



Taw Torridge Crab Tile Survey 2015.

Trialling the use of an Unmanned Aerial Vehicle.



**Lauren Parkhouse
Environment Officer
Devon and Severn Inshore Fisheries and Conservation Authority
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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 a prized sea fishing bait during low water when the tiles are exposed (Black, 2014). This method of bait collection has been used throughout Devon for generations, including in the Taw Torridge Estuary.

The Taw Torridge Estuary is located on the North Devon coast, within the Area of Outstanding Natural Beauty (AONB) and the North Devon UNESCO Biosphere Reserve (Figure 1). The estuary is an important site for wildlife and has been designated a Site of Special Scientific Interest (SSSI) for overwintering and migratory populations of wading birds, special flora, and mudflat and intertidal habitats (Figure 2). The Taw Torridge Estuary was also put forward as a recommended Marine Conservation Zone (rMCZ) during the Finding Sanctuary project (Figure 3). The site was proposed for six Broad Scale Habitats; Subtidal mud, subtidal sand, coastal saltmarshes and saline reed beds, intertidal coarse sediment, intertidal sand and muddy sand, low energy intertidal rock, and one FOCI species the European eel (*Anguilla anguilla*).

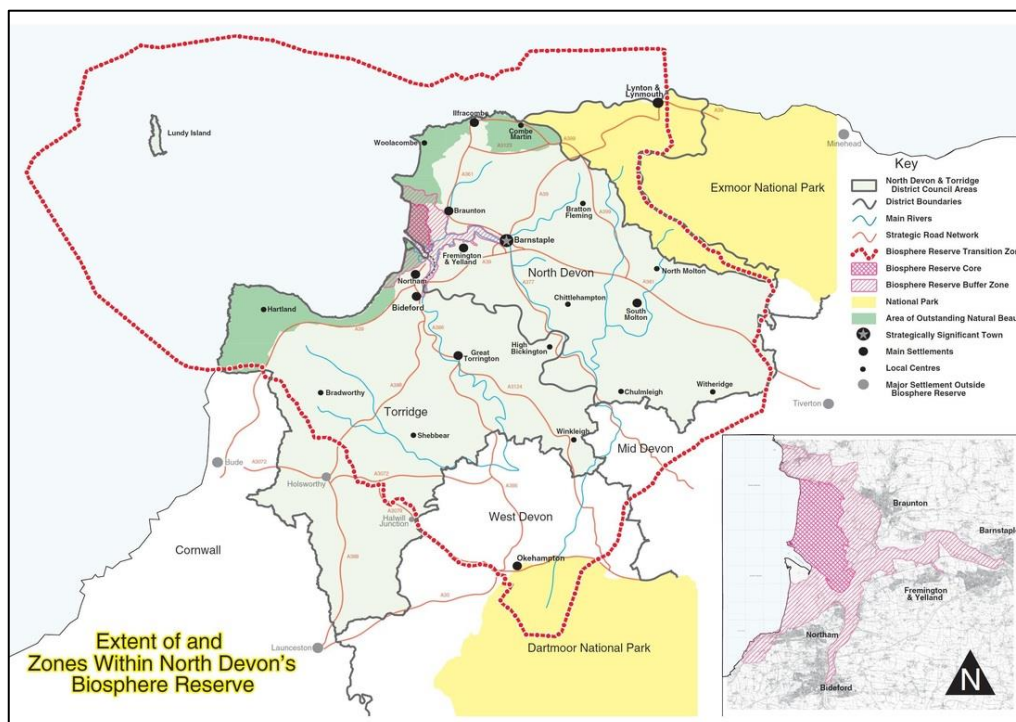


Figure 1 The North Devon Biosphere Reserve and the North Devon Coast AONB with Taw Torridge Estuary in the insert (North Devon Biosphere, 2016).

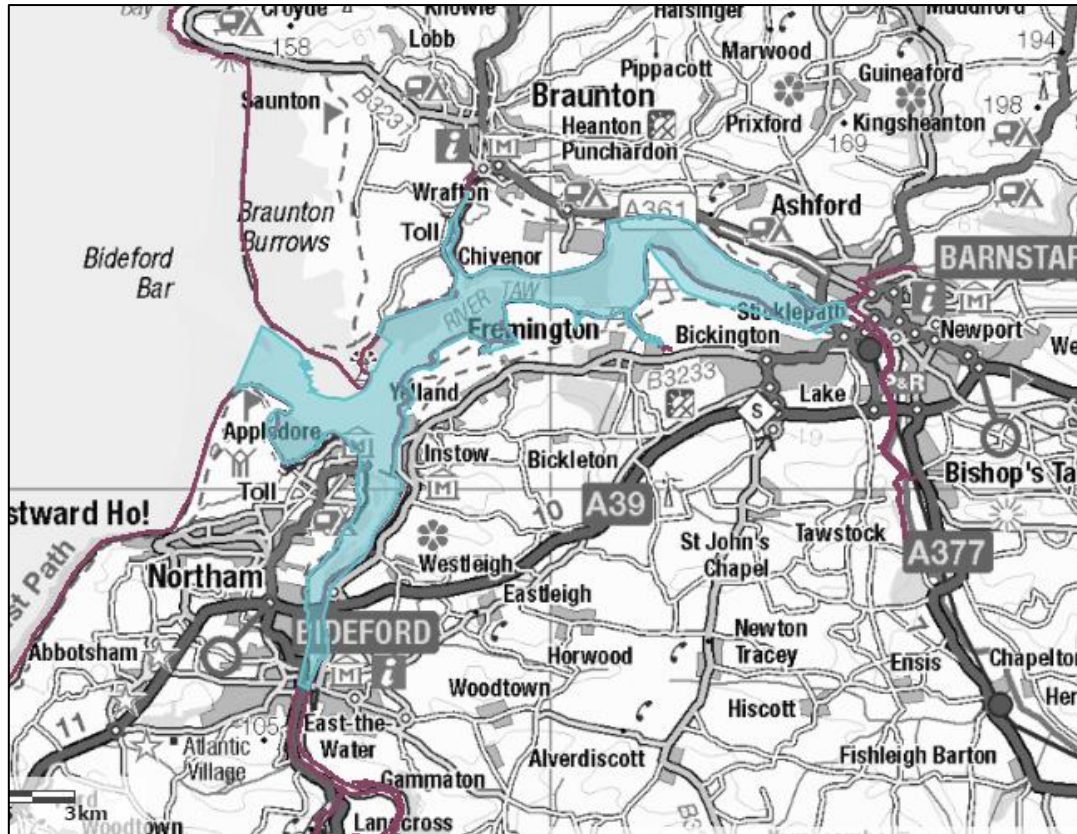


Figure 2 Taw Torridge Estuary SSSI, shown in blue (Defra, 2016).

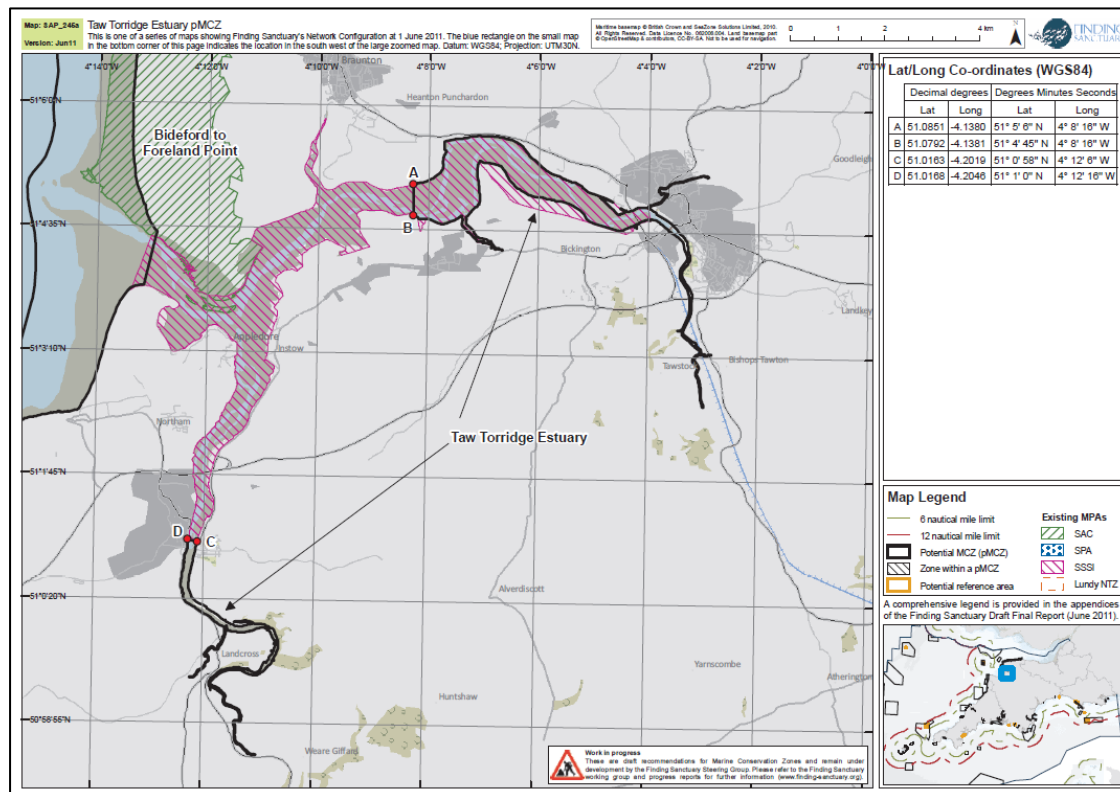


Figure 3 Area of rMCZ, outlined in black. Area of SSSI shown in red hatching, and area of SAC shown by green hatching (Finding Sanctuary, 2011).

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), 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 2015/16 survey results will feed into a hand gathering byelaw which D&S IFCA will start to develop in 2017. Surveys are traditionally undertaken on foot in potentially challenging and muddy conditions, often in remote and hard to reach locations. Due to this, the Environment Team at D&S IFCA used the 2015 survey as a trial to experiment with the use of Unmanned Aerial Vehicle (UAV), or drone as they are commonly referred to, technology to assist research in these potentially dangerous environments.

2. Methodology

Fieldwork was carried out between September and October 2015 to determine the location and number of crab tiles in the estuary. All surveys were carried out over a four-hour time frame, two hours either side of low water on spring tides. This survey saw the use of an Unmanned Aerial Vehicle (UAV) for the first time by Devon and Severn IFCA, and this survey was used as a trial for the method. The aerial imagery company Vertical Horizons Media were chartered to carry out the work.

Crab tile surveys have not been conducted by D&S IFCA on the Taw Torridge Estuary before now, they were previously carried out by other organisations. Due to this, and it being the first use of a UAV for a crab tile survey by the operator, the rough locations of the tiles needed to be determined before the survey could be carried out. Using maps from an old survey undertaken by the Devon Crab Tile Management Forum, two officers spent a day on the estuary to locate the mapped areas, check if tiles were still present, and determine access points for the UAV survey. These areas were then roughly mapped using the MapInfo Bing application; the maps were used by the UAV operator to plan flight paths.

An IFCA officer accompanied the UAV operator for the surveys. Using the site maps produced from the recce (Figure 4 & 5) 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 on a GroPro 3+ 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.



Figure 4 Map of areas of potential crab tiles used for flight paths.



Figure 5 Close up of map used for flight path.

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 (Figure 6).



Figure 6 Geo-located images from drone, stitched together and overlaid onto google earth.

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 (Figure 7). The co-ordinates were transferred to MapInfo to compare results with previous surveys.



Figure 7 Zoomed in image with crab tiles and pinned co-ordinates.

As this is a new method to the IFCA and the UAV operator, two IFCA officers spent a day on the Taw Torridge to ground truth a small, easy access area of the survey to ensure the images and locations matched up with the traditional method of surveying crab tiles. Survey sheets were used to record numbers of tiles in distinct blocks or line formations. GPS co-ordinates were taken around the perimeters, or at the start and end of each line. Crab tiles were counted wherever possible, or estimations were used if there were large amounts of tiles. As well as the number and location of tiles, the substrate, type of material used, orientation, and usage status were recorded. These areas were mapped to compare to the drone count maps.

3. Results

3.1 Crab Tile Results

The total count for the 2015 survey was 3704 tiles. Table 1 compares the number of tiles to previous surveys, Table 2 compares the 2015 counts to the original baseline data from 2000/01. There were 1160 less tiles in 2015 compared to the baseline survey, this is a decrease of 24%.

Table 1: Comparison of Total Tile Counts.

Survey	Number of Tiles	Difference	Percentage Difference
2000/1	4864	-	-
2003/4	3741	-1123	-23%
2011	2213	-1528	-40%
2015	3704	+1491	+67%

Table 2: Comparison of Tile Counts: 2015 Survey and 2000/1 Baseline Data.

No. Tiles 2015	No. Tiles 2000/01	Difference	Percentage
3704	4864	-1160	-24%

Figures 8-17 below show the crab tiled areas from the 2003/4 and 2011 surveys carried out by foot, and the latest 2015 survey carried out with the drone.

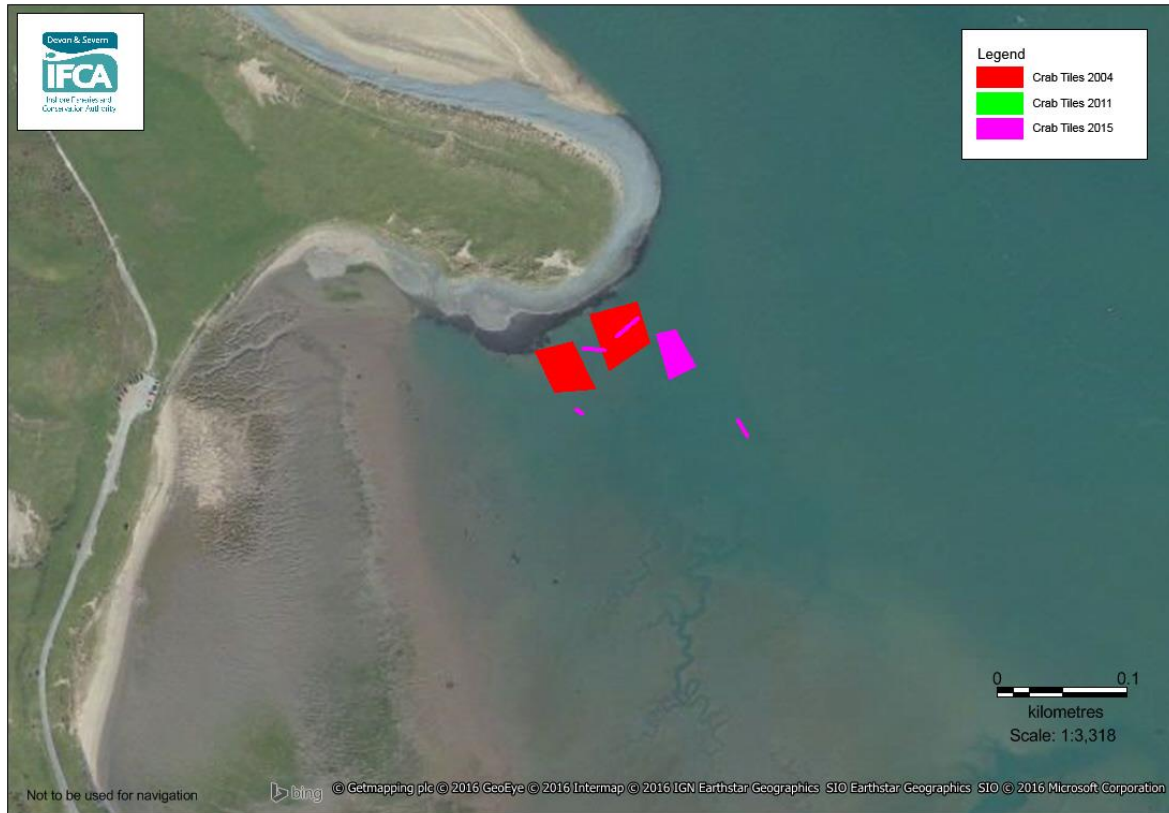


Figure 8 Comparison of crab tile areas at Greysands, 2004, 2011 and 2015 surveys.



Figure 9 Comparison of crab tile areas at Appledore, 2004, 2011 and 2015 surveys.

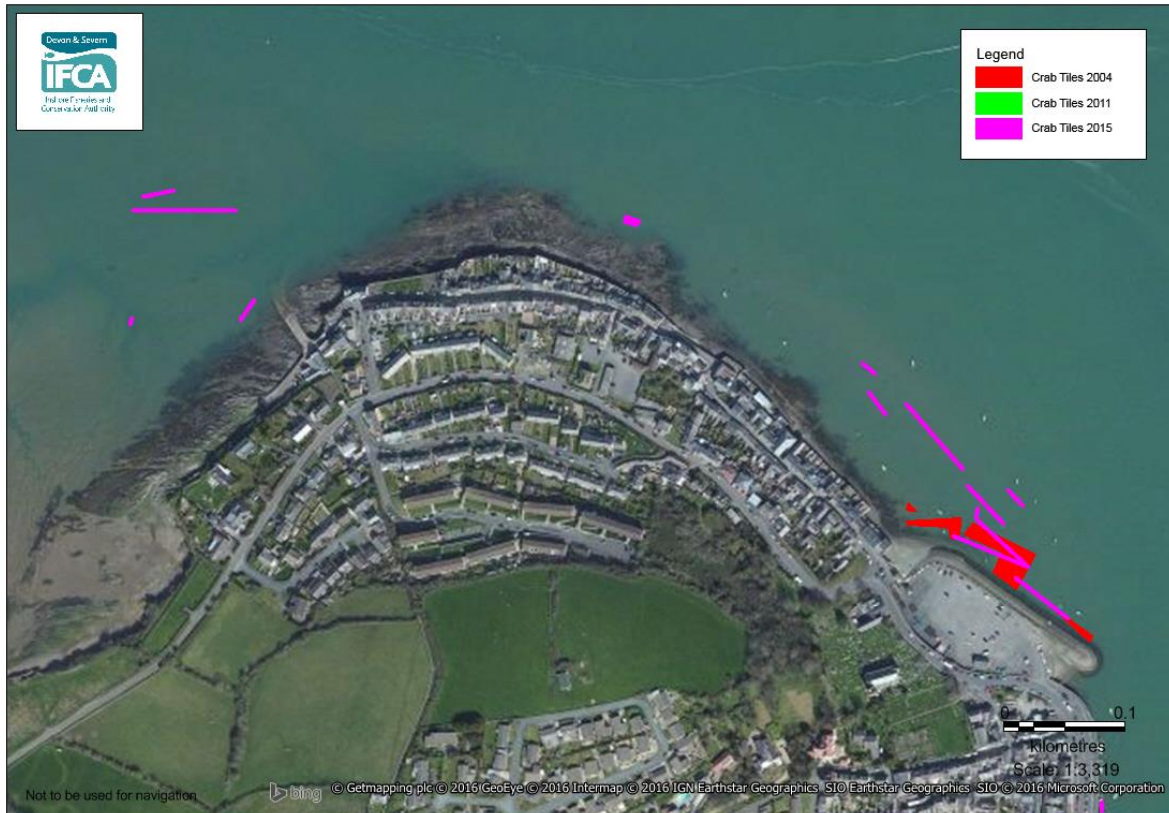


Figure 10 Comparison of crab tile areas at Appledore lifeboat slip to car park, 2004, 2011 and 2015 surveys.



Figure 11 Comparison of crab tile areas at Bowtide, 2004, 2011 and 2015 surveys.

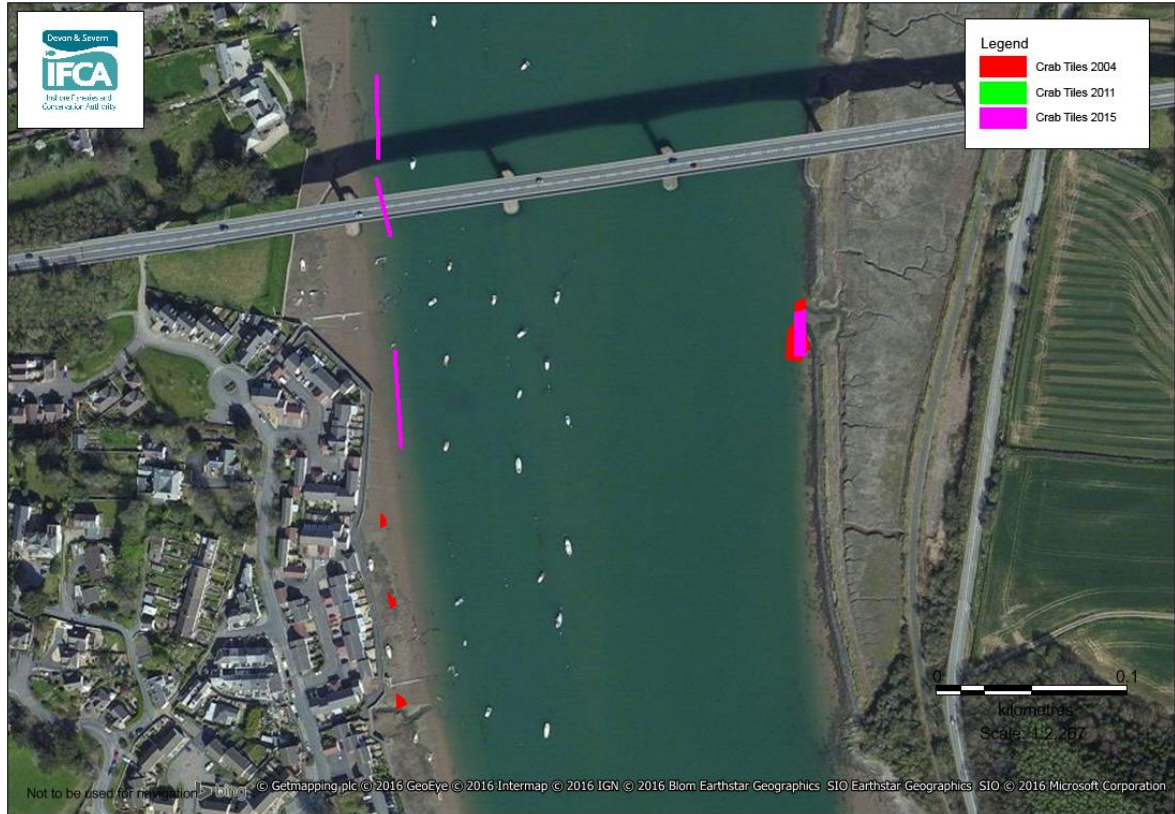


Figure 12 Comparison of crab tile areas at Bideford, 2004, 2011 and 2015 surveys.

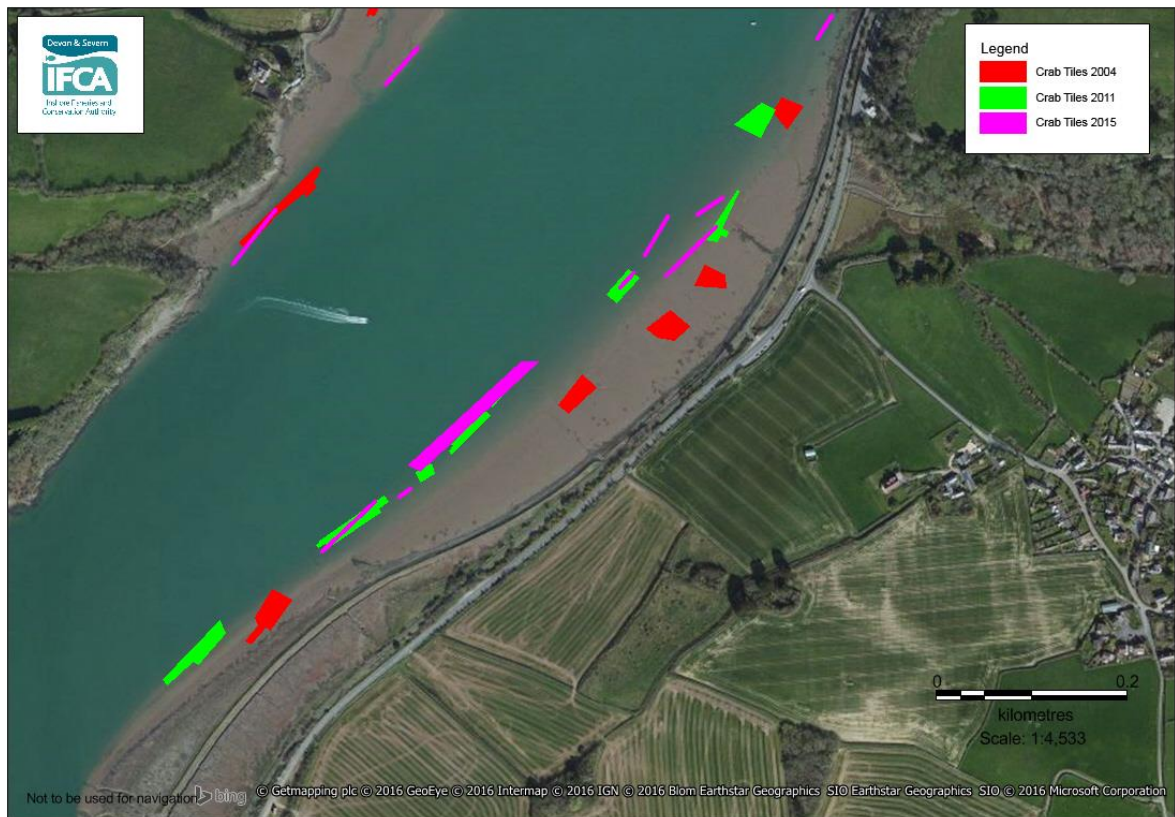


Figure 13 Comparison of crab tile areas at Westleigh, 2004, 2011 and 2015 surveys.

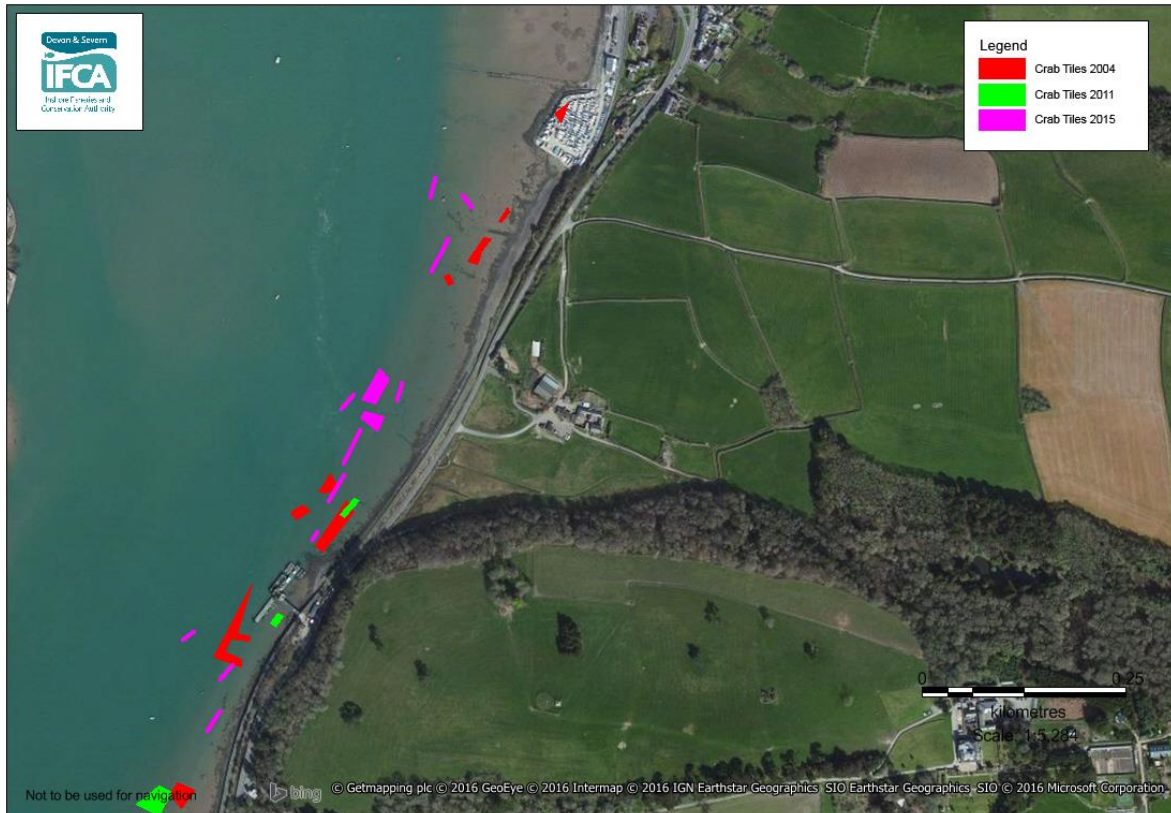


Figure 14 Comparison of crab tile areas at Instow, 2004, 2011 and 2015 surveys.



Figure 15 Comparison of crab tile areas at Yelland, 2004, 2011 and 2015 surveys.

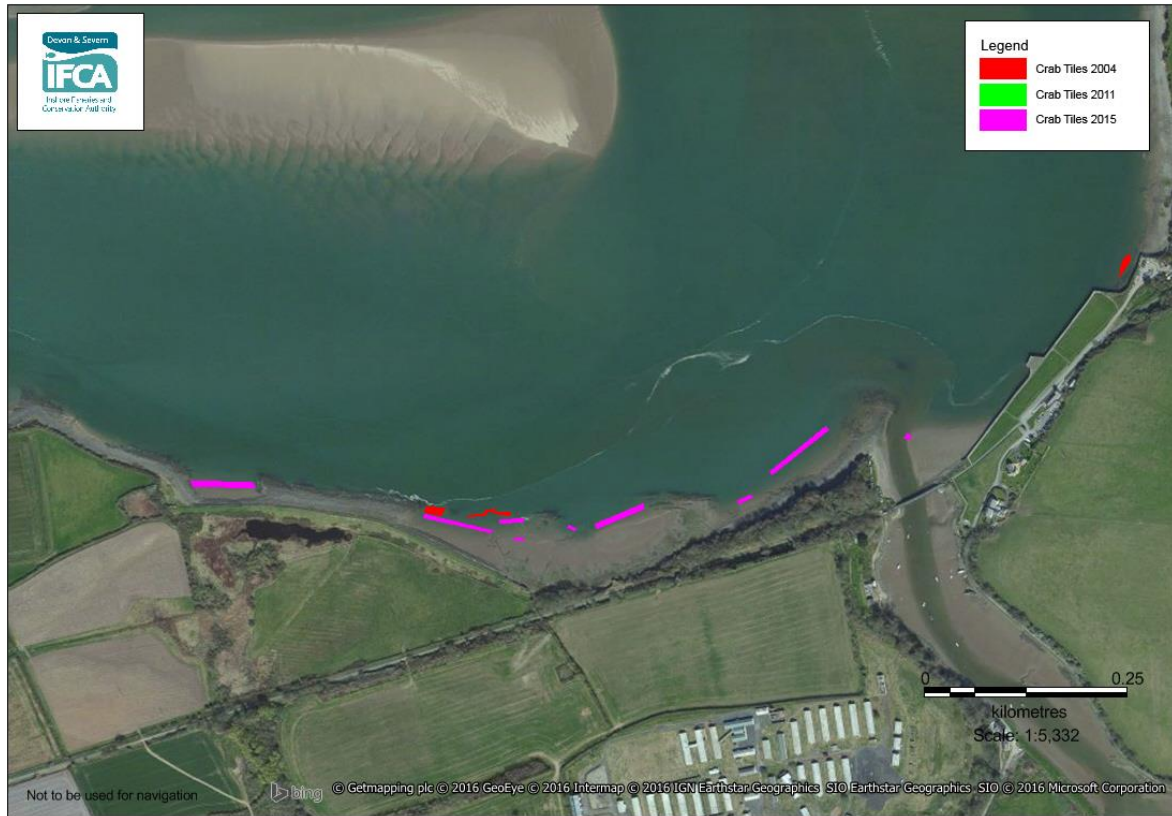


Figure 16 Comparison of crab tile areas at Fremington, 2004, 2011 and 2015 surveys.

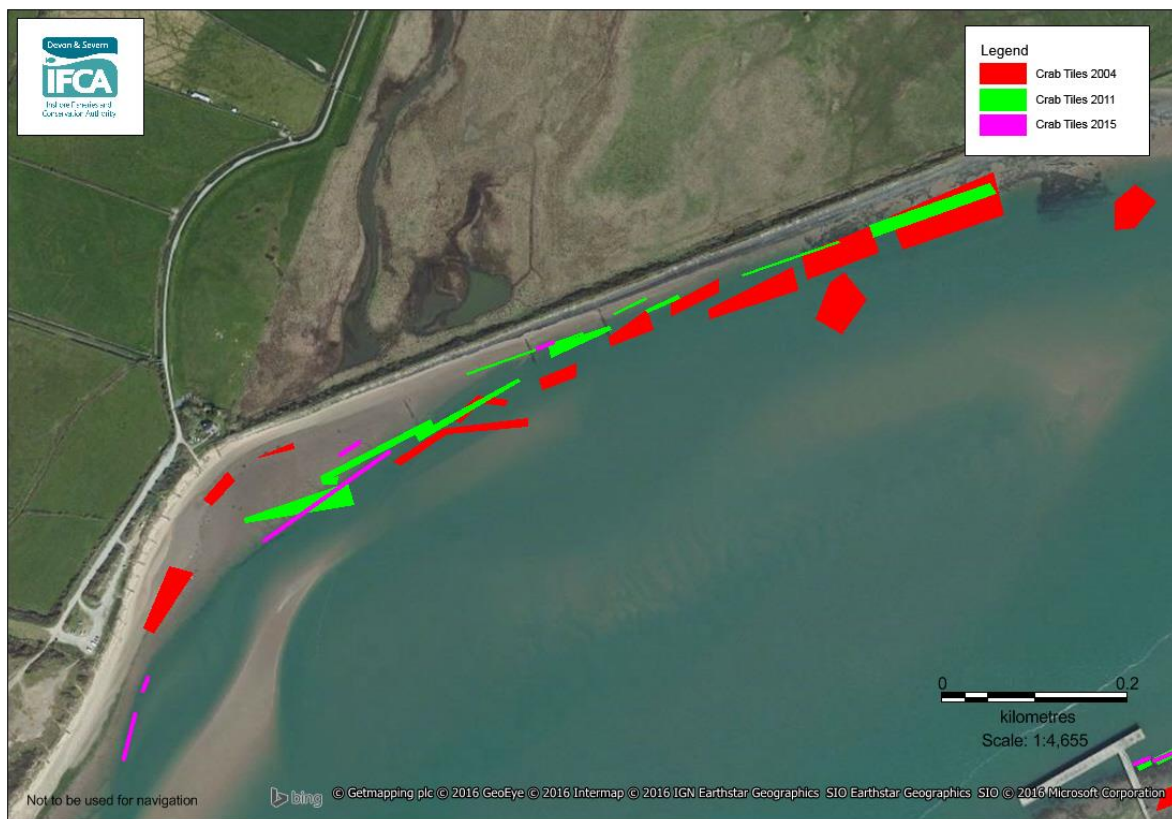


Figure 17 Comparison of crab tile areas at Crow, 2004, 2011 and 2015 surveys.

3.2 UAV Trial Results

As stated in the methodology, a day was used to cross check the drone results with the traditional survey method. Figures 18-21 compare the crab tile areas produced with the drone imaging and areas mapped by foot. The areas and counts mostly match, with more crab tile areas being located with the drone than by foot.



Figure 18 Comparison of drone survey (pink) and traditional foot survey (blue) at Greysands.



Figure 19 Comparison of drone survey (pink) and traditional foot survey (blue) at the lifeboat slip.



Figure 20 Comparison of drone survey (pink) and traditional foot survey (blue) at Appledore carpark.



Figure 21 Comparison of drone survey (pink) and traditional foot survey (blue) at Bideford.

4. Discussion

The total count of crab tiles for the 2015 UAV survey is 3704, this is 1491 more tiles than in the last survey carried out in 2011. There is no report available from the 2011 survey and it was not carried out by D&S IFCA. From the GIS layers alone, it would appear that certain areas of the Taw Torridge were not surveyed in 2011 and this may explain the lower levels of tiles. During the 2003/4 survey 3741 tiles were counted, this is very similar to the 2015 survey with a decrease of just 37 tiles. There was a total decrease from the 2000/1 baseline survey of 1160 tiles. There are no GIS layers from this survey and therefore it is unknown where this decrease occurred. However, the 2004 report carried out by the Devon Biodiversity Records Centre states there was an increase of tiles on the Torridge between 2000/1 and 2003/4 and a decrease of tiles on the Taw (Black, 2004). By removing the incomplete 2011 results it would appear that crab tile numbers have remained stable since 2003/4.

From the comparison maps in the results section it can be seen there has been a decrease of crab tile areas in some locations and an increase in others. A notable decrease can be seen at Crow (Figure 14). There were unconfirmed reports of crab tiles being removed and/or smashed up by rival crab collectors in the area, this could explain the decrease in area covered by the tiles. Movement of crab tiled areas over the years can be expected. This may be due to people no longer tiling, moving tiles to more suitable areas, or the general movement which would occur when replacing the tile. The apparent movement of tiles over the years may also be due to the surveying techniques used. Surveys are carried out by different people, and personal judgement is used with the help of binoculars when the tiles cannot be reached by foot to accurately record GPS location and counts. Therefore, estimates of the location/area covered by tiles and the number of tiles may have differed from survey to survey.

The outcome of the trial to use a UAV to carry out a crab tile survey was considered to be successful. Geolocated images allowed for accurate positions and estimated numbers of crab tiles to be determined without stepping foot on the estuary. This method has made it safer to count the crab tiles in the more challenging and difficult to reach areas. This could lead to more accurate counts and locations of tiles in future surveys, as estimates of positions and tile counts in difficult to reach areas are made using binoculars and personal judgement. The UAV can fly above these difficult areas and retrieve images to be analysed on a computer.

As well as the safety aspects of the traditional surveys, undertaking the crab tile surveys by foot takes a large amount of resources, with officers and volunteers spending a number of spring tides on the estuaries. The UAV surveys can be conducted by the operator alone or with one officer, this leaves the rest of the team free to carry out other important work streams.

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.

Defra (2016) Magic Map [online] Available: <http://magic.defra.gov.uk/MagicMap.aspx>

Finding Sanctuary (2011) Final Report and Recommendations. September 2011

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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

Aerial Surveying Technical Specification

Devon and Severn Inshore Fisheries Conservation Agency (IFCA) & 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:

- GPSTable – 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.