Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL PROGRAMME

RV CEFAS ENDEAVOUR
Survey: C END 05 - 2023

STAFF:

Name	Role	Name	Role
Izzy Lake	SIC	Peter Hamstead	Water Sampling
Axayacatl Molina-Ramirez	2IC	Camille Visinand	Deck support
Matt Brown	Deck lead	Kirsty Clarke	Water Sampling
Tom Hull	Deck support/ data manager	E. E. Manuel Nicolaus	Shadowing all
Elise Brabben	Water Sampling; Chemical lead	Rosalyn Putland	Noise Landers, Water Sampling
Brian Kneafsey	Water Sampling	Veronique Creach	Flow Cytometer

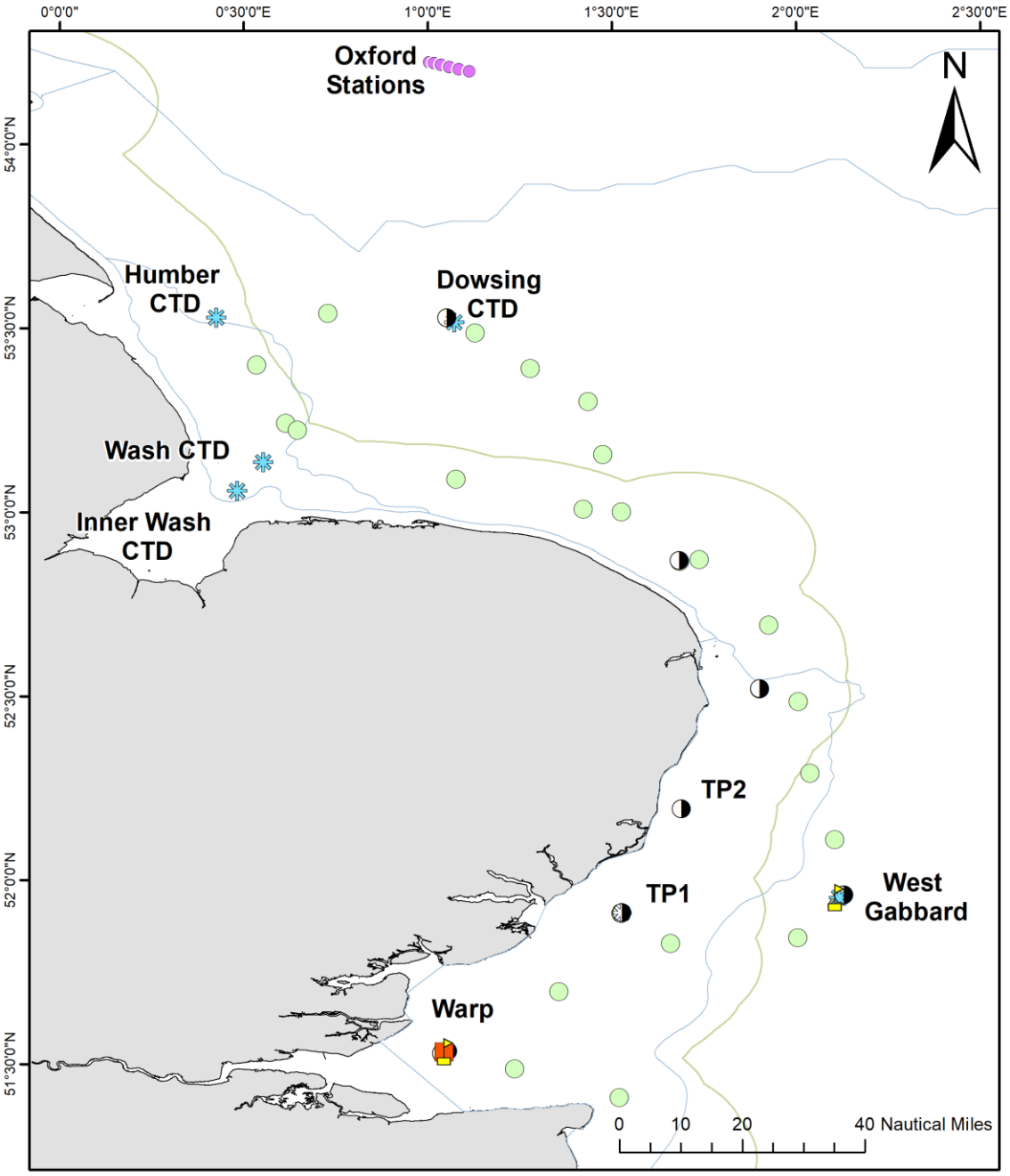
DURATION:

22nd April to 25th April 2023.

21st April: boarding in Lowestoft from 15:00, induction at 16:00

22nd April: Pilot booked and sailing from Lowestoft at 09:15, drill at 11:30.

25th April: docking in Lowestoft at 12:00, disembark at 13:30.



Planned CEND 05/23 Stations

- Oxford Stations
- SmartBuoy
- Noise Lander and Clump
- CTD/ESM2
- UW
- Zooplankton
- Secchi Disk
- 12 nm limit
- UK Coastline
- COMP4 Assessment Areas

LOCATION: England, North Sea

Station #	Latitude	Longitude	Station
1	51.52869	1.043896	Warp Zooplankton
2	51.53338	1.051922	Warp CTD
3	51.53277	1.045888	Warp Noise Lander Clump Deployment
4	51.5332	1.045326	Warp Noise Lander Deployment
5	51.53314	1.049378	Warp SmartBuoy Deployment
6	51.53503	1.056396	Secchi Disk
6a	51.5331	1.1265	East of Warp Zooplankton
7	51.6973	1.356655	UW
8	51.82844	1.660016	UW
9	51.84342	2.005785	UW
10	51.95215	2.111434	West Gabbard SmartBuoy
11	51.95228	2.111698	WG02 Zooplankton
12	51.95187	2.118968	West Gabbard CTD
13	52.11011	2.106258	UW
14	52.29085	2.039059	UW
15	52.485	2.007547	UW
16	52.69276	1.927734	UW
17	52.87181	1.738678	UW
18	53.00109	1.526901	UW
19	53.15713	1.476206	UW
20	53.30129	1.43568	UW
21	53.39047	1.279161	UW
22	53.48733	1.128757	UW
23	53.51584	1.072101	Dowsing CTD
24	53.52909	1.051188	Noise Lander Clump Recovery
25	53.52952	1.052303	Noise Lander Recovery
26	53.52954	1.052332	Secchi Disk
27	53° 32.4178	0° 43.7478	UW
28	53° 31.775	0° 25.554	Humber CTD
29	53° 24.028	0° 32.113	UW
30	53.24272	0.613917	UW
31	53.13837	0.550533	Wash CTD
32	53.06152	0.481781	Inner Wash CTD
33	53.22337	0.646234	UW
34	53.09032	1.076997	UW
35	53.00785	1.422613	UW
36	52.86876	1.683765	Secchi Disk

37	52.86697	1.685302	UW
38	52.5212	1.902652	Secchi Disk
39	52.51933	1.902533	UW
40	52.19434	1.689969	TP2
41	52.19434	1.689969	Secchi Disk
42	51.90932	1.525894	UW
43	51.91004	1.526797	TP1
44	51.91228	1.527899	Secchi Disk
45	54.22361	1.004167	Oxford 1
46	54.22028	1.017222	Oxford 2
47	54.21583	1.036389	Oxford 3
48	54.21056	1.058056	Oxford 4
49	54.20472	1.084722	Oxford 5
50	54.19833	1.113056	Oxford 6

SB- SmartBuoy; WR-Waverider, UW-underway/continuous flow/FerryBox sampling; WG- West Gabbard;
* Low priority station

AIMS:
3.5-day survey to exchange 2 SmartBuoys and 1 Noise Lander and collect water samples and zooplankton samples on transit in the North Sea.

1. Service Noise Lander at Warp (GIA06H) 0.5 days
2. Service SmartBuoy at Warp (GIA03D) 1 day
3. Service SmartBuoy at West Gabbard 1 day
4. Continuous flow and underway water sampling as required on various transects
5. CTD Rosette water sampling as required on various transects
6. Secchi disk deployment and Forel Ule sampling as required on various transects (half hour warnings needed prior)
7. Collection of zooplankton sample at West Gabbard
8. Collection of zooplankton sample Warp
9. Collection of zooplankton sample East of Warp
10. Three vertical plankton hauls and six continuous flow underway water samples at Endurance site (Oxford University/ M. Thompson) 1 day

All timings in UTC (GMT).

Narrative:

Day 1. 22nd April 2023

The RV Cefas Endeavour left port at 08:15 and headed north along the coast of Norfolk. The scientific crew carried out their first toolbox talks and the FerryBox was switched on as we left harbour. This will passively sample as we steam throughout the assessment areas. Two flow cytometers were brought on board to measure phytoplankton communities and run set-up and comparison tests. The flowthrough system and electrical connection were tested with the old flow cytometer in the garage; and the new flow cytometer was in the CTD Annex and its performances were tested with discrete samples.

Figure 1. Flow cytometer installed and connected to the FerryBox on board the RV Cefas Endeavour.

Figure 2. Flow cytometer sampling phytoplankton from a discrete water sample.

At 10:00 scientists proceeded to start hourly underway water sampling from the flowthrough system for the survey. The collected surface seawater samples will be analysed in the lab for salinity, chlorophyll, Suspended Particulate Matter (SPM), Coloured Dissolved Organic Matter (CDOM) and nutrient (phosphate, nitrate, nitrite, silicate and ammonia) concentrations. At 10:30 scientists and crew undertook an abandon ship drill and hourly underway water sampling resumed at 11:00.

The first successful side gantry deployments of the survey occurred at 16:00 at the Inner Wash station. Firstly, the Secchi disk and Forel Ule colour chart were used to measure water turbidity and the colour of the water surface for our seawater assessments. Following this, the ESMX profiler and 10 L Niskin bottle were deployed

to collect bottom and surface seawater samples. These seawater samples are to analyse for dissolved oxygen (3 x samples collected from surface, 3 x bottom); nutrients (1 x surface, 1 x bottom); chlorophyll (3 x surface); suspended particulate matter (SPM) (1 x surface, 1 x bottom); salinity (1 x surface, 1 x bottom); and Coloured Dissolved Organic Matter (CDOM) (1 x surface). These samples can stand alone to contribute to eutrophication assessment but can also be used to calibrate sensors on the SmartBuoy and FerryBox, increasing the valid spatial coverage of relevant assessment parameters autonomously measured throughout the survey. Once the Inner Wash station deployments were completed, we steamed to the Outer Wash for a Secchi disk and ESMX deployments at 17:30. Following this station, hourly underway water samples resumed until we reached the Humber CTD station. At 20:30 it was too dark to deploy the Secchi disk and use the Forel Ule, so we only took surface and bottom water samples using the ESMX profiler and 10 L Niskin. After the Humber CTD station, we steamed East to the Dowsing CTD station for another bottom and surface water sample using the ESMX profiler at 23:30.

Day 2. 23rd April 2023

Two-hourly underway water samples were collected from the flowthrough system whilst steaming 40 nm North to the Endurance sampling site. Here, the scientific crew deployed the zooplankton ring net at 04:00 (0.5 m, 200µm mesh) to collect zooplankton samples. Three locations were sampled for plankton, with an underway sample sandwiched around the plankton net dip at 54.22361 N, 1.004167 E; 54.21583 N,1.036389 E; and 54.19833 N, 1.113056 E.

Figure 3. Zooplankton sample after collection ready to be contained and preserved. Analysis to be undertaken at the lab to assess community assemblage and diversity.

The SiC usually goes up to the bridge at 6:00 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.

After the third zooplankton ring net deployment at the Endurance site, the final underway sample was taken at 07:00 and we steamed about 120nm south to the West Gabbard SmartBuoy station. Hourly underway samples were taken on transit throughout the assessment areas.

Figure 4. View of a North Sea windfarm from the RV Cefas Endeavour.

The RV Cefas Endeavour arrived at the West Gabbard SmartBuoy site (51.907, 1.523 E) at 17:30 and a Secchi Disk and Forel Ule was taken in the available daylight whilst we deployed the pre-recovery CTD, using the ESMX profiler at 17:40. Side gantry operations were completed at 18:00 and we began SmartBuoy operations. The West Gabbard SmartBuoy was recovered at 18:20 (51.9528, 2.1119 E). During recovery it was noted that in the future, the wire should be passed through a block to prevent potential damage to the mid-tether cage. The clump was recovered at 18:40 (51.9526, 2.1119 E). The weight put on was increased during the last deployment and this seems to have prevented dragging of the SmartBuoy. The SmartBuoy and Clump were deployed at 19:38 (51.9521, 2.1114 E). A post-deployment CTD dip was deployed at 20:00 with the ESMX profiler to collect bottom and surface seawater samples. Followed by a Zooplankton net haul at 20:40.

Figure 5. West Gabbard SmartBuoy being prepared for deployment.

Overnight, we steamed slowly using two engines towards the Warp SmartBuoy. During transit we collected underway water samples with CDOMs to analyse a transect of the Thames Plume assessment area between West Gabbard and Warp.

Day 3. 24th April 2023

Overnight underway water samples were collected until we reached the Warp SmartBuoy station at 07:00. A toolbox talk was carried out in the wet lab for the recovery and deployment of the Warp SmartBuoy and Noise Lander. Once this was finished, the zooplankton ring net and ESMX CTD were deployed at 07:30 to collect samples pre-deployment samples.

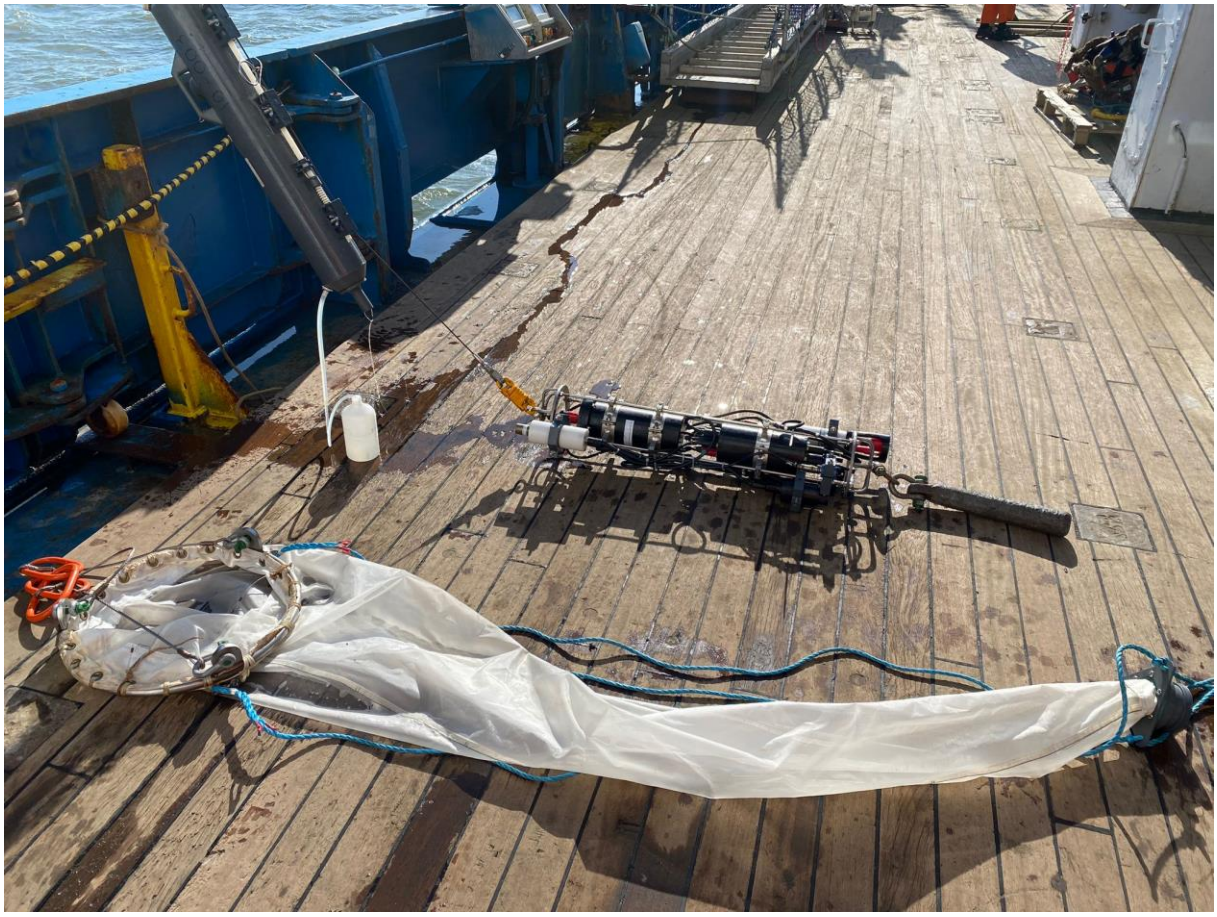


Figure 6. Zooplankton ring net and ESMX CTD profiler on deck after deployment. Water sample being collected from 10 L Niskin bottle.

At 08:20 the SmartBuoy was recovered and clump at 08:30. The Noise Lander clump was then recovered at 08:51 and Noise Lander recovered and back on board by 09:10. Once recovery operations were finished, we situated ourselves to deploy the Noise Lander. The lander failed to deploy at 09:49 as the release mechanism did not correctly work. At 10:13 the Noise Lander was successfully deployed (51.5332, 1.0453 E), and at 10:40 the clump deployed (51.5319, 1.0462 E). Afterwards, we got into position and deployed the Buoy and clump at 11:40 (51.5331, 1.0493 E). ESMX CTD profiler was used to collect the post surface and bottom water samples at 11:55, followed by a Secchi Disk at 12:10.

Following the Warp station, we steam to the East of Warp zooplankton station (51.5331, 1.1265 E) to collect a plankton haul, underway water sample and Secchi disk.

Figure 7. Zooplankton ring net (0.5 m, 200 µm mesh) deployment.

We then steamed north via TP1 and TP2 for ESMX CTD surface water dips and Secchi disks whilst collecting underway samples. The keel and blade were raised at ~19:00 for optode to dry out and therefore EK80 was switched off before the end of sampling. Sampling finished at 22:00 with the final underway water sample being collected and we anchored off Lowestoft for the night.

Day 4. 25th April 2023

The scientific crew packed away gear the morning of the 25th April in preparation for a smooth demobilisation process.

As for the phytoplankton studies, after 3 days of first initial testing stage, we are confident that the new flowthrough system works perfectly for the phytoplankton analysis. We look forward to continuing our testing, for example, the outlet of the FerryBox should be moved to the left side to be more convenient and a discussion still needs to take place to instal a chamber and valves for the future. The results between the two instruments (old and new) are promising.

The pilot was booked midday and we docked at 13:00 at North Quay 6. Staff had disembarked the vessel by 14:00.

Day 5. 26th April 2023

The SIC, 2IC and deck lead met with the Master, Chief Officer, Marine Operations management team and AW management to have a debrief on board as close to the end of the survey as possible at 10:00.

Gear was demobbed and returned to either Pinbush or Lowestoft labs.

RESULTS: In relation to the above-mentioned Aims:
3.5-day survey to exchange 2 SmartBuoys and 1 Noise Lander and collect water samples and zooplankton samples on transit in the North Sea.

1. Service Noise Lander at Warp (GIA06H)
2. Service SmartBuoy at Warp (GIA03D)
3. Service SmartBuoy at West Gabbard
4. Continuous flow and underway water sampling as required on various transects –**successful with some teething problems as first testing stage.**
5. CTD Rosette water sampling as required on various transects – **ESMX profiler used instead, samples collected successfully.**
6. Secchi disk deployment and Forel Ule sampling as required on various transects
7. Collection of zooplankton sample at West Gabbard
8. Collection of zooplankton sample Warp
9. Collection of zooplankton sample East of Warp
10. Three vertical plankton hauls and six continuous flow underway water samples at Endurance site (Oxford University/ M. Thompson) (C8611A)

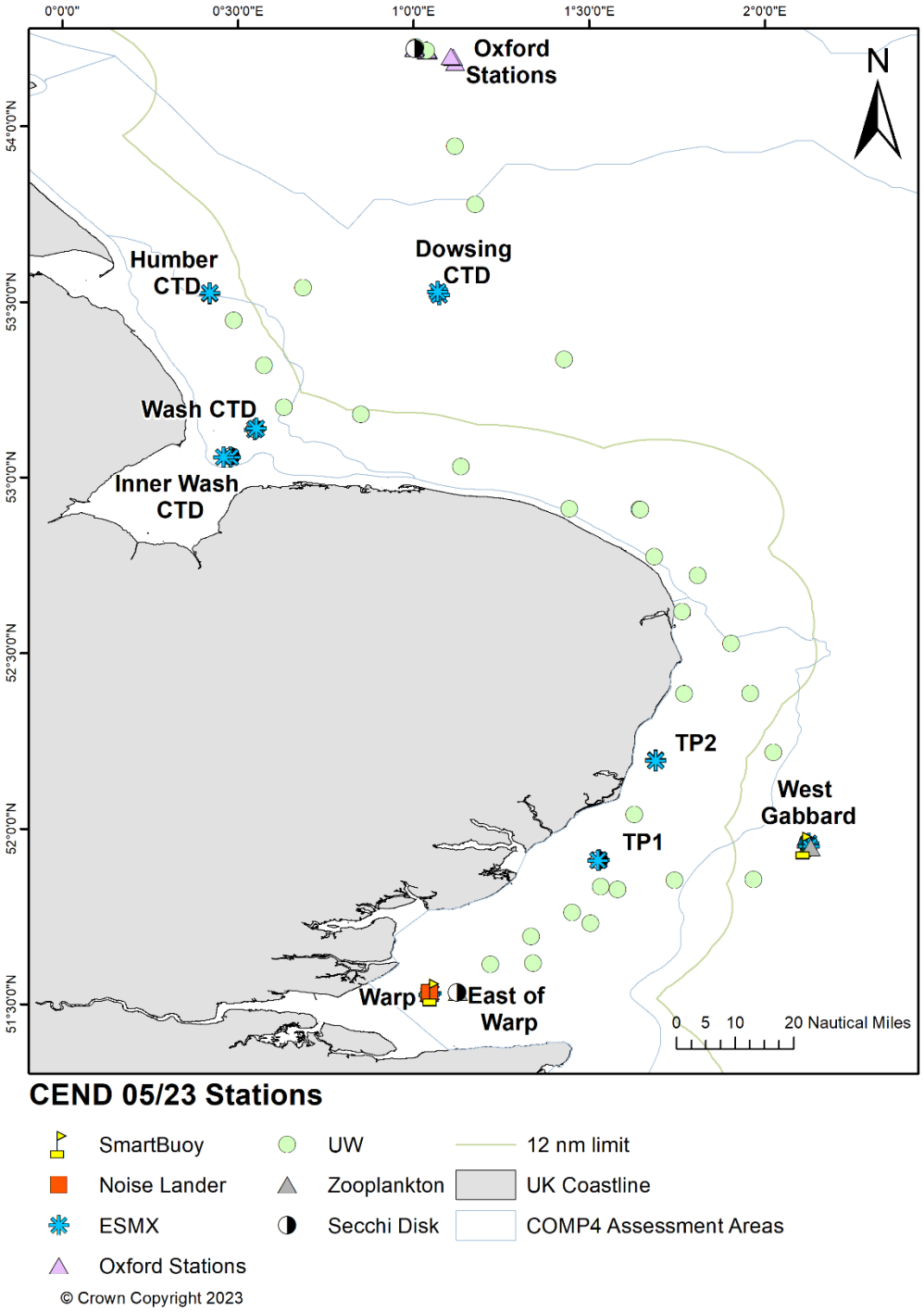


Figure 8. Visited stations from CEND 05/23 on the RV Cefas Endeavour.

The detailed breakdown of equipment deployed, and samples collected for analysis can be found in Table 1.

Table 1. Summary of sample collections including deployments and recoveries of gear. (UW = underway water sample, ESMX = CTD profiler)

STN #	Date	Time	Latitude	Longitude	Gear	Analytic
1	22/04/2023	09:59	52.61796	1.765176	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1
2	22/04/2023	11:01	52.77497	1.684982	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1
3	22/04/2023	12:01	52.91105	1.443839	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1
4	22/04/2023	13:00	53.03101	1.134524	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1
5	22/04/2023	13:59	53.17952	0.850279	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1
6	22/04/2023	14:49	53.20055	0.630942	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1
7	22/04/2023	15:52	53.05896	0.480485	SECCHI	Water Turbidity and
8	22/04/2023	15:57	53.05718	0.47894	Inner Wash ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
9	22/04/2023	16:23	53.05669	0.460091	Inner Wash ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1
10	22/04/2023	17:35	53.13795	0.549425	SECCHI	Water Turbidity and colour
11	22/04/2023	17:40	53.13531	0.548285	Wash ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
12	22/04/2023	18:14	53.1388	0.552735	Wash ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1
13	22/04/2023	19:26	53.31958	0.57414	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
14	22/04/2023	20:09	53.44805	0.488278	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
15	22/04/2023	20:44	53.52235	0.419977	Humber ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
16	22/04/2023	20:56	53.52485	0.419775	Humber ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1

17	22/04/2023	21:56	53.54044	0.68565	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
18	22/04/2023	23:33	53.51926	1.073141	Dowsing ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
19	22/04/2023	23:52	53.52855	1.06934	Dowsing ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1
20	23/04/2023	02:00	53.94339	1.117389	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
21	23/04/2023	03:07	54.18226	1.11917	Oxford UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
22	23/04/2023	03:19	54.19647	1.113228	Oxford ZP	Zooplankton
23	23/04/2023	03:59	54.19857	1.106999	Oxford UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
24	23/04/2023	04:31	54.21604	1.041579	Oxford UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
25	23/04/2023	04:38	54.21426	1.038918	Oxford ZP	Zooplankton
26	23/04/2023	05:03	54.21782	1.038054	Oxford UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
27	23/04/2023	05:14	54.21561	1.036737	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
28	23/04/2023	05:28	54.22563	1.005481	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1; CDOM x1
29	23/04/2023	05:30	54.22648	1.005062	Oxford UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
30	23/04/2023	05:40	54.22362	1.003195	Oxford ZP	Zooplankton
31	23/04/2023	05:52	54.22101	1.003575	Oxford UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
32	23/04/2023	05:54	54.22081	1.00371	SECCHI	Water Turbidity and colour
33	23/04/2023	08:00	53.77816	1.175992	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
34	23/04/2023	10:00	53.33649	1.428776	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
35	23/04/2023	12:00	52.90993	1.643453	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
36	23/04/2023	12:01	52.9083	1.645062	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
37	23/04/2023	13:02	52.72165	1.809206	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
38	23/04/2023	14:07	52.52727	1.90385	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
39	23/04/2023	14:55	52.386	1.959102	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
40	23/04/2023	15:54	52.21792	2.024599	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1

41	23/04/2023	17:30	51.95291	2.122968	SECCHI	Water Turbidity
42	23/04/2023	17:37	51.95732	2.125543	ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
43	23/04/2023	18:00	51.95207	2.123244	ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1
44	23/04/2023	18:22	51.95281	2.111986	SmartBuoy Recovery	West Gabbard SmartBuoy Recovery
45	23/04/2023	18:42	51.95269	2.11196	Clump Recovery	West Gabbard Clump Recovery
46	23/04/2023	19:38	51.95213	2.111433	SmartBuoy Deployment	West Gabbard SmartBuoy Deployment
47	23/04/2023	19:58	51.94899	2.122273	ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
48	23/04/2023	20:18	51.94903	2.126645	ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1; Phytoplankton x1
49	23/04/2023	20:41	51.94647	2.130785	ZP	Zooplankton
50	23/04/2023	22:24	51.85559	1.9676	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
51	24/04/2023	00:14	51.85367	1.742648	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
52	24/04/2023	01:30	51.82725	1.581059	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
53	24/04/2023	02:45	51.76162	1.451083	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
54	24/04/2023	04:00	51.69341	1.334158	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
55	24/04/2023	05:20	51.61421	1.218759	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
56	24/04/2023	07:20	51.53117	1.045742	ZP	Zooplankton
57	24/04/2023	07:34	51.53133	1.049994	ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
58	24/04/2023	07:52	51.53128	1.050312	ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1;

						Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1
59	24/04/2023	08:18	51.53306	1.049976	SmartBuoy Recovery	Warp SmartBuoy Recovery
60	24/04/2023	08:30	51.53297	1.049796	Clump Recovery	Warp Clump Recovery
61	24/04/2023	08:51	51.53286	1.045845	Noise Lander Recovery	Warp Noise Lander Recovery
62	24/04/2023	09:07	51.53272	1.046076	Fail	Failed Deployment
63	24/04/2023	09:49	51.53322	1.045364	Fail	Failed Deployment
64	24/04/2023	10:13	51.53328	1.045303	Noise Lander Deployment	Warp Noise Lander Deployment
65	24/04/2023	10:38	51.53194	1.046279	Noise Lander Deployment	Warp Noise Lander Clump Deployment
66	24/04/2023	11:41	51.53314	1.04936	SmartBuoy Deployment	Warp SmartBuoy Deployment
67	24/04/2023	11:54	51.53011	1.049177	ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
68	24/04/2023	12:08	51.52697	1.044506	ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1; Phytoplankton x1
69	24/04/2023	12:12	51.5262	1.043099	SECCHI	Water Turbidity and colour
70	24/04/2023	14:20	51.53458	1.1267	ZP	Zooplankton
71	24/04/2023	14:21	51.53448	1.126254	UW	Salinity x1; Nutrients x1; SPM x1; Chlorophyll x1; CDOM x1
72	24/04/2023	14:27	51.53383	1.123741	SECCHI	Water Turbidity and colour
73	24/04/2023	15:43	51.617	1.340527	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
75	24/04/2023	16:44	51.73111	1.503221	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
76	24/04/2023	17:14	51.83471	1.533761	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
77	24/04/2023	17:46	51.90964	1.528218	ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
78	24/04/2023	17:50	51.91023	1.529192	SECCHI	Water Turbidity and colour
79	24/04/2023	18:02	51.90891	1.525512	ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1

80	24/04/2023	18:53	52.04047	1.628008	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1
81	24/04/2023	19:47	52.19542	1.690309	ESMX	Bottom: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1
82	24/04/2023	20:03	52.19288	1.68976	ESMX	Surface: Dissolved oxygen (3x bottom); Salinity x1; Nutrients x1; Chlorophyll x3; SPM x1; CDOM x1
83	24/04/2023	21:42	52.38465	1.770665	UW	Salinity x1; Nutrients x1; Chlorophyll x1; SPM x1

Gear:

See Gear List

Scientist in Charge: Izzy Lake Date: 25/04/2023
Second Scientist in Charge: Axayacatl Molina-Ramirez

DISTRIBUTION:

BODC
MIST
AW
Cefas Staff