Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL PROGRAMME

RV CEFAS ENDEAVOUR

Survey: C END 16 - 2023

STAFF:

Name	Role	Name	Role
Izzy Lake	**SIC**	Matt Brown	Deck lead
Peter Hamstead	2IC/ Shadowing back deck support	Axa Molina-Ramirez	Deck support
Barnaby Andrews	Shadowing deck support	Tom Hull	Deck support/ data manager
Elise Brabben	Water Sampling; Chemical lead	Camille Visinand	Deck support
Freya Mickleburgh	Water sampling	Mark Etherton-Nicoll	Shadowing all
September Hall	Water sampling/ passive samplers	Emanuele Reggiani	Water sampling/ pH sensor
Karolina Klimaszweska	Water sampling		

DURATION: 4th to 6th November 2023.

3rd Nov: boarding in Lowestoft from 13:00, induction 14:00. Pilot booked and sailing from Lowestoft first tide leaving 22:30

6th Nov: docking in Lowestoft latest tide 16:00

7th Nov: Demob from 08:00, disembark 09:00 and samples to be delivered to lab at 09:00

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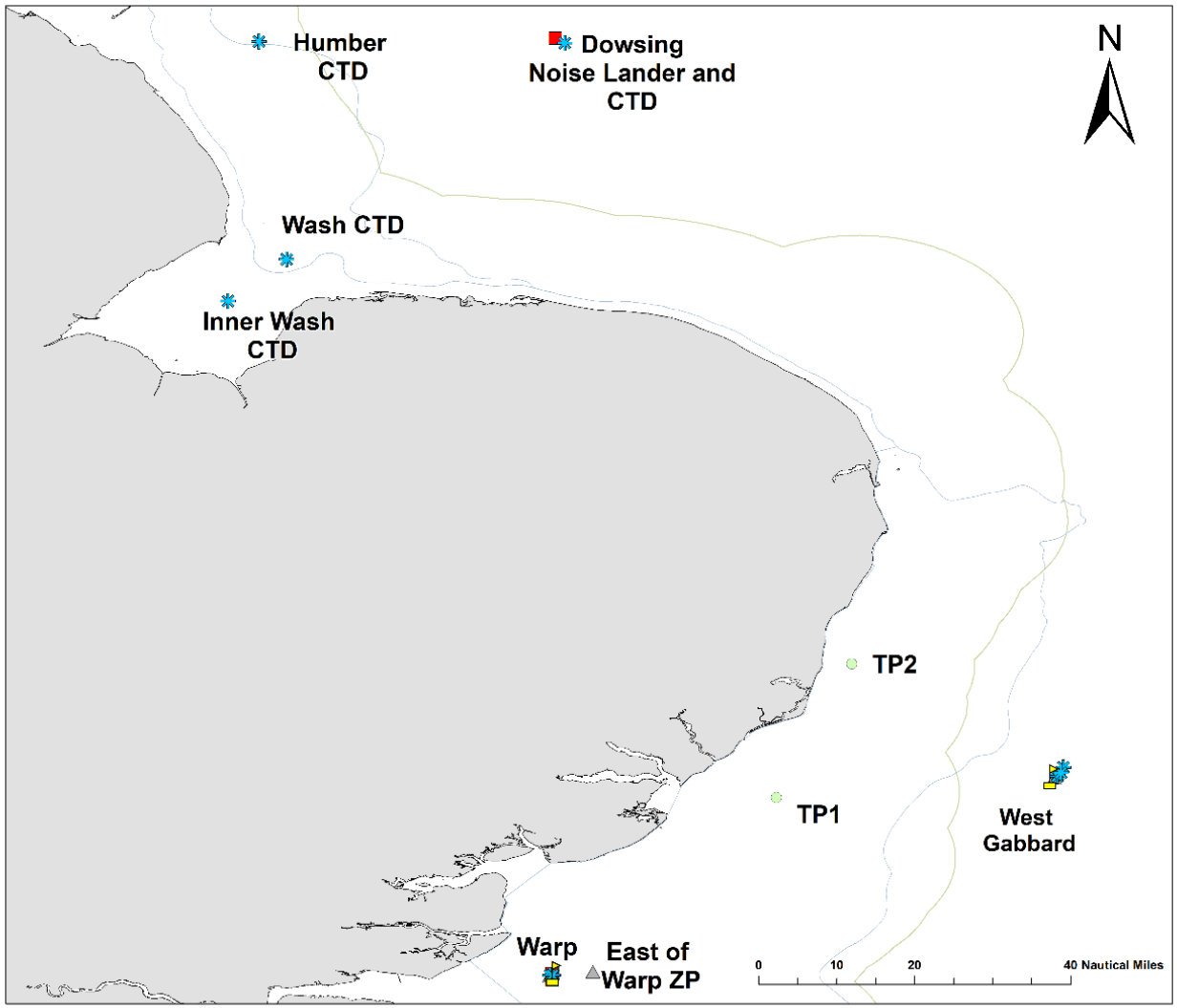

CEND 16/23 Planned Stations

Gear Code

- SmartBuoy
- Noise Lander
- CTD
- Zooplankton
- Under Way
- COMP4 Assessment Areas
- 12 nm limit
- UK Coastline

LOCATION: England

Table 1. Planned Stations for CEND 16/23

Latitude	Longitude	Station
51.95049	2.118848	West Gabbard Zooplankton
51.95727	2.126287	West Gabbard Pre-CTD
51.95279	2.111927	West Gabbard SmartBuoy Recovery (August ‘23)
51.95277	2.112074	West Gabbard SmartBuoy Clump Recovery (August ‘23)
51.95282	2.111997	West Gabbard SmartBuoy and Clump Deployment
51.95416	2.12605	West Gabbard Post-CTD
51.53675	1.133716	East of Warp Zooplankton
51.5273	1.040371	Warp Zooplankton
51.5297	1.042674	Warp Pre-CTD
51.53205	1.046483	Warp Noise Lander Clump Recovery (August ‘23)
51.53245	1.044595	Warp Noise Lander Recovery (August ‘23)
51.53291	1.04867	Warp SmartBuoy Recovery (August ‘23)
51.53299	1.04892	Warp SmartBuoy Clump Recovery (August ‘23)
51.53318	1.049314	Warp SmartBuoy and Clump Deployment
51.532	1.046712	Warp Noise Lander Deployment
51.53266	1.04496	Warp Noise Lander Clump Deployment
51.52868	1.04187	Warp Post-CTD
51.90891	1.525512	TP1 UW or CTD and Secchi Disk
52.19419	1.68627	TP2 UW or CTD and Secchi Disk
53.52952	1.052303	Dowsing NL
53.51926	1.073141	Dowsing CTD
53.52235	0.419977	Humber CTD
53.05718	0.47894	Wash CTD
52.96823	0.354014	Inner Wash CTD

GEAR CODES:

SB- SmartBuoy; NL- Noise Lander; UW-underway/continuous flow/FerryBox sampling; CTD – CTD Rosette/Profiler; ZP – Zooplankton; WG02- West Gabbard; DOW – Dowsing

AIMS:

3-day survey to exchange 2 SmartBuoys and 2 Noise Landers and collect water and zooplankton samples for eutrophication monitoring and calibration exercises whilst on transit in the North Sea.

1. Service Noise Lander at Warp (GIA06H) 0.5 days
2. Service Noise Lander at Dowsing (GIA06H) 0.5 days
3. Service SmartBuoy at Warp (GIA03D) 1 day
4. Service SmartBuoy at West Gabbard (GIA03D) 1 day
5. Continuous flow/underway water sampling as required on various transects
6. CTD Rosette water sampling as required on various transects
7. Secchi disk deployment and Forel Ule sampling as required on various transects (half hour warnings needed prior)
8. Collection of zooplankton sample at West Gabbard
9. Collection of zooplankton sample Warp
10. Collection of zooplankton sample East of Warp
11. Service the FerryBox flowthrough system

NARRATIVE:

3rd of November 2023

Scientific crew joined the vessel at 13:00, followed by induction 14:00. Survey Brief was carried out with Bridge crew, Deck crew and scientists at 15:00. The entire survey plan is discussed at this point, for example our aims to turnaround the Warp and Gabbard SmartBuoys, to deploy the Noise Lander back at Dowisng again after regaining permissions, and to sample water via the flowthrough FerryBox system as well as CTD Rosette. A muster drill with abandon ship drill occurred at 15:30.

Pilot boarded and the RV Cefas Endeavour sailed at 22:40, we sailed North towards the Dowsing Noise Lander and CTD station.

Day 1. Saturday 4th November

The Ferrybox was switched on once we had left the port at 02:00 whilst steaming and the scientists commenced 2-hourly underway water samples from the continuous flow seawater tap whilst on transit to Dowsing at 02:15. Surface seawater is pumped through the FerryBox which provides continuous monitoring of the seawater with a range of sensors which includes salinity, seawater temperature, chlorophyll fluorescence, turbidity, and pCO_2. The FerryBox runs in tandem with the seawater

surface sample collection which will be analysed in the lab for salinity, chlorophyll-*a*, suspended particulate matter (SPM), and dissolved nutrient concentrations (phosphate, nitrate, nitrite, silicate and ammonia).

We arrived at the Dowsing site at 08:00 for a CTD Rosette deployment. The CTD Rosette comprises of twelve 10 L niskins which can be fired at certain depths chose by the operator to collect bottom and surface seawater samples. These seawater samples are collected to analyse for dissolved oxygen (3 x replicate samples collected from surface, 3 x bottom); salinity (1 x surface, 1 x bottom); nutrients (1 x surface, 1 x bottom); chlorophyll (3 x surface); suspended particulate matter (SPM) (1 x surface, 1 x bottom); Coloured Dissolved Organic Matter (CDOM) (1 x surface); total alkalinity/dissolved inorganic carbon (3 x bottom) and Phytoplankton (1 x surface). The CTD provides a profile of the water column whilst the seawater samples can stand alone to contribute to eutrophication assessment but can also be used to calibrate sensors on the SmartBuoys and FerryBox. Analysis increases the valid spatial coverage of relevant assessment parameters autonomously measured throughout the survey. When possible, in daylight hours, a simultaneous Secchi Disk and Forel Ule colour scale was also deployed to observe the water quality by looking at water clarity (Secchi Disk) and seawater surface colour (Forel Ule scale).

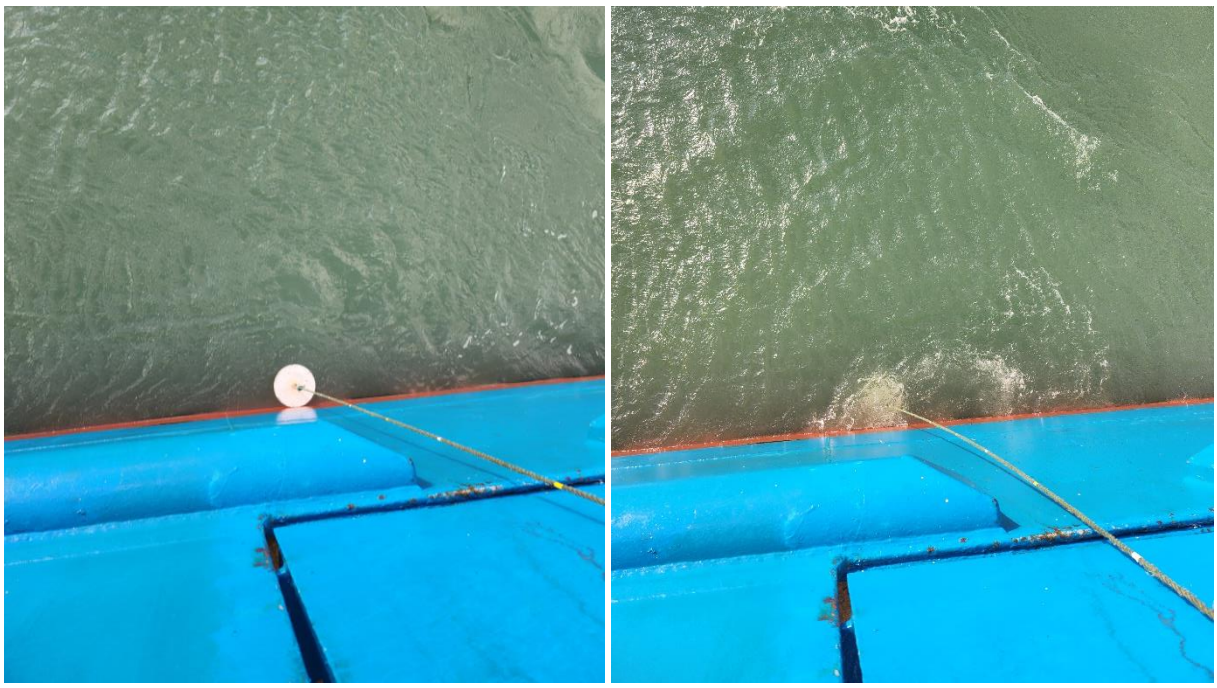

Figure 1. Secchi Disk being lowered off the side on the RV Endeavour to observe water clarity for water quality assessments.

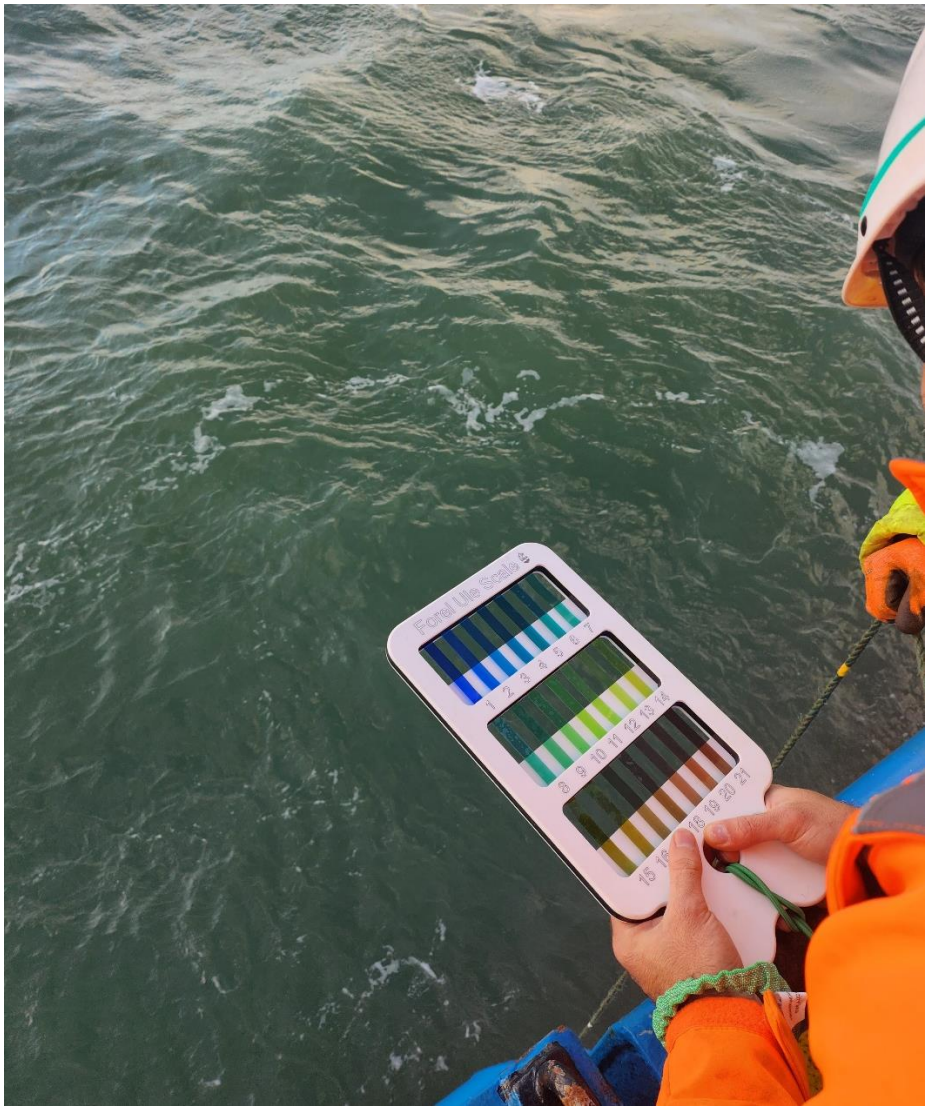

Figure 2. Forel Ule Colour Scale used to observe surface seawater colour for water quality assessments.

Once the rosette was back on board, we positioned to deploy the Dowsing Noise Lander. The Dowsing Noise Lander was successfully deployed at 09:35 (53.5295, 1.0523 E), followed by the Noise Lander Clump at 10:00 (53.5290, 1.050 E). The Dowsing Noise Lander houses a noise recorder (hydrophone) maintained by the Noise and Bioacoustics Team at Cefas. When deployed, it records audio files of underwater sound levels in UK waters (both natural and anthropogenic sources). The data is later used as scientific evidence for management of UK Marine Strategy underwater noise commitments under Descriptor 11. After this, the locator beacon on the Lander was tested to receive a signal. Once successful tests were complete, we left the site and steamed west towards the Humber CTD station. The FerryBox continuous flow stopped at 10:30 due to a pump issue. The pump was fixed, and no sampling was lost. At 11:00 the blade optode which is situated in the hull of the ship was noted to not be working.

The RV Cefas Endeavour arrived at the Humber CTD station 12:50 for a CTD deployment, parameters collected at each station can be seen in Table 1 in the results section. We then steamed south to the Wash to arrive for 15:45 for a CTD deployment and deployed the Secchi disk and Forel Ule scale. Following this, we steamed to the Inner Wash for a CTD deployment at 17:20. The sun had set by this point and therefore no Secchi Disk or Forel Ule results were available.

Once deployments in the Wash were complete, we steamed East along the north Norfolk coastline taking hourly underways towards the West Gabbard site. The RV was scheduled to arrive the next morning. At 19:30 the initial FerryBox intake pump failed again and could not be fixed, therefore the second pump used for flowthrough surface seawater sample collection is now relied upon for the entire system. Enough flow was achieved to sample from the flowthrough tap, as well as FerryBox.

Day 2. Sunday 5th November

Hourly underway samples were taken overnight, and the water sampling team carried out dissolved oxygen analysis on board throughout the survey using an automatic Winkler titration method with a Metrohm SiS Dosimat analyser.

The SiC usually goes up to the bridge before breakfast to catch up with the Chief Mate to discuss any issues that may have occurred over the night. Additionally, at 08:00 the SiC catches up with the Master and Navigation Officer to discuss the planned route and operations for the day ahead and submit the DPR.

The RV Cefas Endeavour arrived at West Gabbard at 05:00, the Pre-deployment CTD was undertaken at 05:45, the CTD Rosette completed the full list of parameters at this sampling site. Following this was a zooplankton ring net deployment, the zooplankton ring net (0.5 m, 200µm mesh) collects zooplankton samples which are preserved for analysis to be undertaken at the lab to assess community assemblage and diversity.

Figure 3. The West Gabbard SmartBuoy before recovery operations.

Once the side gantry deployments were completed, we changed to stern gantry deployments for the West Gabbard SmartBuoy. An SOP run through and toolbox talk were carried out before any operations commenced. The RV Cefas Endeavour was in position arrived at the West Gabbard SmartBuoy site at 08:00. The West Gabbard SmartBuoy had "lost positioning/stopped sending data" of Buoy 031 around 05/08/2023 when the team received alerts. This was three days after initial deployment. When we arrived on site it the buoy was out of position by ~0.1 nm. We recovered the West Gabbard SmartBuoy at 08:50 (51.9539, 2.1127 E).

Figure 4. Lowering the A-Frame prior to recovery of the West Gabbard SmartBuoy from the RV Cefas Endeavour.

Upon recovery, it was noted that the SmartBuoy had been in a major collision. The licor arm had been sheared, many sensors were missing including the Optode, Flurometer and OBS; as well as significant damage to the logger. The clump was recovered at 09:20 (51.9537, 2.1124 E). The mid tether cage for passively sampling microplastics was recovered for the final time due to the project ending and was not needed upon re-deployment.

Figure 5. Frayed wires and missing sensors showing damage to West Gabbard Buoy.

Figure 6. Back deck team jet washing the algal fouling off the SmartBuoy. Note the damage to the licor arm hanging off the right side of the Buoy.

Figure 7. Dismantling of the West Gabbard SmartBuoy by back deck team (Left) and prepping of the Warp SmartBuoy by back deck team (Right). Note the correctly assembled and intact licor arm (Right/Centre).

The RV got back to the initial position and the SmartBuoy and clump were deployed at 10:10 (51.9535, 2.1123 E). The post-deployment CTD rosette was deployed at 10:30 to collect bottom and surface water, followed by Secchi Disk and Forel Ule colour scale at 10:35.

Once finished at West Gabbard, the RV Endeavour steamed to TP2 to arrive for 14:00 for a CTD deployment and Secchi Disk (52.1894, 1.686 E). Then we steamed South to TP1 for a CTD and Secchi Disk deployment at 16:30 (51.9105, 1.5255 E). Following this, we slowly steamed to East of Warp with underway water stations to be every hour through assessment areas for arrival after midnight. The Tower software we use for recording positions and fixing GPS positions for hourly underway seawater samples crashed periodically during the night, and therefore any time we needed a “fix” the position was noted on the Transas system and so we didn’t lose data. In addition, the FerryBox computer logs the position as it samples and therefore we also have a back-up for positioning.

Day 3. 6th November

The RV arrived at East of Warp Zooplankton (51.5366, 1.1332) at 00:10 to undertake a zooplankton ring net deployment. The deployments on this trip have been throughout the year alongside the mNCEA project to build a yearlong, regular sampling effort to understand the zooplankton abundance and diversity. It also presented a good learning

opportunity for two scientists on board who will be joining the next MPA survey (CEND 17/23) and carrying out zooplankton ring net deployments.

We steamed to Warp for arrival at 04:00. A zooplankton ring net deployment occurred at 04:00 followed by the pre-deployment CTD at 04:45. The ship was in position at 07:00. A toolbox talk with the back deck crew was carried out at 07:45 followed by Warp SmartBuoy retrieval at 07:53 (51.5332, 1.0496 E) and clump recovery at 08:05 (51.5332, 1.0495 E).

Figure 8. Recovery of the Warp SmartBuoy from the RV Cefas Endeavour.

Following we got into position for the Warp Noise Lander Clump recovery at 08:30 (51.5328, 1.0453 E) and Noise Lander recovery at 08:55 (51.5321, 1.0467 E). The RV repositioned to deploy the Warp Noise Lander and it was successful deployed at 09:41 (51.5319, 1.0467 E). The Noise Lander clump was deployed at 09:55 (51.5326, 1.0450 E). The RV the moved back to the SmartBuoy position and the deployment was successful at 10:25 (51.5331, 1.0493 E). Moving off from the Buoy the scientific team then got the CTD rosette ready. It was noted that one conductivity cell was broken but still able to deploy. The CTD rosette was deployed at 10:30, following this we steamed back North towards Lowestoft for the pilot.

Underway sampling stopped at 16:00 and the Pilot boarded at 16:30.

Day 4. 7th November

Cefas scientists disembarked the vessel by 09:00 and kit was demobbed at 09:30. Staff demob and disembark 09:00.

Results:

In relation to the above-mentioned Aims:

3-day survey to exchange 2 SmartBuoys and 2 Noise Landers and collect water and zooplankton samples for eutrophication monitoring and calibration exercises whilst on transit in the North Sea.

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2. Service Noise Lander at Dowsing (GIA06H) 0.5 days
3. Service SmartBuoy at Warp (GIA03D) 1 day
4. Service SmartBuoy at West Gabbard (GIA03D) 1 day
5. Continuous flow/underway water sampling as required on various transects
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8. Collection of zooplankton sample at West Gabbard
9. Collection of zooplankton sample Warp
10. Collection of zooplankton sample East of Warp
11. Service the FerryBox flowthrough system

The detailed breakdown of equipment deployed, and samples collected for analysis can be found in Table 2.

Table 2. Summary of sample collections including deployments and recoveries of gear. (SB- SmartBuoy; NL- Noise Lander; UW- underway/continuous flow/FerryBox sampling; CTD – CTD Rosette/Profiler; ZP – Zooplankton; WG02- West Gabbard; DOW – Dowsing; TP – Thames Plume)

STN#	Date	Time	Latitude	Longitude	Gear Code	Analytic
1	04/11/2023	02:16	52.88083	1.61461	UW	2 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
2	04/11/2023	04:00	53.10508	1.393095	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
3	04/11/2023	06:02	53.34797	1.233481	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
4	04/11/2023	07:30	53.52275	1.061953	CTD DOWSING	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
4	04/11/2023	07:33	53.52292	1.062436	CTD DOWSING	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM
5	04/11/2023	09:34	53.52953	1.052308	DOW NL CLUMP DEP	Dowsing Noise Lander Deployment
6	04/11/2023	09:59	53.52905	1.050704	DOW NL DEP	Dowsing Noise Lander Clump Deployment
7	04/11/2023	11:32	53.56805	0.758665	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
8	04/11/2023	12:19	53.54272	0.492242	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
9	04/11/2023	12:52	53.52748	0.37816	CTD HUMBER	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
9	04/11/2023	12:55	53.52584	0.378808	CTD HUMBER	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM; 1 x Phytoplankton
10	04/11/2023	14:00	53.38397	0.557987	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
11	04/11/2023	15:00	53.22292	0.629096	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
12	04/11/2023	15:41	53.1403	0.553806	CTD WASH	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
12	04/11/2023	15:43	53.1414	0.552653	CTD WASH	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM; Secchi Disk and Forel Ule

13	04/11/2023	17:21	52.96871	0.359598	CTD INNER WASH	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
13	04/11/2023	17:23	52.96889	0.359927	CTD INNER WASH	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM
14	04/11/2023	18:33	53.1337	0.57946	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
15	04/11/2023	19:42	53.21205	0.777682	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
16	04/11/2023	20:42	53.07044	1.021973	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
17	04/11/2023	21:45	52.96977	1.346906	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
18	04/11/2023	22:51	52.84998	1.704954	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
19	04/11/2023	23:53	52.74314	2.014404	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
20	05/11/2023	01:59	52.46633	2.11364	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
21	05/11/2023	04:00	52.1671	2.098232	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
22	05/11/2023	05:43	51.95697	2.130596	CTD WG02 PRE	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
22	05/11/2023	05:47	51.95838	2.133048	CTD WG02 PRE	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM; 1 x Phytoplankton
23	05/11/2023	06:09	51.95713	2.129893	ZP	West Gabbard Zooplankton
24	05/11/2023	08:47	51.95397	2.112778	WG02 SB REC	West Gabbard SmartBuoy Recovery
25	05/11/2023	09:18	51.95373	2.11242	WG02 SB CLUMP REC	West Gabbard SmartBuoy Clump Recovery
26	05/11/2023	10:10	51.95351	2.112385	WG02 SB CLUMP DEP	West Gabbard SmartBuoy Clump Deployment
27	05/11/2023	10:28	51.95528	2.1206	CTD WEST GAB 2 POST	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
27	05/11/2023	10:32	51.9557	2.123061	CTD WEST GAB 2 POST	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x Phytoplankton; 1 x CDOM; Secchi Disk and Forel Ule
28	05/11/2023	12:13	52.05417	2.007722	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll

29	05/11/2023	13:13	52.12488	1.845333	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
30	05/11/2023	14:09	52.1894	1.686	CTD TP2	Bottom: 2 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
30	05/11/2023	14:12	52.18894	1.6866	CTD TP2	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM
31	05/11/2023	15:07	52.07581	1.660207	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
32	05/11/2023	15:43	51.98938	1.600931	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
33	05/11/2023	16:40	51.90994	1.5249	CTD TP1	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
33	05/11/2023	16:42	51.91056	1.52552	CTD TP1	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x CDOM; 1 x Phytoplankton
34	05/11/2023	18:00	51.81181	1.537451	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
35	05/11/2023	19:00	51.74581	1.493807	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
36	05/11/2023	20:00	51.6898	1.440971	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
37	05/11/2023	20:59	51.6505	1.375176	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
38	05/11/2023	21:58	51.61347	1.301486	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
39	05/11/2023	22:53	51.57609	1.23956	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
40	05/11/2023	23:44	51.55345	1.162904	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
41	05/11/2023	00:12	51.53662	1.133294	ZP	East of Warp Zooplankton
42	06/11/2023	01:01	51.51813	1.07603	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
43	06/11/2023	02:10	51.48197	0.954823	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
44	06/11/2023	03:00	51.5078	0.947918	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
45	06/11/2023	04:01	51.52462	1.022648	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
46	06/11/2023	03:58	51.52409	1.020307	ZP	Warp Zooplankton
47	06/11/2023	04:44	51.53001	1.053423	CTD WARP PRE	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC

47	06/11/2023	04:46	51.53055	1.05347	CTD WARP PRE	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x Phytoplankton; 1 x CDOM
48	06/11/2023	07:53	51.53328	1.049647	WARP SB REC	Warp SmartBuoy Recovery
49	06/11/2023	08:04	51.53323	1.049548	WARP SB CL REC	Warp SmartBuoy Clump Recovery
50	06/11/2023	08:33	51.53281	1.045337	WARP NL CL REC	Warp Noise Lander Clump Recovery
51	06/11/2023	08:55	51.53219	1.046734	WARP NL REC	Warp Noise Lander Recovery
52	06/11/2023	09:40	51.532	1.046716	WARP NL DEP	Warp Noise Lander Deployment
53	06/11/2023	09:56	51.53261	1.045064	WARP NL CL DEP	Warp Noise Lander Clump Deployment
54	06/11/2023	10:23	51.53317	1.04938	WARP SB CL DEP	Warp SmartBuoy Clump Deployment
55	06/11/2023	10:32	51.53224	1.050096	CTD WARP POST	Bottom: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Oxygen; 3 x TA/DIC
55	06/11/2023	10:34	51.53212	1.051087	CTD WARP POST	Surface: 1 x Salinity; 1 x Nutrients; 1 x SPM; 3 x Chlorophyll; 3 x Oxygen; 1 x Phytoplankton; 1 x CDOM
56	06/11/2023	12:02	51.73287	1.403414	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
57	06/11/2023	13:04	51.82667	1.694422	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
58	06/11/2023	14:05	51.98085	1.81104	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
59	06/11/2023	15:03	52.17529	1.810032	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll
60	06/11/2023	15:58	52.35647	1.80216	UW	1 x Salinity; 1 x Nutrients; 1 x SPM; 1 x Chlorophyll

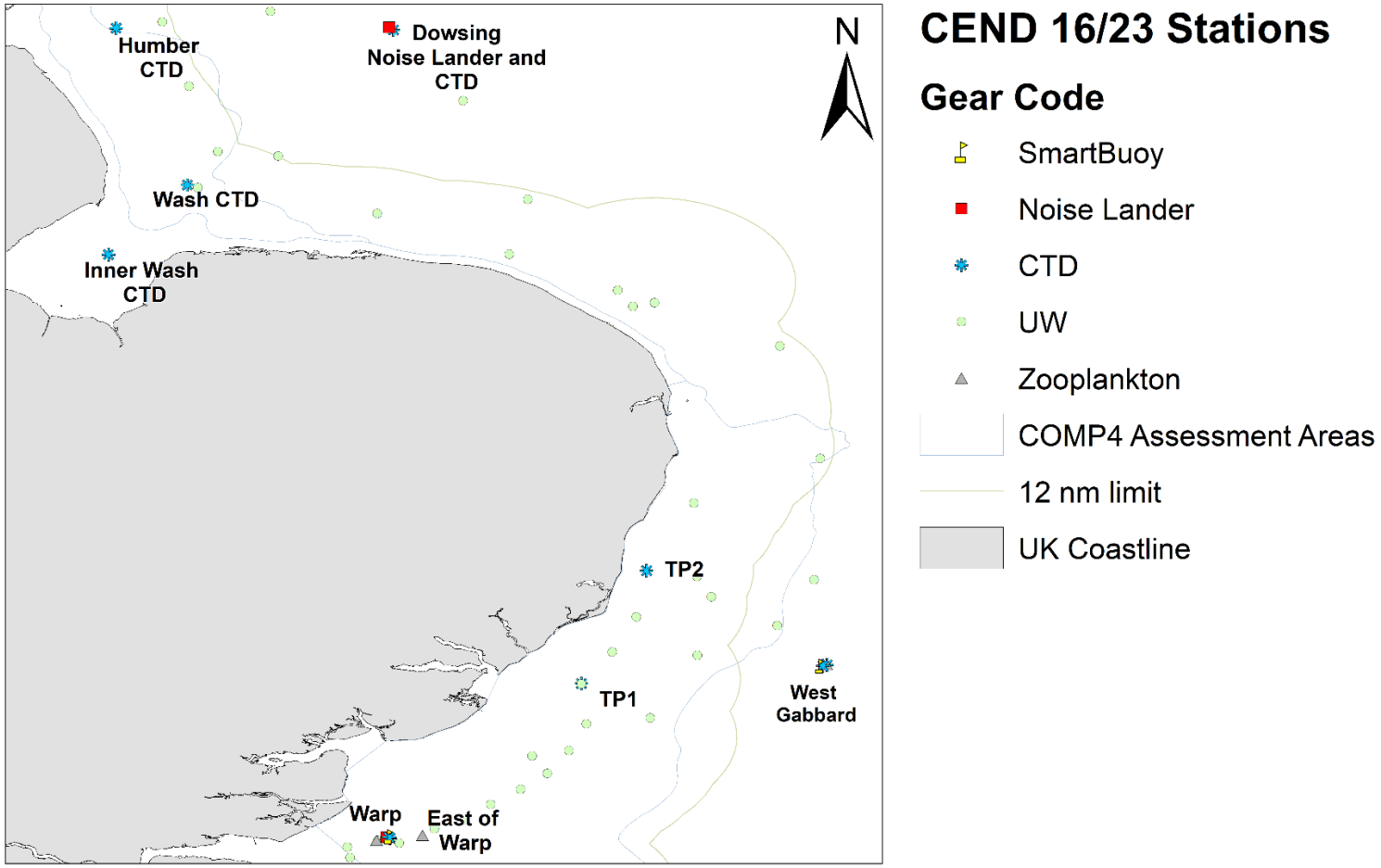

Figure 9. Sites visited by RV Cefas Endeavour on CEND 16/23 SmartBuoy and Noise Lander servicing survey from 04/11/2023 to 06/11/2023.

Centre for Environment Fisheries & Aquaculture Science

Cefas

Izzy Lake
Scientist in Charge
15/11/2023

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