Centre for Environment Fisheries & Aquaculture Science

Cefas

Research Vessel Survey Report: RV Cefas Endeavour CEND 01/23

Clean Seas Environmental Monitoring Programme (CSEMP)

English Channel, Celtic and Irish Sea

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January 2023

Cefas Document Control

Submitted to:	
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Quality control by:	Jon Barber
Approved by and date:	
Version:	V2
Recommended citation for this report:	

Contents

Survey Aims

The information generated during this survey will be used to meet UK's obligations for reporting of contaminant, eutrophication and marine litter data to MERMAN and the ICES database and for subsequent assessments for OSPAR and Good Environmental Status (GES descriptors 5, 8, & 10) assessment as part of the 25-year Environmental Plan. After discussions with the Environment Agency (EA) and National Resources Wales (NRW) colleagues a coordinated approach is being taken to help deliver additional EQSD requirements for these agencies.

Primary aims

1. To collect samples of demersal fish for chemical analysis from the Celtic and Irish Sea in support of the Clean Seas Environmental Monitoring Programme (CSEMP) (OSPAR Common indicator and UK specific Indicator assessments) (Figure 1,Table 1).

2. To collect fish samples at CSEMP sites for fish disease, biochemical markers (e.g. EROD and bile metabolites analysis and AChE) (UK specific Indicator Assessments) (Figure 1,Table 1).

3. To conduct marine litter surveys of seafloor macrolitter (following the ICES guidelines) and microplastics in sediment and biota, to gather data towards the OSPAR Commission Common Indicator and UK Evidence Group marine litter indicators.

4. To conduct marine litter surveys (OSPAR Common indicator and UK specific Indicator assessments) by collecting benthic litter information from collecting sediment samples for litter analysis.

5. To conduct opportunistic sampling of seafloor macro litter for Non-Native Species (NNS) research and development under the Clean Atlantic 2 programme.

6. Collect information on dab stomach content analysis to feed into the dabstats database to assess benthic community changes over time.

Secondary Aims

1. To collect water conductivity, temperature, nutrient, and depth information, and Plankton community information to provide additional knowledge on Eutrophication levels (OSPAR Common indicator and UK specific Indicator assessments) using CTD Rosette.

2. To collect additional fish for the EA and NRW to analyse as part of their Water Framework Regulations remit. EA require 9 fish from stations 534, 584, 706, 715, 769, 796 and Liverpool Bay trend. NRW require up to 9 Dab from Welsh stations 616, 649, 654 and 776 (Table 1)

3. To collect mackerel and sediment from four areas (English Channel, Celtic Sea, Cardigan Bay, and Irish Sea) following a request via the Working Group on Marine Chemistry (MCWG). Samples will be collected as close as possible to complementary fishing and sediment stations. Samples will used to investigate the distribution of a specific mackerel parasite as part of a large international study.

4. To collect flounder to analyse under the 25 Year Environment Plan H4 contaminants in wildlife indicator. Recently, work has been carried out under the BECEMO project (C8417) to look at biological effects in flounder in estuaries. To link up this work with the CSEMP programme, flounder have been sampled from coastal CSEMP stations to allow a comparison between what is observed in dab offshore and flounder in estuaries.

Survey particulars

DURATION: 19th January from Lowestoft (06:00 Pilot) – 28th January in Liverpool.

LOCATION: English Channel, Celtic and Irish Sea

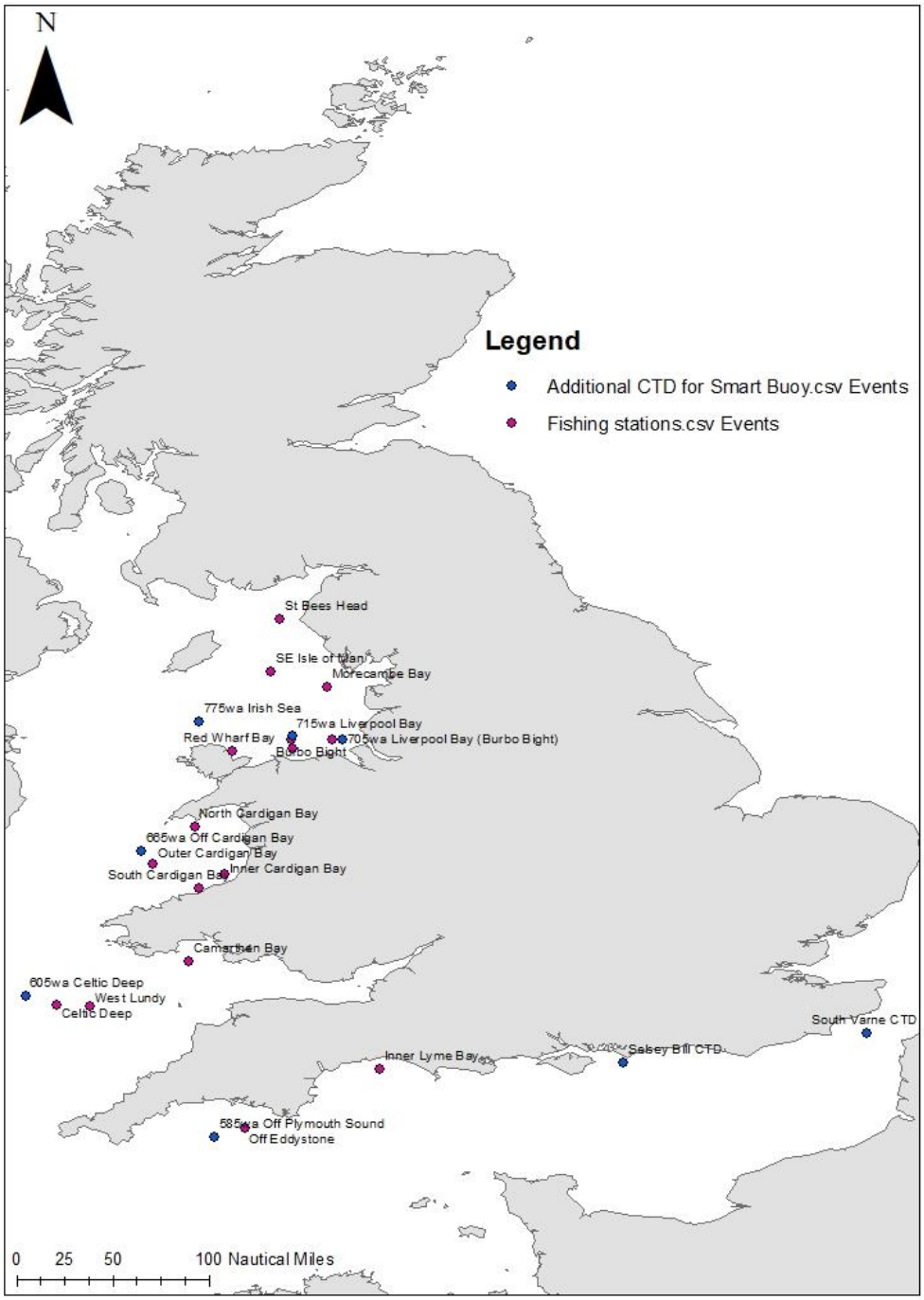


Figure 1: CSEMP fishing stations and additional Smartbuoy CTD water stations.

Stations

The survey plan included the following stations for sampling.

Table 1: CSEMP fishing stations positions

Additional 9 fish collected per site for the EA. Additional 9 fish collected per site for NRW.

CSEMP Number	Location	Mid tow Lat. Long.
New	West Lundy	51 09.79 N 05 26.67 W
605	Celtic Deep	51 10.29 N 05 43.75 W
616	Camarthen Bay	51 32.82 N 04 35.13 W
649	North Cardigan Bay	52 42.44 N 04 32.29 W
654	South Cardigan Bay	52 10.90 N 04 29.87 W
706	Burbo Bight	53 28.24 N 03 20.47 W
715	Liverpool Bay	53 28.32 N 03 41.91 W
Trend_Liv	Liverpool Bay Trend	53 23.76 N 03 41.50 W
769	St Bees Head	54 30.71 N 03 47.63 W
776	Red Wharf Bay	53 22.46 N 04 12.84 W
796	Morecambe Bay	53 55.31 N 03 23.23 W
805	SE Isle of Man	54 03.36 N 03 52.47 W

Table 2: Additional CTD Deployment locations

Station name	Latitude	Longitude
South Varne CTD	50.9333	1.28
Selsey Bill CTD	50.6783	-0.8267
705wa Liverpool Bay (Burbo Bight)	53.4715	-3.2597
715wa Liverpool Bay	53.5	-3.6917
775wa Irish Sea	53.625	-4.5
665wa Off Cardigan Bay	52.5	-5
605wa Celtic Deep	51.25	-6
585wa Off Plymouth Sound	50.0333	-4.3667

Survey Team

Our survey team (Table 3, Figure 2) consisted of skilled staff members from both Weymouth and Lowestoft, including histopathologists, chemists, ecotoxicologists, research scientists, fisheries scientists, and marine litter scientists. All staff works on a day shift system and staggering shifts as necessary on busier days.

Table 3: CSEMP Survey team and roles

Name	Role
Freya Goodsir	SIC
Manuel Nicolaus	2SIC
Izzy Lake	Data/Water
Mathew Green	FD Lead
Sam Westcott	FD
Ruth Hicks	FD
Joanna Uzyczak	FD/Ecotox
Richard Humphreys	Fish sorting/Otolith/Stomach
Briony Silburn	Data/Litter
Karen Vanstaen	Fish sorting/Otolith/Stomach
Peter Hamstead	Water/Data/Fish sorting
Josh Davidson	Ecotox/Fish sorting

Figure 2: CSEMP Survey Team: Josh Davidson, Izzy Lake Joanna Uzyczak, Ruth Hicks, Richard Humphreys, Freya Goodsir, Karen Vanstaen, Briony Silburn, Manuel Nicolas, Sam Westcott, Mathew Green and Peter Hamstead.

Survey Narrative

17th January

Scientific staff from Weymouth, along with the SIC arrived at the RV *Cefas Endeavour* for 19:00 Figure 3.

Figure 3: RV Cefas Endeavour at night alongside at Lowestoft dock

18th January

The remaining scientific staff arrived at the vessel at 08:00 to board. A visual risk assessment was carried out before the sampling equipment from Weymouth was unloaded from the vans to the dockside. The vessel was then mobbed with all scientific equipment and chemicals. Scientific staff set up the wet lab and dry lab and secured equipment for sailing. Additionally, the stations were uploaded to the Tower and TRANSAS systems and the data logging procedures were prepared. All staff carried out an induction of the vessel at 18:00, starting on the bridge.

19th January

The vessel sailed at 06:30 from Lowestoft via pilot and made its way south towards the first Smartbuoy CTD station. All staff and crew carried out a muster drill at 11:00, immediately followed by a general survey toolbox talk in the duty mess room. At 14:00 a toolbox talk was carried out in

the garage with crew and Cefas staff, to go through standard operating procedures (SOPs) of the CTD. Shortly after, we arrived at the South Varne Smartbuoy CTD site, where two successful deployments of the ESM2 logger and Niskin were performed, collecting both bottom and surface water samples. The vessel continued heading west through the English Channel arriving at the Selsey Bill Smartbuoy CTD station at 22:45, collecting bottom and surface samples with the ESM2 logger and Niskin. Once all operations were complete at 23:30, the vessel transited towards the Off Plymouth Sound Smartbuoy CTD station.

20th January

The vessel continued to transit west through the English Channel, arriving at the Off Plymouth South Smartbuoy CTD station 10:30 to complete two dips for bottom and surface water with the ESM2 logger and Niskin. Once operations were complete, the vessel continued transiting west, heading to the first CSEMP fishing station, Celtic Deep. At 13:00 all scientific staff attended a toolbox talk for the wet lab roles, responsibilities, and procedures, covering catch sorting, fish processing and general housekeeping of the area. Following this, final set up of the lab areas was conducted, ready for fishing to start in the morning (Figure 4).

Figure 4: Typical wet lab set up

21st January

The vessel arrived at Celtic Deep overnight, allowing for fishing activities to commence at first light. At 06:30 we started the trawling activities, successfully performing 3 tows by 11:00. There were very low numbers of dab, so no biomarkers, fish disease or chemistry could be collected. This is typical of this site as it does not retain large numbers of dab historically. However, 25 juvenile mackerel for Marine Chemistry Working Group (MCWG) and 25 of each whiting and mackerel for microplastics were sampled successfully as this site retains more of pelagic fish species (Figure 5). Once fishing operations were complete, a single deployment of the ESM2 logger and Niskin was carried out to sample bottom water, collecting the surface water from the Ferrybox continuous flow. After a 1.5 hour transit the vessel arrived as West Lundy CSEMP fishing station at 13:00. On arrival the ESM2 logger and Niskin was deployed for bottom water, sampling the surface from the Ferrybox. Four fishing tows were performed with the trawl, completing the fishing activity by 19:00. Similar to Celtic Deep, low numbers of dab were collected, completing 10 dab for Biomarkers, with a further 6 dab kept for Chemistry, and 25 whiting and 9 dab kept for microplastics. Once the trawling activities were complete, the vessel began the transit to Camarthen Bay to commence fishing at first light.

Figure 5: Granton trawl Catch in hopper at Celtic Deep

22nd January

The vessel arrived at Carmarthen Bay overnight and commenced fishing activities at 07:30. After completing 2 tows with smaller catches, we paused fishing activities as it was apparent the strong spring tides were affecting the trawl's ability to fish efficiently and these tows were considered invalid. In the meantime, the ESM2 logger and Niskin were deployed to collect bottom water and surface water was taken from the Ferrybox. After 11:00 when slack water began, we began fishing again. Lower numbers of dab were present, however enough to sample 12 fish were for biomarkers, 45 dab kept for chemistry, 9 for NRW and additional fish for microplastics. A large number of marine litter items were apparent at this site, this showed similar levels to that previously, with a large proportion of marine litter present being lost and abandoned fishing gear (Figure 6). At 16:00 the vessel slowly began the transit to South Cardigan Bay (Figure 7).

Figure 6: A bundle of lost and abandoned fishing gear found at Carmarthen Bay

Figure 7: RV Cefas Endeavour steaming from Carmarthen Bay to Cardigan Bay

23rd January

Fishing activities commenced at first light at 06:30 at South Cardigan Bay, with 4 tows completed by 11:30. The catches were good, with plentiful dab caught to complete the 20 biomarkers, 60 fish disease, 50 for chemistry, 9 NRW and additional fish for microplastics. Following this, the ESM2 logger and Niskin were deployed to collect bottom water and surface water was taken from the Ferrybox. A pod of around 300 common dolphins were spotted in the area of Cardigan Bay (Figure 8).

The vessel then transited for 3 hours, arriving at North Cardigan Bay at 15:00. After 2 tows with very small catches (again typical for this site historically, though usually there are enough fish caught for chemistry), fishing was ceased for the day, and the only samples collected from this station was whiting for microplastics. Again, the ESM2 logger and Niskin were deployed to collect bottom water and surface water was taken from the Ferrybox. With a long transit to the next fishing station in Liverpool Bay, it was decided to skip the 775wa Irish Sea Smartbuoy water station as this can be picked up during the next survey.

Figure 8: Common Dolphin at Cardigan Bay

24th January

A busy day started with fishing operations at 06:00 at Liverpool Bay, completing three successful tows with a good range of species and fish numbers. A CTD was deployed before transiting to Liverpool Bay Trend to collect further species for Trend analysis and to top up numbers from the Liverpool Bay site. Two tows were completed at Liverpool Bay Trend completing all primary aims, allowing for 20 dab to be processed for biomarkers, 60 for fish disease, 50 for chemistry, 9 for EA as well as additional fish for microplastics and the MCWG. After a short transit to Red Wharf Bay, arriving at 16:00, we completed a further 3 tows with the Granton trawl (

Figure 9), completing fishing activities at 19:30. During this time 20 dab for biomarkers, 25 for chemistry and 9 for NRW, with all the target fish collected for microplastics. Again, the final operation for the day was a deployment of the ESM2 logger and Niskin to collect bottom water, with surface collected from the Ferrybox. Once operations were all complete, we began the overnight transit to the South East Isle of Man fishing station.

Figure 9: Granton trawl being deployed off the stern of the RV Cefas Endeavour

25th January

The day started early at 06:30 with fishing operations at South East Isle of Man. Three good fishing tows were completed with a good number and variety of fish species (Figure 10), collecting biomarker and 60 for fish disease samples, as well as 50 dab for chemistry, and additional fish for microplastics. An ESM2 logger and Niskin was deployed, before commencing the 3 hour transit to St Bees Head. We arrived at St Bees Head at 14:00 and carried out four good fishing tows with a large quantity of dab, however, most of the males were on the smaller size range. All primary aims were completed, with 20 for biomarkers, 60 for fish disease, 50 for chemistry, 9 for EA and additional fish for microplastics and MCWG. A deployment of the ESM2 logger and Niskin completed the station, before an overnight transit to Morecambe Bay.

Figure 10: Scientists sorting the catch from the Granton trawl

26th January

Fishing commenced at Morecambe Bay at 08:00, with 5 fishing tows conducting to collect enough fish to meet the primary aims, with 20 dab processed for biomarkers, 60 for fish disease and a further 50 collected for chemistry, 9 for EA and additional fish for microplastics and the MCWG. A deployment of the ESM2 logger and Niskin was the final activity of the day, before we transited overnight to Burbo Bight.

27th January

We arrived at Burbo Bight overnight ready to commence fishing at first light. The trawl was in the water by 07:00 and we completed 3 tows of the gear, collecting enough fish to complete the 20 for biomarkers, an additional 30 for extra bile and liver and a further 30 for fish disease. We also processed 9 flounder for biomarkers and fish disease, as well as collected fish for the EA and microplastics. After the fishing activities were completed, bottom water was collected with the ESM2 logger and Niskin, before heading to 705wa Liverpool Bay (Burbo Bight) and then 715wa Liverpool Bay Smartbuoy CTD stations. At both stations the ESM2 logger and Niskin were deployed 2 times to collect bottom and surface water. Lastly, a plankton ring net was deployed to collect a plankton sample from the Smart buoy station (Figure 11). With this, all the survey activities were complete and we went to anchor overnight.

Figure 11: Plankton ring net being deployed off the side gantry at Liverpool Smart buoy station.

28th January

With all the primary and secondary aims of the survey completed, the day was spent packing all scientific kit and gear ready for demob tomorrow or storage in the net store until the vessel returns to Lowestoft. All the scientific work areas were thoroughly cleaned ready to hand the ship over to the next survey. The pilot boarded the vessel at 15:30 and we were alongside in Liverpool by 20:00.

29th January

The vessel was demobbed of equipment to be returned to Weymouth lab, and all staff were on the road home by 12:00.

Results

Fishing stations

Out of the eleven fishing stations (as Liverpool Bay and Liverpool Bay Trend have been considered as a single station here in the results) that remained to complete the sampling that began in November, ten were completed successfully (Table 4). Overall, we collected a good number of dab, better than when we last conducted the western CSEMP stations in December 2020. However, as noted in both 2020 and 2021, when surveying outside of the summer months, there were varying sizes, where male dab were on the smaller size in the majority of cases, apart from those in Burbo Bight/Liverpool Bay area. At the majority of target stations, 50 dab for chemical analysis were collected (Table 4). Biomarkers were collected from nine of the eleven target stations (Table 4). At the two stations where we did not collect any dab for chemistry, we also did not process any fish for biomarkers, this included Celtic Deep which has low numbers of dab historically. However, it was the first time that we did not manage to get samples for chemistry from North Cardigan Bay. Further fish were taken for fish disease at six of the stations, as well as three stations where flounder were processed for biomarkers (Table 4). At all stations, fish were collected for microplastics, analysis, totalling 275 whiting, 206 dab, 181 plaice and 75 mackerel. As part of our secondary survey aims, nine additional dab were collected from specific stations for NRW and the EA as part of a collaboration exercise, as well as mackerel, whiting, plaice, herring and flounder for the Marine Chemistry Working Group (MCWG).

In total, we sampled 522 dab for 14 different fish diseases that can be detected by visual examination, as well as a further 35 flounder. The most abundant occurrence was Lepeophtheirus sp (157 times) and Glugea sp. (104 times). A breakdown of the fish disease observations can be seen in Table 5. Stomach contents analysis was also carried out as part of our analysis. Twenty stomach contents were collected for the individual dab processed for biomarkers. Table 6 provides an overview of the 162 dab from 12 stations that were assessed for stomach content.

Table 4: Fished Stations and number of fish caught for specific analysis

Date	Location	CSEMP code	Mid tow Lat. decimal	Mid tow Lon. decimal	time shot	time haul	Fish numbers for Chemical analysis	Dab numbers for Biomarker analysis; Fish Disease (FD)	Environment Agency/ Natural Resources Wales	Microplastics
22/01/22	Carmarthen Bay	CSEMP 616	51.532847	-4.617378	08:14:00	08:44:00	1 x 25; 1 x 20	12 biomarker (2 M, 10 F)	3 x 3	22 dab, 6 plaice, 25 whiting
23/01/23	South Cardigan Bay	CSEMP 654	52.181029	-4.513250	06:38:00	07:12:00	2 x 25	20 biomarkers (10 M, 10 F) and 60 fish disease	3 x 3	25 dab, 25 plaice, 25 whiting
23/01/23	North Cardigan Bay	CSEMP 649	52.711800	-4.538608	15:14:00	15:44:00	-	-	-	25 whiting
24/01/23	Red Wharf Bay	CSEMP 776	53.351522	-4.113189	16:06:00	16:36:00	1 x 25	20 biomarkers (10 M, 10 F), plus 4 flounder for biomarkers	3 x 3	25 dab, 25 plaice, 25 whiting, 25 mackerel
24/01/23	Liverpool Bay	CSEMP 715	53.496506	-3.736583	06:12:00	06:42:00	2 x 25	50 biomarkers (21 M, 29 F) and 30 fish disease, plus 20 flounder for biomarkers	3 x 3	25 dab, 25 plaice, 25 whiting, 25 mackerel
24/01/23	Liverpool Bay Trend	Trend_Liv	53.412842	-3.649650	12:20:00	12:50:00	Dab (3 age classes), plaice (5 age classes) and whiting (5 age classes)	-	-	-
27/01/23	Burbo Bight	CSEMP 706	53.464683	-3.394628	07:06:00	07:32:00	2 x 25	50 biomarkers (23 M, 27 F) and 30 fish disease, plus 12 flounder for biomarkers	3 x 3	25 dab, 25 plaice, 25 whiting
26/01/23	Morecambe Bay	CSEMP 796	53.929240	-3.357653	08:12:00	08:42:00	2 X 25	20 biomarkers (10 M, 10 F) and 60 fish disease	3 x 3	25 dab, 25 plaice, 25 whiting
25/01/23	SE Isle of Man	CSEMP 805	54.056100	-3.866678	06:41:00	07:13:00	2 x 25	20 biomarkers (10 M, 10 F) and 50 fish disease	-	25 dab, 25 plaice, 25 whiting
25/01/23	St Bees Head	CSEMP 769	54.494154	-3.756133	14:13:00	14:43:00	2 x 25	20 biomarkers (10 M, 10 F) and 50 fish disease	3 x 3	25 dab, 25 plaice, 25 whiting
21/01/23	Celtic Deep	CSEMP 605	51.164511	-5.697400	06:58:00	07:28:00	-	-	-	25 whiting, 25 mackerel
21/01/23	West Lundy	CSEMP 604	51.157829	-5.455521	13:27:00	13:57:00	6	10 biomarkers (4 M, 6 F)	-	9 dab, 25 whiting

Table 5: Observed occurrences of the fourteen recorded external and internal fish diseases

Lymphocystis	Skin Ulcer	epidermal hyperplasia/papilloma	hyperpigmentation	liver disease - nodule/tumour	X-cell gill lesions	Stephanostomum sp	Lepeophtheirus sp.	Acanthochondria sp.	Nematodes	Glugea sp	Lateral lipoidosis	Skeletal deformity	fin rot/erosion
0	**21**	**8**	**41**	**10**	**0**	**7**	**157**	**7**	**19**	**104**	**3**	**1**	**6**

Table 6: Stomach content of 20 sampled dab at **Off Eddystone** on 13th November 20, 2022

CSEMP ST. NO.	Length (cm 1dp)	Weight (g)	SEX	STOMACH ANALYSIS
604	21.5	110.5	F	Neckless shell, euspira mtbia spp; fullness 1
604	24	127.9	F	ophuria; fullness 2
604	22	108.2	F	empty; fullness 0
604	23.4	129.9	M	White organic matter (WOM), unidentified origin; fullness 1
604	22.2	108.7	F	White organic matter (WOM), unidentified origin; fullness 1
604	24	127.9	F	Pagarus (HIS), bivalve, ophiuroid; fullness 3
604	20.7	99.1	M	WOM, hydroid 1?; fullness 1
604	21.5	86.7	M	Pagarus (Prideaux?), hermits; fullness 2
604	20.2	69.5	M	WOM, shell fragments; fullness 1
604	22.6	125	F	WOM, shell fragments; fullness 1
616	23.5	138.5	F	empty; fullness 0
616	24.5	172.2	F	unidentifiable green matter; fullness 2
616	22.6	121.9	F	brittle star, bilvalve, sand; fullness 4
616	23.8	127.4	F	empty; fullness 0
616	20.4	81.9	M	bivalve; fullness 1
616	23	136.9	F	hermit crab in shell; fullness 4
616	24	142.4	F	brittle star; long-legged spider crab (Hyas); fullness 3
616	23.4	133.6	F	brittle star, sand; fullness 4
616	19.4	70.6	M	WOM; fullness 1
616	23	130.7	F	empty; fullness 0
616	23	127.2	F	brittle star, small bits of hydroid; fullness 2
616	22.9	127.5	F	brittle stars; fullness 3
654	22.2	111.6	F	Brittle star, bivalve, hydroids; fullness 4
654	20.8	92	F	brittle star, macropodia; fullness 4
654	23.9	132.7	F	pagarus sp. X 4; fullness 4
654	23.9	134.4	F	2 x pink shrimp, brittle star fragments, phaxus sp; fullness 4
654	21	85	F	brittle star fragments; fullness 4
654	21.2	107.5	F	mollusc shell fragments, polychaete, digested matter; fullness 4
654	20.5	101.2	F	brittle star fragments, hydroid; fullness 4
654	20	77	F	phaxus x 2, hydroid, brittle star fragments; fullness 4
654	20.8	98	F	phaxus x 1, brittle star fragments, organic matter, hydroids; fullness 4
654	21	99.7	F	brittle star fragments, hydroids; fullness 4
654	18.8	56.4	M	empty; fullness 0
654	18	63.6	M	brittle star, hydroid; fullness 4
654	18.8	60.6	M	brittle star fragments, polychaete; fullness 4
654	18.4	62	M	brittle star fragments, hydroid; fullness 2
654	16.8	48.4	M	brittle star fragments; fullness 1
654	19	68.3	M	empty; fullness 0
654	19.5	55.5	M	worm polychaete, brittle star; fullness 3
654	18.6	59.7	M	pagarus, brittle star fragments; fullness 2
654	18.6	54.1	M	WOM; fullness 1

654	18	54.2	M	brittle star; fullness 2
715	20.6	77.8	M	empty: fullness 0
715	22.5	112.2	F	empty: fullness 0
715	20.6	104.5	F	empty: fullness 0
715	20.7	86.2	M	digested matter; fullness 1
715	22.4	114.8	F	empty: fullness 0
715	20	79.9	M	brittle star fragments, digested matter; fullness 1
715	20.5	78	M	empty: fullness 0
715	20.2	77.5	M	empty: fullness 0
715	20.8	84.8	M	empty: fullness 0
715	19.5	66.9	M	empty: fullness 0
715	19.2	58.1	M	empty: fullness 0
715	20.1	78.1	M	empty: fullness 0
715	21.3	94.1	M	empty: fullness 0
715	24	151.7	F	empty: fullness 0
715	21.3	95.2	F	whelk foot; fullness 1
715	21.2	89.6	F	goosefoot leg, tube worm; fullness 1
715	22.9	134.3	F	empty: fullness 0
715	20.2	79.4	F	empty: fullness 0
715	21.9	102.8	F	brittle star fragments, digested matter; fullness 1
715	23.9	152.6	F	empty: fullness 0
776	20.5	90.5	F	7 X SMALL SPIDER CRABS, MACROPODIA; FULLNESS 4
776	20	72.1	M	DIGESTED STARFISH MATTER; FULLNESS 1
776	19	68.5	M	EMPTY; FULLNESS 0
776	19.7	72.7	M	BRITTLE STAR FRAGMENTS; FULLNESS 1
776	20.2	89.4	F	SWIMMING CRAB LEGS, DIGESTED APHRODITE, 17 X MACROPODIA; FULLNESS 4
776	21.1	82.9	M	PARASITIC WORM PRESENT; FULLNESS 0
776	19.3	63.1	M	EMPTY; FULLNESS 0
776	19.2	46.4	M	EMPTY; FULLNESS 0
776	19.6	68.9	M	CRAB CLAW, CARAPACE, BRITTLE STAR FRAGMENT, WELL DGESTED APHRODITE; FULLNESS 2
776	19.3	66.6	M	BRITTLE STAR FRAGMENT, WELL DIGESTED BRITTLE STAR MATTER; FULLNESS 1
776	23	125.6	F	JELLYFISH; FULLNESS 2
776	22.1	115.2	F	EMPTY; FULLNESS 0
776	20.4	95.1	F	WELL DIGESTED APHRODITE; FULLNESS 1
776	20.1	98.9	F	WHELK FOOT; FULLNESS 1
776	22	123.9	F	CRAB CLAW; FULLNESS 1
776	22.1	132	F	WELL DIGESTES BRITTLE STAR MATTER; FULLNESS 1
776	21.8	109	F	EMPTY; FULLNESS 0
776	23.1	150.8	F	BRITTLE STAR FRAGMENTS; FULLNESS 1
776	19.7	63.5	M	EMPTY; FULLNESS 0
776	19.6	65.8	M	POLYCHAETE (WORM); FULLNESS 1
805	20	79.1	M	BRITTLESTAR FRAGMENTS, FULLNESS 2
805	22	89.4	M	EMPTY; FULLNESS 0
805	19.8	69.7	M	EMPTY; FULLNESS 0
805	19.3	57.1	M	EMPTY; FULLNESS 0
805	20.7	86.1	M	HYDROID AND PHAXUS, FULLNESS 1
805	20.2	59.2	M	WOM WHITE ORGANIC MATTER, FULLNESS 1

805	21.1	81.6	M	EMPTY; FULLNESS 0
805	20	69.9	M	EMPTY; FULLNESS 0
805	20.3	67.8	M	DIGESTIVE MATTER AND APHRODITIES BRISTLES, FULLNESS 1
805	19	59.1	M	EMPTY; FULLNESS 0
805	22.5	124.7	F	EMPTY; FULLNESS 0
805	23.2	137.2	F	EMPTY; FULLNESS 0
805	22.3	122.7	F	WOM WHITE ORGANIC MATTER, FULLNESS 1
805	23.9	130.9	F	WOM WHITE ORGANIC MATTER AND SEDIMENT, FULLNESS 2
805	21.5	124.9	F	WOM WHITE ORGANIC MATTER, FULLNESS 1
805	23.9	139.6	F	EMPTY; FULLNESS 0
805	23.4	152.7	F	EMPTY; FULLNESS 0
805	22.6	116.4	F	POLYCHAETE (WORM); FULLNESS 3
805	22.4	122.5	F	WOM WHITE ORGANIC MATTER, FULLNESS 1
805	19.8	77.4	F	EMPTY; FULLNESS 0
769	22.1	99.6	F	BRITTLE STAR FRAGMENTS; FULLNESS 4
769	20.5	77.6	F	PHAXUS; FULLNESS 2
769	20.5	73.7	F	PHAXUS; FULLNESS 2
769	20	73.2	F	PHAXUS, PAGARUS SP.; FULLNESS 2
769	19.5	75.5	F	WHITE ORGANIC MATTER (WOM); FULLNESS 1
769	19.3	69.8	F	PHAXUS WOM; FULLNESS 2
769	21.4	119	F	WOM, SEDIMENT/BROWN MATTER; FULLNESS 1
769	22.8	139	F	WOM, OPHURIA SP; FULLNESS 1
769	20.3	89.6	F	WOM, SEDIMENT/BROWN MATTER; FULLNESS 2
769	22.7	105.4	F	BROWN MATTER; FULLNESS 2
769	21.5	85.2	M	WOM; FULLNESS 1
769	20	76.5	M	UNIDENTIFIED CRUSTACEAN; FULLNESS 3
769	18.6	54.7	M	EMPTY; FULLNESS 0
769	18.5	52.2	M	PHAXUS; FULLNESS 3
769	18.5	51.7	M	BROWN MATTER; FULLNESS 2
769	18	55.2	M	PHAXUS, BROWN MATTER; FULLNESS 3
769	18.7	58.5	M	WOM; FULLNESS 1
769	18	49.3	M	WOM, BROWN MATTER; FULLNESS 2
769	17.5	48.4	M	POLYCHAETE, BROWN MATTER; FULLNESS 2
769	17.5	42.8	M	EMPTY; FULLNESS 0
796	22.2	126	F	Bivalve x2, amphipod, ophuria x 10; Fullness 3
796	20.6	120.1	F	hydroids, ophuria, phaxus, polychaete; Fullness 3
796	22.1	120.3	F	Ophuria x 5; Fullness 2
796	19.7	91.5	F	Well digested Ophuria; Fullness 2
796	22.1	113.1	F	Hydroids, aphrodite, large brittle star, pagarus claws x 3; Fullness 4
796	22.2	90.7	F	Empty; Fullness 0
796	21.2	89.2	F	Well digested matter; Fullness 1
796	21.1	76.8	F	Empty; Fullness 0
796	22.8	129.4	F	Well digested Ophuria, polychaete x 2; Fullness 3
796	20.9	63.9	F	Empty; Fullness 0
796	18.4	57.7	M	Well digested brittle star (Ophuria), polychaete x 1; Fullness 2
796	19	66.3	M	Well digested brittle star (Ophuria), polychaete x 1; Fullness 2
796	18.6	51	M	Well digested ophuria; Fullness 2

796	18.9	54.9	M	Ophuria x 5; Fullness 1
796	18.1	58.1	M	Ophuria x 2; Fullness 1
796	18.8	56.8	M	Empty; Fullness 0
796	18.5	55.9	M	Well digested brittle star (Ophuria), polychaete x 1; Fullness 3
796	18	52.2	M	Well digested Ophuria; Fullness 2
796	18	54.9	M	Well digested Ophuria; Fullness 1
796	17.9	52.8	M	Parasitic worm, whelk foot, well digested ophuria, phaxus shell; Fullness 2
706	20.4	81.3	M	Empty; Fullness 0
706	220	86.8	M	Empty; Fullness 0
706	20.4	91.9	M	Empty; Fullness 0
706	19.4	73.5	M	White Organic Matter (WOM); Fullness 1
706	20.5	81.6	M	Empty; Fullness 0
706	20.8	79.5	M	Empty; Fullness 0
706	20.6	80.2	M	Small fragment of brittle star (Ophura); Fullness 1
706	21	86.6	M	Empty; Fullness 0
706	20.8	70.5	M	Empty; Fullness 0
706	22.1	94	M	Mostly digested Polychaete; Fullness 1
706	24	151.5	F	Empty; Fullness 0
706	22	117.9	F	WOM; Fullness 1
706	22	107.3	F	Empty; Fullness 0
706	22.4	124.6	F	WOM; Fullness 1
706	20.6	93.8	F	Brittle star fragments very digested, polychaete; Fullness 2
706	23.9	127.8	F	Empty; Fullness 0
706	21.3	103.8	F	Digested brittle star, phaxus; Fullness 2
706	20.9	102.5	F	2 x brittle star (ophura); Fullness 3
706	20.9	83.6	F	Empty; Fullness 0
706	21.1	97.1	F	Phaxus x 2; Fullness 2

CTD profiles

At each fishing station, an ESM2 logger and Niskin was deployed to establish a full water profile of salinity, temperature, oxygen, fluorescence and turbidity. Water samples were collected using the Niskin from bottom waters and analysed for oxygen, salinity, chlorophyll, nutrients and SPM (Table 7). Additionally, surface water (~4m) samples were collected from the Ferrybox continuous flow and analysed for salinity chlorophyll, nutrients and SPM. At the additional Smartbuoy water sampling stations, the ESM2 logger and Niskin were deployed twice to collect both the bottom and surface waters, and each deployment was analysed for oxygen, salinity, chlorophyll, nutrients and SPM. A summary of the CTD stations can be found in Table 7. In addition, Figure 12 shows the mean dissolved oxygen data from the bottom water Niskin samples collected at each fishing station and additional Smartbuoy CTD station, as analysed onboard using the dissolved oxygen analyser.

Table 7: CTD rosette samples collected.

Station	Station Code	Station No.	Fix No.	Date	Time	Latitude	Longitude	Water Depth (m)	ESM2 Depth (m)
South Varne	-	1	1, 2	19/01/2023	15:07	50.933	1.275	27	24
Selsey Bill	-	2	3, 4	19/01/2023	22:47	50°39.929 N	00°49.891 W	21	18
Off Plymouth Sound	-	3	5, 6	20/01/2023	10:48	50.03345	-4.362003	69	65
Celtic Deep	605	4	7	21/01/2023	11:28	51°09.96 N	05°41.81 W	84	83
West Lundy	-	5	8	21/01/2023	13:05	51°10.47 N	05°22.34 W	73	70
Carmarthen Bay	616	6	10	22/01/2023	10:10	51°31.729 N	04°39.539 W	38	35
South Cardigan Bay	654	7	11	23/01/2023	11:57	52°10.36 N	04°31.24 W	29	26
North Cardigan Bay	649	8	12	23/01/2023	18:04	52°44.33 N	04°28.155 W	29	26
Liverpool Bay	715	9	13	24/01/2023	11:05	53°29.386 N	03°44.241 W	40	37
Red Wharf Bay	776	10	14	24/01/2023	19:45	53°21.316 N	04°09.094 W	14	11
Irish Sea	775	11	15	24/01/2023	22:15	53°37.557 N	04°09.094 W	65	62
SE Isle of Man	805	12	16	25/01/2023	10:17	54°03.107 N	03°53.916 W	49	42
St Bees Head	769	13	17	25/01/2023	19:16	54°29.713 N	03°43.601 W	23	20
Morecambe Bay	796	14	18	26/01/2023	14:19	53°56.536 N	03°22.384 W	26	23
Burbo Bight	706	15	19	27/01/2023	10:20	53°27.717 N	03°25.540 W	20	17
Burbo Bight (Liverpool Bay)	706	16	20, 21	27/01/2023	12:51	53°27.370 N	03°16.703 W	19	16
Liverpool Bay SmartBuoy	706	17	22, 23	27/01/2023	14:37	53°32.399 N	03°21.664 W	26	23

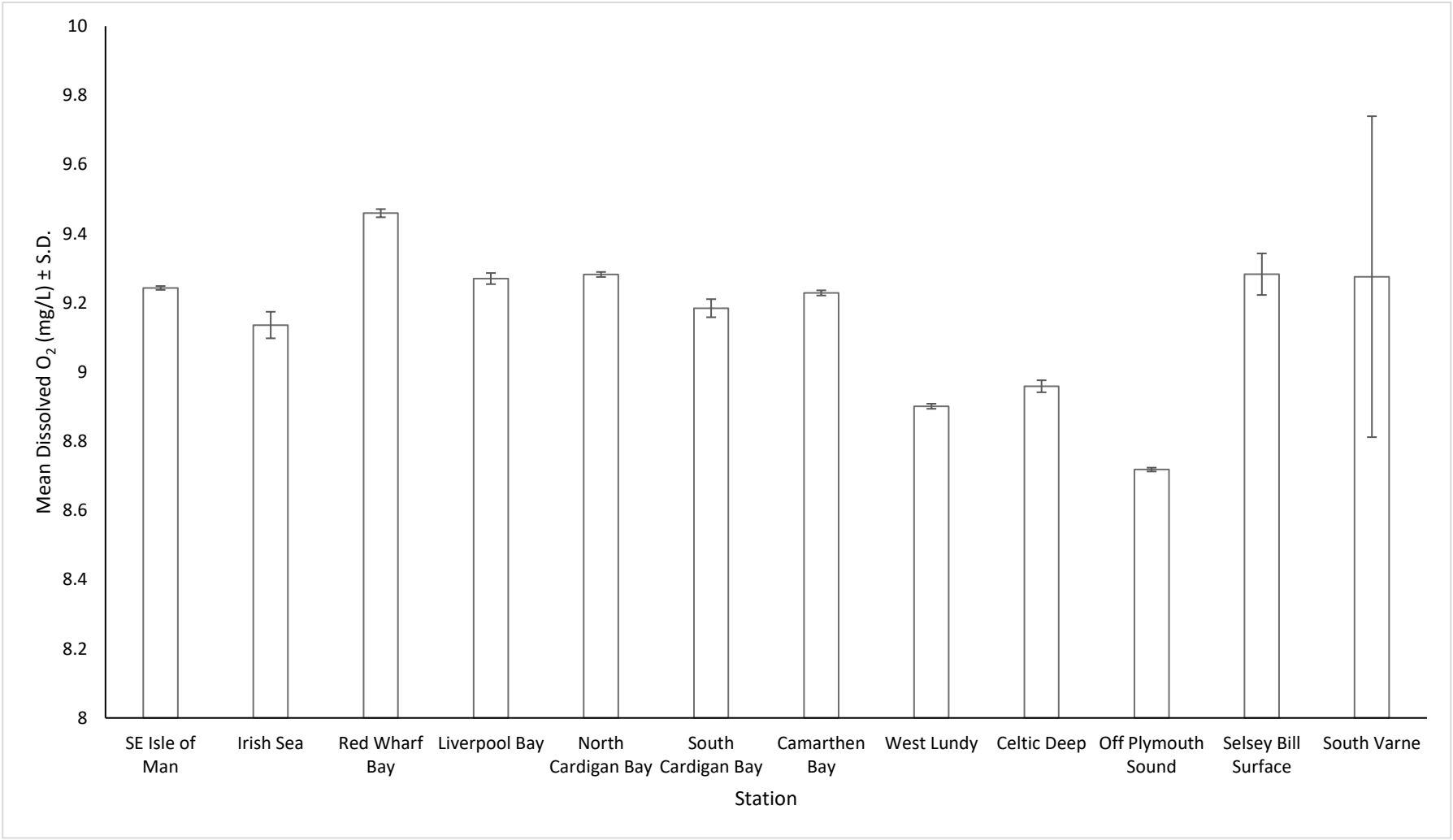
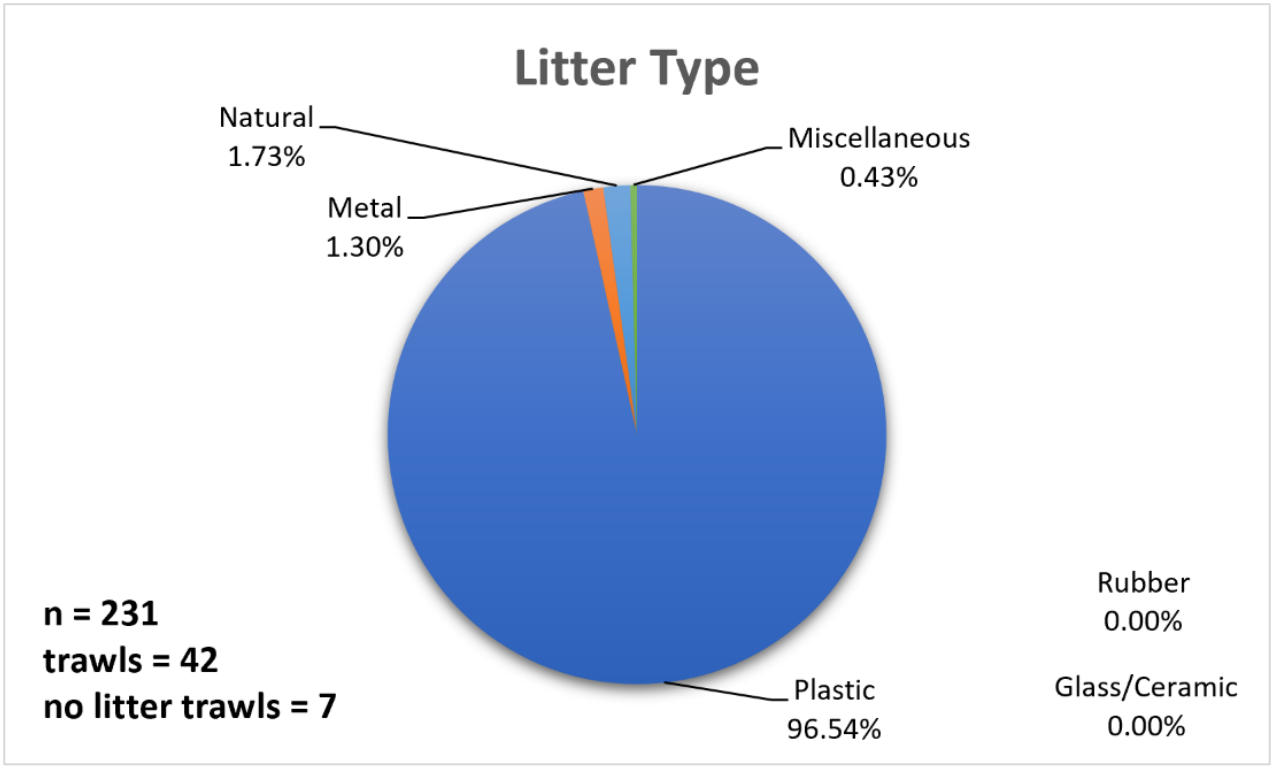


Figure 12: Bottom mean dissolved oxygen concentration

Seafloor litter

During our trawling activities, and as part of our survey objectives, analysis of any collected seafloor litter was conducted. In total, 231 litter items were collected over 42 trawls, weighing a total of 21.0614 kg. Of the 42 trawls conducted, just 7 of them contained no litter. Off these litter items, 223 items were plastics, accounting for 96.54% of all litter collected. The highest polluted with litter station was Carmarthen Bay, where 100 litter items along with a large amount of lost and abandoned fishing gear (Figure 13) were collected. Figure 13 shows a breakdown of all litter collected by count, split by material type, as well as a breakdown of the plastic categories as these made up the majority of all litter collected. In addition, 18 items of seafloor litter with substantial attached organisms attached have been kept for further analysis in the lab, feeding into the gathering evidence towards non-native species settling on seafloor litter.



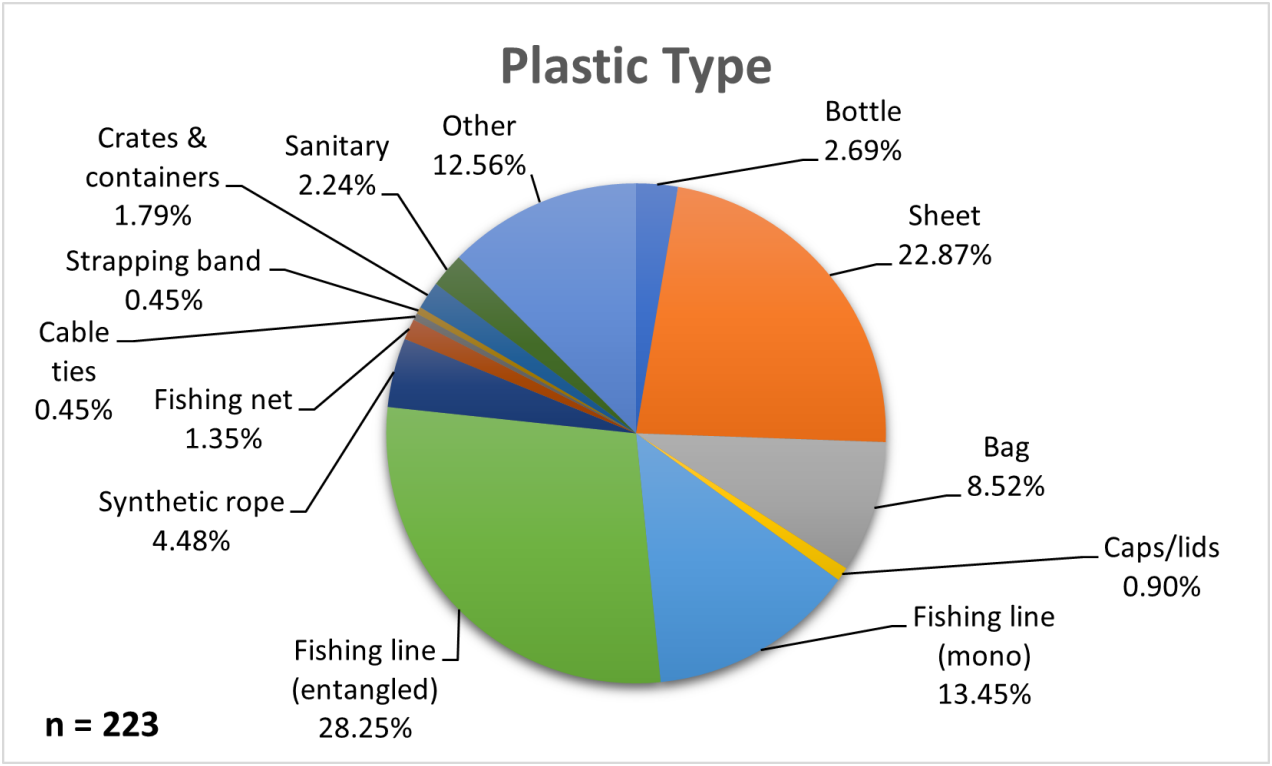


Figure 13: Pie charts showing marine litter composition (%) by count for all litter and for plastic litter only.

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13/02/2023

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