS 60 handheld GPS
- 1 x Backup Garmin GPS 60 handheld GPS
- Spare batteries
- Camera (Olympus Tough TG-5 4K 12.0MP Compact Digital Camera)
- 1 x waterproof notepad
- 2 x seawriter pencils
- 1 x chart showing positions of crab tiles from the previous survey

4 Results

A total of 7,067 crab tiles were recorded in the Tamar Estuary (CIFCA District only). This was a 13% increase since the 2012 survey. Table 1 shows the difference in numbers of crab tiles since 2000.

Table 1: Comparison of crab tile counts in 2017 from previous surveys in the Tamar Estuary

Survey	Number of crab tiles	Difference	Percentage difference
2017	7,067	+836	13%
2012 (Noble, 2013)	6,231	+3,441	123%
2003/04 (Black, 2004)	2,790	+755	37%
2000/01 (Black, 2004)	2,035	-	-

Table 2 shows the increase in tiles since 2012 was primarily down to a significant increase near Palmer Point (TAM37) and Thanckes Lake (TAM26). The area near Redshank Point (TAM00) saw a large decrease in tile counts by 28%, however, this was due to missing aerial imagery which means the total count of tiles is an underrepresentation.

Table 2: Breakdown of crab tile counts and distribution in the Tamar Estuary (*tiles missing from total counts)

Estuary	Location	Area	2017 Tiles	2012 Tiles	2003/04 Tiles	2000/01 Tiles	Count difference (2017-2012)	Percentage difference (2017-2012)
Lynher	South & West of Redshank Point	TAM00	911*	1,269	200	-	-358	-28%
	Warren Point	TAM01	715	814	741	532	-99	-12%
	Juipter Point	TAM02	-	-	-	8	-	0%
	Antony Passage	TAM03	-	-	-	43	-	0%
	Sand Acre Bay	TAM04	406	415	840	834	-9	-2%
	Tredown Lake	TAM27	218	262	-	-	-44	-17%
Tamar	Saltash	TAM05	400	254	340	108	+146	57%
	Saltmill Creek	TAM06	629	635	327	314	-6	-1%
		TAM23	-	-	92	-	-	0%
	Cargreen to Neal Point	TAM24	298*	160	250	-	+138	86%
	Torpoint	TAM16	-	-	-	79	-	0%
		TAM25	626	580	-	-	+46	8%
	Thanckes Lake	TAM26	1,729	1,316	-	-	+413	31%
	Southdown	TAM17	-	-	-	117	-	0%
	Palmer Point	TAM37	1,135	526	-	-	+609	116%
		TOTAL	**7,067**	**6,231**	**2,790**	**2,035**	**+836**	**13%**

4.1 Foot survey

A total of 1,729 crab tiles were recorded near Thanckes Lake and Yonderberry Jetty (TAM26). This was 413 more tiles since 2012, a 31% increase. Figure 3 shows the location of crab tiles recorded on foot near Thanckes Lake in 2017 and 2012. The areas of crab tiles have remained fairly similar, with the exception of an increase in tiles to the west of Thanckes Lake (Figure 3).

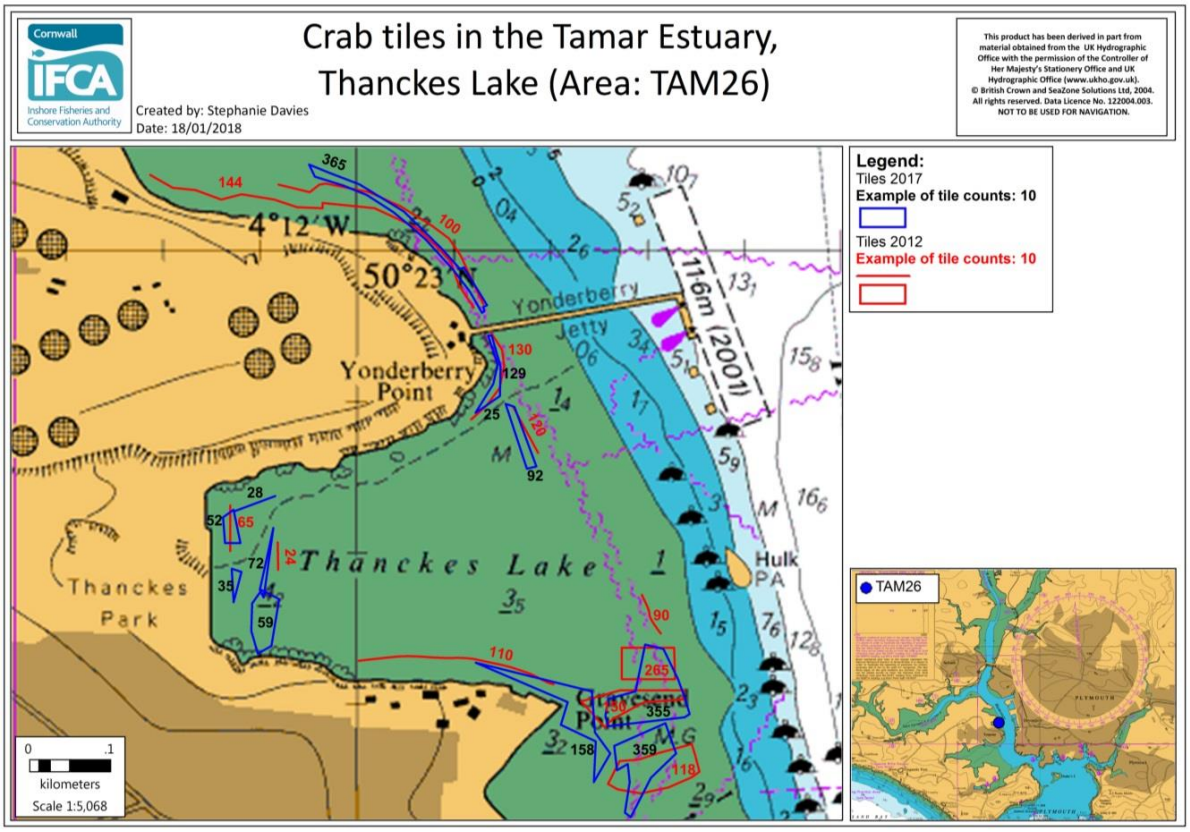

Figure 3: Crab tiles in the River Tamar, Thanckes Lake (TAM26) surveyed by foot 2017 and 2012.

4.2 Drone survey

The drone flights were successful in obtaining aerial imagery of the areas which contained crab tiles in 2012, covering a total area of 85 ha. The results can be seen in Figure 4 to Figure 17, which show the crab tile distribution and counts for 2017 and 2012 over the aerial imagery.

An area on the River Lynher, near Redshank Point, had a high voltage power line which obstructed the drone's coverage and meant 264m of the 2012 survey line was not covered (TAM00, Figure 4). Additionally, in some areas, a narrow strip between the trees and waterline caused stitch errors during processing which resulted in 108m of 2012 survey line unaccounted for in TAM00 (Figure 5). These issues explain the difference in tile numbers from 2012 to 2017 in TAM00 (Table 2). Some tiles were not uncovered at low tide on the day of survey (namely area TAM25, Figure 15) but tiles could just be made out under the surface of the water and the majority were thought to be accounted for.

No crab tiles were seen in 2017, near the 2012 line for north of Weir Point (TAM24, Figure 13) and one 2012 line near Cargreen (TAM24, Figure 14). However, tiles extended the area covered by the drone south of Weir Point (TAM24, Figure 12) which results in the underestimated counts for Cargreen to Neal Point (TAM24) in Table 2.

No new areas of tiles were found from the aerial imagery, only changes to the overall counts and slight alterations to the distributions. The largest increase from 2012 was seen in TAM37 near Palmer Point with five new rows recorded resulting in an extra 282 tiles in Figure 16 and 327 more tiles added to historic lines in Figure 17. A slight increase of 46 tiles was recorded in Torpoint in TAM25 (Figure 15). Slight decreases in the number of tiles were seen near Warren Point in TAM01 (Figure 7 and Figure 6), Sand Acre Bay in TAM04 (Figure 9), Tredown Lake in TAM27 (Figure 8) and Saltmill Creek in TAM06 (Figure 11).

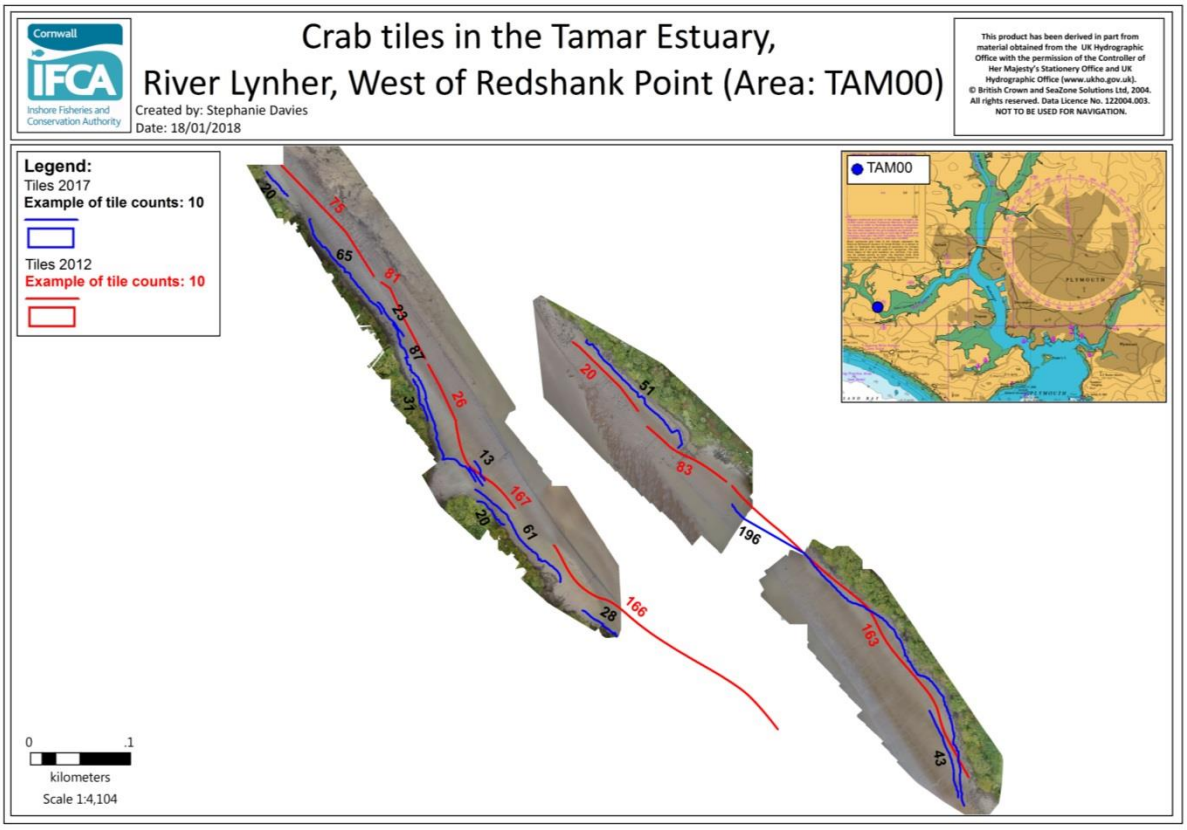

Figure 4: Crab tiles in the River Lynher, west of Redshank Point (TAM00) 2017.

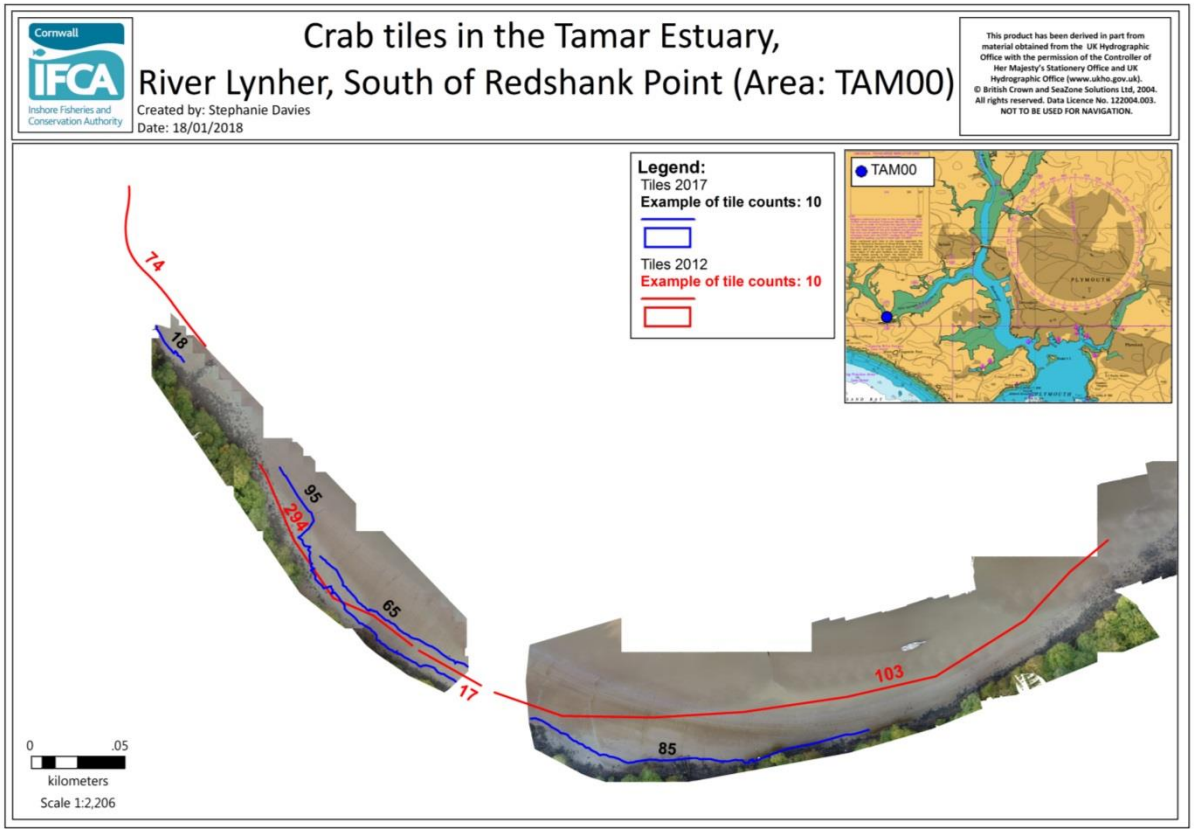

Figure 5: Crab tiles in the River Lynher, south of Redshank Point (TAM00) 2017.

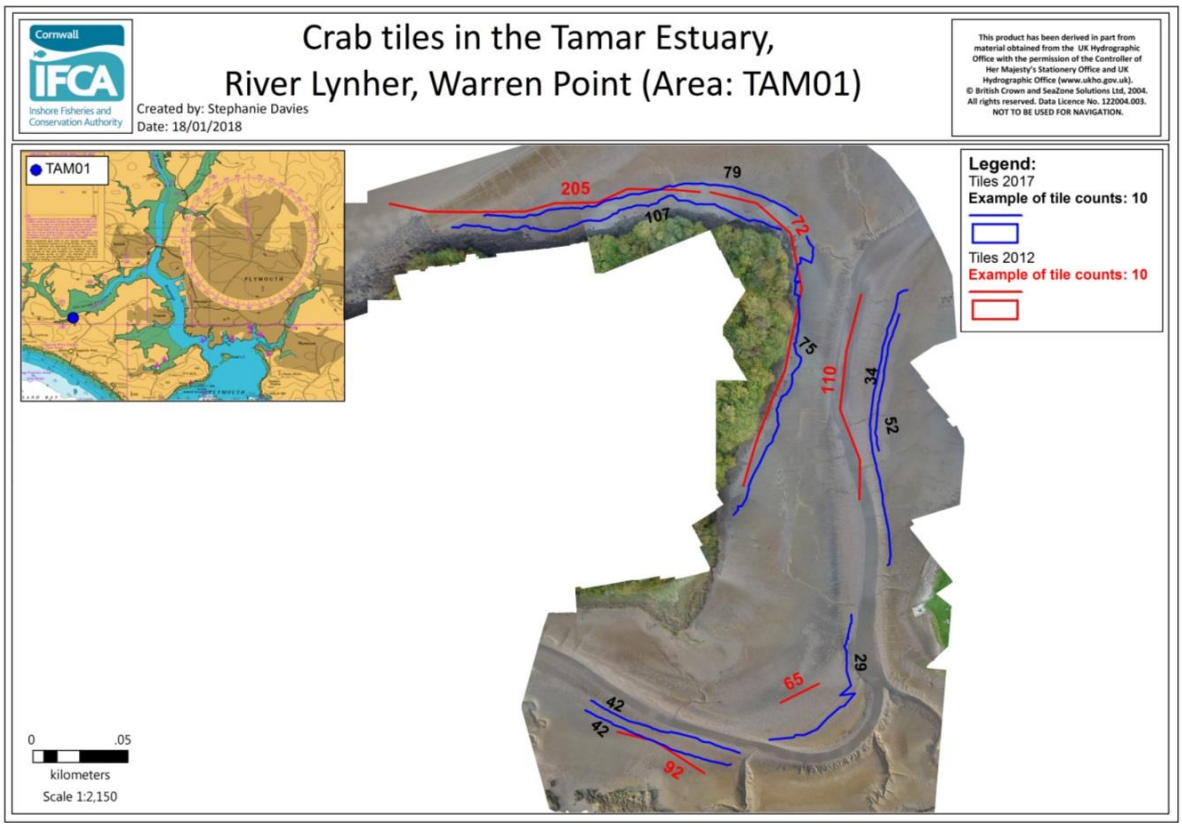

Figure 6: Crab tiles in the River Lynher, Warren Point (TAM01) 2017.

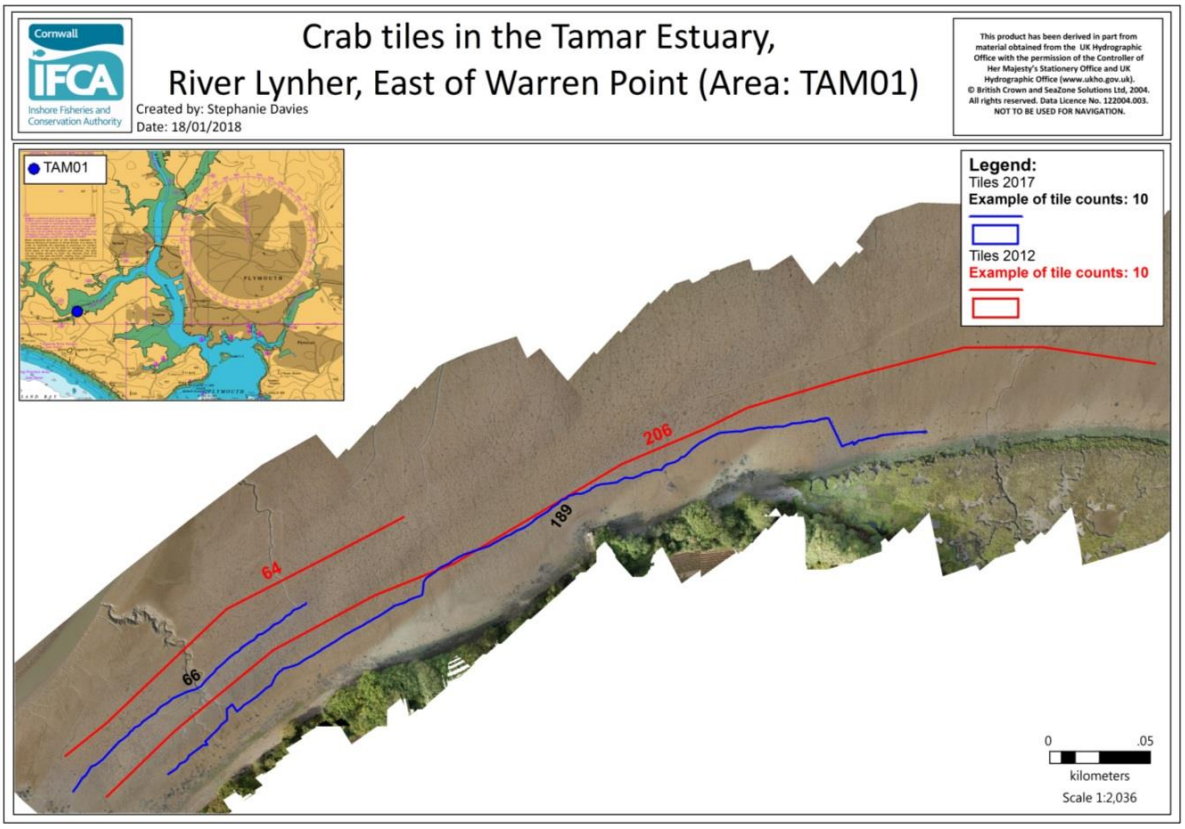

Figure 7: Crab tiles in the River Lynher, east of Warren Point (TAM01) 2017.

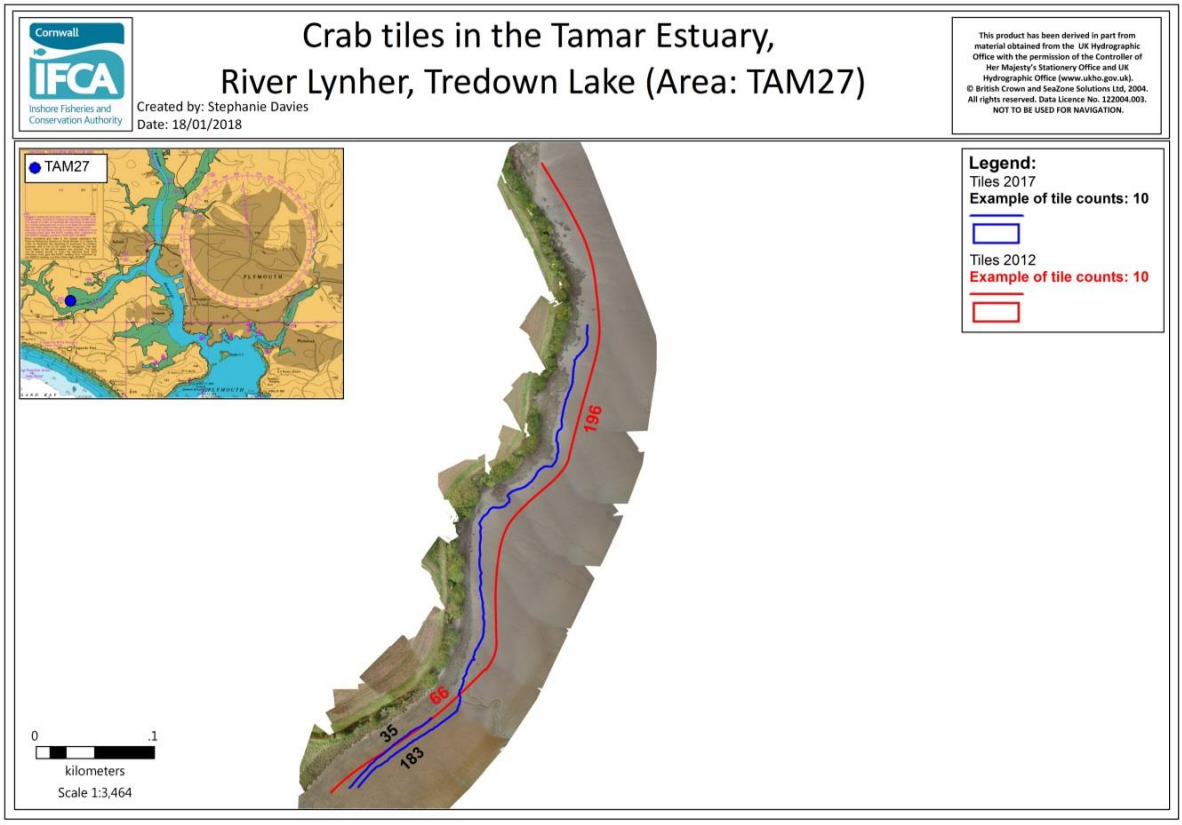

Figure 8: Crab tiles in the River Lynher, Tredown Lake (TAM27) 2017.

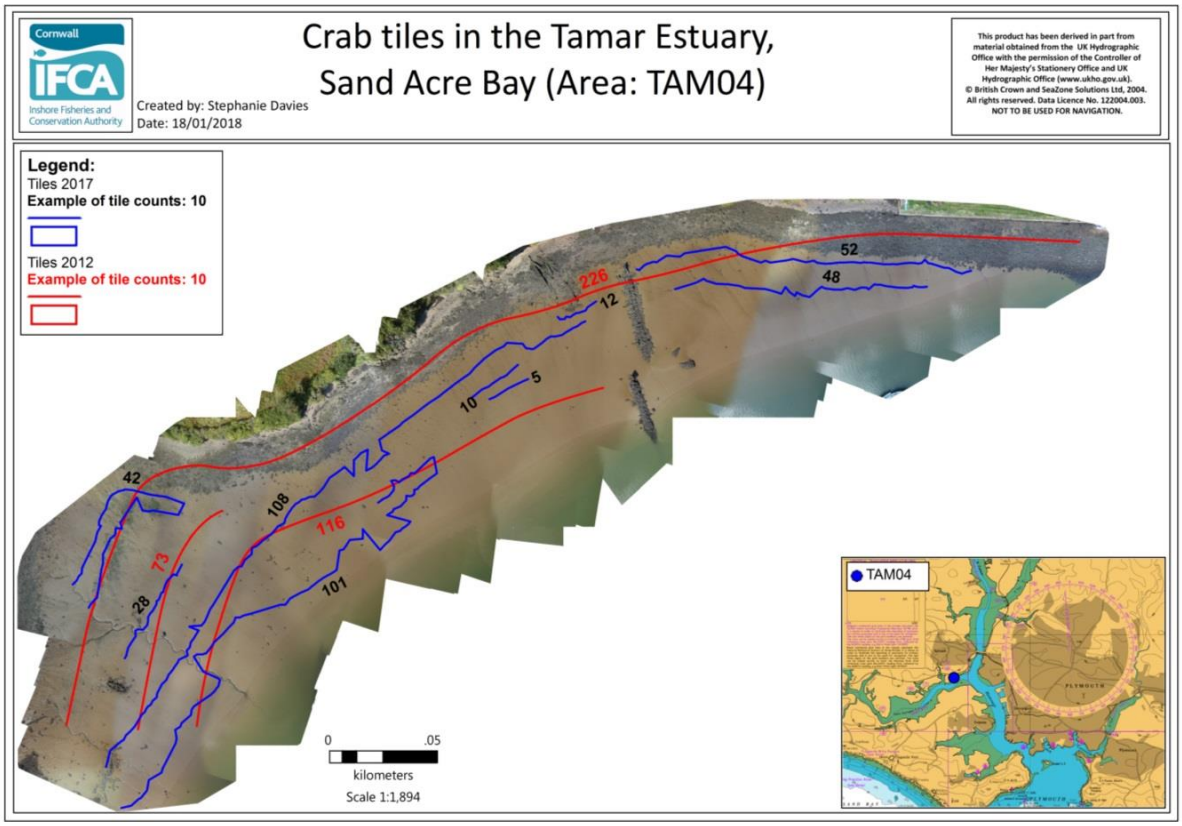

Figure 9: Crab tiles in the River Lynher, Sand Acre Bay (TAM04) 2017.

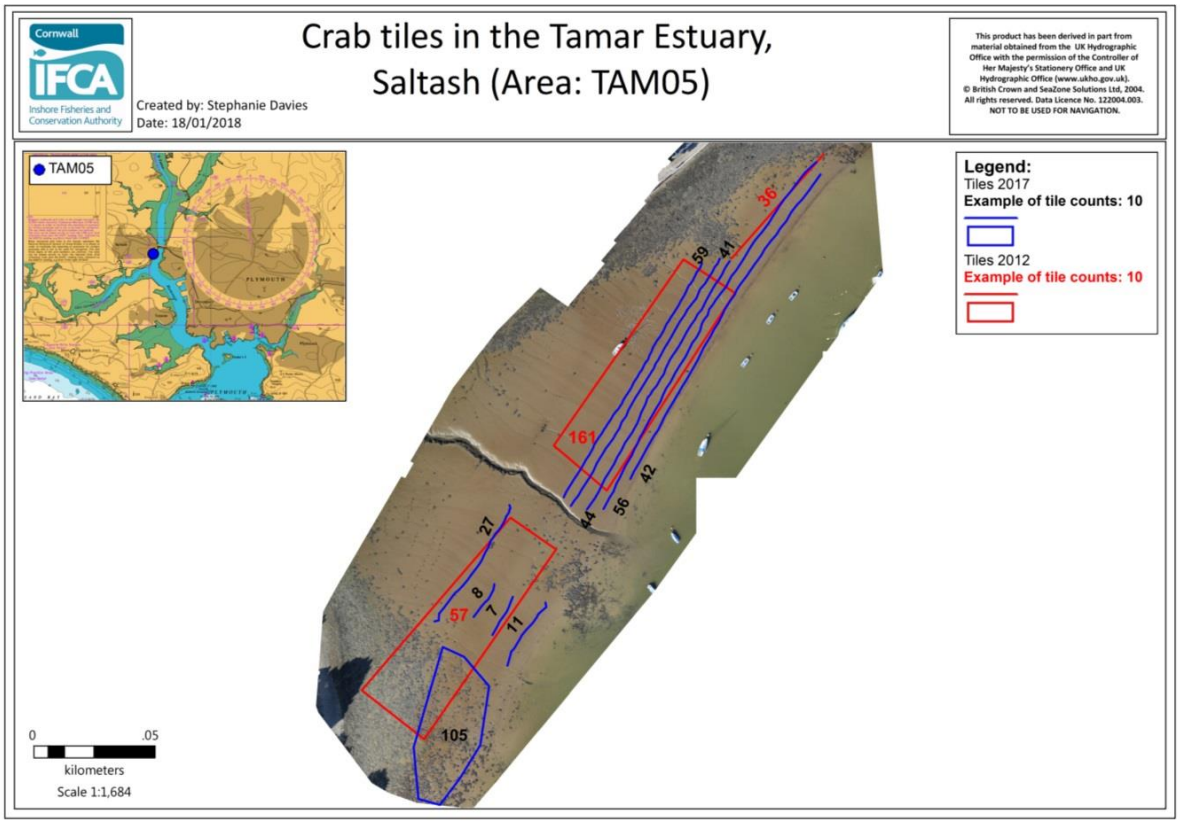

Figure 10: Crab tiles in the River Tamar, near Saltash (TAM05) 2017.

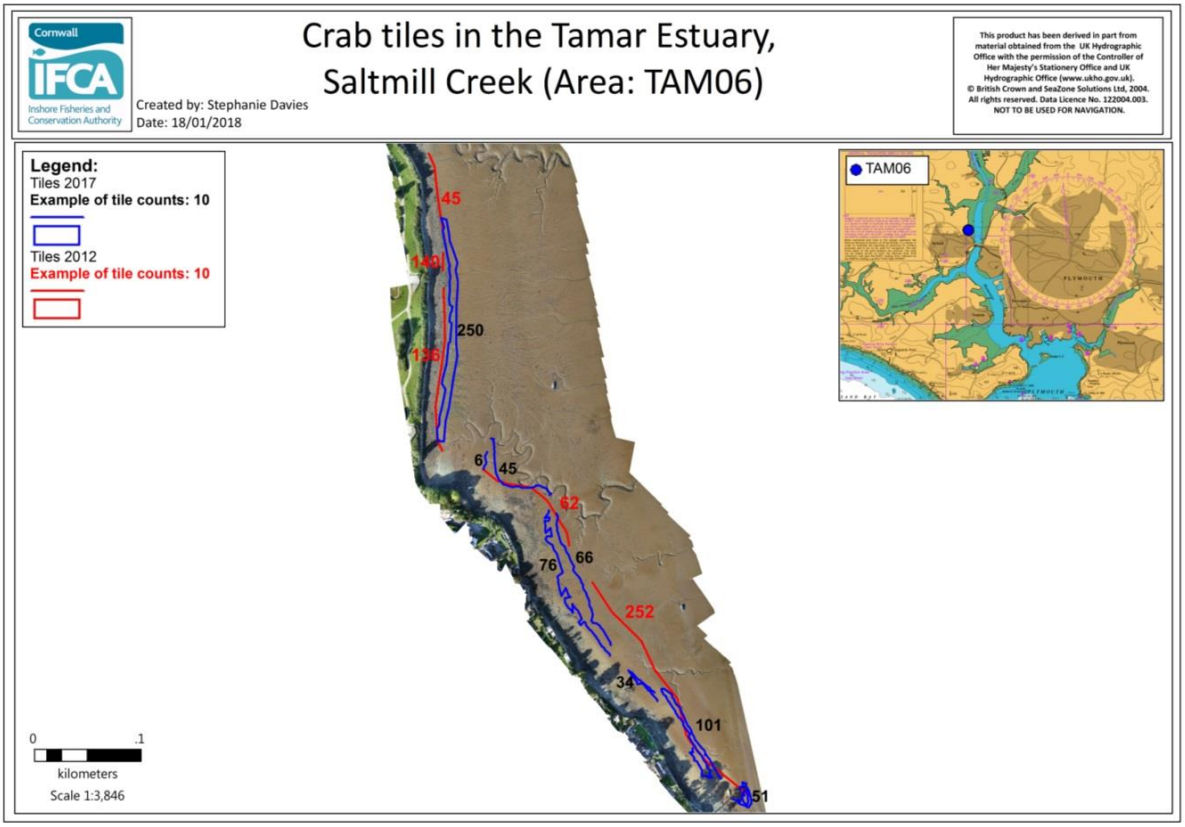

Figure 11: Crab tiles in the River Tamar, near Saltmill Creek (TAM06) 2017.

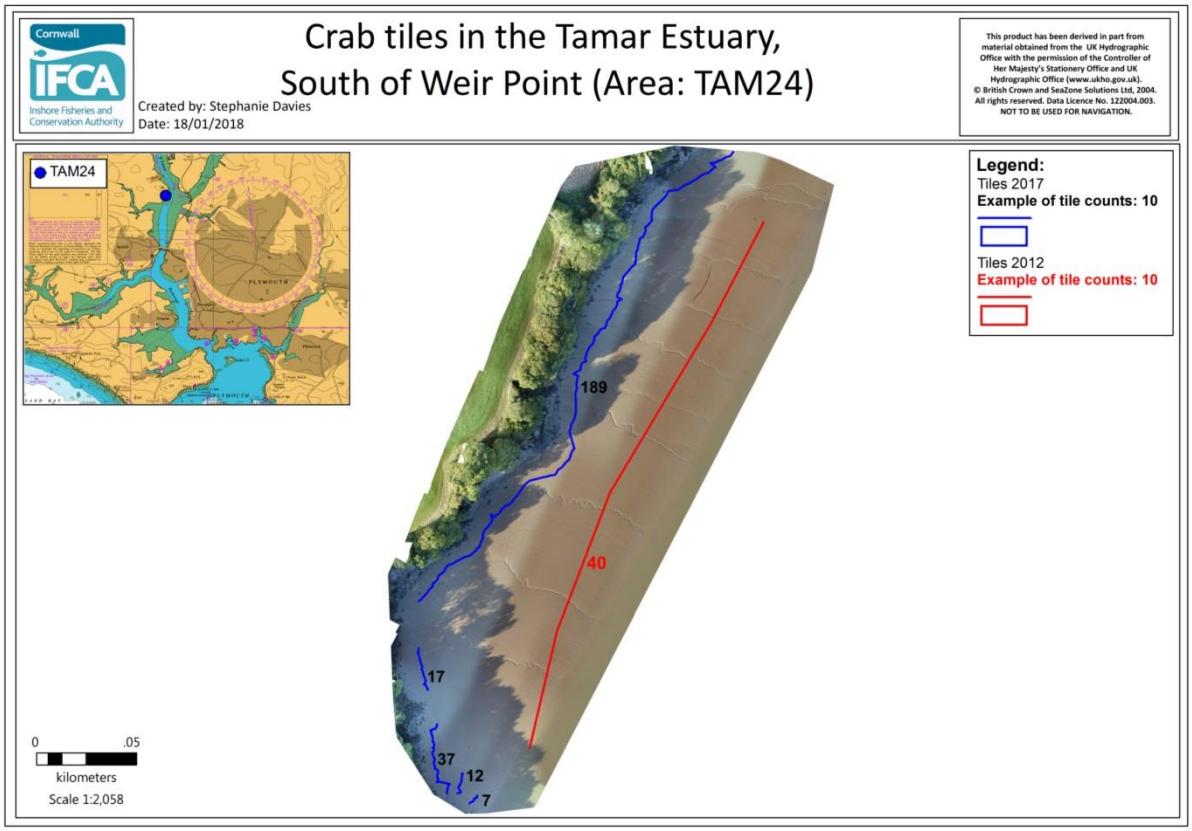

Figure 12: Crab tiles in the River Tamar, south of Weir Point (TAM24) 2017.

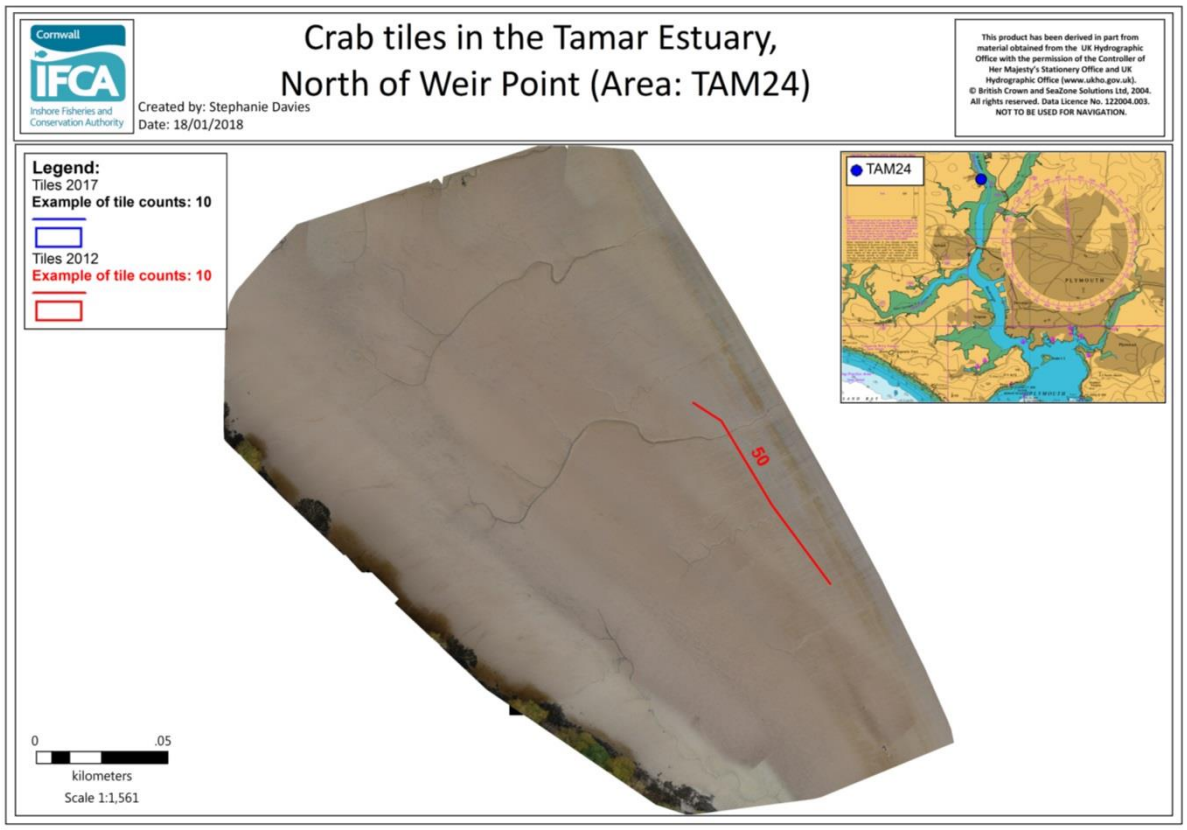

Figure 13: Crab tiles in the River Tamar, north of Weir Point (TAM24) 2017.

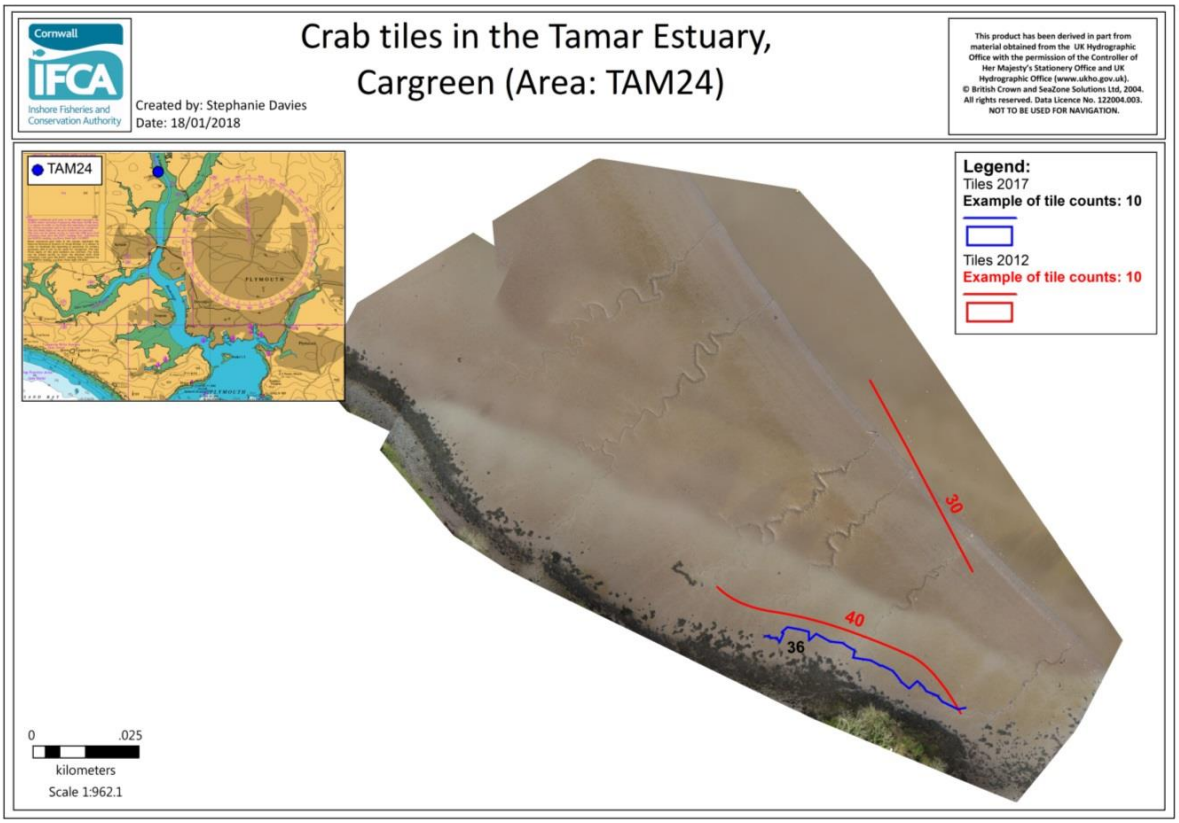

Figure 14: Crab tiles in the River Tamar, near Cargreen (TAM24) 2017.

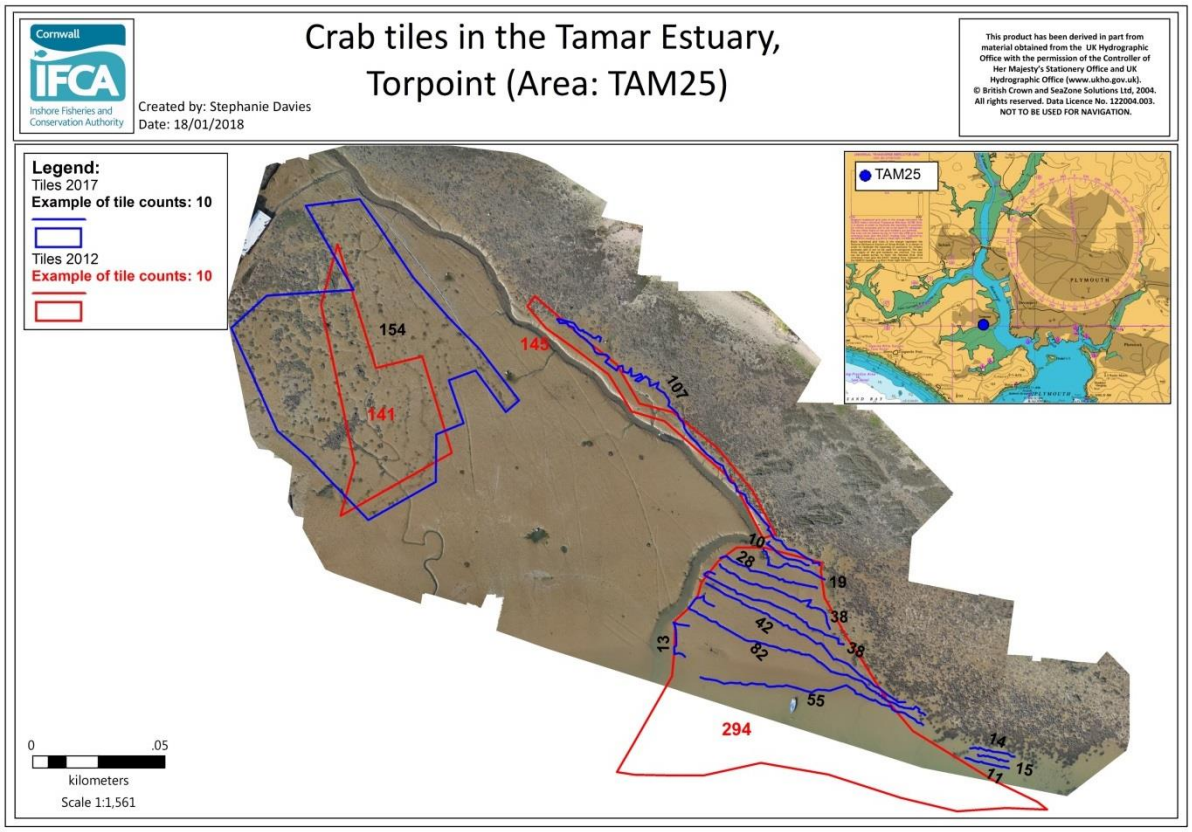

Figure 15: Crab tiles in the River Tamar, near Torpoint (TAM25) 2017.

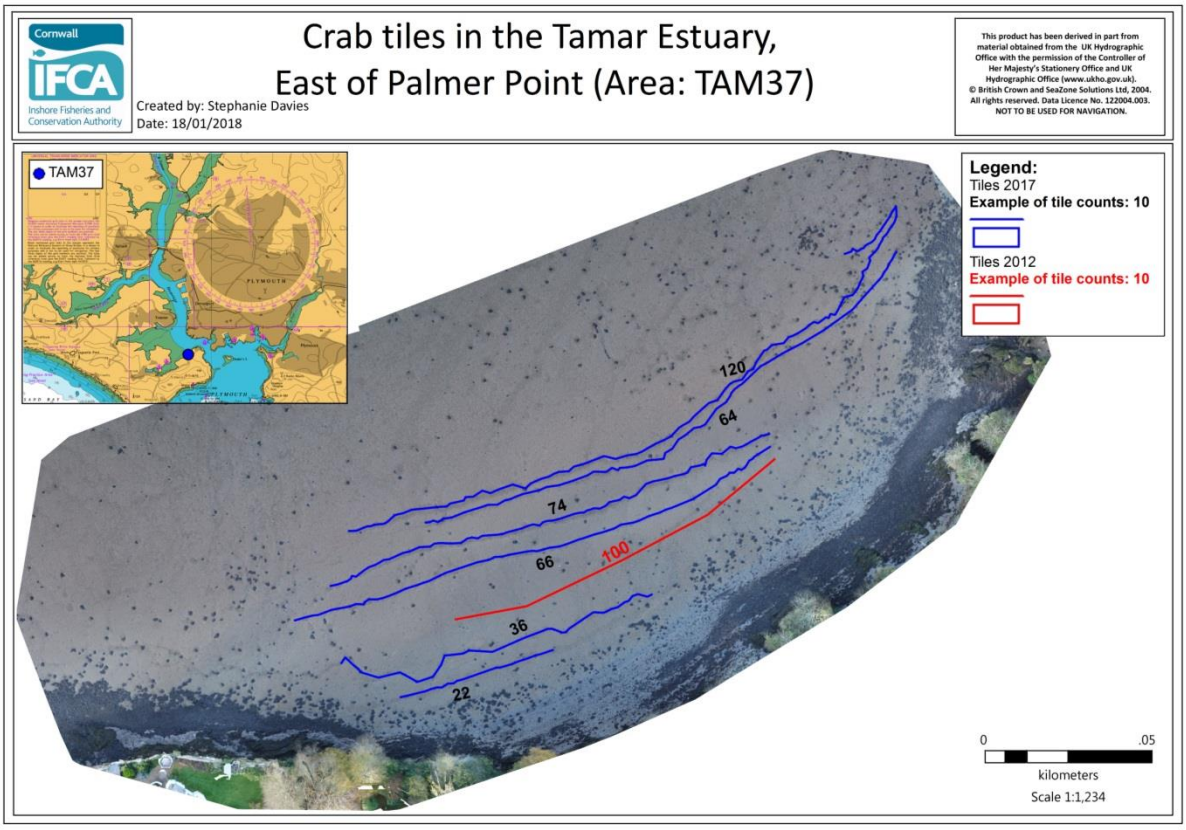

Figure 16: Crab tiles in the River Tamar, east of Palmer Point (TAM37) 2017.

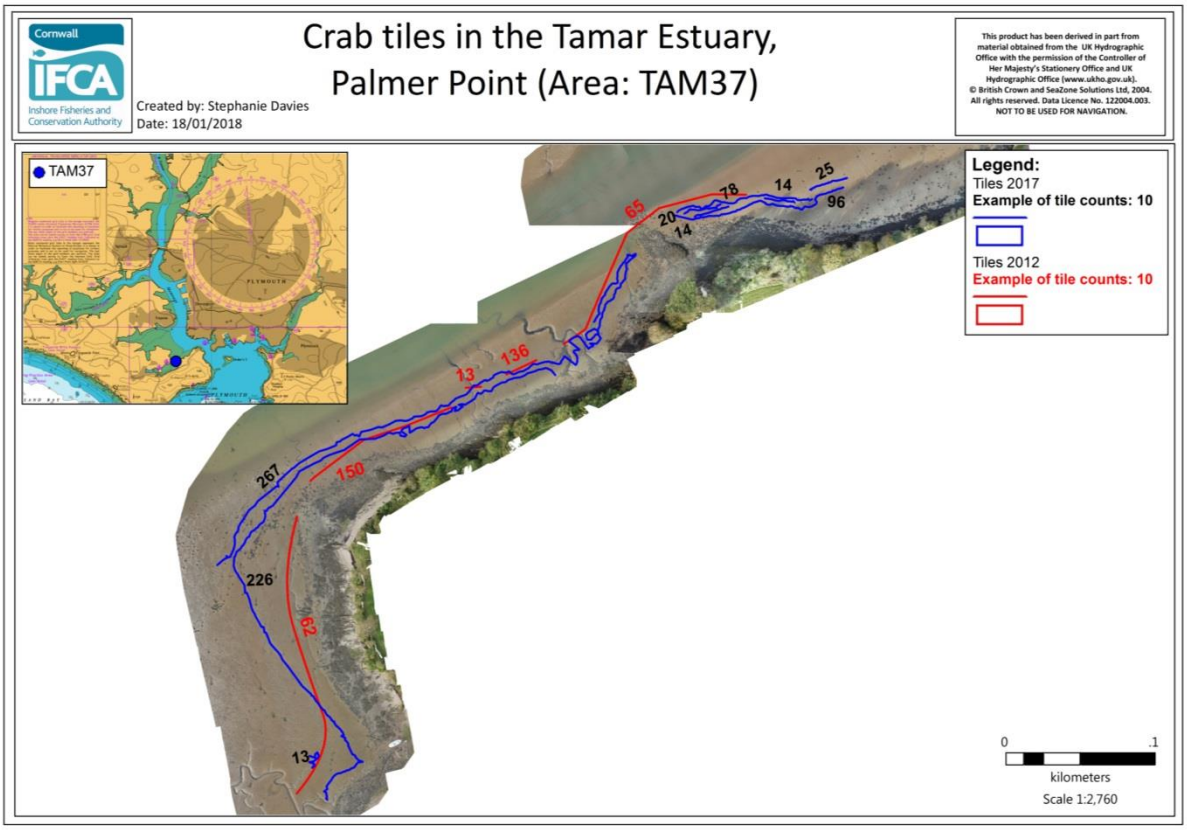

Figure 17: Crab tiles in the River Tamar, Palmer Point (TAM37) 2017.

4.3 Additional species and non-natives recorded

Observations of other species were made when they were seen but this was not a focus of the survey.

- Leathery sea squirt (*Styela clava*)
- Pacific Oysters (*Magallana gigas* previously known as *Crassostrea gigas*) – present mostly as large individuals and very sparsely populated (Figure 18).

Figure 18: Pacific oysters recorded during the 2017 on foot survey within Thanckes Lake

Some of the crabs found in the Thames carry a disease which the crab tiler informed Cornwall IFCA about. When crabs with this disease are found they are killed by the fishermen to prevent the disease from spreading. The fishermen did not know the name of the disease. One common form of infestation to shore crab populations is the parasitic barnacle, *Sacculina carcini*. Cornwall IFCA did not record any crabs with this disease described by the fishermen or see any observations of the parasitic barnacle during the survey, although this was not an aim of the survey and Cornwall IFCA did not assess the number of crabs or the condition of the crabs as part of the survey.

5 Discussion

Crab tile numbers were relatively stable between 2000/01 (2,790) and 2003/04 (2,035). In 2012 they dramatically increased two-fold to 6,231 and have since increased a further 13%, to 7,067 in 2017. This 13% increase in numbers is within historic crab tile areas and there have been no new establishment of new areas of tiles known to Cornwall IFCA. The likely reason for the recent growth in numbers is due to the increased accuracy of counts by using aerial imagery from the drone.

The crab tilers have a set area of tiles which is generally worked by an individual who owns them. There is a limit to the number of crab tiles which can be placed within an estuary due to the available habitat which is suitable for crab tiles. This may explain why there is no significant increase in the number of tiles recorded from 2012 to 2017.

Usage was recorded where possible from the aerial imagery, out of the 95 vector features recorded, 24 had footprints to and around the tiles. The 36 tiles in TAM24 Figure 14 were covered in seaweed and not thought to be in use. The row of 250 tiles in TAM06, Figure 11, where covered in green algae and not thought to be in recent use. The tiles recorded east of Palmer Point in Figure 16 where half buried and therefore hard to identify.

During the foot survey near Thanckes Lake, the crab tiler which was met on site informed Cornwall IFCA officers that some of the crab tiles just off Yonderberry Point are no longer used but the rest of them in the area are still active. The lower line of tiles in this section are only accessible during spring low tides. Tiles are generally accessed a few times a fortnight over the spring tides. There was reference to summer and winter tiles, where the tiles higher up the shore were summer tiles as the crabs seem to be more mobile then and venture into the shallower water.

There have been slight changes in the distributions and locations of crab tiles compared to the 2012 mapping. This is because of the increased accuracy by using aerial images which have created detailed polylines identifying each tile within a row of crab tiles and polygons for areas with no coherent distributions of tiles. With the continued use of aerial images in the future, it can demonstrate more detailed changes over time.

An undergraduate project by Godden (1995) reported the number of crab tiles in Plymouth raised in a few years from almost zero to 8,750. A few years later, in 1998, the Tamar Estuaries Bait Collection Working Group gave an estimate of around 20,000 crab tiles within the River Tamar, Plym, Lynher and Tavy (Fowler, 1999). The survey by Black (2004) reduced this estimated amount to an actual total count of 8,403 in 2000/01 and 8,165 in 2003/04. In 2012, the total raised to 12,870 tiles (Noble, 2013). After the results of this survey and that of Devon and Severn IFCA, currently, there are a total of 12,656 crab tiles within the Plymouth Estuaries (Davies, 2017).

5.1 Data limitations

While every effort was made to ensure high accuracy during data collection, there are some limitations in the survey which may affect the overall counts and distribution. During previous foot surveys it has been noted that an estimation of counts has been taken for large areas with high numbers of tiles (Noble, 2013). Additionally, in the past, for areas where full access was not possible (e.g. due to deep mud) the area coverage and distance away was estimated and the process of mapping can be subjective (Davies, 2017).

When analysing the aerial imagery from the drone it was subject to personal judgement. In some areas it was difficult to determine the difference between crab tiles and rocks, namely in the polygons in Figure 10

and Figure 15. Additionally, when crab tiles have not been worked for a while, they sink into the sediment and can be hard to identify.

In the figures presented, disparity between the 2017 and 2012 layers can be seen with up to a 20m difference in projection between the lines (example Figure 7). Additionally, some of the raster images north of Warren Point in Figure 6 had projection errors resulting in approximately 3m off from the raster images south of Warren Point.

Moreover, there is missing count data from issues with the aerial imagery including an overhead power line blocking the flight path and stitching errors due to vegetation coverage.

While Cornwall IFCA are not aware of any new tiles being placed in any other areas within the Tamar Estuary, new areas of crab tiles may have been overlooked as the drone flight path only used areas which crab tiles were seen in 2012.

5.2 Recommendations for future work

It is necessary that the crab tiling survey is continued so that the monitoring of crab tile numbers and distribution in the Tamar Estuary is continual. The data collected helps inform Habitat Regulation Assessments (HRAs) for Plymouth Sound and Estuaries SAC and Tamar Estuaries Complex SPA as well as MCZ assessments for Tamar Estuary MCZ. It is important to monitor the activity and determine whether levels are environmentally sustainable for these MPAs.

This survey was carried out a year after a similar survey was carried out by Devon & Severn IFCA on the intertidal areas on the east side of the Tamar Estuary. To bring the timing of the two surveys together, Cornwall IFCA has committed to shorten the next review period so it will coincide with Devon & Severn IFCA cycle. Accordingly, the next survey will be scheduled for 2020.

5.3 Acknowledgements

Cornwall IFCA would like to thank Plymouth City Council for providing joint funding to carry out the survey and especially Beth Siddons for her support during this project and assistance on the foot survey.

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7 Appendices

Annex 1: Aerial Surveying Technical Specification for Vertical Horizons Media

Survey vehicle:

- Airframe- Based on DJI Phantom 2.
- Avionics –Naza M, IOSD, 2.5G ground station, Flytrex core2 GPS logger
- Sensors – GPS location, GPS altitude, barometric pressure altitude, Magnetic compass
- Autopilot- Fully autonomous, max 16 waypoints.
- Imaging – H3-3D 3 axis gimbal, gopro 3+ with 12mm rectilinear optics.

Operator details:

- Operator – Duncan Hine T/A Vertical Horizons media
- Insurance - £5 million public liability underwritten by Lloyds.
- License – Permitted by the CAA to conduct aerial works.

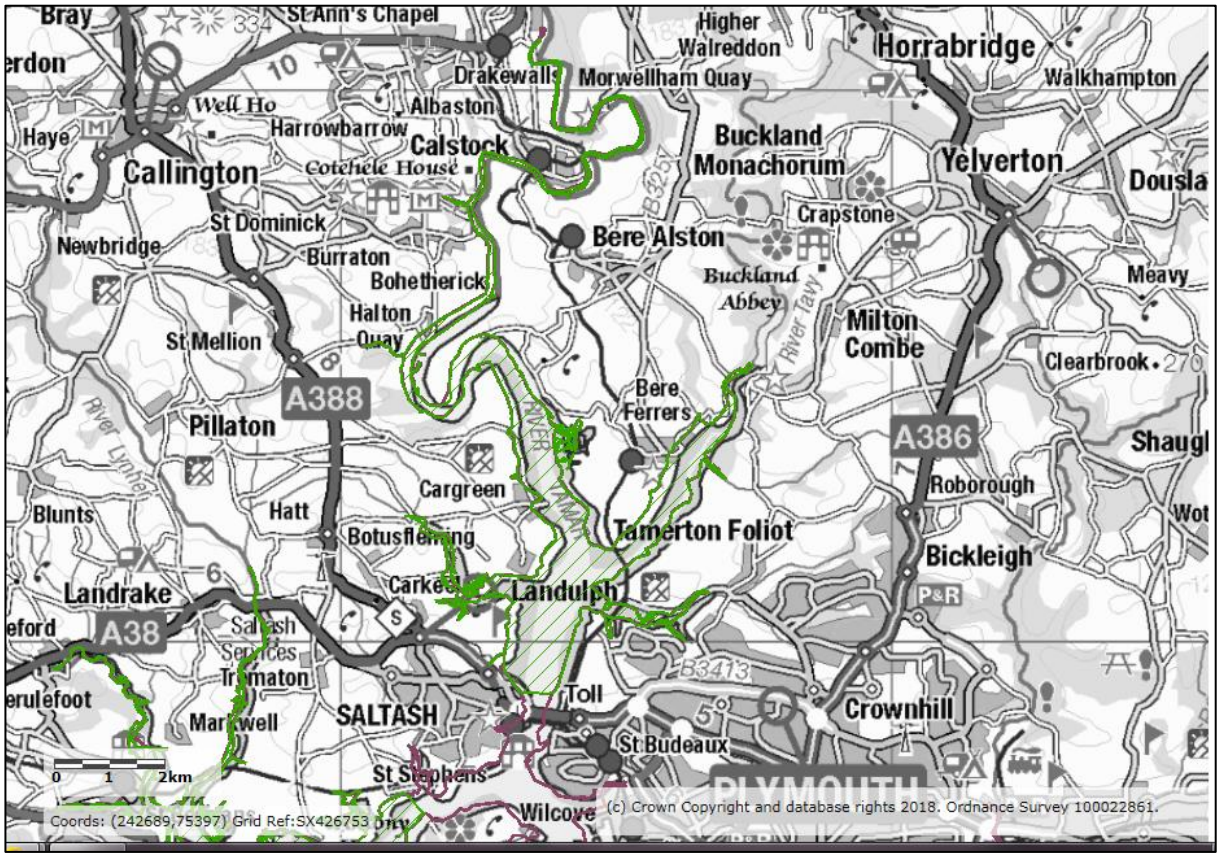
Survey parameters:

- Target Ground Spacing Distance (GSD) – 1pixel/cm
- Airspeed – 6 m/s
- Survey altitude – 20m AGL
- Approx. area covered by each image to obtain a GSD of 1@20m AGL – 40x30m
- Target frontal overlap – 80%
- Target lateral overlap- 74%
- Approximate track spacing – 25m
- Track generation – Manual to allow operator to compensate for obstacles and wind drift.

Post processing software:

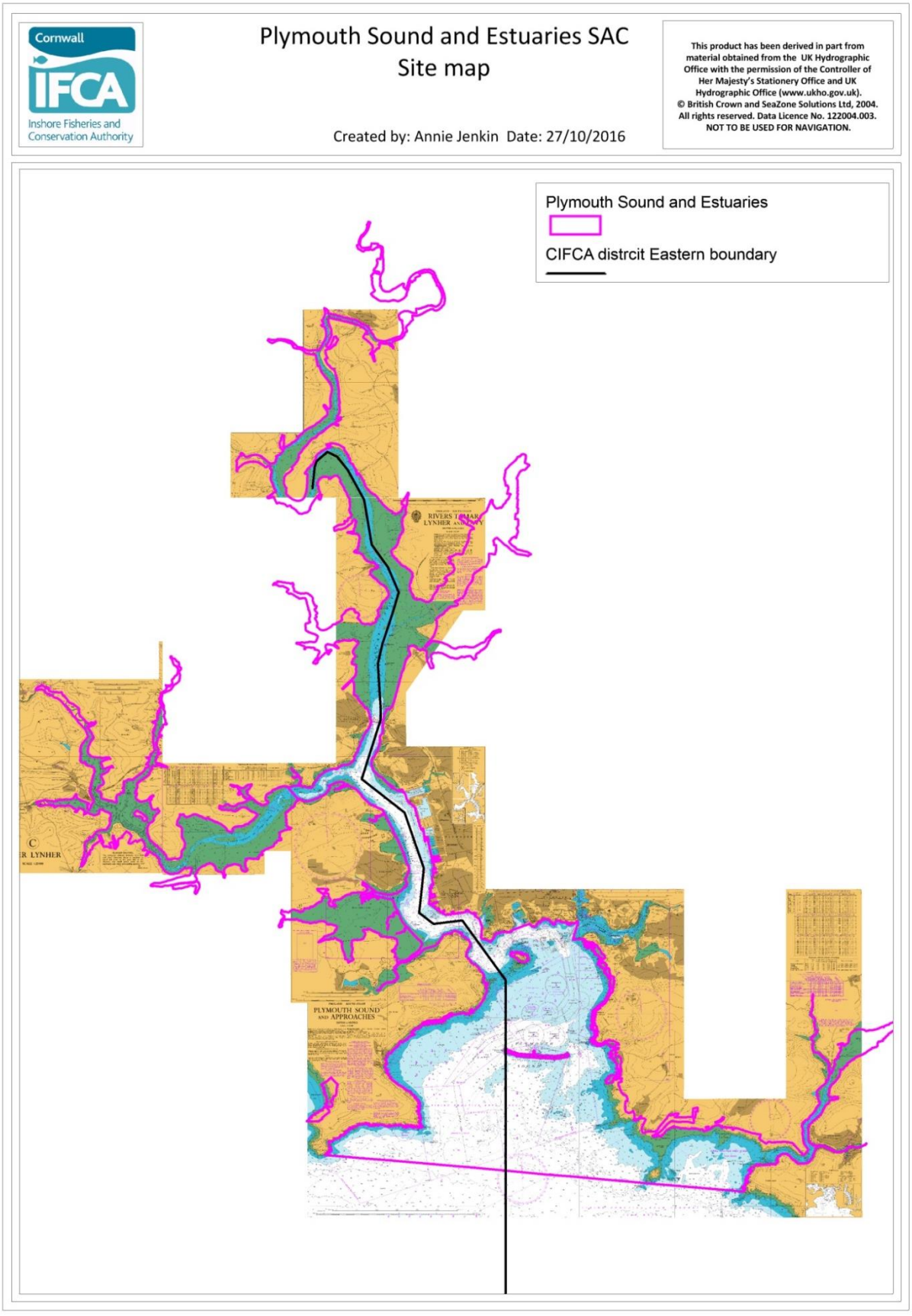
- GPSBable – Convert raw GPS log data to GPX format
- Geosetter – Insert GPS track data from GPX into image EXIF data
- Pix4D – Image stitching and geo-tile creation.

Annex 2: Tamar Estuary Marine Conservation Zone (MCZ)

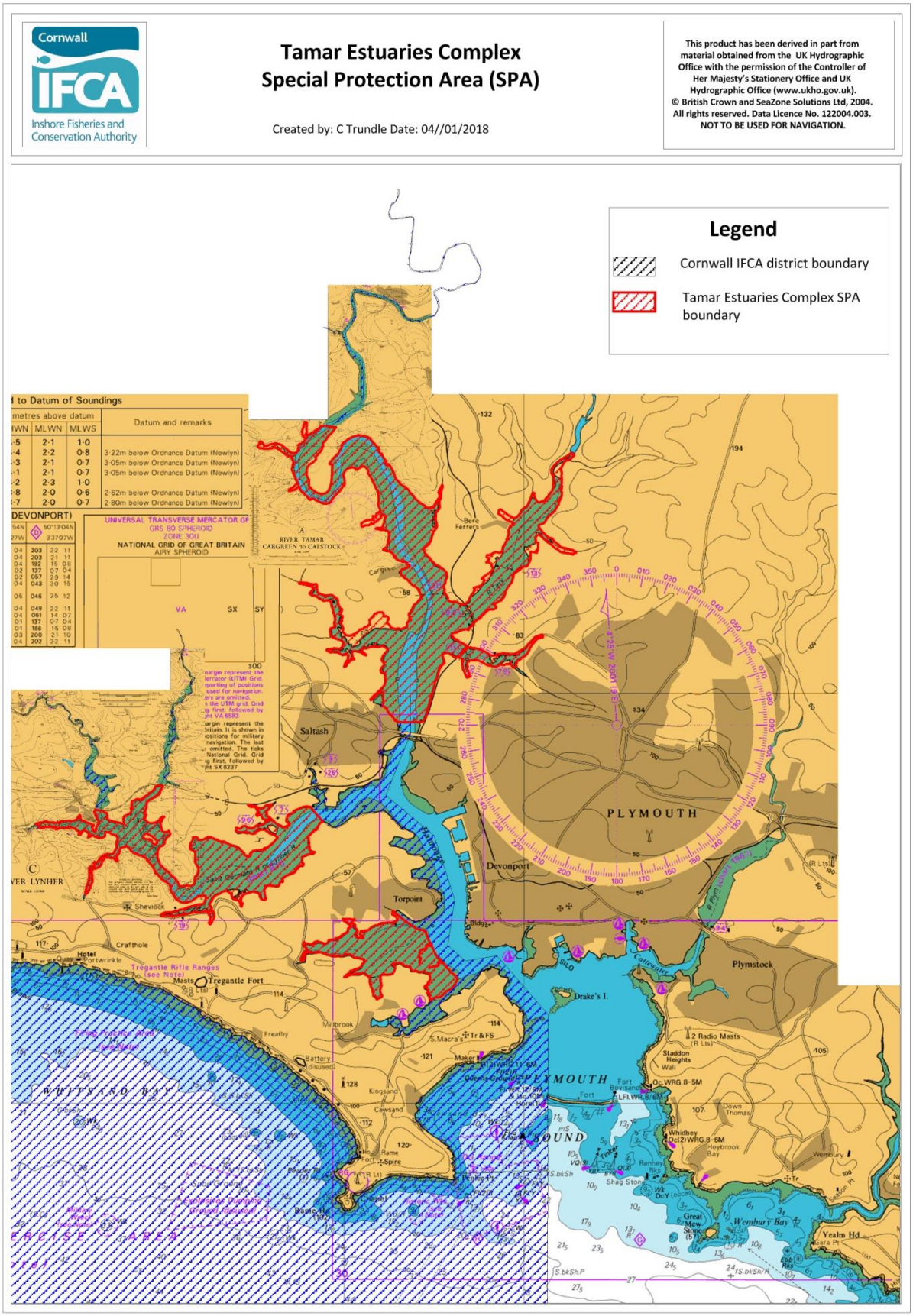


Source: http://magic.gov.uk/MagicMap.aspx

Annex 3: Plymouth Sound and Estuaries Special Area of Conservation (SAC)



Annex 4: Tamar Estuaries Complex Special Protection Area (SPA)



Annex 5: Sites of Special Scientific Interest (SSSI) within the Tamar Estuaries Complex