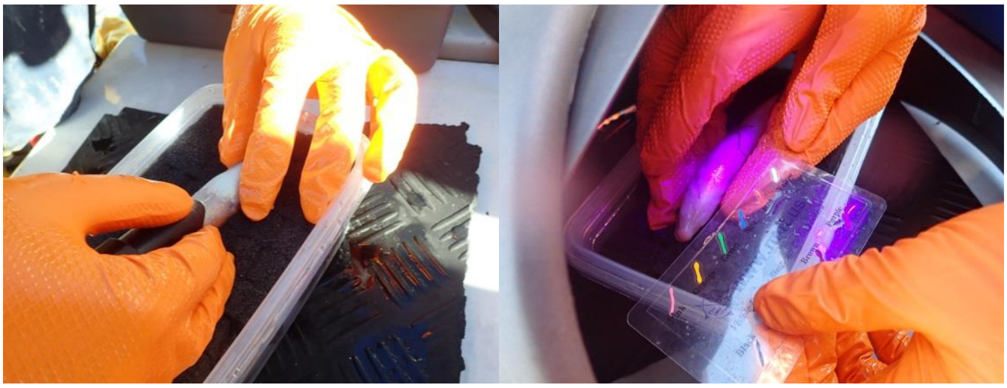
Wrasse Tagging Veryan Bay Pilot Survey Report 2018



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Glossary of terms

Nights Lie: the numbers of nights since the traps were baited

String(s): A collection of traps, set together on one back rope.

Trap(s): The individual fish traps used for catching wrasse.

(Wrasse) Tagged: All ballan, goldsinny, corkwing and rock cook that were retained in traps were tagged using coloured tags which are injected beneath clear or translucent tissue and externally visible.

(Wrasse) Recaptured: All ballan, goldsinny, corkwing and rock cook that were previously tagged and that were retained in traps again.

1 Project background

Wrasse have been found to be particularly effective as cleaner fish and have been used as part of many salmon production company's sea lice control strategies along with more traditional chemical treatments. Although having been practiced in Scotland and off the Norwegian coast for nearly 30 years, fishing for and retaining of live wrasse to supply the salmon production industry with cleaner fish is an extremely new and innovative fishery to the south west of England. Concerns for the long term effectiveness of current chemical treatments and the impact of those chemicals to the wider marine environment has seen measures introduced to restrict their use. Additionally, the industry has recognised the economic benefits of using cleaner fish rather than a dependence on chemical controls. The restrictions applied to the use of chemical treatments and increased use of cleaner fish has seen production companies sourcing wrasse from further afield than Scotland to maintain supply without exhausting local stocks (L Bennett, R Hawkins, 2017, pers. comm.). In Cornwall, fishing for wrasse using traps began as very small scale experimental fishing during 2014. Those initial trials have led to the fishermen who carried out those early experiments now almost wholly relying on the fishery for their income. There are five known species of wrasse in Cornwall IFCA district; ballan (*Labrus bergylta*), corkwing (*Symphodus melops*), rock cook (*Centrolabrus exoletus*), goldsinny (*Ctenolabrus rupestris*) and cuckoo (*Labrus mixtus*). Cuckoo wrasse are not targeted by the fishery. Ballan, corkwing, rock cook and goldsinny are targeted out of Plymouth and only ballan wrasse are targeted near Falmouth and Mevagissey.

Cornwall Inshore Fisheries and Conservation Authority (IFCA) Scientific Officers have carried out independent sampling effort on board their own survey vessel, Tiger Lily VI, in 2016 (Street *et al.* 2016) and 2017 (Street *et al.* 2017a), alongside carrying out sampling on board the commercial wrasse fishing vessels (Street *et al.* 2017b). This data has gathered information on catch per unit effort (CPUE), fishery spatial distribution, species composition, length frequency, spawning state, size at maturity and sex ratios of wrasse within Cornwall IFCA district. This data has resulted in greater understanding of wrasse habitat preferences locally and baseline data on wrasse populations retained in traps. There is still, however, limited information on wrasse stocks within Cornwall IFCA district and because of this Cornwall IFCA is in the process of creating a Live Wrasse Fishing (Limited Permit) Byelaw[1] to manage and monitor the fishery. Street *et al.* (2017b) recommended for future Cornwall IFCA surveys a mark and recapture study could be undertaken in order to estimate population sizes locally.

With the help of Natural England, Cornwall IFCA received funding from the DEFRA Science Capital Bid to purchase survey equipment including; fish traps (and associated rigging e.g. ropes, buoys) and Visible Implant Elastomer (VIE) Tagging equipment (Northwest Marine Technology Inc.). VIE tags are coloured tags which are injected as liquid, implanted beneath clear or translucent tissue, which then cures into a pliable solid. The VIE tags remain externally visible and when using fluorescent colours, they can be highly visible under a deep violet light.

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[1] The Live Wrasse Fishing (Limited Permit) Byelaw came into force on 4th February 2019 https://secure.toolkitfiles.co.uk/clients/17099/sitedata/Byelaws%20and%20orders/Cornwall_IFCA/Live-Wrasse-Fishing-Byelaw-2018.pdf

This report summarises a pilot survey which was carried out in order to determine VIE tagging methodology and the effectiveness of using VIE tags to carry out a mark and re-capture survey. This pilot survey and methodology will form the basis of a larger survey project to provide baseline data of wrasse population estimates in previously unfished and fished areas for future monitoring and provide data to inform management for a sustainable fishery.

1.1 Aims and Objectives

The aims of the study were to determine the suitability of using VIE tags on wrasse and evaluate the effectiveness of using VIE tags for a mark and re-capture survey.

1.1.1 Aims

- Determine the suitabliliy of tagging wrasse with VIE tags.
- Develop an effective survey methodology for mark and recapture surveys using VIE tags.

1.1.2 Objectives

- Evaluate suitable VIE tag locations, retention rates and tag visibility on wrasse.
- Set and haul six strings of 10 traps within Veryan Bay from research vessel (R/V) Tiger Lily VI.
- Compare catch data from two separate hauls at each string and between the two separate locations
- Assess number of tagged wrasse recaptured.

2 Methodology

2.1 Survey equipment set up

2.1.1 Size of traps

The local fishers use wrasse traps supplied by the salmon farms. The traps (Figure 1) are supplied by Carapax[2], measure 72 cm length x 40 cm width x 28 cm height, weigh 3.7 kg and are composed of small mesh netting with a self-closable parlour entrance. Due to difficulty sourcing new traps in time for the pilot survey, a local fisher allowed Cornwall IFCA to borrow their gear while it was not in use. The traps were already rigged with a back rope, and markers.

[2] http://en.carapax.se/creelspotstraps/cleaning-wrasse-traps/wrasse-trap.html

Figure 1: Carapax wrasse trap used for survey (source: carapax.se).

2.1.2 Weight of traps

The traps used had a frame around the base of the trap to add weight and protect the base (Figure 2). In the wrasse fishery, modifications have been made that appear to increase the efficieny and lonevity of the traps.

Figure 2: Example of modifications that have been made to wrasse traps.

2.1.3 Condition of the traps

The traps used had not been cleaned during the season and had built up a layer of algae (Figure 3).

Figure 3: An example of the algae growth covering the wrasse traps.

2.1.4 Escape gaps

The traps had escape gaps which were closed off using flexible black plastic and cable ties (Figure 4).

Figure 4: An example of the closed off escape gaps on each wrasse trap.

2.1.5 Distance between traps

Local fishermen have a 10 fathom (18.3 m) backrope between traps.

2.1.6 Weighted ends

The strings were rigged with one parlor pot at each end as shown in Figure 5.

Figure 5: Parlour pots attached to either end of the string of wrasse traps, used as weight ends.

2.1.7 Number of traps per string

The strings were set with 10 traps per string and six strings were used in the survey. However, one string only had eight traps with no parlour on one end.

2.2 Methodology for setting and hauling traps

The survey was carried out from Cornwall IFCA research vessel (R/V) Tiger Lily VI (Figure 6), which is a South Boats 11 m Island MkII catamaran with twin IVECO 450hp engines (Annex 1).

Figure 6: Research Vessel (R/V) Tiger Lily VI – Cornwall IFCA's research survey vessel.

2.2.1 Shooting

The traps were shot into the tide, with the back rope kept tight so that the traps were evenly spaced. Once at the starting position for a string the first marker was deployed over the side. The skipper slowly navigated the boat to the desired end point of the string whilst the deck crew deployed the traps; as the back rope became tight the first trap was deployed, then the processed repeated with each trap until the entire string was in the water. A target was made on HYPACK®MAX (Version 2018) when each parlour pot and trap was deployed over the side and was labelled with the trap and string number. A clear line of sight and communication was maintained between skipper and deck crew throughout the shooting operation.

The traps were baited using a big handful of cooked crab shell (approximately two handfuls per trap). In total, two bongos of cooked crab meat were supplied from W Harvey & Sons which was sufficient for baiting 116 traps (baiting the six strings twice).

2.2.2 Hauling

The traps were hauled into the tide so that the vessel didn't run over the back line as it was being hauled. The traps were hauled slowly to try to prevent swim bladder damage so as to limit damage to the wrasse. As each trap was brought aboard the contents of each trap were emptied into a fish box (Figure 7) and a photograph was taken using an Olympus TG-5 camera. The state of the trap including the escape gaps on each trap was noted. Any by-catch which could potentially impact the wrasse was noted down (including eels, velvet swimming crabs and spiny starfish). The species, size and sex of the individual wrasse was recorded and a note was made if they were spawning. To check if the wrasse were spawning they were 'stripped' by running two fingers with a small amount of pressure along the underside of the wrasse and noting if eggs (female) or milt (male) came out. Once measured, the wrasse were transferred to a bucket full of seawater (Figure 7) before being tagged. The remaining contents of the fish box were emptied over the side of the vessel. The trap was then safely stacked on deck. This process was repeated for each trap in the string.

Figure 7: Wrasse being measured from the fish box and then into a bucket with fresh seawater.

2.2.3 VIE Tagging

The unmixed VIE was stored in the fridge on board the vessel when not in use. Before each string was hauled, the selected coloured elastomer and curing agent were mixed in a 10:1 ratio according to Northwest Marine Technology Inc. instructions[3] (NWM, 2017). Officers used 0.25 ml of elastomer and 0.025 ml of the curing agent which would equate to approximately 50-125 tags and 25-62.5 wrasse (two tags per wrasse) once mixed. The elastomer and curing agent were mixed in a 15ml cup using a toothpick for one minute. The mixed VIE was drawn up into a 1 ml transfer syringe and approximately 0.1 ml was filled into a 0.3 ml injection syringe. Care was taken to ensure no air pockets had formed within the syringes. The injection syringe containing the mixed VIE was stored in the freezer compartment of the fridge until needed to maximise shelf life. To verify the elastomer had cured properly, the mixing cups and transfer syringes were kept in a sealed container for over 24 hours and checked to see if they had set.

Pick and pluck foam was fitted into a plastic box and filled with seawater. Each wrasse that had been measured was placed upside down into a slot in the foam to stabilise the wrasse (Figure 8) and ensure that the sampling officer could keep their non-injecting hand away from the needle. Using the Manual Elastomer Injector, pressure was exerted until the coloured VIE was seen on the tip of the needle. Excess VIE was cleared using paper towel. The needle was inserted under the skin in front of the pectoral fins and VIE was injected as the needle was pulled back. Dispensing of the VIE was stopped before the needle was completely withdrawn. This was to ensure that there was no trailing material to stop the wound from healing or increase tag loss. The two VIE tags were placed parallel, ventrally and were approximately 5 mm long depending on the size of the wrasse (Figure 9).

[3] Available from: https://www.nmt.us/wp-content/uploads/2017/11/10-to-1-Manual-VIE-Kits-Nov-2017.pdf [Accessed: 04/10/2018].

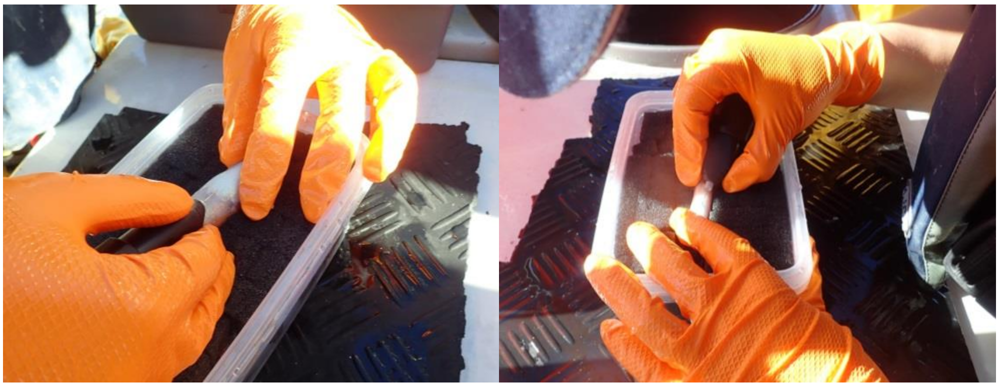


Figure 8: Examples of wrasse placed in upside down in foam, whilst inserting VIE tags.

Figure 9: Example of VIE tags; yellow VIE in ballan (left) and blue VIE in goldsinny (right).

After tagging, the wrasse were placed carefully into a bin full of fresh seawater to recover. Two bins were used to split the fish into traps one to five and traps six to ten (Figure 10). This was so the wrasse could be separated from which traps they were caught in and returned as close to where they were caught as possible.

Figure 10: Bins of fresh seawater to acclimatise tagged wrasse before returned back to sea which were split into wrasse from traps 1-5 and 6-10.

At the end of each string, the wrasse were returned to the sea. This was done by first returning those caught in traps one to five by positioning the vessel centrally as possible to the set of five traps where they were caught using the targets marked on HYPACK. Wrasse were transferred to a smaller bucket using a hand net and once the vessel was in position the bucket was slowly tipped under the water from the stern of the vessel. Officers ensured all the wrasse had swum down before the vessel moved. This was repeated for the wrasse caught in traps six to ten.

For the second day of hauling, the method from section 2.2.2 was repeated. But instead of tagging the wrasse after measuring, wrasse were screened for the presence of VIE tags. This was carried out by placing the wrasse onto the foam in a shaded area. Shade was created using a tarpaulin canopy and putting the wrasse inside a domestic bin lid.

Using a Visible Implant (VI) Light torch (supplied by Northwest Marine Technology Inc.), the area in front of the pectoral fins, ventrally, was lit to show signs of VIE tags (Figure 11). The VI torch is used to fluoresce VIE tags and it has a deep violet wavelength (405 nm). Officers also looked in ambient light in case the glare of the VI Light torch obscured the VIE tags (Figure 12). The VIE Colour Standard (supplied by Northwest Marine Technology Inc.) was kept in close proximity in order to compare the colour sample directly beside a VIE tag for comparison (Figure 12).

Figure 11: Wrasse being screened for VIE tags using the VI Light torch

Figure 12: The recaptured goldsinny with VIE tags under VI Light and the VIE Colour Standard (left) and VIE tags in ambient light (right).

2.3 Ethics

For animal welfare the three R's (Replace, Reduce and Refine) were considered during the initial survey planning (Russell and Burch 1959; ASPA 1986). During previous surveys Cornwall IFCA officers have been able to refine the sampling procedure in order to minimise stress to all species caught (Street *et al.* 2016, 2017a & 2017b). This includes the handling and release of all species (including by-catch) promptly and with minimal injury. Handling was kept to a minimum and gloves were worn to reduce unnecessary loss of external mucus or scales. Holding buckets and bins were replenished with fresh seawater and monitored to allow wrasse to recover before returning to sea. By-catch was photographed and returned immediately.

Ethical considerations were made for intrusive sampling (VIE tagging) on the welfare of wrasse. Prior to carrying out the survey, Cornwall IFCA officers experimented on dead fish (two mackerel and one ballan) to become familiar with the tagging procedure and determine suitable tagging locations. The size and location of the VIE tags used in wrasse were deemed to be appropriate for the size of wrasse. It was also thought desirable that the size and type of tag used should not affect wrasse social interactions or reduce predator avoidance. During the survey cuckoo wrasse were excluded from tagging as this species is not targeted by the wrasse fishery and therefore deemed to be not relevant to meet the aims of the survey. By carrying out the tagging in September, this avoided the main spawning period and would reduce tagging vulnerable breeding wrasse. It was also decided before carrying out the survey that any wrasse which were under 7 cm were deemed too small to be tagged without accidently harming.

Before tagging, the wrasse were visually inspected for any signs of damage to ensure tagging would not hinder the wrasse's health further. For each wrasse the total handling and tagging procedure took less than 30 seconds. During the tagging procedure, wrasse remained still and docile when on their underside, being immersed in water and eyes covered. All wrasse which were caught (excluding cuckoo and individuals less than 7 cm total length) were tagged as this was deemed an appropriate amount in order to obtain a large enough sample size for a mark and recapture study and achieve the objectives of the survey.

The use of VIE tags in wrasse was deemed to have no lasting harm to wrasse or not to be harmful to humans from introduction into the food chain. The VIE tags are non-toxic and information on the ingestion of VIE tags can be seen in Annex 2. Additionally, the wrasse were not anesthetised as it was deemed unnecessary and it was not possible to ensure that the anaesthetised wrasse, once released, would not end up for human consumption.

Before undertaking the survey, Cornwall IFCA researched relevant legislation and regulations to this survey methodology and sought advice from the University of Exeter. It was decided that VIE tagging carried out to the planned method was not considered to be a regulated procedure under the Animals (Scientific Procedures) Act 1986 Section 2 (8) (e).

2.4 Temporal variables

There are a number of temporal variables which were judged to have a potential impact on the results of this survey. To limit the impact of the tide, wind speed, wind direction and water visibility the following mitigation measures were followed;

2.4.1 Tidal range

It has been reported that tidal range has an influence over catch rates and Street *et al.* (2017) found catch rates were highest for the period of time after a peak spring tide. The tidal height range was 5 m to 5.2 m (taken from the closest port, Mevagissey) for the duration of the survey.

2.4.2 Wind speed

The survey would only take place in wind speeds of less than 30 mph for the entire time that the traps are fishing.

2.4.3 Wind direction

All survey locations were to be on the south coast with a southerly or easterly aspect. No survey would take place in an easterly wind with a NE-S wind above 10 mph. This was for vessel safety when working so close in to shore and to reduce the influence of wind on the survey.

2.4.4 Water parameters

A profile using Cornwall IFCA's Valeport Swift Sound Velocity Profiler (SVP)[4] was taken on every survey on hauling and setting days to determine sound velocity, pressure, temperature, salinity and density.

2.5 Location of strings

Two locations within Veryan Bay were chosen as the focus of the study; near Portloe (Figure 13) and west of Dodman Point (Figure 14). These have been chosen as areas that are previously and currently unfished. These locations were also in reasonable proximity to the location of the traps to be borrowed from the fisher. Previously recorded side scan data (Jenkin *et al.,* 2016) was observed to identify suitable habitat. The west of Dodman Point was chosen as exposed reef habitat and the area near Portloe was chosen as sheltered reef habitat. Three strings were set per location.
An image of the plotter was taken when each trap was deployed to determine the habitat and topography of the seabed where each trap was set, allowing comparisons to be made (Table 8, Annex 3).

[4] Valeport Swift Sound Velocity Profiler Specifications http://www.valeport.co.uk/Portals/0/Docs/Datasheets/Valeport-SWiFT-SVP.pdf

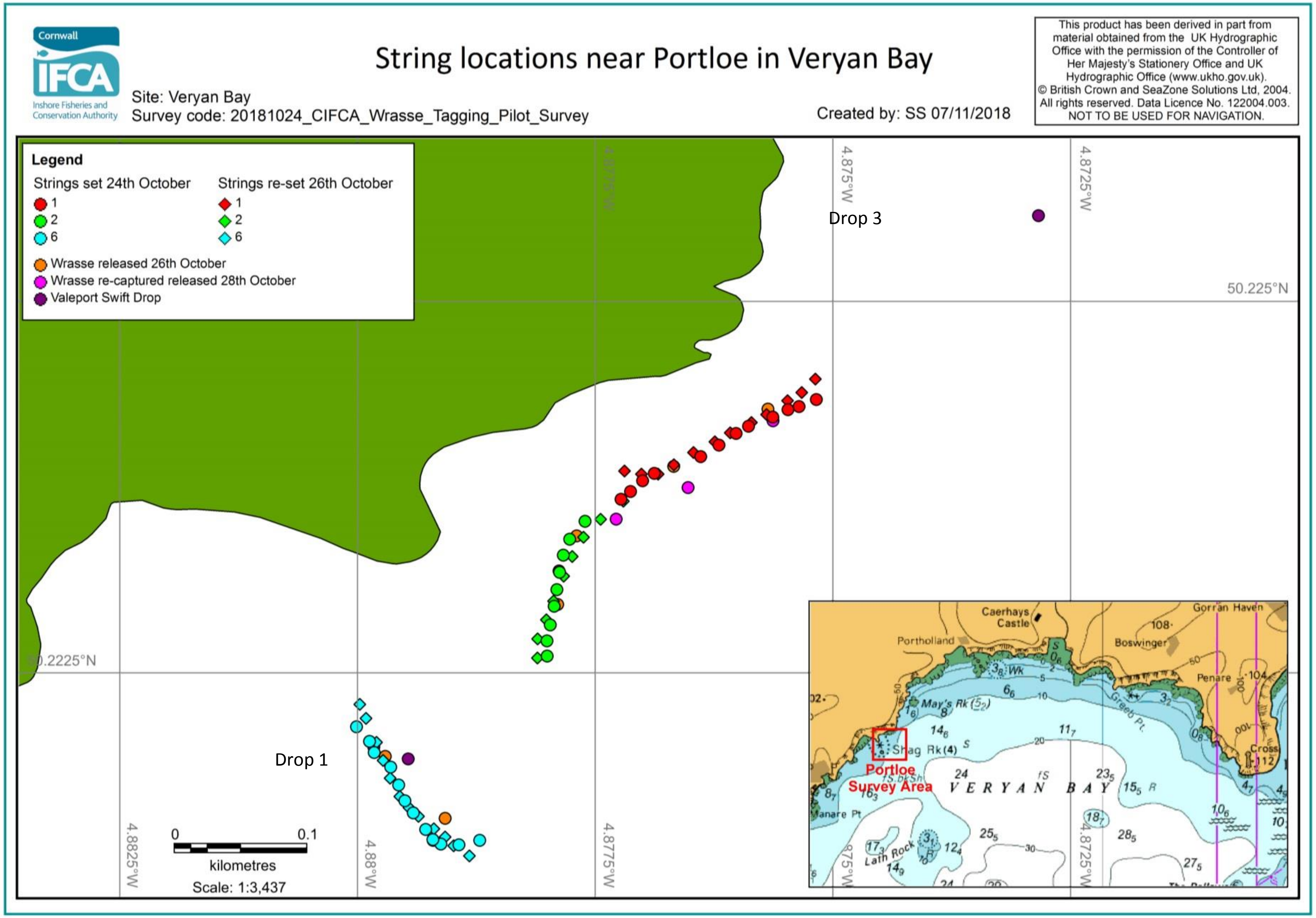


Figure 13: Location of strings and Valeport Swift Sound Velocity Profiler drop near Portloe in Veryan Bay.

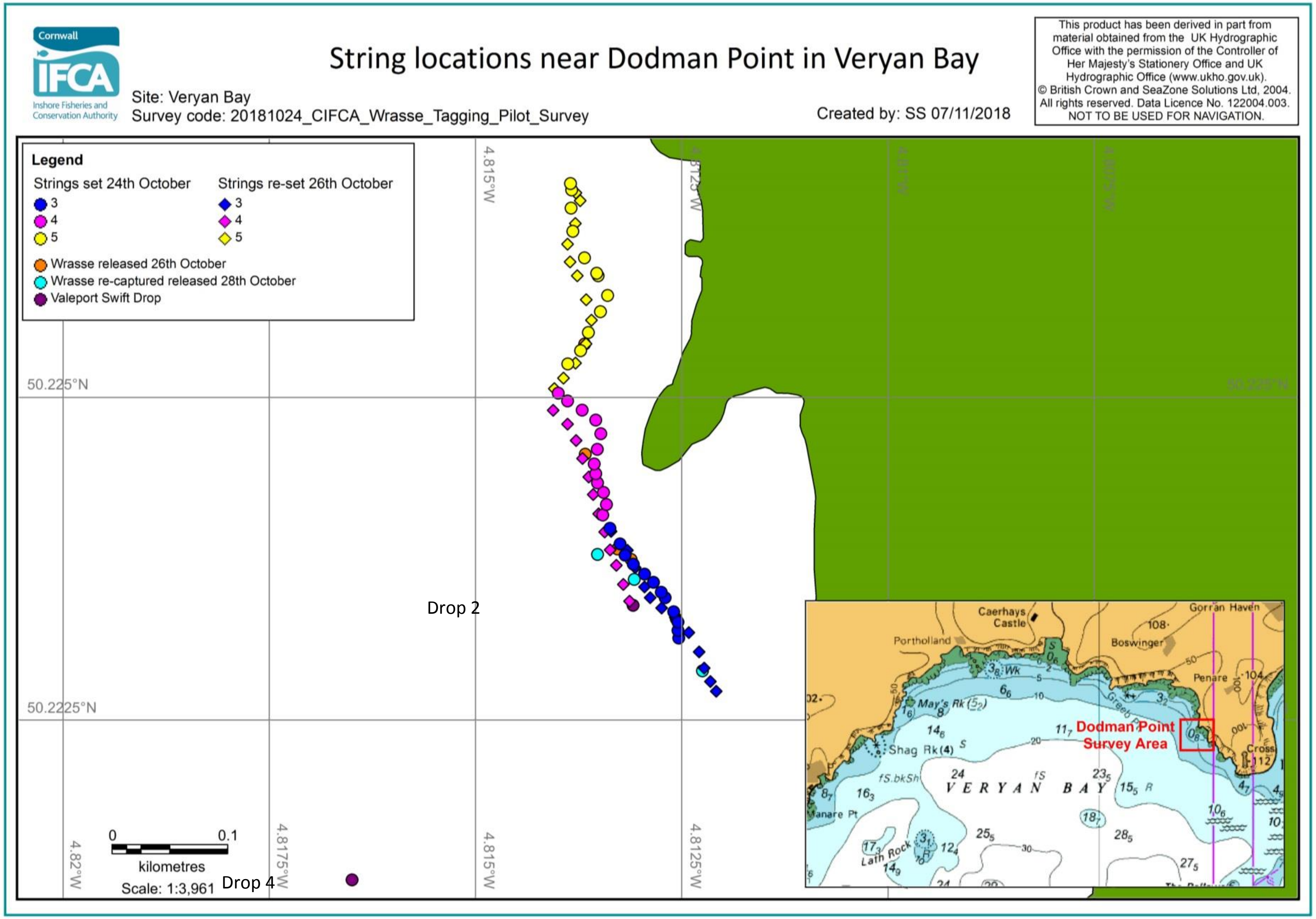


Figure 14: Location of strings and Valeport Swift Sound Velocity Profiler drop near Dodman Point in Veryan Bay.

2.6 Data recording

When each trap was shot overboard a HYPACK target for their position was created, enabling them to be accurately located and the whole string replicated for the following recapture. Images taken on the camera were copied and transferred into organised files. When recording catch details, the species, length, sex, spawning or not spawning, damage to the wrasse and swim bladder damage was documented on waterproof paper. As well as tag colour, number of tags and tag location and any other relevant information e.g. hole in trap. All catch details were then transferred into a Microsoft Excel workbook for analysis. The targets were exported from HYPACK as a .txt file and opened in Excel. Once reviewed, the Excel file was then transferred to the GI software, MapInfo Profession (Version 17) where data points were created to give a visualisation of the location of each string.

The daily logs for all survey days are shown in Annex 4.

2.7 Statistical Analysis

To estimate population size for wrasse within the two survey sites, the Petersen model was used. This is based on a closed population for two visits. Where $\widehat{N}$ is estimated population size, *C* catch taken, *M* marked individuals, and *R* marked individuals recaptured.

$$\widehat{N} = \frac{C \times M}{R}$$

For where small sample sizes (*R*≥7) were found and where the numbers of recaptures were zero, the Chapman modification (Chapman, 1951) was used.

$$\widehat{N} = \frac{(M+1)(C+1)}{R+1} - 1$$

The variance (*V*) of $\widehat{N}$ can be estimated as:

$$V = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

An approximate 95% confidence interval (normality for $\widehat{N}$ is assumed) can be estimated as:

$$\widehat{N} \pm 1.965 \times V^{0.5}$$

3 Results

A total of 329 wrasse were retained and measured from five different species of wrasse; ballan, cuckoo, goldsinny, corkwing and rock cook, with 167 recorded on the 26th September 2018 and 162 recorded on the 28th September 2018. A total of 159 wrasse (excluding cuckoo) were tagged and one was recaptured (Table 1 and Table 2).

Table 1: Number of ballan, goldsinny, corkwing and rock cook caught, tagged and recaptured at Portloe on 26th and 28th September 2018 and population size estimates.

Portloe					Estimate population size (Chapman modification) and 95% confidence interval
	26th September 2018		28th September 2018		
Species	Caught	Tagged	Caught	Recaptured	
#Ballan	7	7	4	0	39±47
#Goldsinny	78	78	46	1	1855±2035
#Corkwing	6	6	4	0	34±40
#RockCook	16	16	24	0	424±561
Total#	107	107	78	1	

Table 2: Number of ballan, goldsinny, corkwing and rock cook caught, tagged and recaptured at Dodman Point on 26th and 28th September 2018 and population size estimates. Table excludes cuckoo wrasse.

Dodman Point					Estimate population size (Chapman modification) and 95% confidence interval
	26th September 2018		28th September 2018		
Species	Caught	Tagged	Caught	Recaptured	
#Ballan	3	3	4	0	19±22
#Goldsinny	13	13	11	0	167±215
#Corkwing	14	14	27	0	419±554
#RockCook	22	22	35	0	827±1109
Total#	52	52	77	0	

The percentage catch composition of the surveys for Portloe can be seen in Table 3 and Table 4 and for Dodman Point in Table 5 and Table 6.

Table 3: Percentage catch composition of the survey at Portloe on 26th September 2018.

	String 1		String 2		String 6		Portloe All Strings	
Species	Number	% of catch	Number	% of catch	Number	% of catch	Number	% of catch
#Ballan	4	7.4	0	0.0	3	12.0	7	6.1
#Cuckoo	2	3.7	4	11.1	2	8.0	8	7.0
#Goldsinny	32	59.3	30	83.3	16	64.0	78	67.8
#Corkwing	5	9.3	0	0.0	1	4.0	6	5.2
#RockCook	11	20.4	2	5.6	3	12.0	16	13.9
Total#	54		36		25		115	

Table 4: Percentage catch composition of the survey at Portloe on 28th September 2018.

	String 1		String 2		String 6		Portloe All Strings	
Species	Number	% of catch	Number	% of catch	Number	% of catch	Number	% of catch
#Ballan	2	11.1	0	0.0	2	6.9	5	5.1
#Cuckoo	0	0.0	3	8.8	0	0.0	4	4.0
#Goldsinny	8	44.4	18	52.9	20	69.0	33	33.3
#Corkwing	1	5.6	1	2.9	2	6.9	11	11.1
#RockCook	7	38.9	12	35.3	5	17.2	46	46.5
Total#	18		34		29		99	

Table 5: Percentage catch composition of the survey at Dodman Point on 26th September 2018.

	String 3		String 4		String 5		Dodman Point All String	
Species	Number	% of catch	Number	% of catch	Number	% of catch	Number	% of catch
#Ballan	1	4.0	2	8.3	0	0.0	3	5.8
#Cuckoo	0	0.0	0	0.0	0	0.0	0	0.0
#Goldsinny	4	16.0	8	33.3	1	33.3	13	25.0
#Corkwing	6	24.0	7	29.2	1	33.3	14	26.9
#RockCook	14	56.0	7	29.2	1	33.3	22	42.3
Total#	25		24		3		52	

Table 6: Percentage catch composition of the survey at Dodman Point on 28th September 2018.

	String 3		String 4		String 5		Dodman Point All String	
Species	Number	% of catch	Number	% of catch	Number	% of catch	Number	% of catch
#Ballan	3	6.4	1	2.9	0	-	3	4.8
#Cuckoo	1	2.1	3	8.8	0	-	3	4.8
#Goldsinny	7	14.9	4	11.8	0	-	24	38.1
#Corkwing	9	19.1	18	52.9	0	-	20	31.7
#RockCook	27	57.4	8	23.5	0	-	13	20.6
Total#	47		34		0		63	

The catch composition of the species per location on each survey day is shown in Figure 15 to Figure 18.

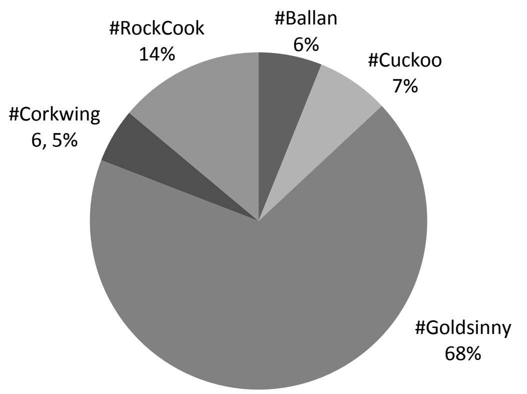


Figure 15: Catch composition of the wrasse species recorded at Portloe on 26th September 2018.

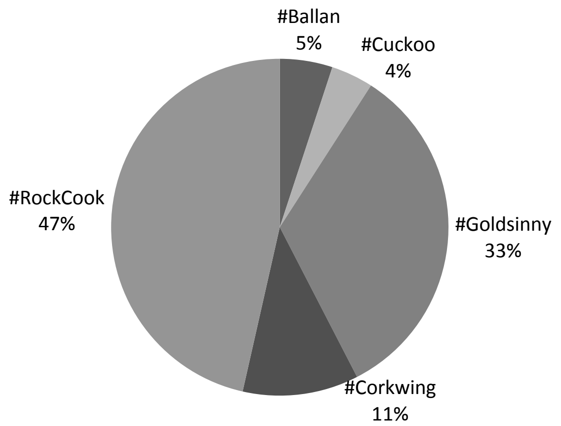


Figure 16: Catch composition of the wrasse species recorded at Portloe on 28th September 2018

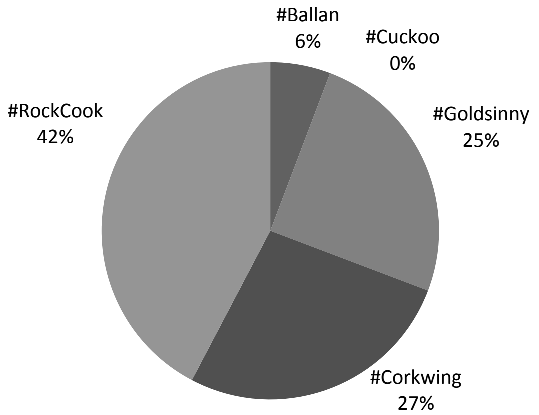


Figure 17: Catch composition of the wrasse species recorded at Dodman Point on 26th September 2018.

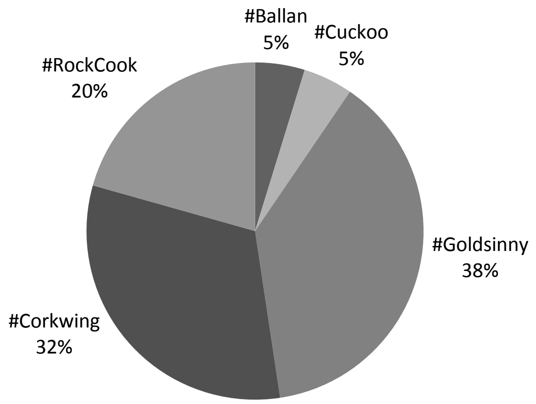
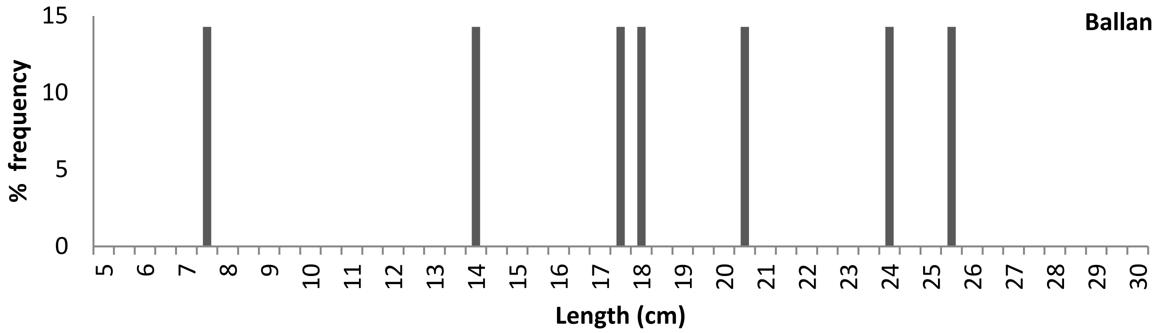
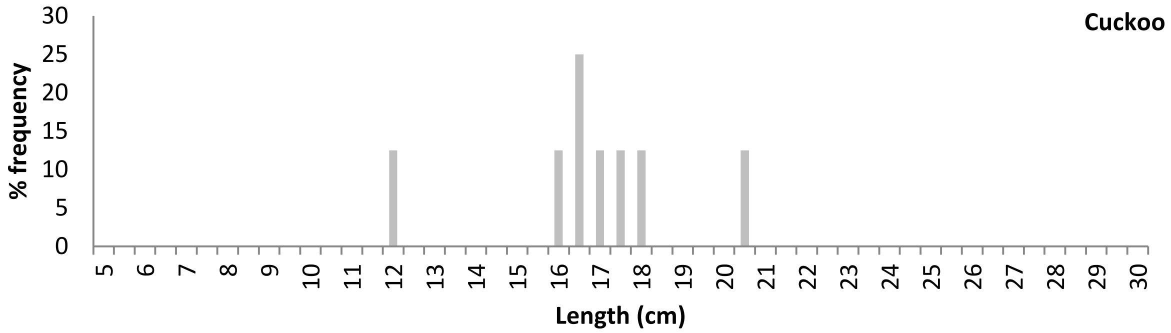


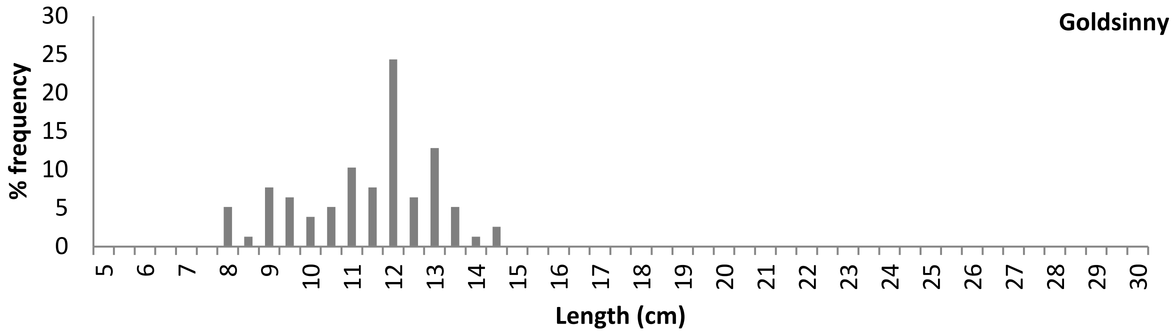
Figure 18: Catch composition of the wrasse species recorded at Dodman Point on 28th September 2018

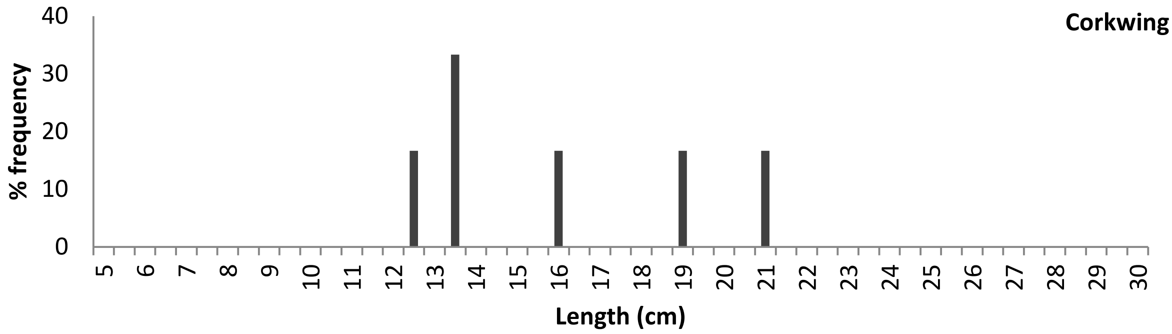
The percentage length frequency plots for both survey days are shown in Figure 19 and Figure 20 for Portloe and Figure 21 and Figure 22 for Dodman Point.

3.1 Portloe Length Frequency 26th September 2018









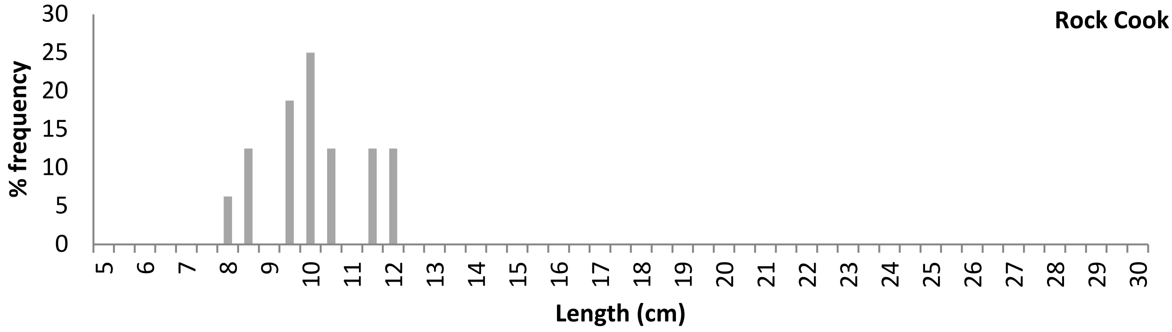
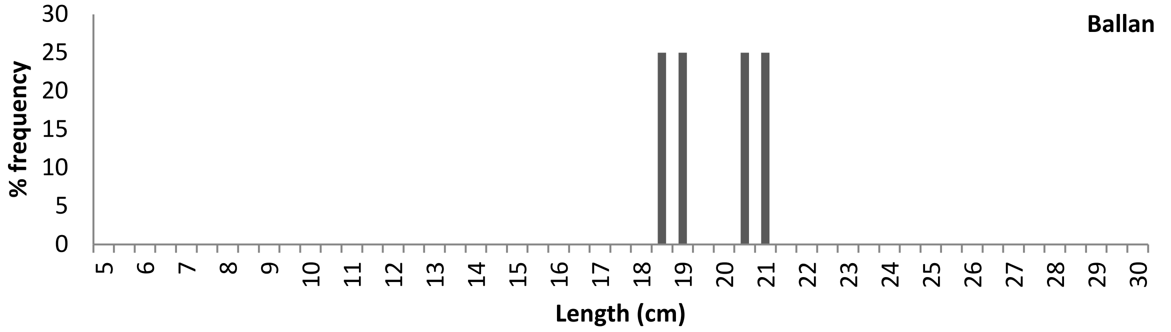
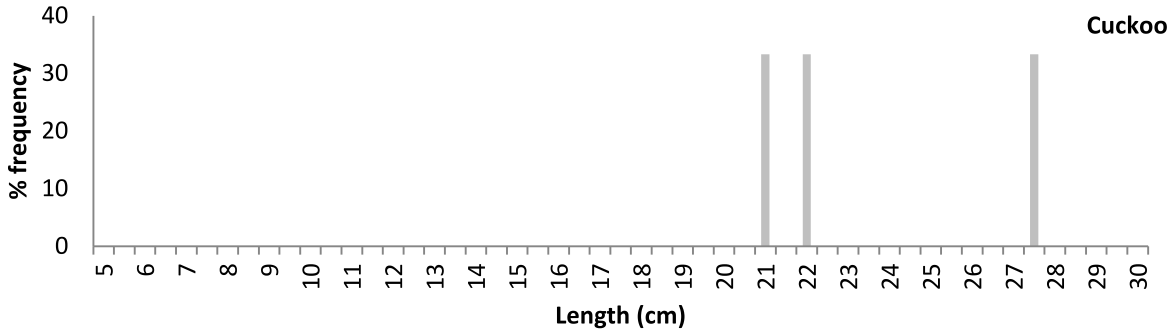
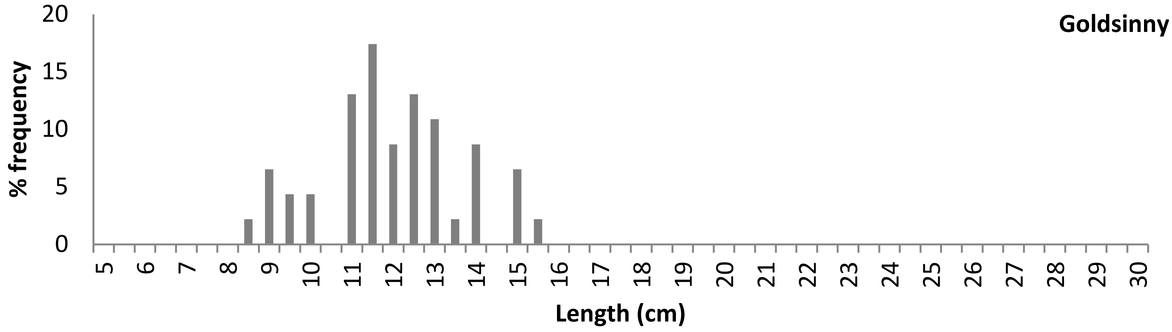


Figure 19: The percentage (%) length frequency of species of wrasse (ballan, cuckoo, goldsinny, corkwing and rock cook) from three strings near Portloe on 26th September 2018.

3.2 Portloe Length Frequency 28th September 2018







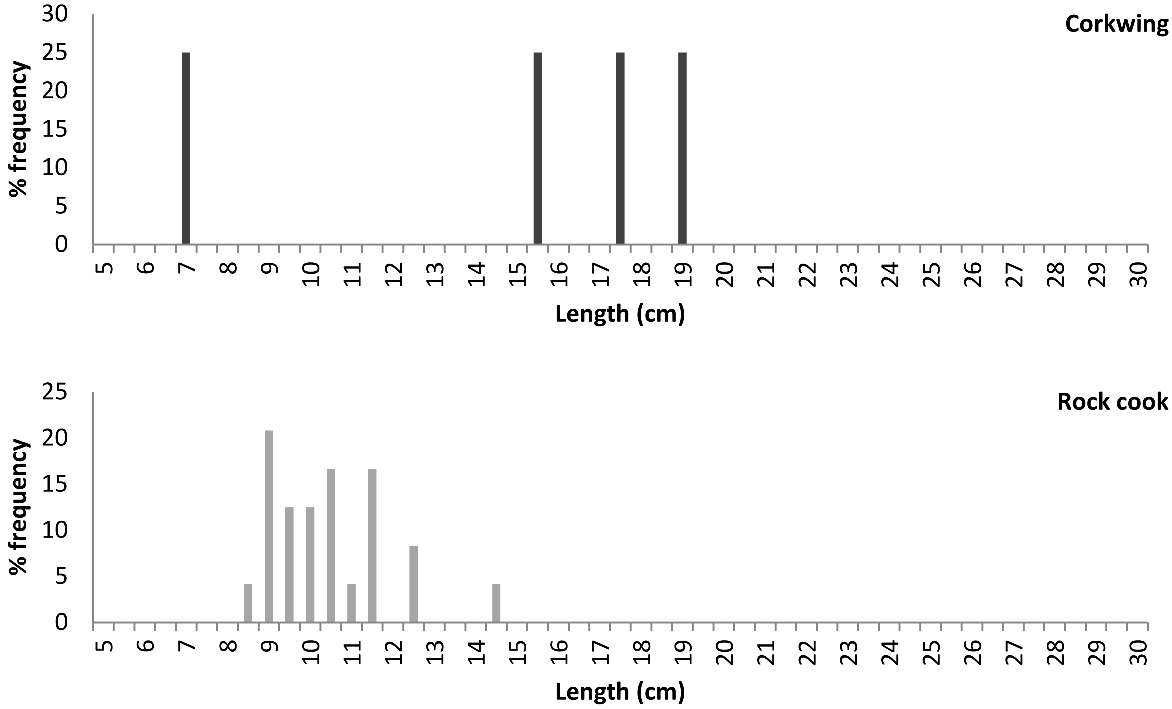
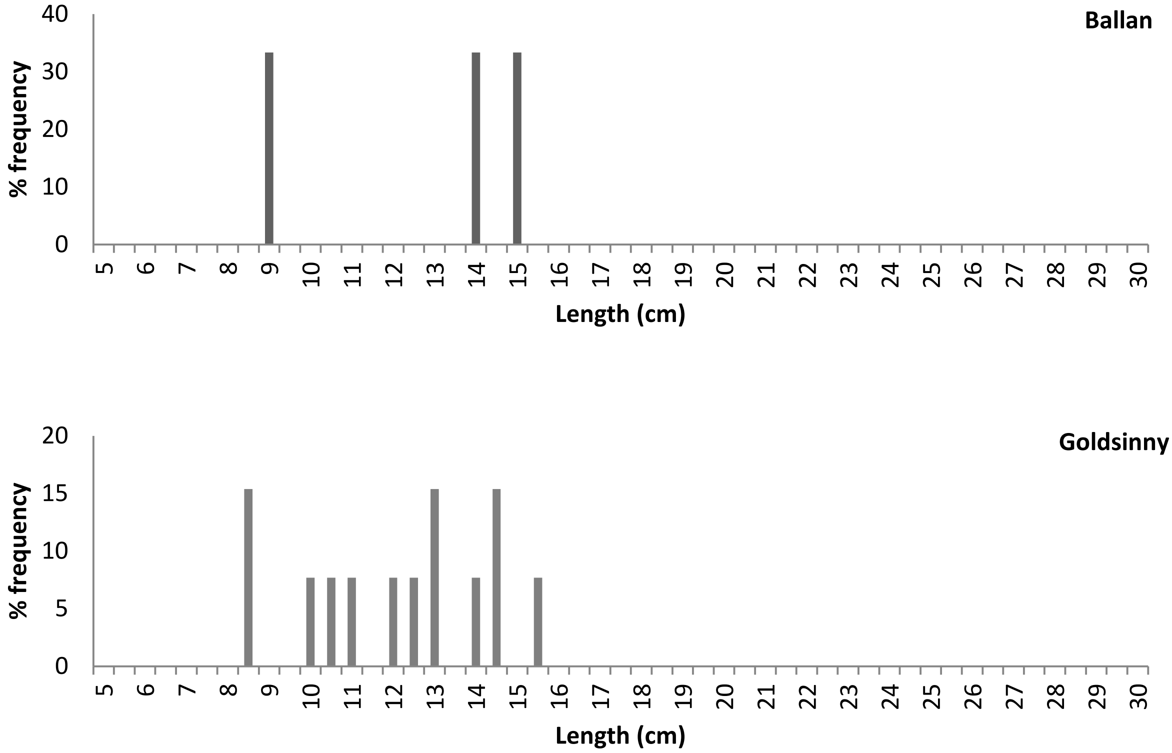
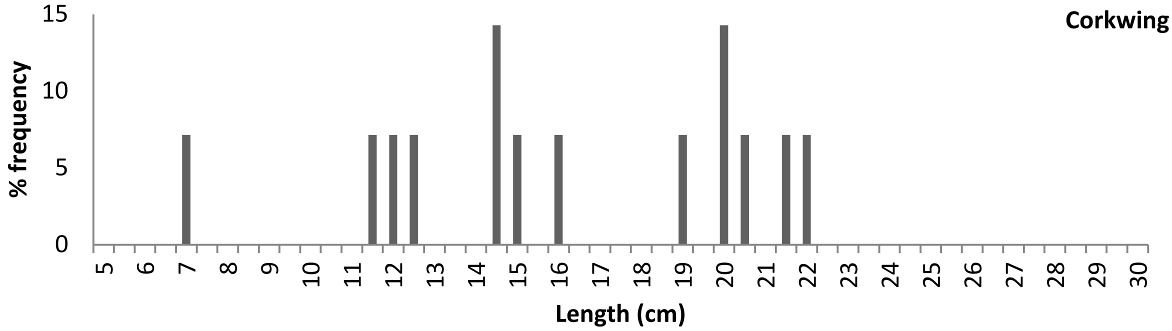


Figure 20: The percentage (%) length frequency of species of wrasse (ballan, cuckoo, goldsinny, corkwing and rock cook) from three strings near Portloe on 28th September 2018.

3.3 Dodman Point Length Frequency 26th September 2018





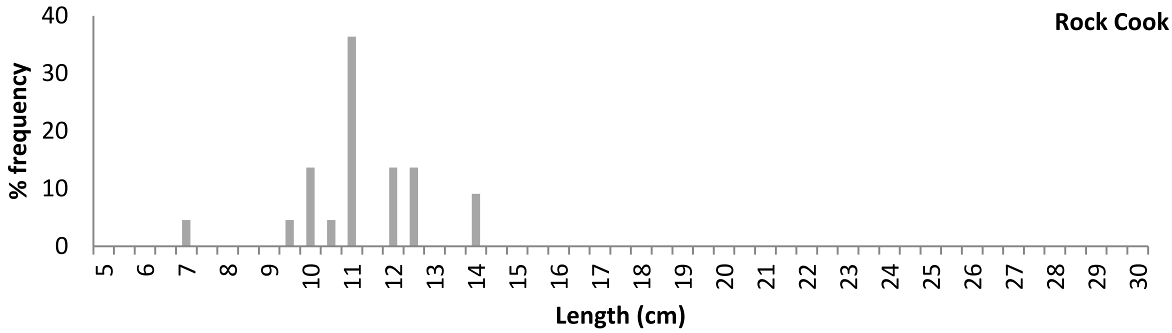
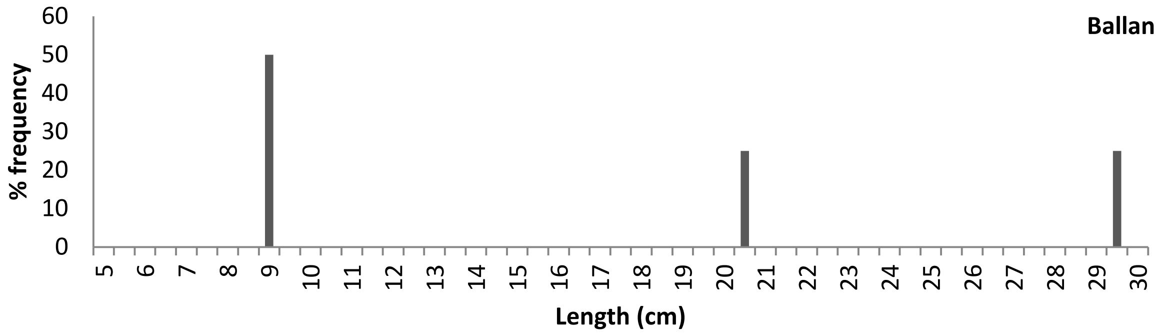
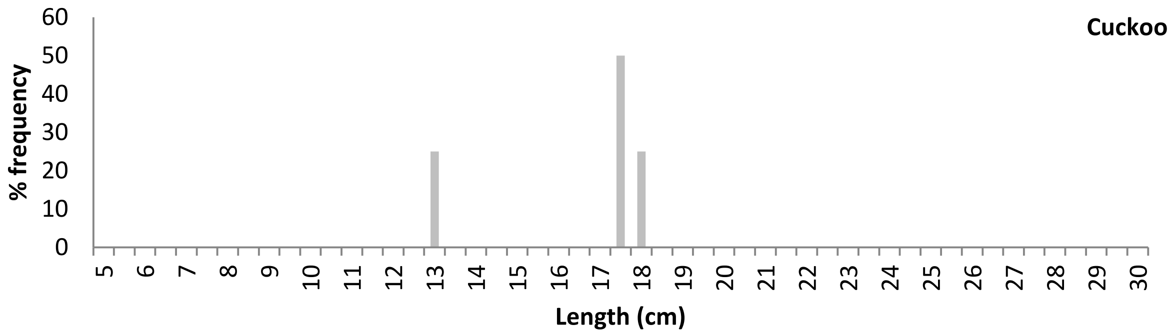


Figure 21: The percentage (%) length frequency of species of wrasse (ballan, goldsinny, corkwing and rock cook) from three strings near Dodman Point on 26th September 2018.

3.4 Dodman Point Length Frequency 28th September 2018





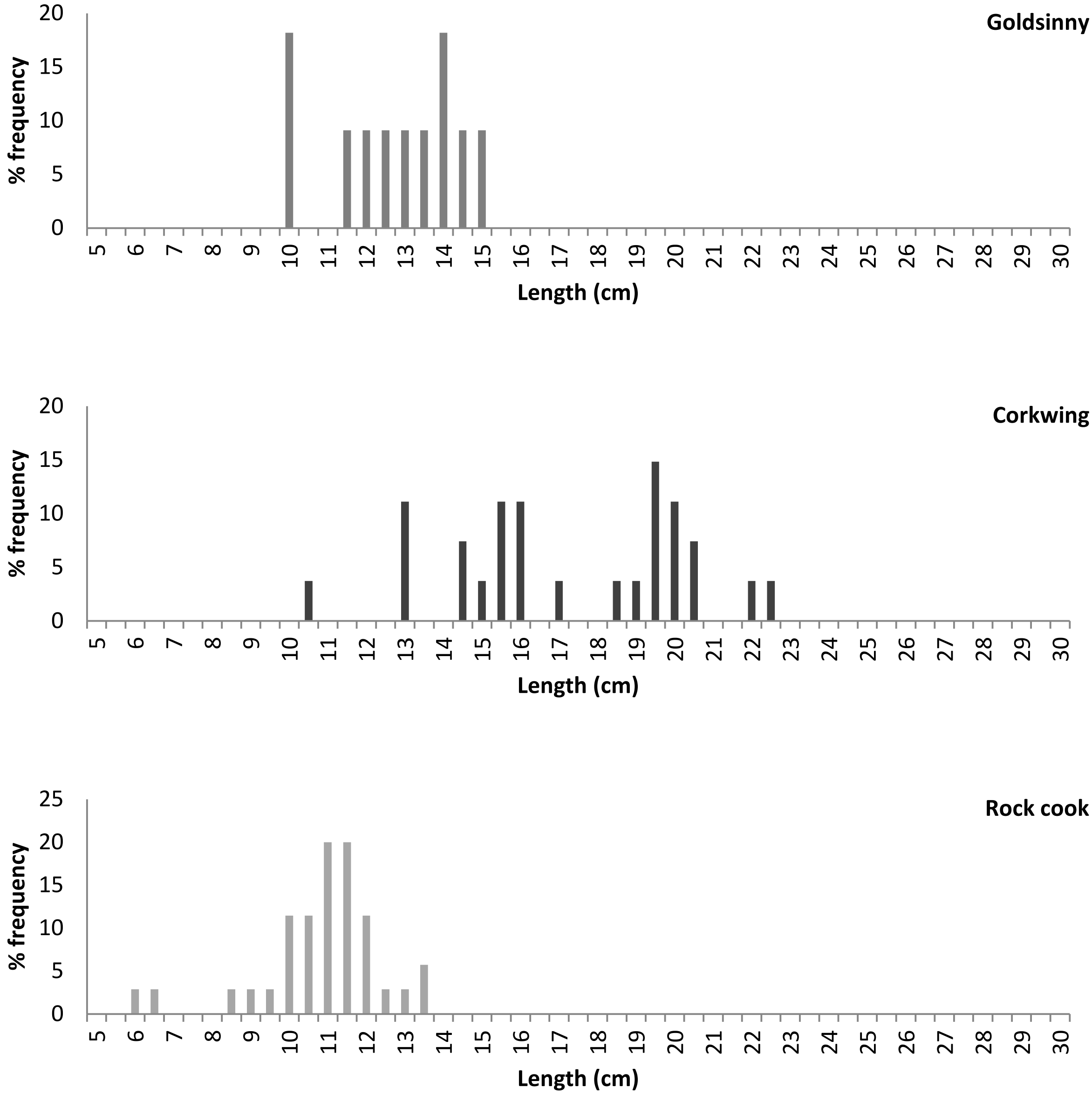


Figure 22: The percentage (%) length frequency of species of wrasse (ballan, cuckoo, goldsinny, corkwing and rock cook) from three strings near Dodman Point on 28th September 2018.

The percentage frequency distribution per string for each survey day is shown in Figure 23 and Figure 24.

3.5 Percentage Frequency Distribution per string 26th September 2018

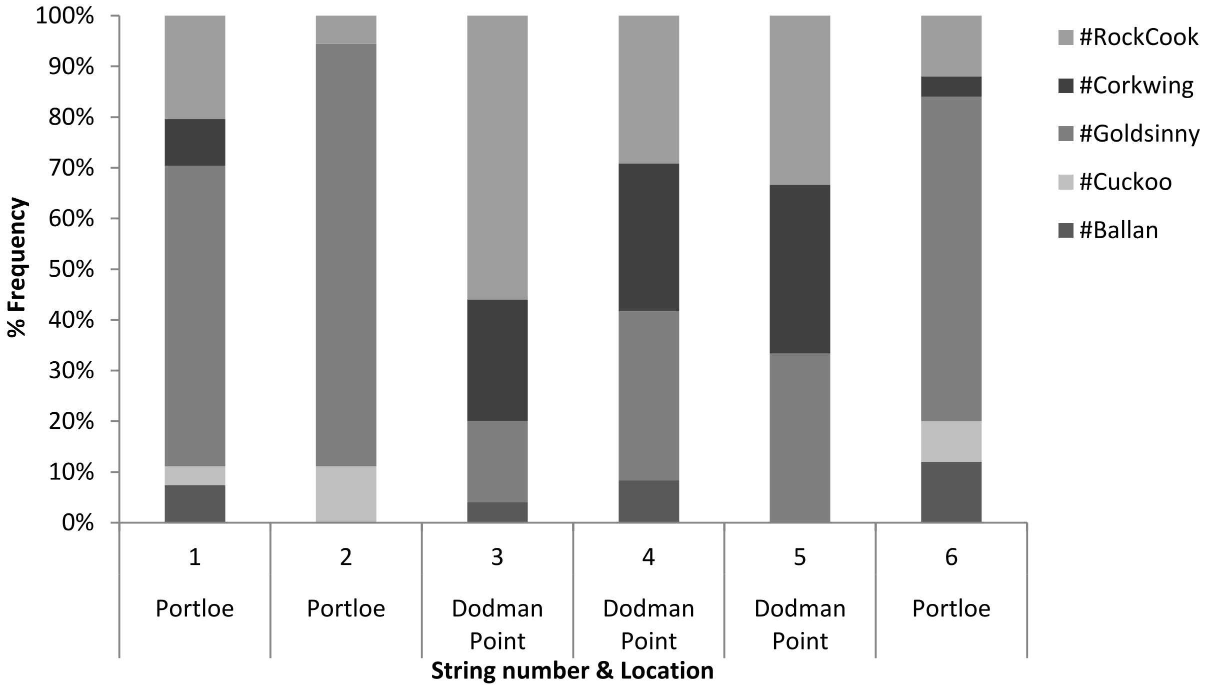


Figure 23: The percentage (%) frequency of species of wrasse (ballan, corkwing, cuckoo, goldsinny and rock cook) per string from a survey on 26th September 2018

3.6 Percentage Frequency Distribution per string 28th September 2018

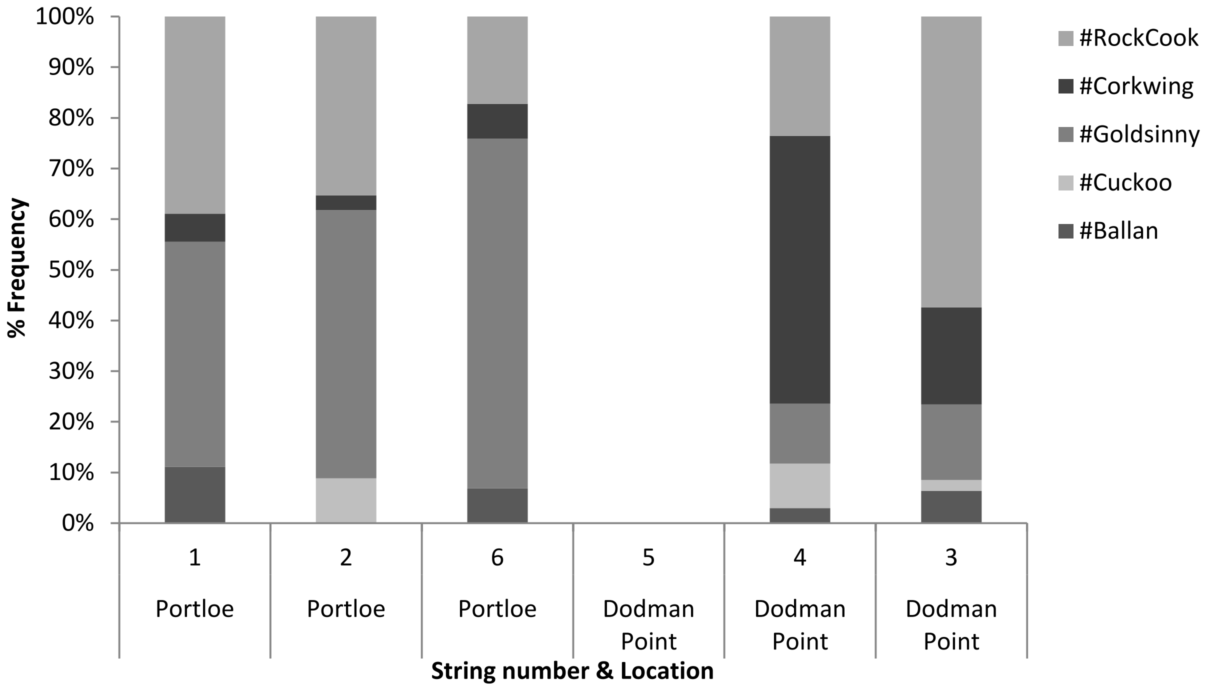


Figure 24: The percentage (%) frequency of species of wrasse (ballan, corkwing, cuckoo, goldsinny and rock cook) per string from a survey on 28th September 2018

3.7 By-catch

Each trap was emptied into a fish box once recovered to deck. Images showing the emptied traps for the 26th September 2018 are shown in Table 12 and for the 28th September 2018 are shown in Table 13, Annex 5.

A list of the recorded by-catch can be seen in Table 7.

Table 7: List of by-catch species recorded during the wrasse surveys on 26th and 28th September 2018.

26th September 2018		28th September 2018	
Common name	Species name	Common name	Species name
Common dragonet	*Callionymus lyra*	Edible crab	*Cancer pagurus*
Edible crab	*Cancer pagurus*	Conger eel	*Conger conger*
Conger eel	*Conger conger*	Juvenile Gadidae	Gadidae spp.
Juvenile Gadidae	Gadidae spp.	Squat lobster	*Galathea squamifera*
Squat lobster	*Galathea squamifera*	Spider crab	*Hyas spp*
Bloody henry	*Henricia oculata*	Spider crab	*Inachus spp.*
Juvenile lobster	*Homarus gammarus*	Spider crab	*Maja spp.*
Spider crab	*Hyas spp*	Spiny starfish	*Marthasterias glacialis*
Spider crab	Inachus spp.	Red mullet	*Mullus surmuletus*
Spiny starfish	*Marthasterias glacialis*	Velvet swimming crab	*Necora puber*
Velvet swimming crab	*Necora puber*	Prawn sp.	*Palaemon spp.*
Worm pipefish	*Nerophis lumbriciformis*	Tompot Blenny	*Parablennius gattorugine*
Prawn sp.	*Palaemon spp.*	Pollack	*Pollachius pollachius*
Tompot Blenny	*Parablennius gattorugine*	Long-spined sea scorpion	*Taurulus bubalis*
Greater pipefish	*Syngnathus acus*	Bib	*Trisopterus luscus*
Long-spined sea scorpion	*Taurulus bubalis*	Netted dog whelk	*Tritia reticulata*
Bib	*Trisopterus luscus*		
Netted dog whelk	*Tritia reticulata*		

3.8 Water parameters

Two profiles using the Valeport Swift SVP were taken on both the 26th and 28th September 2018 which recorded depth (m), sound velocity (m/s), pressure (dBar), temperature(°C), salinity (PSU) and density (kg/m³). At the maximum depth the average seabed temperature was 15.3°C and average salinity 34.9 PSU. Figure 25 to Figure 28 show the temperature profiles at each dop in Veryan Bay, the location of each drop can be seen in Figure 13 and Figure 14.

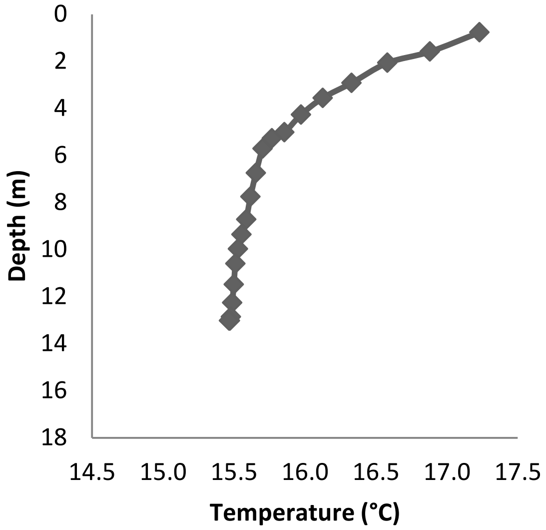


Figure 25: Temperature profile from Valeport Swift Sound Velocity Profiler Drop 1 near Portloe on 26/09/2018.

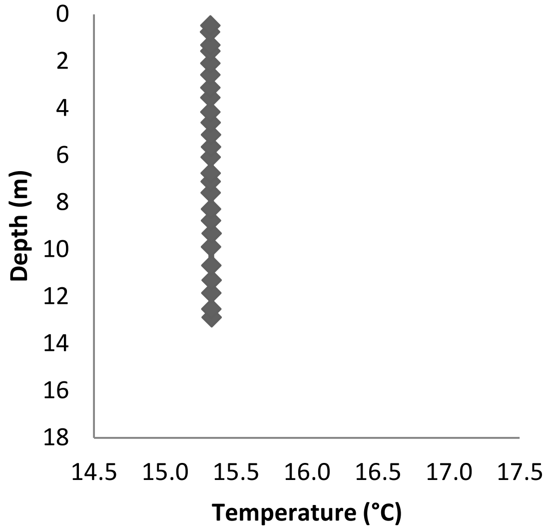


Figure 26: Temperature profile from Valeport Swift Sound Velocity Profiler Drop 2 near Dodman Point on 26/09/2018.

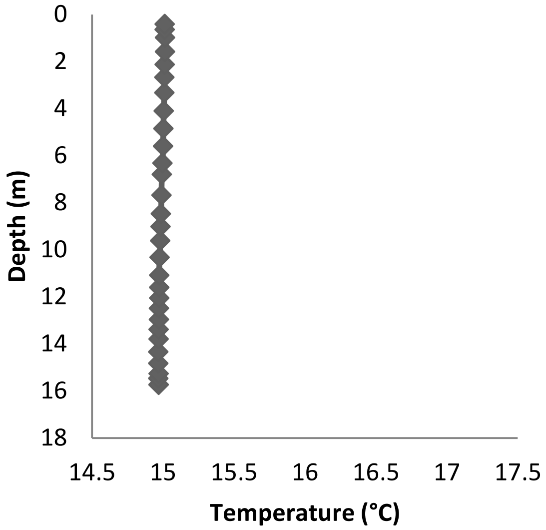


Figure 27: Temperature profile from Valeport Swift Sound Velocity Profiler Drop 3 near Portloe on 28/09/2018.

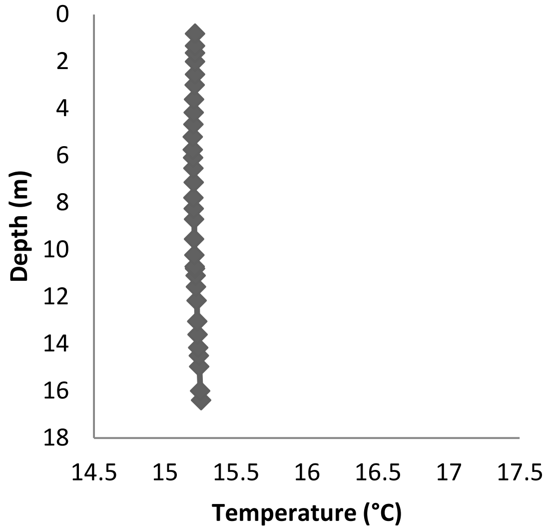


Figure 28: Temperature profile from Valeport Swift Sound Velocity Profiler Drop 4 near Dodman Point on 28/09/2018.

4 Discussion

4.1 Suitability of using VIE tags for wrasse:

Identifying a suitable position to tag wrasse with VIE was aided by experimenting with dead individuals and consulting with previous work carried out (Skiftesvik *et al.,* 2013) before undertaking the field work. The chosen location of the tag appeared to be successful with individuals recovering quickly after tagging and the tags being highly visable on all species, regardless of wrasse colouration. The colours used were noticable under ambient light and VI Light. The certainty of the VIE colour of the one wrasse recaptured was questioned between red and pink due to slight discolouration from being subcutaneous. The correct VIE colour was determined using the VIE Colour Standard and highlighted the importancance of checking the corresponding colour with and without VI Light. The VIE tags were proven to be correctly injected and retained, during observation of the recaptured goldsinny.

4.2 Survey methodology for mark and recapture surveys using VIE tags:

Mixing of the VIE onboard Tiger Lily was relatively easy and was aided by the calm sea state. The quantity required for tagging meant mixing in the 15ml cups resulted in some wastage as not all the VIE could be scraped out of the cup into the transfer syringe. The VIE could be stored in the fridge to maximise shelf life.

The use of pick and pluck foam for holding wrasse while tagging was effective. It allowed the wrasse to be kept stable without the need of exessive handling and reducing the risk of injury to officers. By tagging on the underside of wrasse, it appeared to calm the wrasse by keeping it immersed in water and eyes covered. The large bins used to store the wrasse after tagging proved effective, with wrasse aclimitising quickly. The lids of these bins were also useful for providing shade while screening for VIE tags upon recapture.

The tagging of each wrasse was carried out by one officer. As tagging was a longer process than measuring, when larger numbers of wrasse were retained there could often be a backlog of wrasse waiting to be tagged. In order to speeed up the proccess during future surveys, an additional officer tagging would alleviate the time delay.

The Petersen model estimates only refers to the catchable proportion of the population of wrasse in traps, which is not the entire population for each species. For example, the mouths of the traps are selective to exclude bigger fish and the larger ballan wrasse. Closing off the escape gaps meant the smaller species of wrasse had a higher probability of being retained.

For the estimation of population size to be accurate the Petersen model depends on meeting the following assumptions:

- The population is closed (geographically and demographically)
- All individuals within each sample are equally likely to be captured
- Capture and tagging does not affect catchability
- Each sample is random
- Tags are not lost between sampling

- All tags are recorded correctly and detected upon recapture

For the first assumption to hold, the time between tagging and recapture should be over a short period of time. In the first instance this was 48 hours after tagging. However, this short time frame may have affected the recapture probabilty due to a change in behaviour while wrasse aclimitise back into their natural habitat after being returned to sea. This may explain why there was a low (one goldsinny) recapture rate (Table 1 and Table 2). A second recapture sampling period should be carried out, with a greater length of time between tagging and recapture.

Every attempt was made to ensure there was no bias in mark and recapture. To fulfill one of the assumptions of the Petersen model, each wrasse was double marked to reduce the risk of losing a tag. A controlled tag retention and tag related mortality study, prior to this survey, could not be carried out due to limited facilities for husbandry. It was assumed tag retention rates were 100%. However, it should be noted that tag retention rates may also explain why there was a low recapture rate. Tag retention rates were dependent on various variables such as trailing material, handling, material curing and wound healing. No mortality of wrasse was observed during the study and all wrasse swam down below the sea surface when returned. Tag related mortality was assumed to be 0%. As each individual wrasse was carefully screened for tags this ensured all marks were recorded correctly and reported on recapture, thus meeting another one of the assumptions of the Petersen model.

Another possibility for the low recapture rate may have been because of the sample size tagged for both locations. The Petersen model is bias to small sample sizes and tends to overestimate the actual population which is why the Chapman modification was used in the analysis. The results of the estimated population sizes produced wide confidence intervals which is down to the number of wrasse recaptured being small or zero (Table 1 and Table 2). The confidence intervals were greater than the population estimates themselves and therefore the population estimates are not reliable. It is recommended that a survey has enough wrasse tagged in the first sampling period and the second sample is large enough to ensure that more than seven tagged wrasse are recpatured, then the bias of the Chapman equation can be considered negligible (Robson and Regier, 1964).

4.3 Limitations

The limitations in this study and recommendations to minimise these on future surveys are shown below.

4.3.1 Water visibilty

Secchi disks should be taken on every survey on hauling and setting days to determine water visability, as it is considered that this may have an influence on the catch rates.

4.3.2 Location of strings

The number of wrasse caught may have been influenced from the habitat that the strings were set on. Although every effort was made to ensure habitat suitability, some of the traps were set on sediment. The areas chosen had not previously been fished before, so there was no previous data on suitable ground or catch composition.

Additionally, while every effort was made to ensure the traps were re-set in the exact same location, the exact positioning was not directly comparable for some traps. The tagged wrasse were released as close as possible to the location they were caught. However, it is assumed the wrasse swim straight down and inhabit the seabed within close proximity. The area of influence of each trap is unknown and therefore makes it difficult to determine the area the estimated population size relates to.

4.3.3 Population estimate

The Petersen model is based on assumptions which need to be met for the estimate of population size to be accurate. The recapture numbers were low which could have been due to sampling bias on the individuals behaviour by carrying out the re-capture 48 hours after tagging as this did not allow time for the tagged wrasse to aclimatise back into their natural habitat. Additionally, the survey sample size was not large enough to ensure there was no bias in the analysis.

4.4 Future surveys

- Ensure suitable habitats are identified prior to deploying traps (habitat type, exposure and depth range)
- Determine a minimum sample size for statistical power.
- In order to get larger sample size, if multiple days of tagging have occurred then the Schnabel model could be used for analysis. Same assumptions as Petersen model.
- Second sampling period should be after 48 hours but no longer than two months to exclude sampling bias and meet assumptions.
- Undertake survey work in fished (skewed population) and un-fished areas (control)
- If using a combination of colours for VIE tags to ensure they can be easily distinguished from each other (e.g. do not combine green and yellow).
- Having an additional officer tagging would speed up the process.

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5 References

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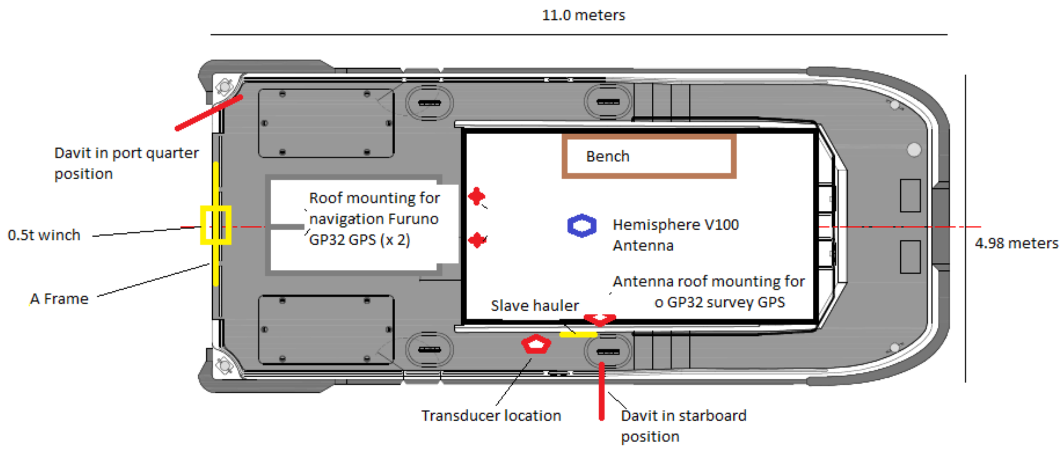
6 Appendices

Annex 1 – RV Tiger Lily vessel specification, deck plan and 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 2 – Ingestion of Visible Implant Elastomer

Northwest Marine Technology, Inc.

13 May, 2014

Ingestion of Visible Implant Elastomer

Northwest Marine Technology's Visible Implant Elastomer (VIE) is made from a two part silicon-based material that is mixed together just before tagging. One part is the "curing agent" and the other part is the silicon base. It is injected as a liquid and cures to a pliable solid. About 90% of the VIE is comprised of the pigment and a medical grade silicone which is approved in the United States for surgical implants in humans, specifically for breast implants. Like all silicones used for human implants, ours uses the non-toxic platinum catalysts.

The manufacturer of the pigment states "The pigments … have been pre-approved through Duke University for the ACMI certification program. They are essentially non-toxic and contain no constituent heavy metals or inorganic phosphors." (ACMI stands for Arts and Crafts Manufacturers Institute who approves materials used for things like crayons, paints, and children's toys; www.acminet.org).

We have not applied for approval of VIE as a food additive by the Food and Drug Administration (i.e. it is not approved by the FDA for consumption), and therefore, when possible, encourage people to tag in body parts that would not be consumed. On the other hand, we know that the elastomer has been consumed, including by some people in our office, and there have been no reports of ill effects.

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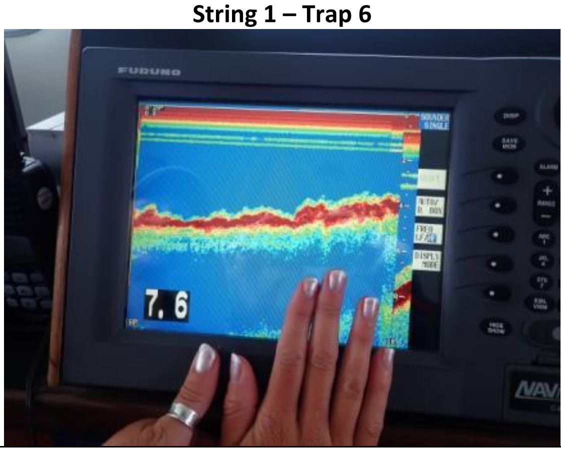
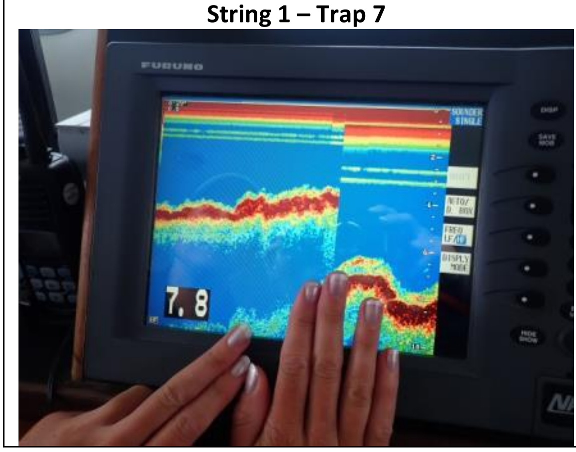
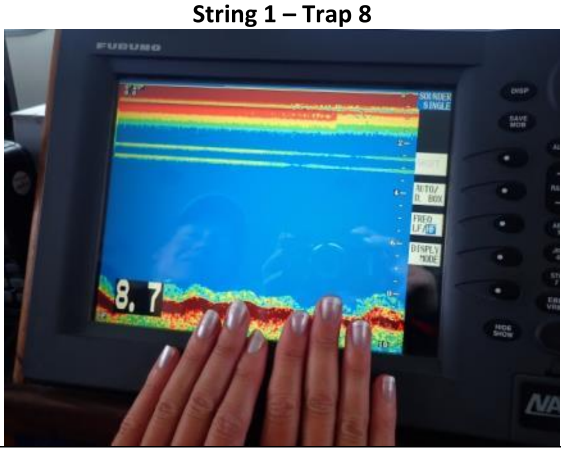
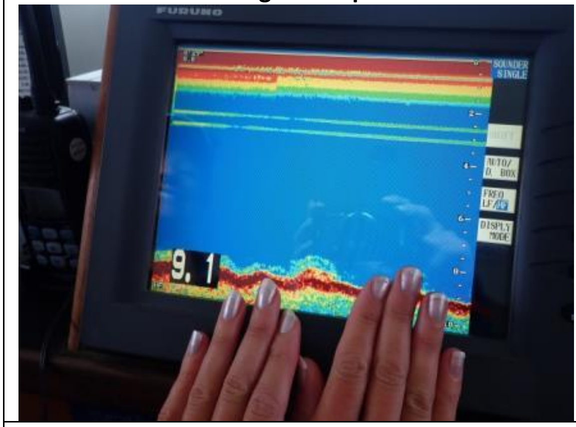
Annex 3 – Sounder Images

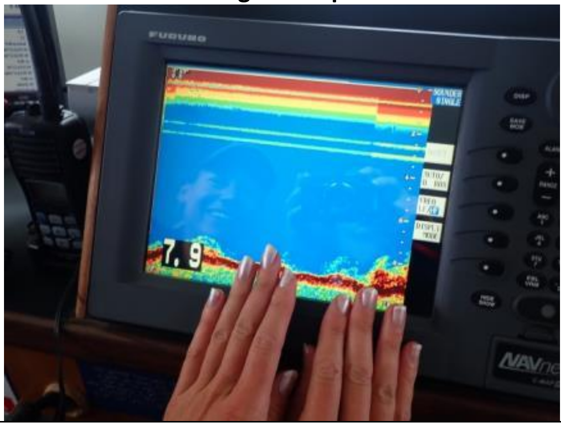
Table 8: Sounder images to determine habitat type from wrasse survey on 26th September 2018

String 1 – Trap 1 	**String 1 – Trap 2** 
String 1 – Trap 3 	**String 1 – Trap 4** 
String 1 – Trap 5 	**String 1 – Trap 6** 
String 1 – Trap 7 	**String 1 – Trap 8** 

String 1 – Trap 9

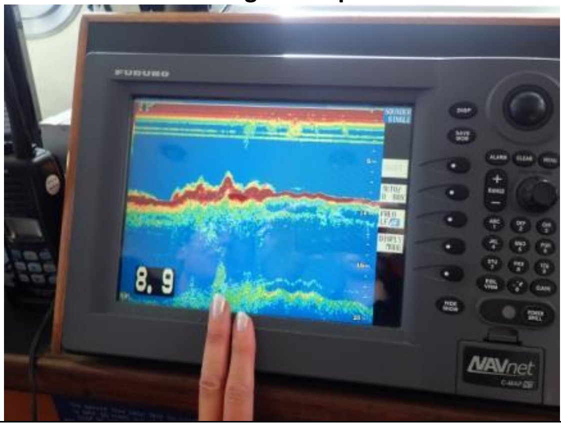


String 1 – Trap 10

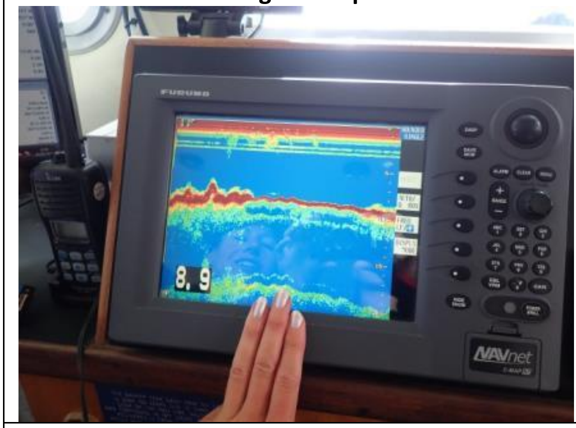


String 2 – Trap 1

String 2 – Trap 2

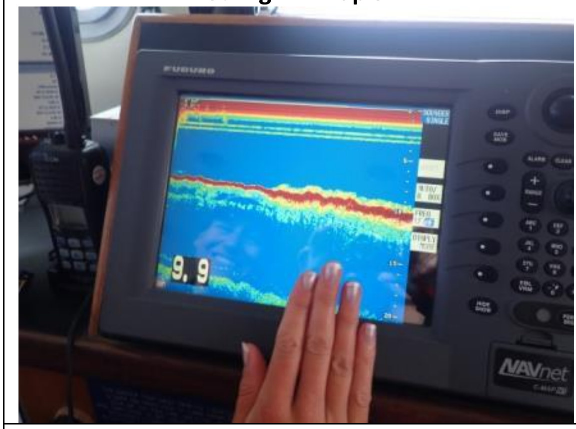


String 2 – Trap 3

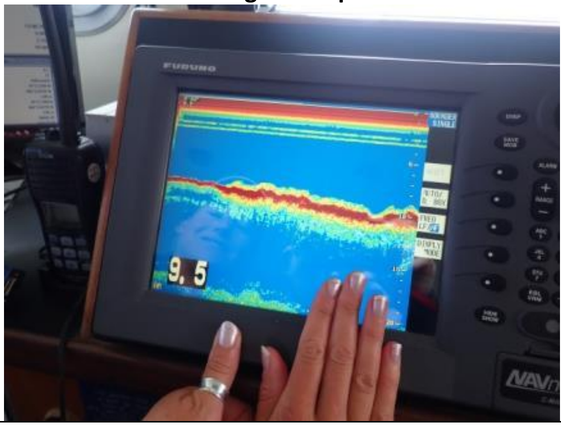


String 2 – Trap 4

String 2 – Trap 5

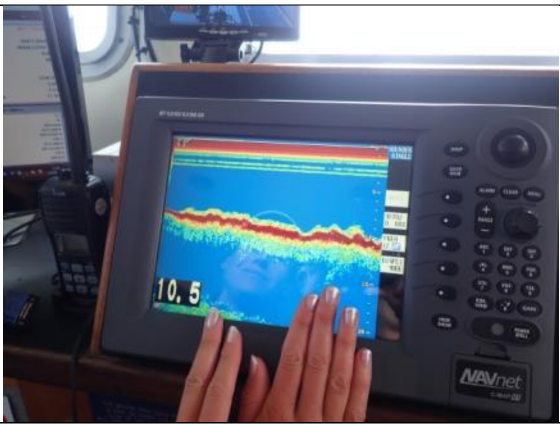


String 2 – Trap 6

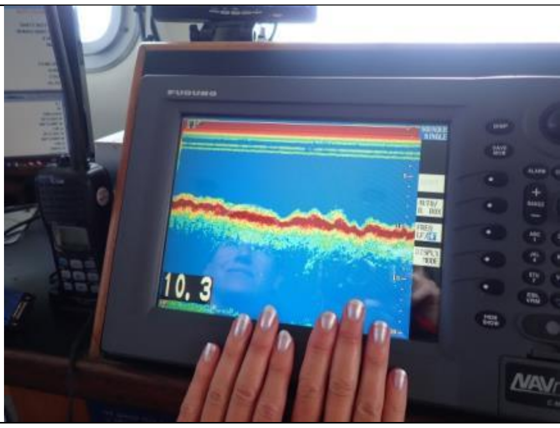


String 2 – Trap 7

String 2 – Trap 8



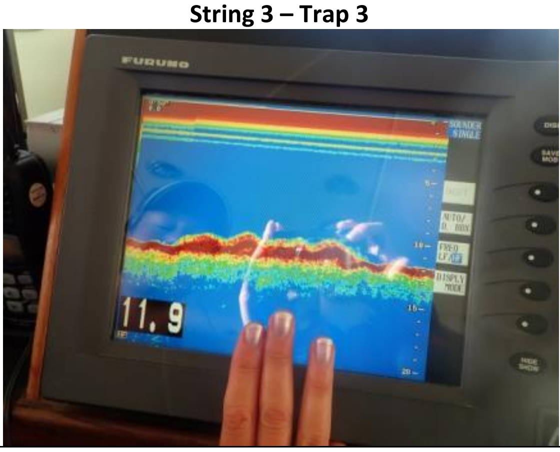
String 3 – Trap 1



String 3 – Trap 2

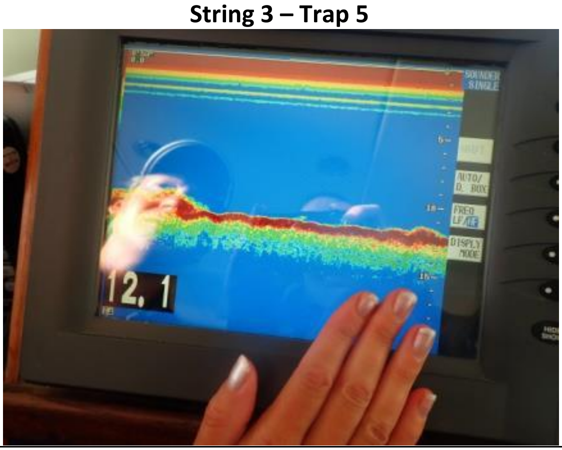
String 3 – Trap 3

String 3 – Trap 4

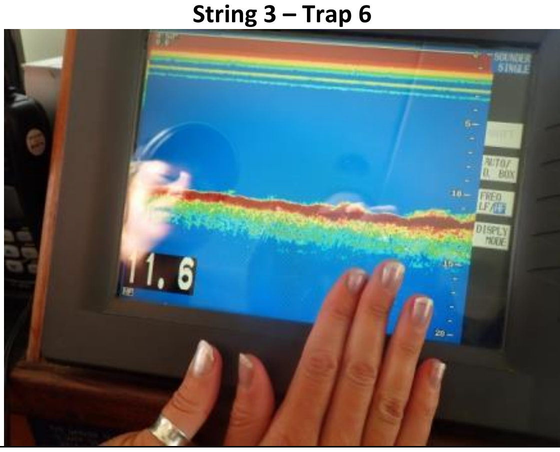


String 3 – Trap 5

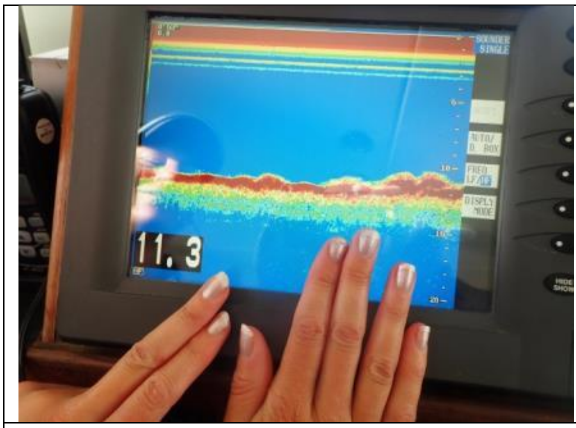
String 3 – Trap 6



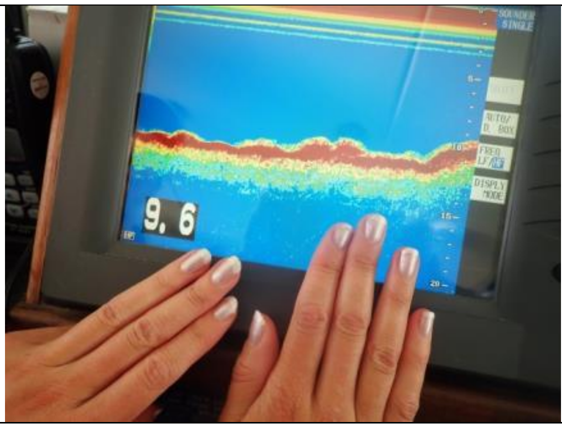
String 3 – Trap 7



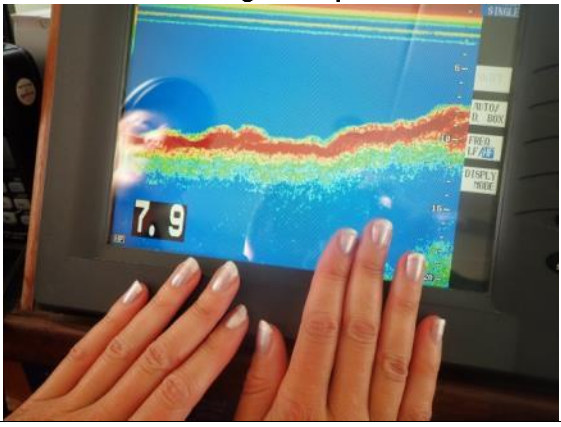
String 3 – Trap 8



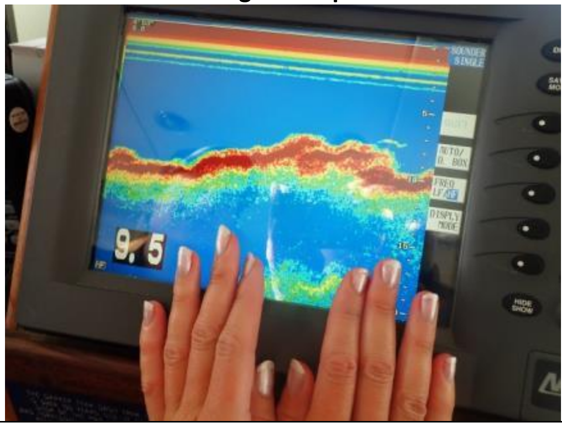
String 3 – Trap 9



String 3 – Trap 10



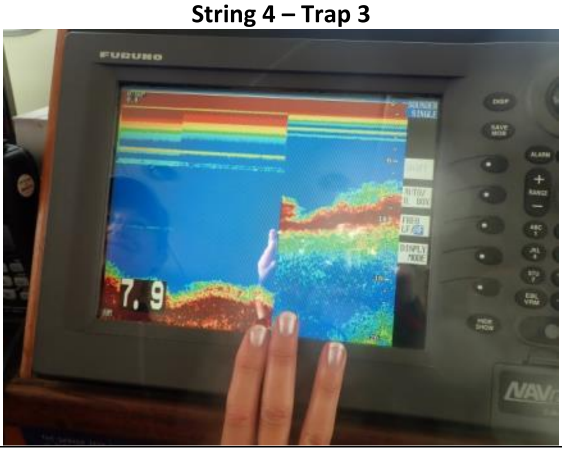
String 4 – Trap 1



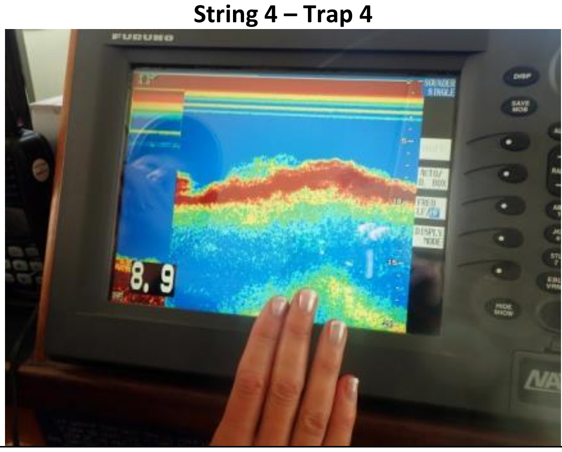
String 4 – Trap 2

String 4 – Trap 3

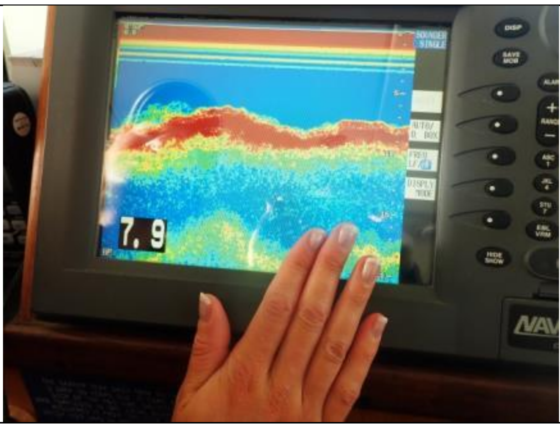
String 4 – Trap 4



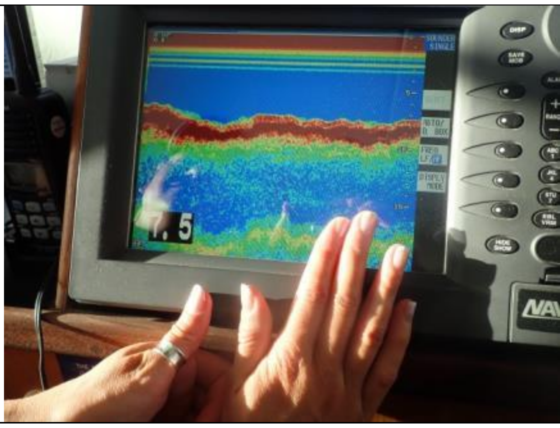
String 4 – Trap 5



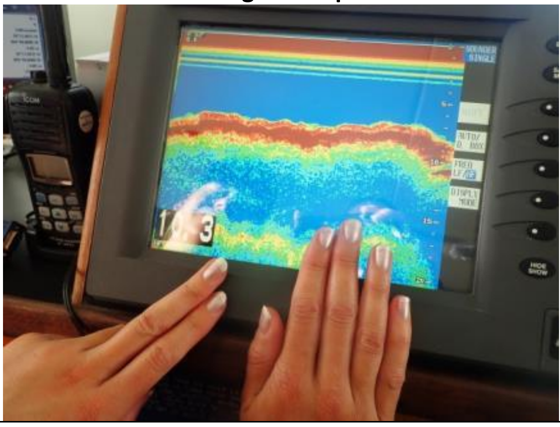
String 4 – Trap 6



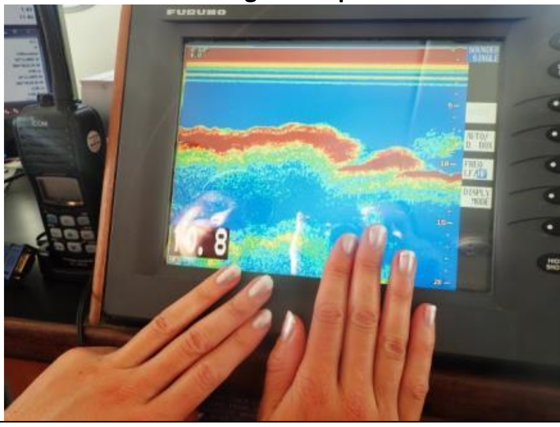
String 4 – Trap 7



String 4 – Trap 8

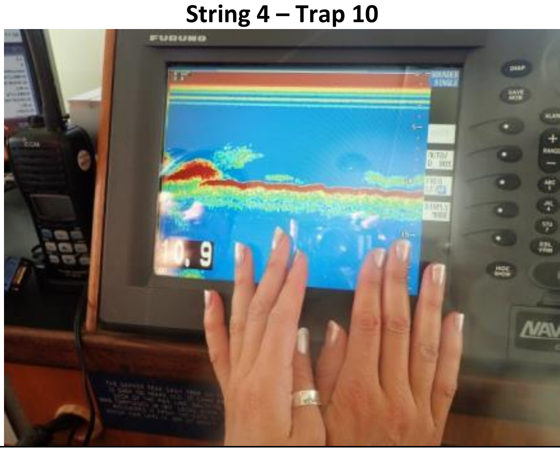


String 4 – Trap 9

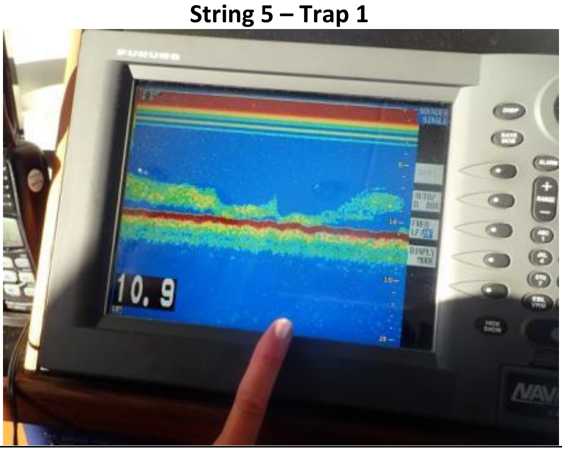


String 4 – Trap 10

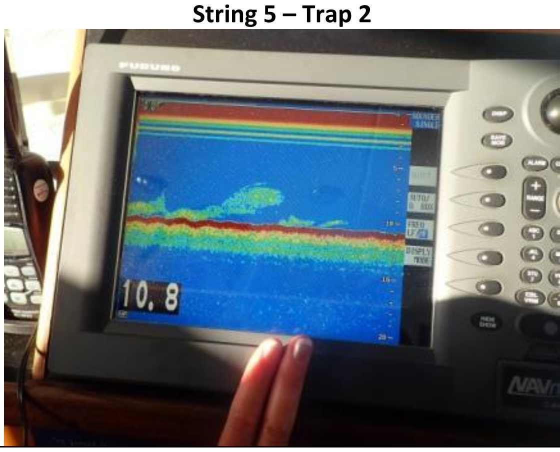
String 5 – Trap 1



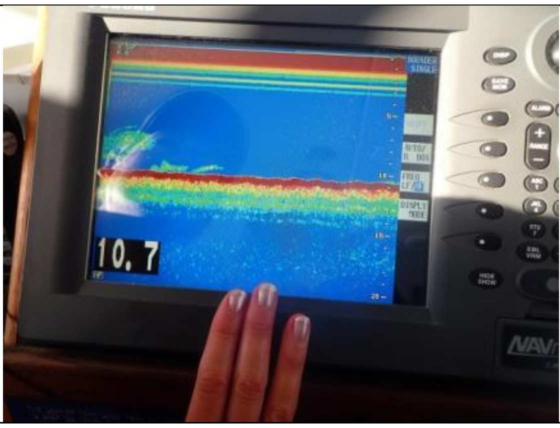
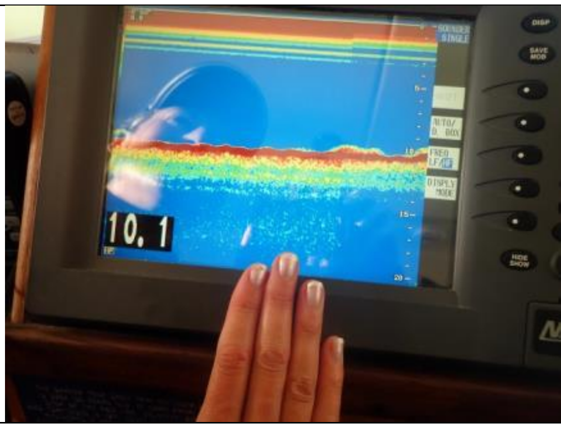
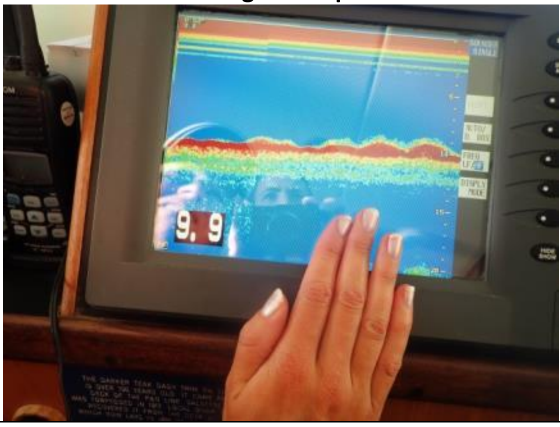
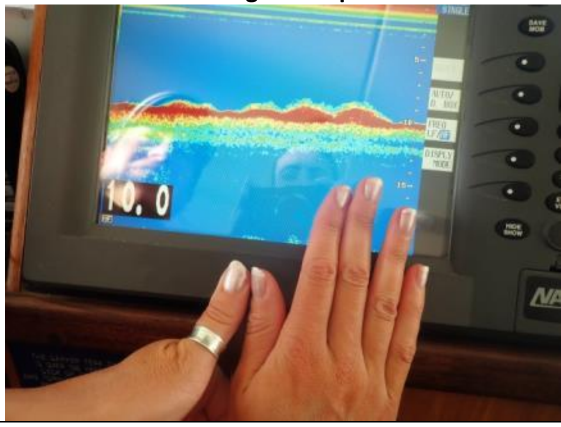
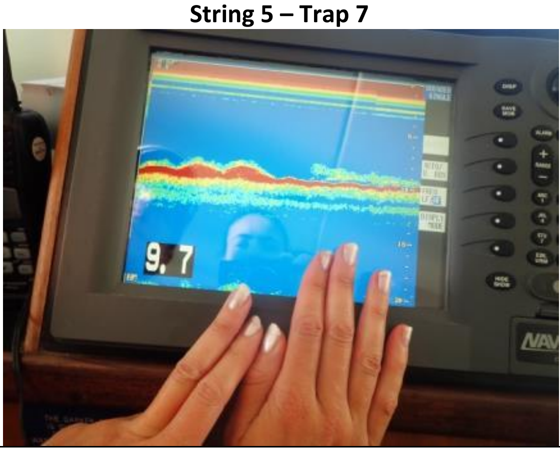
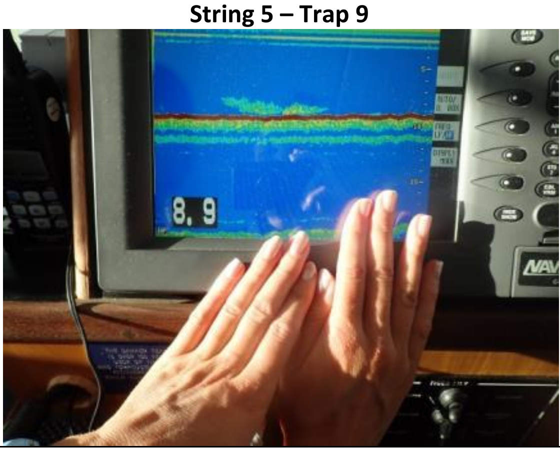
String 5 – Trap 2



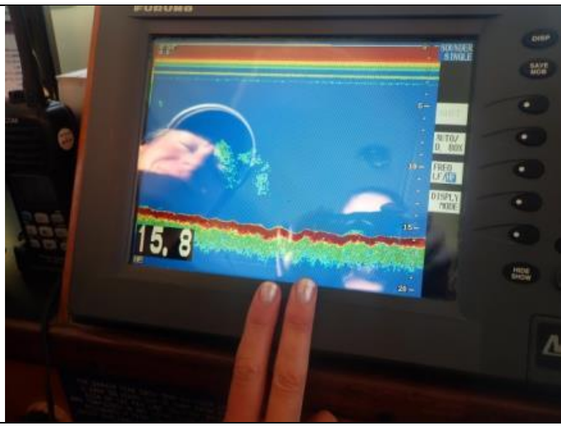
String 5 – Trap 3



String 5 – Trap 4

	
String 5 – Trap 5	**String 5 – Trap 6**
	
String 5 – Trap 7	**String 5 – Trap 8**
	
String 5 – Trap 9	**String 5 – Trap 10**
	
String 6 – Trap 1	**String 6 – Trap 2**

String 6 – Trap 3

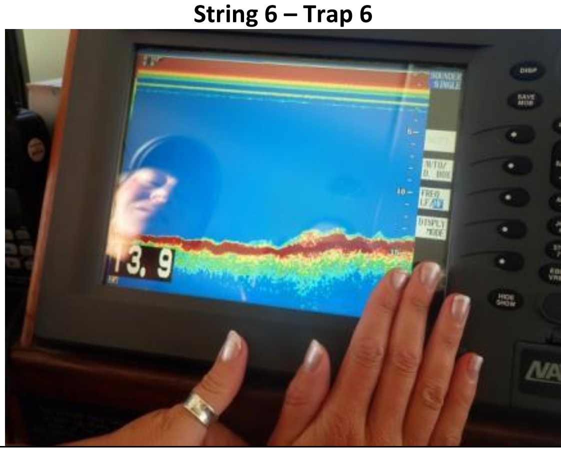


String 6 – Trap 4

String 6 – Trap 5

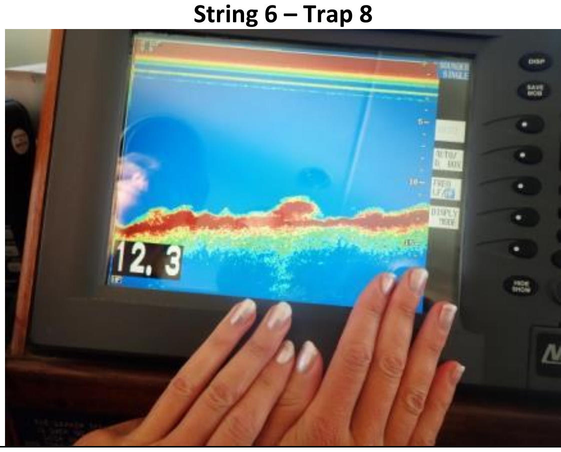
String 6 – Trap 6

String 6 – Trap 7



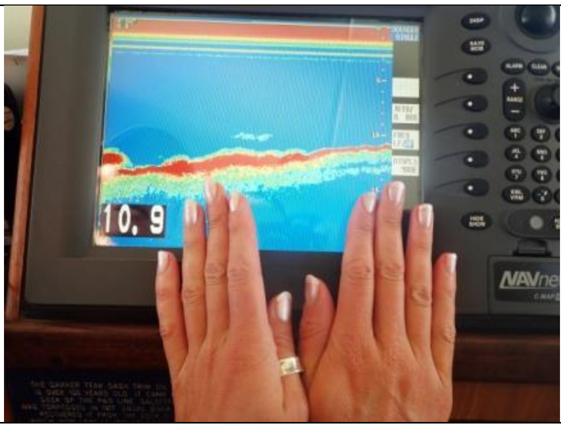
String 6 – Trap 8

String 6 – Trap 9



String 6 – Trap 10


12. 0


10. 9

Annex 4 – Daily Logs

24th September 2018 – Wrasse Tagging Pilot Survey

Daily log for the survey carried out on 24th September 2018:

Survey code: 20180824_CIFCA_Wrasse

Staff: Colin Trundle (Principal Scientific Officer, Cornwall IFCA), Stephanie Sturgeon (Scientific Officer, Cornwall IFCA), Hilary Naylor (Scientific Officer, Cornwall IFCA), Kate Owen (Scientific Officer, Cornwall IFCA), Annie Jenkin (Scientific Officer, Cornwall IFCA) and Daniel McIntyre (Skipper/ Enforcement Officer, Cornwall IFCA).

Vessel: Tiger Lily VI

Table 9: Daily log for the survey carried out on 24th September 2018. All times are in UTC.

Survey conditions	
Cloud	2/8
Wind	SE 5
Sea State	2
Tide	Falmouth HW 18:00 (5.14m)
Time	**Activity**
09:55	Left Mylor
11:20	Hauled first string from St Austell Bay
11:50	Hauled second string from St Austell Bay
12:20	Steam to survey site and lunch
12:30	Arrive at survey site
12:58	Set first string
13:04	Set second string
13:13	Steam back to St Austell Bay
14:00	Hauled third string
14:17	Looking for fourth string
14:30	Hauled fourth, fifth and sixth string
16:25	Steam to survey site
16:50	Set third string
16:53	Set fourth string
16:58	Set fifth string
17:14	Set sixth string
17:17	Steam back to Mylor
18:00	Arrive back on mooring

26th September 2018 – Wrasse Tagging Pilot Survey

Daily log for the survey carried out on 26th September 2018:

Survey code: 20180826_CIFCA_Wrasse

Staff: Colin Trundle (Principal Scientific Officer, Cornwall IFCA), Stephanie Sturgeon (Scientific Officer, Cornwall IFCA), Kate Owen (Scientific Officer, Cornwall IFCA), Annie Jenkin (Scientific Officer, Cornwall IFCA), PhD Student (University of Exeter) and Daniel McIntyre (Skipper/ Enforcement Officer, Cornwall IFCA).

Vessel: Tiger Lily VI

Table 10: Daily log for the survey carried out on 26th September 2018. All times are in UTC.

Survey conditions	
Cloud	0/8
Wind	SE 7-10mph
Sea State	2
Tide	Falmouth HW 06:58 (5.07m)
Time	**Activity**
07:05	Departed Mylor
07:13	Fuelling at Falmouth Fuel Services
07:15	Mixed VIE tags - pink (1ml) and yellow (0.5ml)
08:03	Finished fuelling, steam to survey site
08:51	Arrived at survey site
09:00	SOL String 5
09:25	EOL String 5
09:30	Re-set String 5
09:40	SOL String 4
10:13	EOL String 4
10:19	Re-set String 4
10:22	Mixed VIE tag - blue (0.25ml)
10:35	SOL String 3
11:08	EOL String 3
11:17	Re-set String 3
11:24	Finished 3 strings at Dodman Point, steaming to next survey site
11:33	Lunch
12:10	Mixed VIE tags - orange, green & red (0.25ml)
12:26	SOL String 1
13:17	EOL String 1
13:24	Re-set String 1
13:34	SOL String 2
13:54	EOL String 2
14:07	Re-set String 2
14:17	SOL String 6
14:45	EOL String 6
14:53	Re-set String 6
15:08	Cleared down deck
15:37	Valeport Swift Drop 1 near Portloe

15:49	Valeport Swift Drop 2 near Dodman Point
15:52	Departed site for Mylor
16:30	Moored at Mylor

28th September 2018 – Wrasse Tagging Pilot Survey

Daily log for the survey carried out on 28th September 2018:

Survey code: 20180828_CIFCA_Wrasse

Staff: Colin Trundle (Principal Scientific Officer, Cornwall IFCA), Stephanie Sturgeon (Scientific Officer, Cornwall IFCA), Hilary Naylor (Scientific Officer, Cornwall IFCA), Kate Owen (Scientific Officer, Cornwall IFCA), Annie Jenkin (Scientific Officer, Cornwall IFCA), PhD Student (University of Exeter) and Daniel McIntyre (Skipper/ Enforcement Officer, Cornwall IFCA).

Vessel: Tiger Lily VI

Table 11: Daily log for the survey carried out on 28th September 2018. All times are in UTC.

Survey conditions	
Cloud	1/8
Wind	SE 16-20mph
Sea State	5
Tide	Falmouth HW 08:00 (5.03m)
Time	**Activity**
07:05	Departed Mylor
08:03	Valeport Swift Drop 3 near Portloe
08:10	SOL String 1
08:36	EOL String 1
08:54	SOL String 2
09:13	EOL String 2
09:31	SOL String 6
10:04	EOL String 6
10:20	Transit to return three strings to St Austell Bay
12:10	Finished lunch and arrived at Dodman Point
12:10	Valeport Swift Drop 4 near Dodman Point
12:18	SOL String 5
12:33	EOL String 5
12:36	SOL String 4
13:06	EOL String 4
13:15	SOL String 3
13:45	EOL String 3
14:00	Transit to return three other strings to St Austell Bay
14:50	Left St Austell Bay
16:00	Arrived in Mylor

Annex 5 – Trap contents

Table 12: The contents from each wrasse trap. Images from wrasse survey on 26th September 2018.

String 1 – Trap 1	String 1 – Trap 2
	
String 1 – Trap 3	**String 1 – Trap 4**
	
String 1 – Trap 5	**String 1 – Trap 6**
	

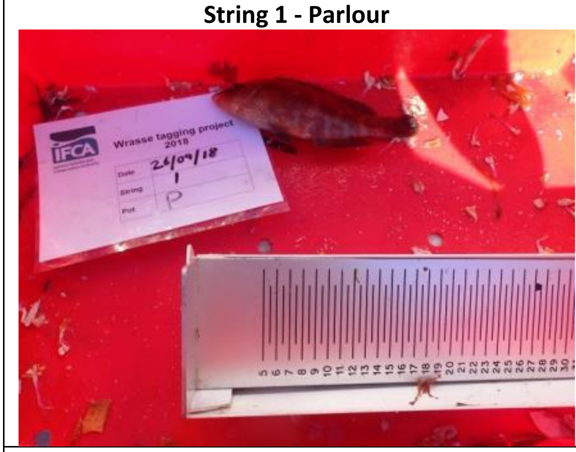
String 1 – Trap 7

String 1 – Trap 8

String 1 – Trap 9

String 1 – Trap 10

String 1 - Parlour



String 2 – Trap 1

String 2 – Trap 2

String 2 – Trap 3

String 2 – Trap 4

String 2 – Trap 5

String 2 – Trap 6

String 2 – Trap 7

String 2 – Trap 8

String 3 – Trap 1

String 3 – Trap 2

String 3 – Trap 3

String 3 – Trap 4

String 3 – Trap 5

String 3 – Trap 6

String 3 – Trap 7

String 3 – Trap 8

String 3 – Trap 9

String 3 – Trap 10

String 4 – Trap 1

String 4 – Trap 2

String 4 – Trap 3

String 4 – Trap 4

String 4 – Trap 5

String 4 – Trap 6

String 4 – Trap 7

String 4 – Trap 8

String 4 – Trap 9

String 4 – Trap 10

String 5 – Trap 1

String 5 – Trap 2

String 5 – Trap 3

String 5 – Trap 4

String 5 – Trap 5

String 5 – Trap 6

String 5 – Trap 7

String 5 – Trap 8

String 5 – Trap 9

String 5 – Trap 10

String 6 – Trap 1

String 6 – Trap 2

String 6 – Trap 3

String 6 – Trap 4

String 6 – Trap 5

String 6 – Trap 6

String 6 – Trap 7

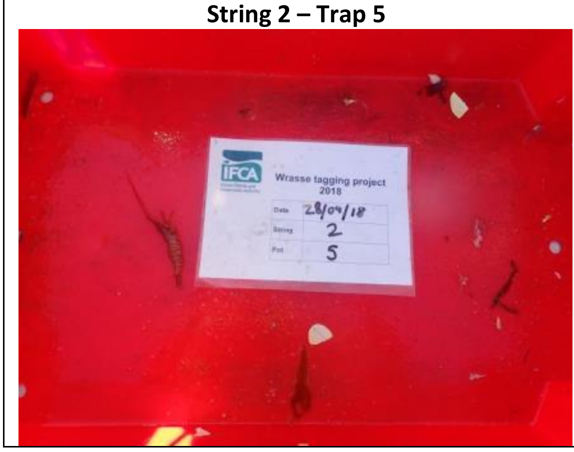
String 6 – Trap 8

String 6 – Trap 9

String 6 – Trap 10

Table 13: The contents from each wrasse trap. Images from wrasse sampling survey on 28th September 2018.

String 1 – Trap 1	String 1 – Trap 2
	
String 1 – Trap 3	**String 1 – Trap 4**
	
String 1 – Trap 5	**String 1 – Trap 6**
	
String 1 – Trap 7	**String 1 – Trap 8**
	

String 1 – Trap 9	String 1 – Trap 10
	
String 2 – Trap 1	**String 2 – Trap 2**
	
String 2 – Trap 3	**String 2 – Trap 4**
	
String 2 – Trap 5	**String 2 – Trap 6**
	

String 2 – Trap 7

String 2 – Trap 8

String 3 – Trap 1

String 3 – Trap 2

String 3 – Trap 3

String 3 – Trap 4

String 3 – Trap 5

String 3 – Trap 6

String 3 – Trap 7

String 3 – Trap 8

String 3 – Trap 9

String 3 – Trap 10

String 3 – Parlour

String 4 – Trap 1

String 4 – Trap 2

String 4 – Trap 3	String 4 – Trap 4
	
String 4 – Trap 5	**String 4 – Trap 6**
	
String 4 – Trap 7	**String 4 – Trap 8**
	
String 4 – Trap 9	**String 4 – Trap 10**
	

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String 5 – Trap 1	String 5 – Trap 2
	
String 5 – Trap 3	**String 5 – Trap 4**
	
String 5 – Trap 5	**String 5 – Trap 6**
	
String 5 – Trap 7	**String 5 – Trap 8**
	

String 5 – Trap 9

String 5 – Trap 10

String 6 – Trap 1

String 6 – Trap 2

String 6 – Trap 3

String 6 – Trap 4

String 6 – Trap 5

String 6 – Trap 6

String 6 – Trap 7

String 6 – Trap 8

String 6 – Trap 9

String 6 – Trap 10