SUPPLEMENTARY FIGURES

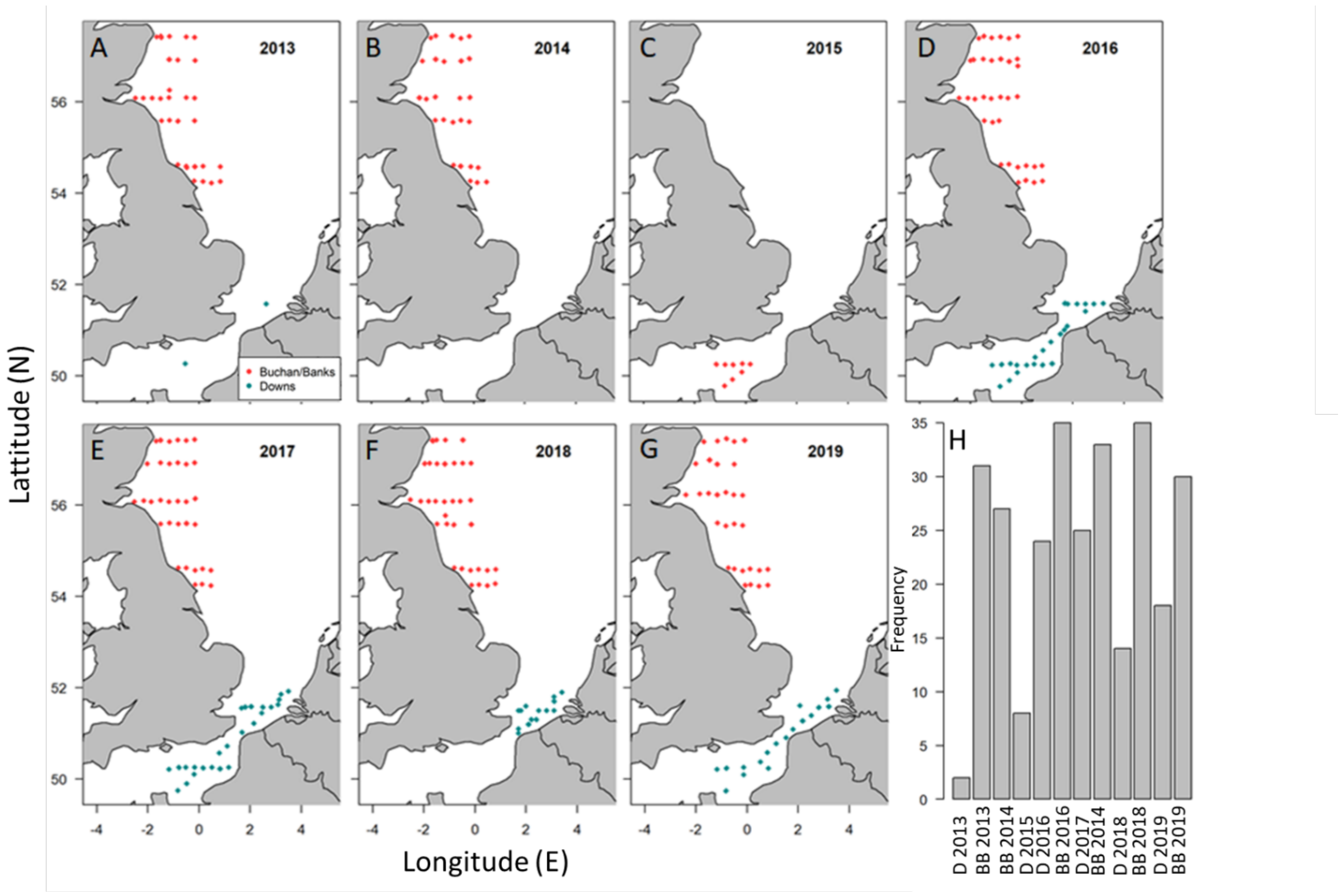

Figure S1. Map of stations per year (panels A-G) from the International Herring Larval Survey in the Buchan/Banks (September, red dots) and Downs spawning grounds (December, cyan dots) analyzed in this study. H) shows the number of stations per spawning ground (BB= Buchan/Banks, D= Downs) and year. Note that there was no data available for Downs in 2014 and in Buchan/Banks in 2015.

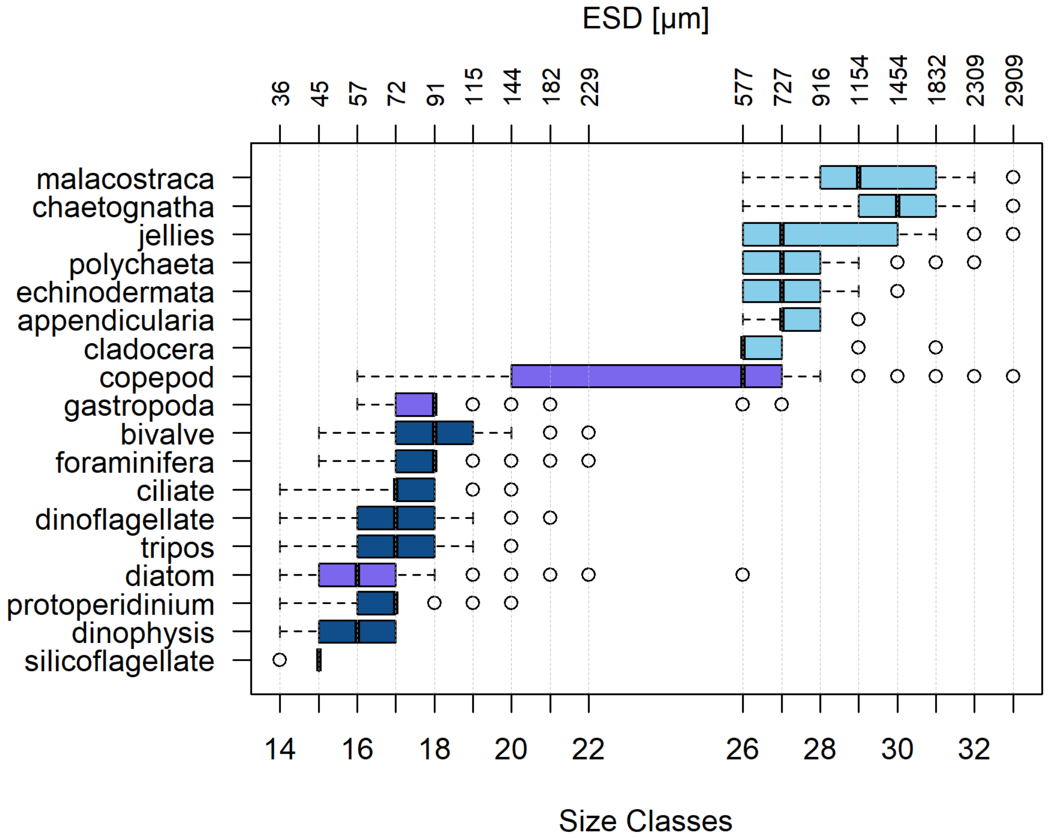

Figure S2. Size classes for the different taxa analyzed using the FlowCAM (dark blue), the (ZooSCAN (light blue) or both (purple). Sizes classes are based on the biovolume, using an octave scale with the top y-axis representing the size as equivalent spherical diameter (ESD). The box represents the inter-quartile ranges (IQR), the circles are the outliers, detected as higher or below quartiles +/- 1.5*IQR, and the dashed lines shows the maximum/minimum values without outliers

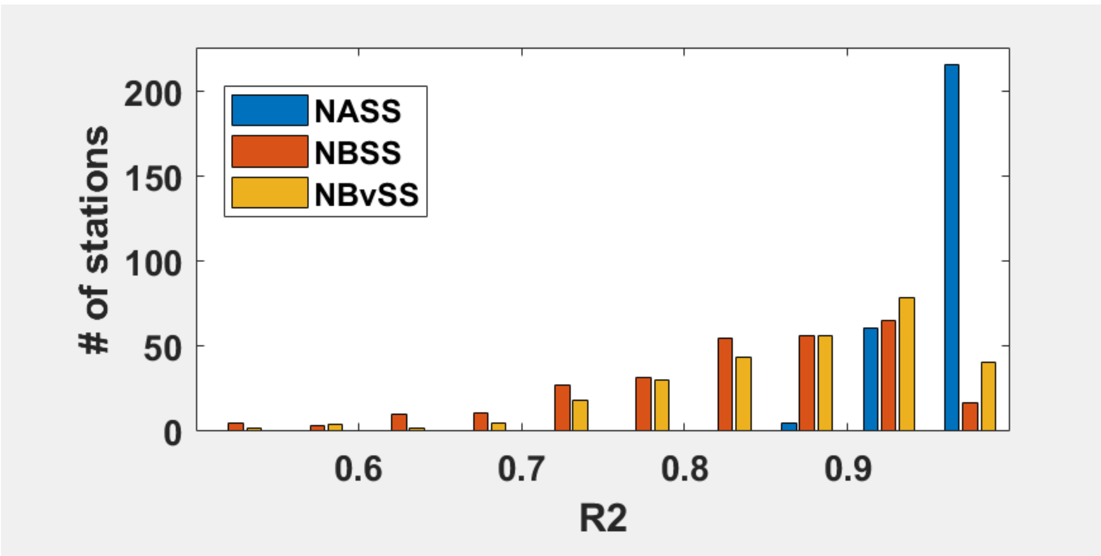

Figure S3. Distribution of the adjusted R2 obtained for the normalized size-spectra constructed based on the abundance (NASS), biomass (NBSS) and biovolume (NBvSS).

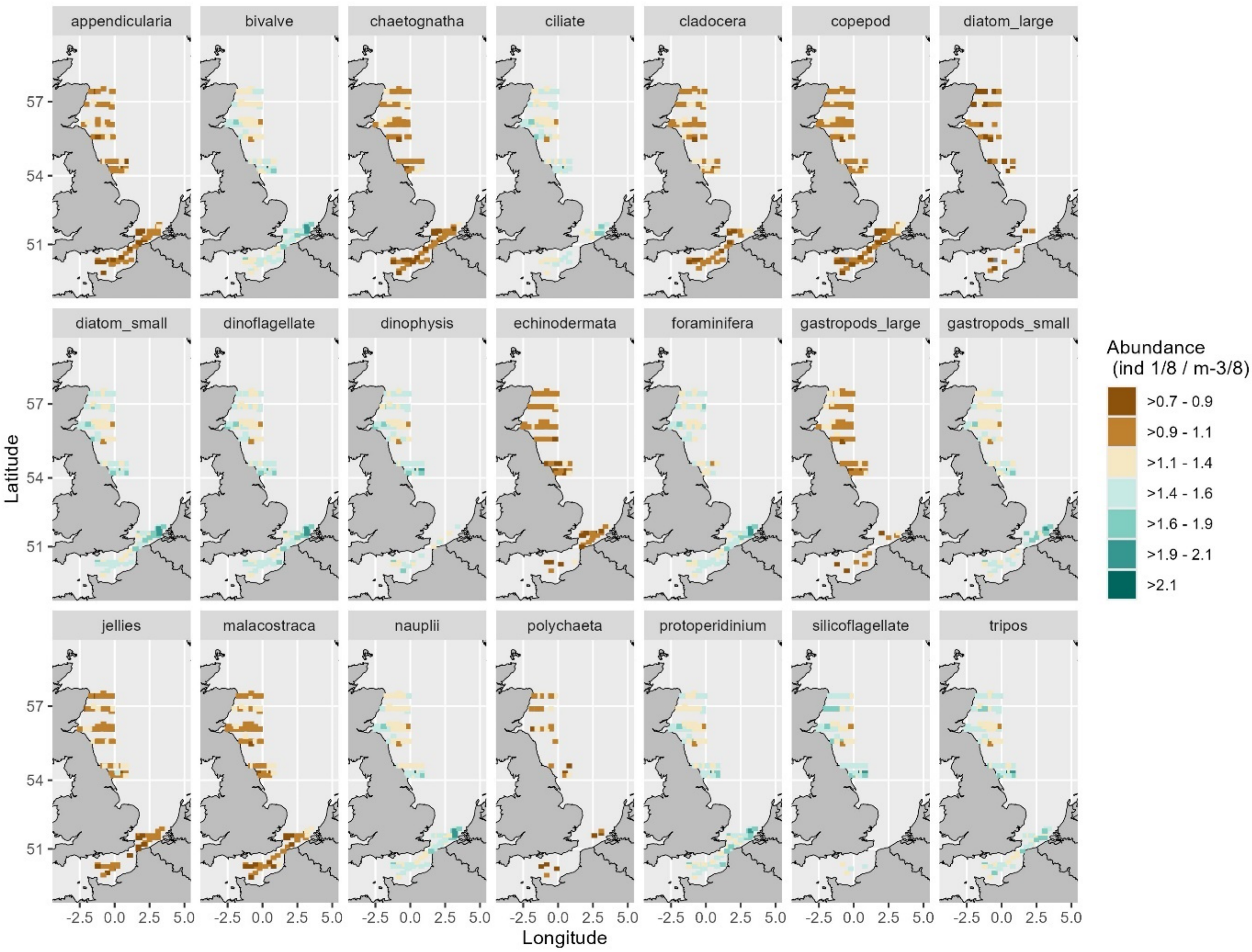

Figure S4. Mean variability of the concentration (Log+1 ind m^{-3}) of the studied taxa groups across the sampling period (2013-2019) in the Buchan/Banks area (September) and Downs (December). Labels on top of each panel refer to the taxa represented there.

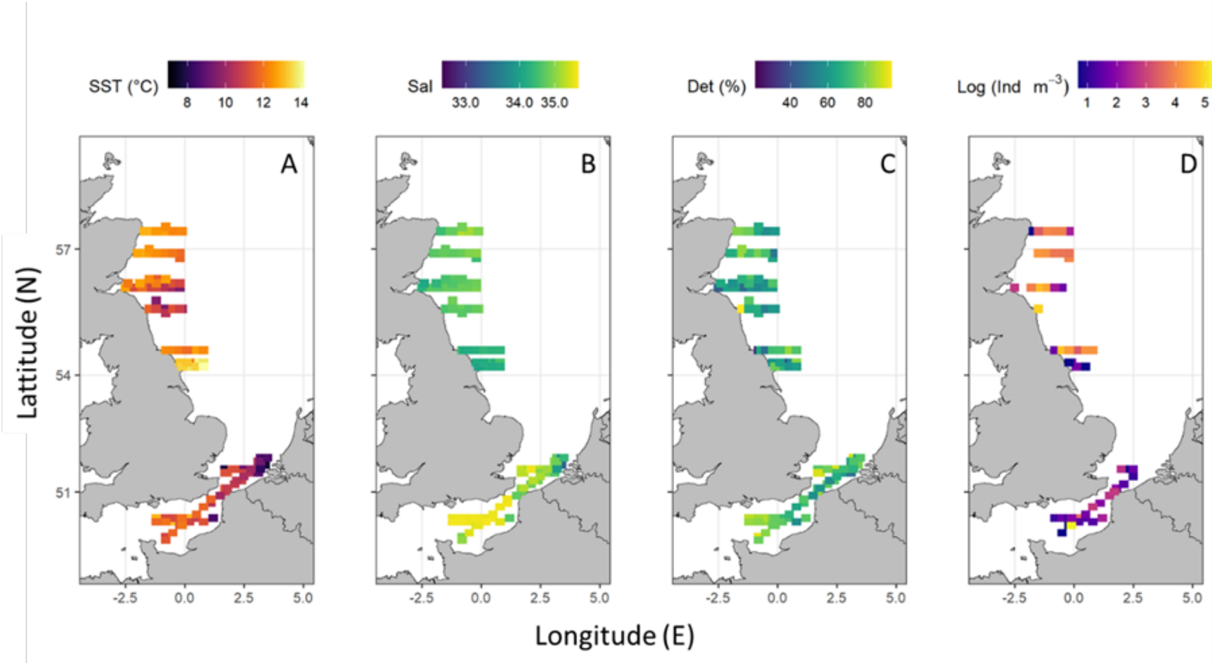

Figure S5. Mean variability of the environmental and biological variables across the sampling period (2013-2019) in the Buchan/Banks area (September) and Downs (December). (A) mean temperature (SST (°C)), (B) mean salinity (Sal), (C) relative turbidity (%) and (D) logarithmic larval herring abundance (Log (ind m^{-3})). Water temperature in the Buchan/Banks area varied between 10 and 15°C and was generally higher close to the coast than at more offshore stations. As for the Downs area, the warmest water (T > 12°C) was observed in the southwestern stations and temperature decreased to 7–9°C toward northeast (Fig. S3A). Salinity above 35 was observed at the northern offshore stations and gradually decreased to 34.4 to the south and toward the coast (Fig. S3B). Salinity in Downs varied between 33 and 35.5 and the strongest differences in salinity were observed between off- and inshore stations (Fig. S3B). An exceptionally low salinity <34.6 was observed everywhere in this area in September 2016. Highest turbidity was found in the northern coastal stations with a decrease towards offshore and the south (Fig. S3C). Maximum larval herring abundances were comparable across both spawning grounds (207 ind m^{-3} in Buchan/Banks vs 193 ind m^{-3} in Downs), although average larval abundances were generally higher in September (Fig. S3D).

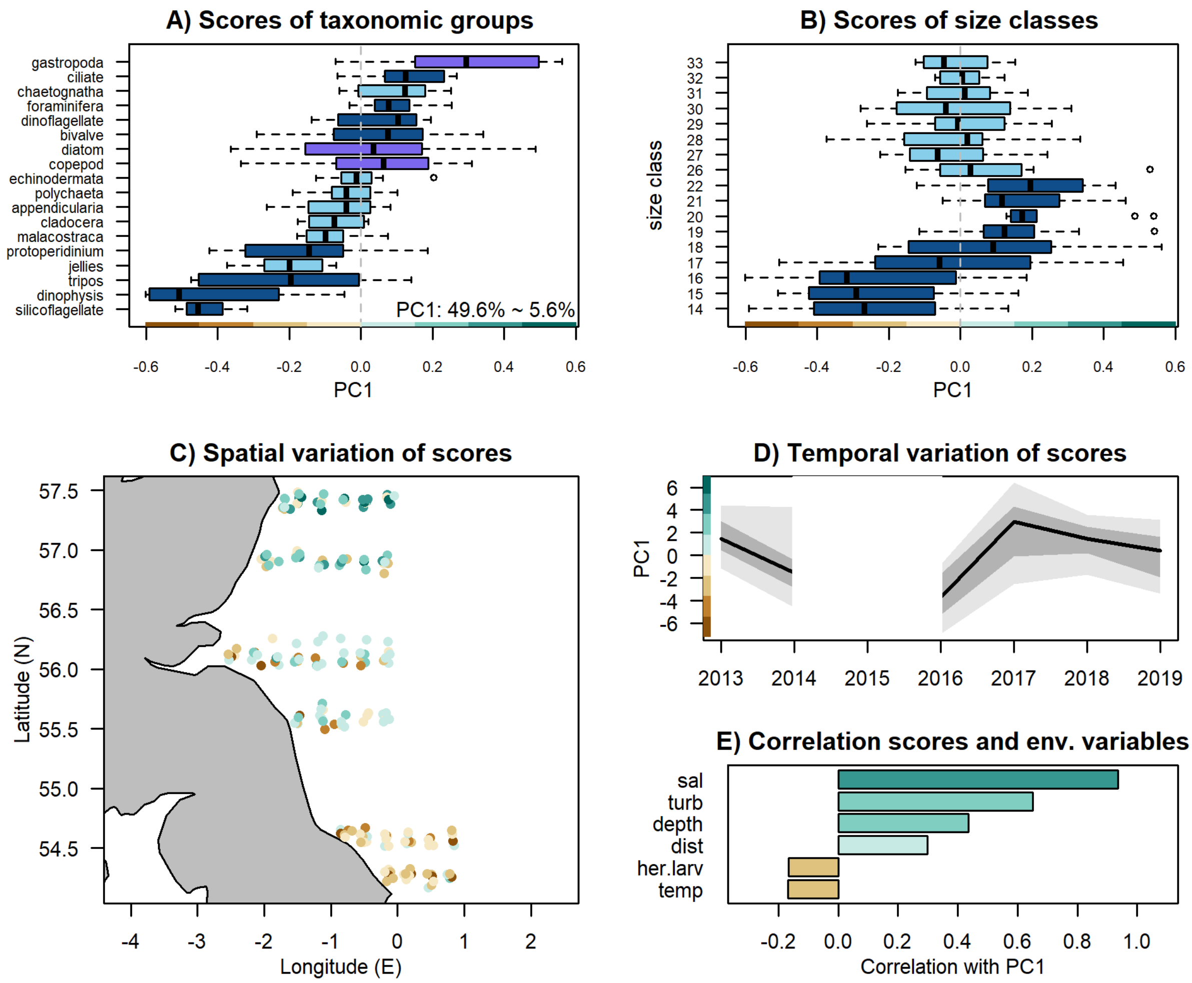

Figure S6. Results of the redundancy analysis (RDA) analyzing the effect of five abiotic and biotic drivers on the zooplankton biovolume in the Buchan/Banks area in September. Unconstrained variables were the following: distance to shore (dist), turbidity (turb), salinity (sal), temperature (temp), and bottom depth (depth), and herring larvae abundance (her.larv). Each subpanel displays the scores of the Principal Component 1 (PC1) among taxonomic groups and the explained variability (A). The size classes with the different types indicated in dark blue (FlowCAM), light blue (ZooSCAN) and purple (both) (B), The map of the stations' score shows its spatial variation, with the stations coordinates being jittered to avoid overlap among years (C). The temporal variation of stations' score is represented with a bold black line for the median, dark grey area for the inter quartile range, and light grey area for the 95% quantiles (D). Pearson correlation coefficient between the PC1 and the six explanatory variables: herring larvae abundance (her.larv), distance to shore (dist), salinity (sal), temperature (temp), turbidity (turb) and bottom depth (depth) including the significance lines (*** $p < 0.001$, * $p < 0.05$). Color intensity is proportional to the correlation coefficients (brown – negative, cyan – positive) and shows the impact on the respective station (E).

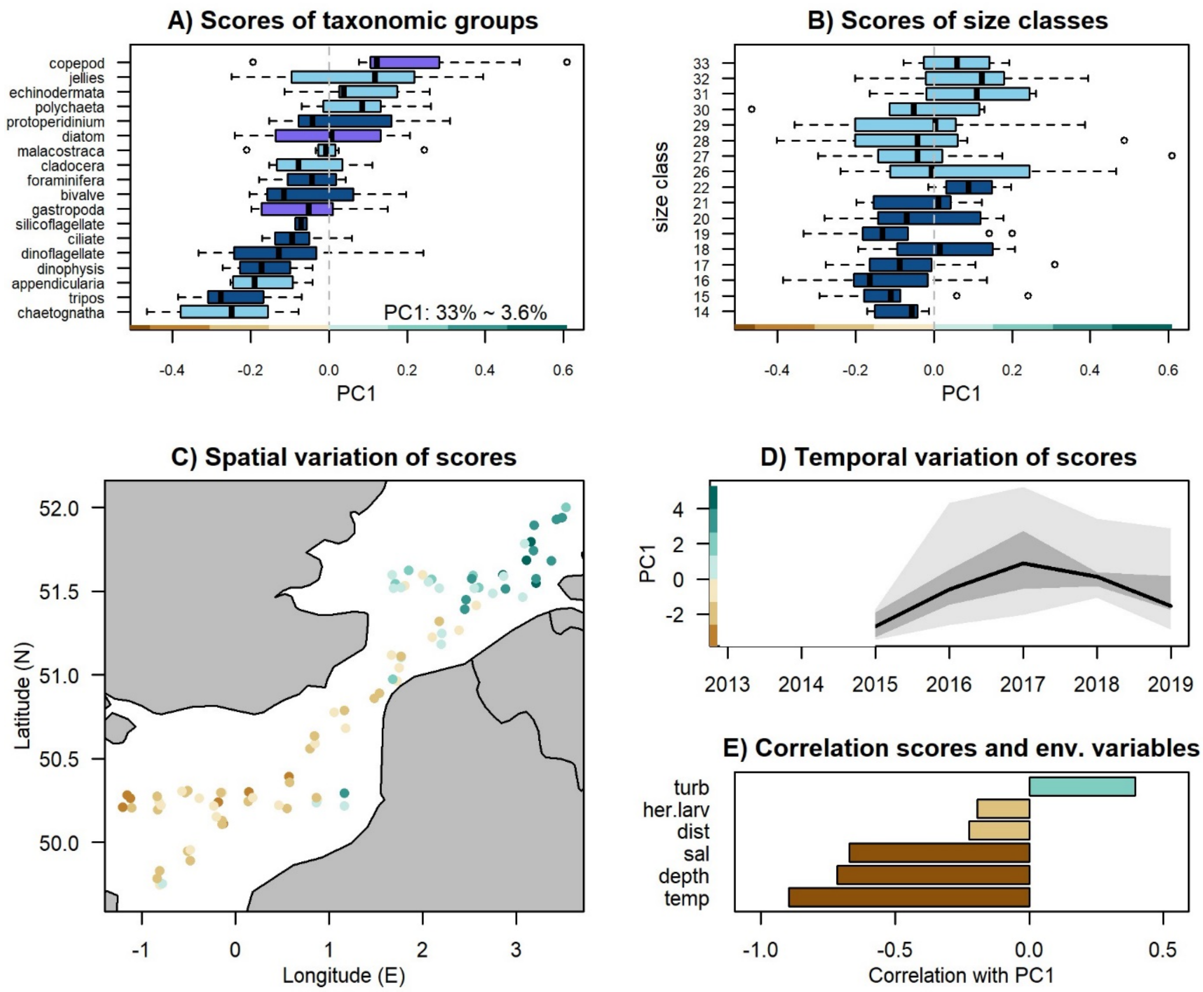

Figure S7. Results of the redundancy analysis (RDA) analyzing the effect of five environmental variables and herring larvae abundance (her.larv) based on the zooplankton community biovolume and distribution during the Downs surveys (December/winter). Environmental variables were: distance to shore (dist), turbidity (turb), salinity (sal), temperature (temp), and bottom depth (depth). Each subpanel displays the scores of the Principal Component 1 (PC1) among taxonomic groups and the explained variability (A), the size classes with the different types indicated in dark blue (FlowCAM), light blue (ZooSCAN) and purple (both) (B), The map of the stations' score shows its spatial variation, with the stations coordinates being jittered to avoid overlap among years (C). The temporal variation of stations' score is represented with a bold black line for the median, dark grey area for the inter quartile range, and light grey area for the 95% quantiles (D). Pearson correlation coefficient between the PC1 and the six explanatory variables: herring larvae abundance (her.larv), distance to shore (dist), salinity (sal), temperature (temp), turbidity (turb) and bottom depth (depth) including the significance lines (*** $p < 0.001$, * $p < 0.05$). Color intensity is proportional to the correlation coefficients (brown – negative, cyan – positive) and shows the impact on the respective station (E).

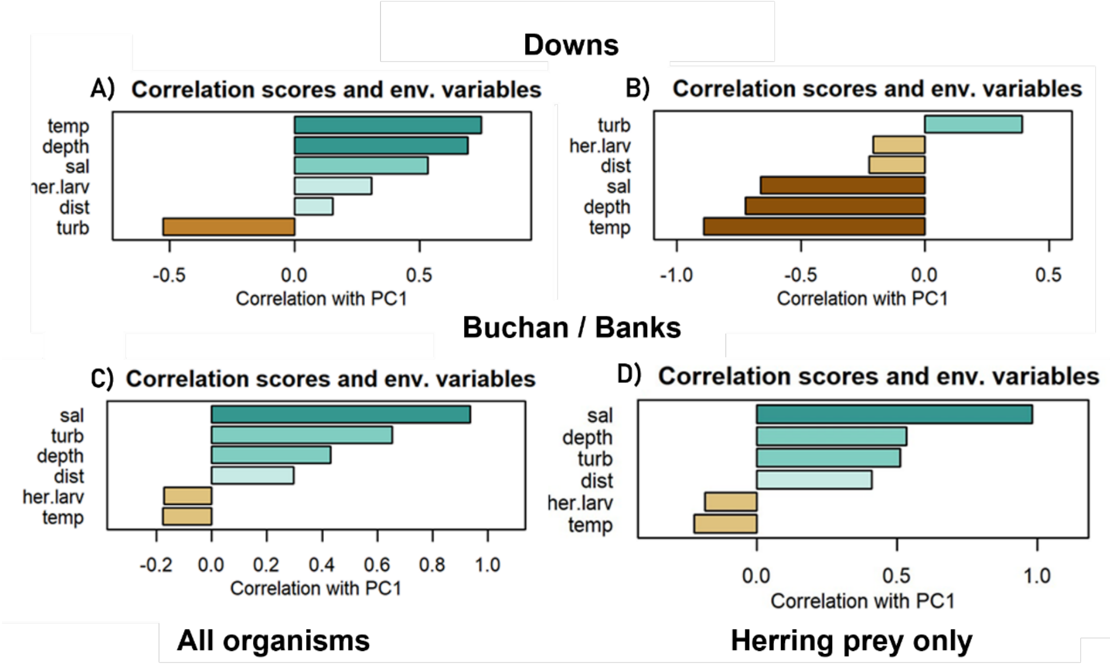

Figure S8. Results of the redundancy analysis (RDA) analyzing the effect of five environmental variables and herring larvae abundance (her.larv) on the plankton community (whole community vs herring prey only) and their distribution. A) Whole plankton community in the Downs area, B) Prey only community in the Downs area, C) whole plankton community in the Buchan/Banks area, B) Prey only community in the Buchan/Banks area. Correlations show the Pearson correlation coefficient between the RDA PC1 and each explanatory variable. Environmental variables include: distance to shore (dist), salinity (sal), temperature (temp), turbidity (turb) and bottom depth (depth). The following planktonic groups were considered as herring prey as described in Akimova et al. (2023): copepods, appendicularians, bivalve larvae, gastropod larvae, echinoderm larvae, ciliates, cladocerans,diatoms, dinoflagellates, foraminiferans, and silicoflagellates.

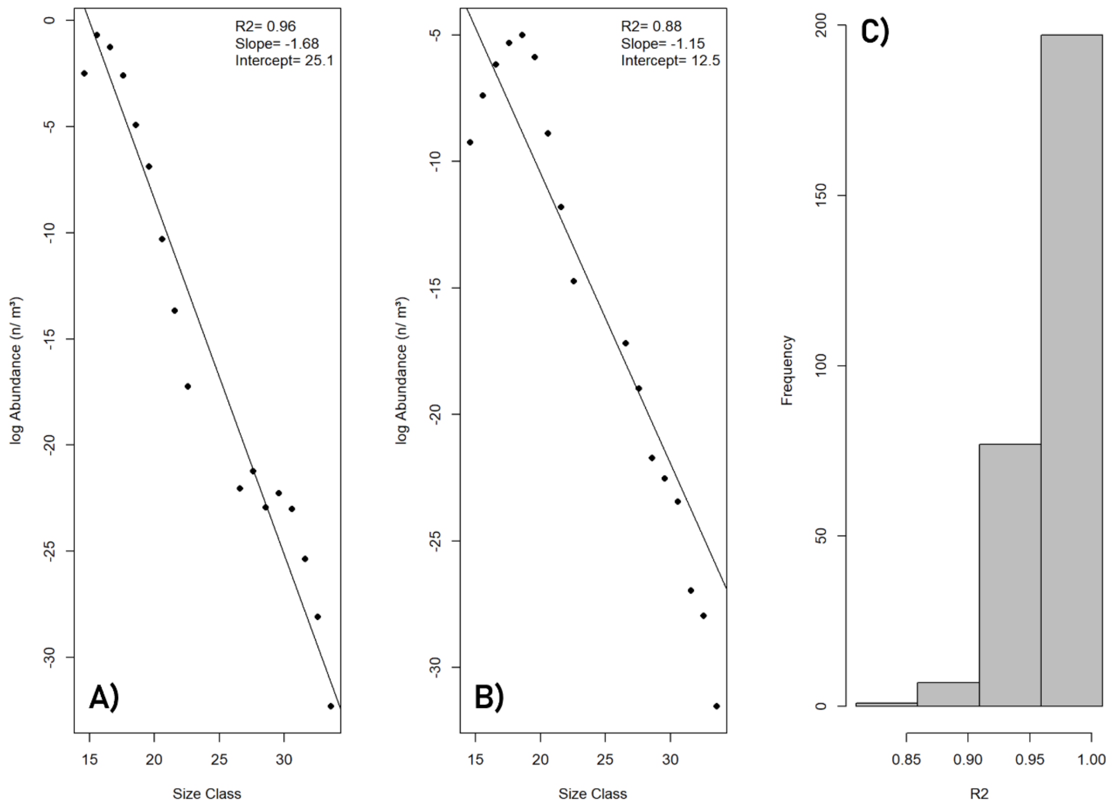

Figure S9. Normalized abundance size spectra (NASS) for individual stations sampled in the North Sea. A) example station (IHLS September 2014, #106) with a strong R2 fit (R^2 = 0.96); B) example station (IHLS September 2018, #003) with lower R^2 fit (R2 = 0.88); C) histogram of the distribution of R^2 values for all stations.

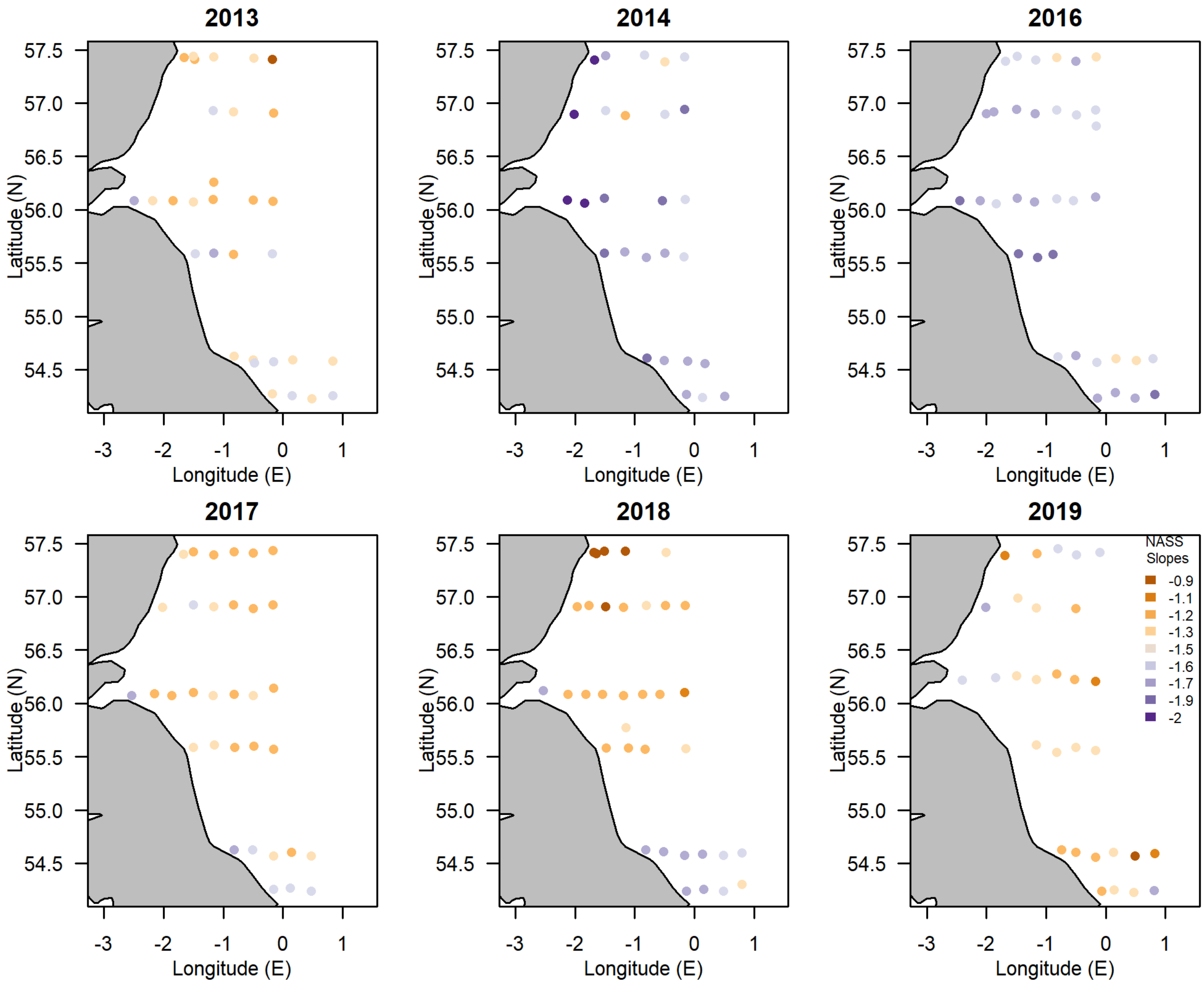

Figure S10. Spatial distribution of the NASS zooplankton slopes per station and year in the Buchan/Banks area.

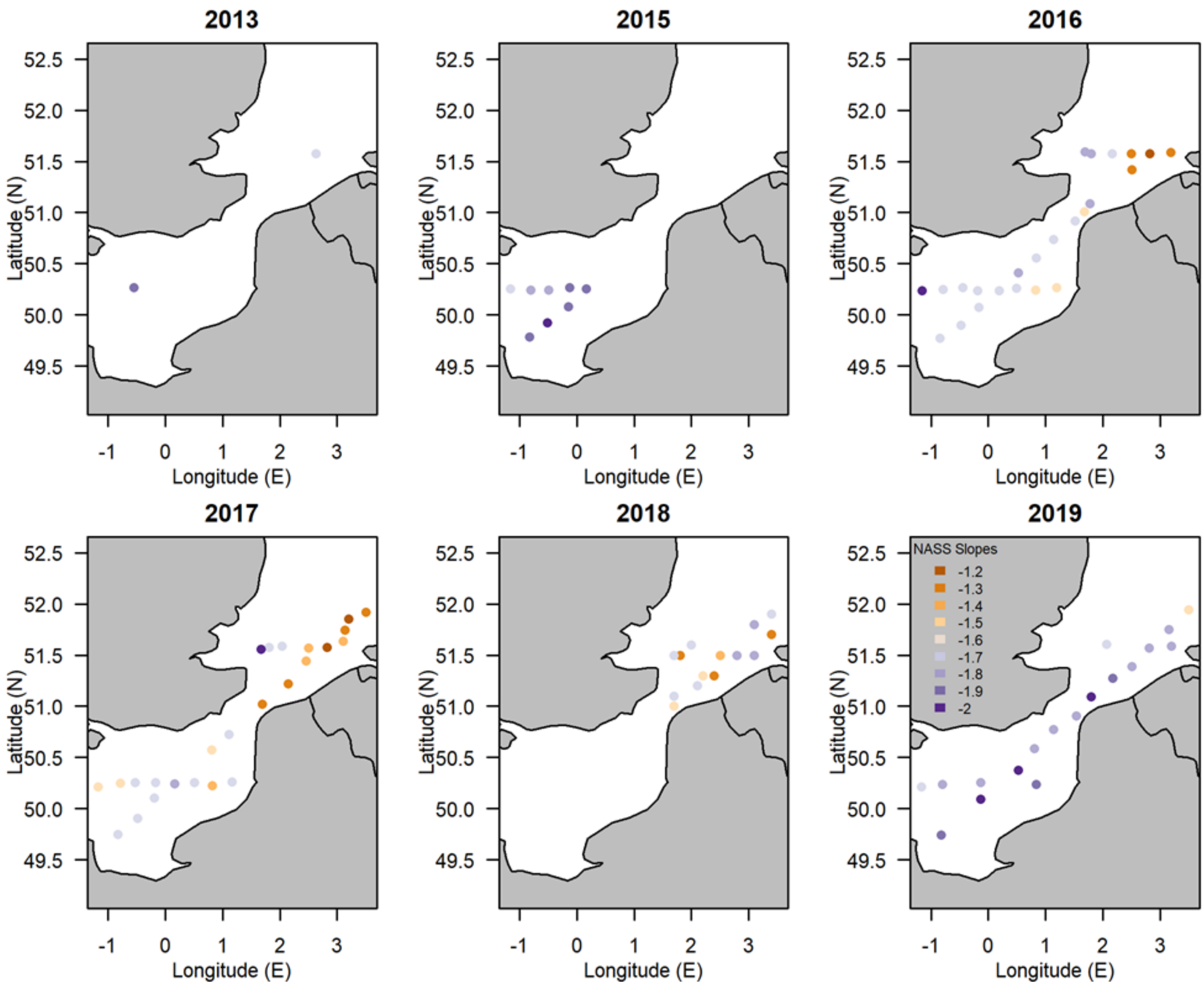

Figure S11. Spatial distribution of the NASS zooplankton slopes per station and year in the Downs area.

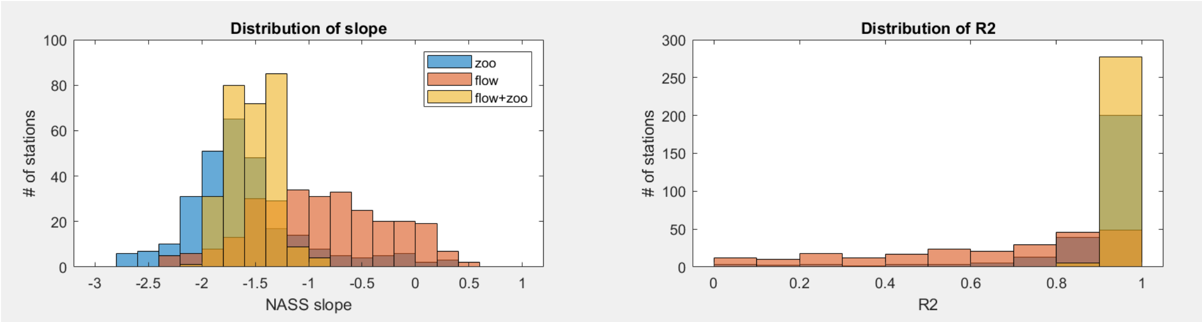

Figure S12. Distribution of the NASS slope (left panel) and R2(right panel) obtained individually with Flowcam (flow, red), Zooscan (zoo, blue) and with both methods combined (flow+zoo, yellow).

SUPPLEMENTARY TABLES

Table S1. Taxa-specific coefficients used for estimating biomass B of individual zooplankters as a function of their biovolume BV: $log_{10}B = a + b \cdot log_{10}BV$. Note that a and b were adjusted to the units of B[μgC] and BV[μm3] used in this study.

Taxa	a	b	Reference
Diatoms (<3000μm)	-6.54	0.811	Menden-Deuer & Lessard (2000)
Diatoms (≥ 3000 μm), phytoplankton	-6.93	0.811	
ciliate tripos dinoflagellate protoperidinium dinophysis silicoflagellate foraminifera	-6.29	0.88	Kiørboe (2013)
copepods	-6.48	0.95	
cladocera malacostraca	-5.85	0.92	
appendicularia chaetognatha polychaeta	-8.49	1.08	
bivalves gastropods	-5.64	0.83	
jellies	-7.22	0.98	
echinodermata	-6.42	0.94	

Table S2: Plankton abundance (Ind x10^2 m^{-3}) per year as total mesozoo- (MesoZP) and microplankton (MicroZP) and by taxa in Buchan/Banks (BB) as minimum (min), maximum (max), average values (mean) as well as the overall average and the relative abundance (%).

	BB 2013 Ind x10^2 m^{-3}			BB 2014 Ind x10^2 m^{-3}			BB 2016 Ind x10^2 m^{-3}			BB 2017 Ind x10^2 m^{-3}			BB 2018 Ind x10^2 m^{-3}			BB 2019 Ind x10^2 m^{-3}			Overall Ind x10^2 m^{-3}	
taxa	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	mean	%
tripos	1.604	879.728	306.738	0.443	574.087	266.405	52.426	6092.999	603.918	13.347	3821.122	826.395	3.175	363.461	132.135	2.563	326.172	149.271	380.810	25.664
ciliate	0.636	114.102	38.820	1.060	111.856	48.535	0.237	181.919	78.125	0.795	19.461	11.136	0.402	57.440	21.227	0.327	142.763	57.523	42.561	3.859
diatom	0.017	499.915	178.483	5.654	107.273	47.135	16.656	6407.280	1066.146	19.943	729.860	169.547	8.051	1436.507	552.772	10.605	1878.529	393.493	401.263	36.379
dinoflagellate	0.330	79.081	18.823	0.186	9.487	4.546	0.922	35.343	14.407	0.421	16.554	6.018	0.084	32.185	8.374	0.189	18.898	5.031	9.533	0.864
dinophysis	0.155	27.147	11.148	2.191	2805.928	714.064	13.952	2919.773	390.431	0.146	193.086	119.690	0.166	218.720	110.660	0.077	59.922	27.177	228.862	20.749
foraminifera	0.082	2.797	0.823	0.030	0.379	0.173	0.237	3.315	1.590	0.092	1.579	0.798	0.075	0.800	0.369	0.036	9.827	3.878	1.272	0.115
protoperidinium	1.584	122.162	34.940	6.998	683.836	265.745	8.850	952.982	263.183	26.560	1102.321	190.225	1.361	128.444	74.756	5.341	138.371	63.067	148.653	13.477
silicoflagellate	0.120	15.026	7.784	0.040	1.884	0.821	0.459	2463.559	849.515	0.108	13.633	5.812	0.052	11.762	3.802	0.031	14.062	3.209	145.157	13.160
bivalve	0.164	13.692	8.207	0.079	32.265	10.914	0.437	30.414	5.100	0.826	36.263	13.597	0.254	12.759	6.412	0.218	15.118	5.737	8.328	0.755
copepod all	10.885	129.801	58.771	7.725	125.973	41.410	13.736	340.826	49.381	17.773	338.698	90.293	9.448	142.357	60.115	16.715	228.490	54.296	59.044	
copepods	1.330	1.210	5.770	0.420	29.330	3.170	1.790	97.510	8.810	0.780	16.030	8.070	0.460	20.340	7.370	0.780	16.030	7.900	6.848	0.621
nauplii	9.002	127.474	59.474	5.334	125.156	44.767	8.831	243.314	41.266	15.595	323.296	83.833	8.005	122.014	53.595	4.674	214.234	47.174	55.018	4.988
gastropoda	0.211	49.016	18.183	0.667	166.561	36.730	0.023	89.452	39.053	0.289	263.202	127.507	2.078	98.628	53.671	0.207	75.444	42.118	52.877	4.794
appendicularia	0.006	0.227	0.117	0.006	0.051	0.031	0.019	1.566	0.225	0.057	0.493	0.231	0.025	0.406	0.176	0.011	0.569	0.264	0.174	0.016
chaetognatha	0.026	0.912	0.371	0.005	2.949	0.470	0.041	2.350	0.422	0.057	1.168	0.533	0.052	1.703	0.644	0.045	0.904	0.513	0.492	0.045
cladocera	0.006	0.152	0.097	0.003	0.155	0.055	0.009	2.350	0.813	0.033	1.851	0.510	0.025	0.992	0.508	0.006	0.650	0.241	0.371	0.034
echinodermata	0.004	0.225	0.073	0.004	0.155	0.027	0.022	1.072	0.305	0.020	0.212	0.084	0.025	1.503	0.626	0.013	0.125	0.094	0.202	0.018
jellies	0.011	1.433	0.616	0.004	0.569	0.289	0.027	5.091	1.044	0.025	0.543	0.292	0.029	1.173	0.631	0.006	0.824	0.456	0.555	0.050
malacostraca	0.034	1.478	0.553	0.008	3.104	0.432	0.036	3.916	0.429	0.033	0.617	0.321	0.103	6.291	2.147	0.040	2.074	0.710	0.765	0.069
polychaeta	0.006	0.094	0.045	0.002	0.013	0.007	0.012	0.268	0.141	0.020	0.209	0.095	0.028	0.109	0.060	0.011	0.100	0.062	0.068	0.006
Total	**64.592**	**1360.076**	**355.815**	**36.517**	**3900.380**	**863.677**	**124.786**	**19273.796**	**1769.658**	**142.587**	**5589.444**	**902.573**	**73.445**	**1609.013**	**544.307**	**70.304**	**2312.206**	**402.071**	**806.350**	**100.000**
MesoZP	2.019	13.943	7.610	0.793	37.816	4.229	3.441	112.784	10.598	1.144	19.863	10.172	2.534	29.104	12.617	1.043	16.013	8.901	9.021	1.102
MicroZP	58.625	1354.473	373.685	35.103	3897.262	893.376	118.128	19161.011	1754.796	136.944	5571.008	901.230	61.548	1600.171	539.057	57.569	2296.194	396.351	809.749	98.898

Table S3. Plankton abundance (Ind x10² m^{-3}) per year as total mesozoo- (MesoZP) and microplankton (MicroZP) and by taxa in Downs (Dow) as minimum (min), maximum (max), average values (mean) as well as the overall average and the relative abundance (%).

	DOW 2013 Ind x10² m^{-3}			DOW 2015 Ind x10² m^{-3}			DOW 2016 Ind x10² m^{-3}			DOW 2017 Ind x10² m^{-3}			DOW 2018 Ind x10² m^{-3}			DOW 2019 Ind x10² m^{-3}			Overall Ind x10² m^{-3}	
taxa	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	mean	%
tripos	0.000	0.000	0.000	1.542	28.171	18.243	0.055	1.940	0.818	0.221	1.448	0.752	0.098	98.295	53.854	0.298	6.159	3.082	12.792	1.435
ciliate	0.000	0.000	0.000	0.567	0.729	0.675	0.113	0.405	0.259	0.118	2.070	1.038	0.102	9.215	4.690	0.115	5.643	4.246	1.818	0.204
diatom	331.802	658.078	474.114	231.327	1030.379	692.146	58.461	1367.317	485.295	28.267	1137.300	312.299	56.989	3158.959	1207.245	78.177	8045.778	1540.732	785.305	88.119
dinoflagellate	1.446	8.025	5.948	3.822	18.781	9.924	0.051	19.638	7.590	0.118	12.935	5.593	0.186	23.617	8.591	1.382	157.027	24.104	10.292	1.155
dinophysis	0.000	0.000	0.000	0.671	3.426	1.960	0.069	0.130	0.096	0.074	0.781	0.507	0.098	0.512	0.325	0.079	0.684	0.382	0.545	0.061
foraminifera	3.132	12.964	9.205	0.849	12.073	5.942	0.720	13.665	4.749	0.265	13.417	3.525	0.116	10.262	3.446	1.422	74.775	15.479	7.058	0.792
protoperidinium	3.704	3.704	3.704	1.082	24.146	13.219	0.257	13.092	6.103	0.106	70.684	23.848	0.279	56.315	17.627	0.145	52.268	17.875	13.729	1.541
silicoflagellate	0.000	0.000	0.000	0.000	0.000	0.000	0.055	0.214	0.135	0.106	0.414	0.311	0.000	0.000	0.000	0.000	0.000	0.000	0.074	0.008
bivalve	0.964	10.495	8.679	0.425	11.403	6.910	0.626	59.009	19.954	0.132	19.609	5.896	1.217	41.980	14.824	1.012	49.655	14.350	11.769	1.321
copepod all	7.329	43.870	28.073	12.525	22.621	17.045	2.774	102.816	47.755	2.445	92.272	37.949	0.285	89.805	19.874	1.895	411.930	72.793	37.248	
copepods	0.340	3.120	1.900	0.090	0.260	0.190	0.270	18.540	6.480	0.010	11.690	5.980	0.280	4.020	2.330	0.060	24.880	3.850	3.455	0.388
nauplii	6.988	40.744	30.440	12.316	22.352	16.535	2.490	95.346	44.916	2.322	81.751	33.590	2.839	86.008	23.125	1.827	403.784	79.744	38.058	4.271
gastropoda	0.723	1.235	0.928	0.018	2.835	1.919	0.012	33.173	24.829	0.006	3.104	1.402	0.003	1.024	0.209	0.145	29.957	5.942	5.871	0.659
appendicularia	0.000	0.000	0.000	0.012	0.028	0.021	0.005	0.155	0.094	0.008	0.058	0.025	0.005	0.116	0.051	0.003	0.175	0.026	0.036	0.004
chaetognatha	0.034	0.042	0.041	0.057	0.377	0.203	0.014	0.603	0.249	0.021	0.490	0.165	0.012	0.798	0.263	0.011	0.719	0.124	0.174	0.020
cladocera	0.000	0.000	0.000	0.011	0.056	0.030	0.006	0.472	0.106	0.058	0.058	0.058	0.001	0.005	0.003	0.004	0.140	0.074	0.045	0.005
echinodermata	0.014	0.014	0.014	0.000	0.000	0.000	0.015	0.044	0.029	0.006	0.050	0.027	0.001	0.037	0.015	0.004	0.005	0.004	0.015	0.002
jellies	0.014	0.014	0.014	0.009	0.098	0.048	0.007	0.314	0.095	0.002	0.122	0.057	0.003	0.032	0.016	0.003	0.047	0.014	0.041	0.005
malacostraca	0.001	0.103	0.097	0.009	0.050	0.025	0.011	0.744	0.248	0.002	0.151	0.059	0.002	0.122	0.048	0.003	0.233	0.056	0.089	0.010
polychaeta	0.072	0.072	0.072	0.005	0.005	0.005	0.024	0.024	0.024	0.002	0.023	0.008	0.005	0.012	0.010	0.001	0.001	0.001	0.020	0.002
Total	**345.439**	**738.608**	**539.080**	**299.163**	**1072.556**	**720.760**	**65.275**	**1438.825**	**515.564**	**38.497**	**1209.195**	**322.990**	**63.316**	**3299.240**	**1161.280**	**90.778**	**8810.034**	**1664.070**	**820.624**	**100.000**
MesoZP	0.380	3.360	2.020	0.210	0.770	0.460	0.410	19.590	6.560	0.160	11.800	5.880	0.430	5.090	2.540	0.160	25.690	3.850	3.552	0.423
MicroZP	345.050	735.250	522.220	298.800	1072.350	721.490	64.790	1436.230	518.480	37.960	1208.740	337.320	60.570	3294.150	1261.120	90.570	8801.000	1654.400	835.838	99.577

Table S4. Plankton biomass (µgC x10^5 m^{-3}) per year as total mesozoo- (MesoZP) and microplankton (MicroZP) and by taxa in Buchan/Banks (BB) as minimum (min), maximum (max), average values (mean) as well as the overall average and the relative biomass (%).

	BB 2013 biomass x 10^5 [µgC m^{-3}]			BB 2015 biomass x 10^5 [µgC m^{-3}]			BB 2016 biomass x 10^5 [µgC m^{-3}]			BB 2017 biomass x 10^5 [µgC m^{-3}]			BB 2018 biomass x 10^5 [µgC m^{-3}]			BB 2019 biomass x 10^5 [µgC m^{-3}]			Overall biomass x10^5 [µgC m^{-3}]	
taxa	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	mean	%
ceratium	0.066	5.731	2.800	0.021	11.679	6.477	1.311	69.075	13.650	0.696	140.989	31.429	0.157	12.640	5.855	0.157	5.738	3.018	10.538	1.836
ciliate	0.008	1.548	0.623	0.011	2.405	1.022	0.002	2.982	1.147	0.017	0.669	0.280	0.004	1.288	0.466	0.003	1.834	1.035	0.762	0.133
diatom	0.077	2.180	0.931	0.059	0.779	0.340	0.074	8.026	1.650	0.148	2.078	1.029	0.131	4.438	1.840	0.080	6.708	1.372	1.194	0.208
dinoflagellate	0.002	1.593	0.369	0.002	0.165	0.079	0.019	0.609	0.314	0.017	0.708	0.235	0.001	1.053	0.308	0.003	0.600	0.153	0.243	0.042
dinophysis	0.001	0.271	0.124	0.022	35.074	8.418	0.142	31.276	4.027	0.003	1.976	1.244	0.003	2.222	1.146	0.001	0.703	0.354	2.552	0.445
foraminifera	0.006	0.253	0.063	0.001	0.017	0.008	0.013	0.311	0.147	0.008	0.200	0.101	0.004	0.152	0.054	0.001	0.593	0.248	0.103	0.018
protoperidinium	0.052	2.619	0.941	0.140	15.288	5.669	0.164	29.415	7.669	0.924	23.770	4.941	0.074	6.111	3.298	0.124	5.678	1.900	4.069	0.709
silicoflagellate	0.001	0.077	0.040	0.000	0.009	0.004	0.002	11.729	4.342	0.000	0.065	0.029	0.000	0.054	0.020	0.000	0.071	0.015	0.742	0.129
copepod	110.105	960.274	447.300	88.058	6352.755	497.588	88.183	3087.109	301.596	75.031	792.192	399.639	45.070	1217.366	418.005	52.675	629.873	347.875	402.001	70.048
nauplii	0.960	13.984	6.760	0.767	11.849	4.831	1.100	21.289	5.120	3.071	41.956	13.728	0.863	15.668	8.375	0.735	35.158	7.843	7.776	1.355
appendicularia	0.017	2.853	1.259	0.012	0.438	0.223	0.039	4.058	0.676	0.098	1.526	0.839	0.067	3.588	0.838	0.017	2.936	1.316	0.859	0.150
bivalve	0.009	1.078	0.729	0.019	5.086	2.099	0.011	2.294	0.912	0.155	6.549	3.542	0.138	5.052	2.630	0.033	4.733	1.359	1.878	0.327
chaetognatha	1.827	124.054	23.297	0.298	309.454	49.582	1.316	97.328	18.369	1.889	64.270	23.828	0.750	71.183	28.083	1.521	58.520	24.849	28.001	4.879
cladocera	0.651	13.283	7.680	0.255	10.892	4.288	0.451	154.386	42.938	1.322	88.506	26.023	0.674	52.221	24.518	0.191	34.351	13.742	19.865	3.461
echinodermata	0.039	3.497	1.177	0.044	5.597	1.281	0.251	22.731	6.835	0.290	5.724	1.528	0.244	19.107	7.854	0.139	1.590	1.191	3.311	0.577
gastropoda	2.669	114.962	61.806	0.251	46.411	15.301	0.340	67.482	27.143	0.042	84.885	45.699	2.271	164.790	67.342	0.087	57.816	22.596	39.981	6.967
jellies	0.248	115.236	53.049	0.229	85.849	41.696	0.525	322.749	61.634	0.092	102.782	27.346	0.321	184.972	67.513	0.233	93.755	48.859	50.016	8.715
malacostraca	4.295	1140.332	375.982	9.457	2388.914	286.823	6.994	1198.953	155.940	8.501	466.972	170.315	12.558	560.630	274.665	14.523	728.707	265.081	254.801	44.399
polychaeta	0.131	10.606	4.393	0.038	3.625	0.848	0.189	33.244	9.614	0.049	10.489	2.631	0.176	2.230	0.919	0.027	8.362	3.124	3.588	0.625
Total	**293.727**	**1428.495**	**634.930**	**212.820**	**9183.152**	**714.039**	**157.451**	**5001.189**	**535.238**	**125.625**	**1261.100**	**630.217**	**133.308**	**1522.093**	**684.771**	**145.271**	**1029.727**	**522.069**	**620.211**	**100.000**
MesoZP	283.745	1417.307	671.586	190.603	9176.340	799.427	147.898	4843.293	519.487	103.965	1201.827	555.921	124.444	1503.394	699.219	141.529	1020.754	515.486	626.854	96.177
MicroZP	1.751	29.021	11.374	1.819	65.208	21.469	3.580	157.895	29.297	12.337	211.157	48.728	5.349	41.037	22.383	2.916	50.375	16.233	24.914	3.823

Table S5. Plankton biomass (µgC x10^5 m^{-3}) per year as total mesozoo- (MesoZP) and microplankton (MicroZP) by taxa in Downs (Dow) as minimum (min), maximum (max), average values (mean) as well as the overall average and the relative biomass (%).

	Dow 2013			Dow 2015			Dow 2016			Dow 2017			Dow 2018			Dow 2019			Overall	
	biomass x10^5 [µgC m^{-3}]			biomass x10^5 [µgC m^{-3}]			biomass x10^5 [µgC m^{-3}]			biomass x10^5 [µgC m^{-3}]			biomass x10^5 [µgC m^{-3}]			biomass x10^5 [µgC m^{-3}]			biomass x10^5 [µgC m^{-3}]	
taxa	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean	mean	%
ceratium	0.000	0.000	0.000	0.034	0.690	0.413	0.002	0.049	0.021	0.003	0.022	0.016	0.001	3.387	1.731	0.007	0.135	0.072	0.375	0.234
ciliate	0.000	0.000	0.000	0.002	0.013	0.009	0.003	0.003	0.003	0.001	0.046	0.029	0.001	0.243	0.126	0.001	0.219	0.162	0.055	0.034
dinophysis	0.000	0.000	0.000	0.008	0.061	0.029	0.001	0.002	0.001	0.001	0.010	0.006	0.001	0.008	0.004	0.001	0.006	0.004	0.007	0.005
silicoflagellate	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.003	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
protoperidinium	0.055	0.055	0.055	0.024	0.619	0.333	0.004	0.221	0.094	0.001	1.765	0.549	0.003	1.829	0.459	0.002	1.008	0.350	0.307	0.191
dinoflagellate	0.014	0.125	0.090	0.120	0.503	0.311	0.001	0.704	0.298	0.003	0.369	0.148	0.009	0.559	0.200	0.037	5.777	0.702	0.291	0.181
foraminifera	0.074	0.327	0.231	0.026	0.532	0.213	0.024	0.673	0.199	0.004	0.578	0.157	0.004	0.313	0.115	0.201	7.938	1.629	0.424	0.264
bivalve	0.164	0.829	0.703	0.036	1.234	0.787	0.134	8.092	2.765	0.020	2.906	0.929	0.113	7.307	2.063	0.148	9.458	2.079	1.554	0.967
diatom	0.945	2.422	1.589	0.977	3.282	2.419	0.156	5.376	2.052	0.140	4.397	1.621	0.237	10.506	4.585	0.472	57.347	9.420	3.614	2.249
gastropoda	0.070	0.102	0.083	0.014	0.344	0.242	0.030	2.922	2.209	0.013	0.245	0.144	0.025	0.275	0.148	0.009	3.354	0.679	0.584	0.363
copepod	7.611	67.624	41.680	4.128	9.232	6.260	5.612	409.641	142.965	2.393	302.708	147.944	9.366	224.708	96.920	2.278	687.327	109.899	90.945	56.596
nauplii	0.796	3.947	2.985	1.144	3.200	1.838	0.271	13.102	4.867	0.260	10.540	4.205	0.269	14.068	3.302	0.151	76.378	13.177	5.063	3.150
appendicularia	0.000	0.000	0.000	0.025	0.070	0.050	0.009	1.004	0.429	0.016	0.206	0.085	0.017	0.342	0.154	0.007	0.419	0.087	0.134	0.084
cladocera	0.000	0.000	0.000	0.266	2.928	1.238	0.269	45.977	6.602	3.803	3.803	3.803	0.030	0.157	0.123	0.094	4.545	2.378	2.357	1.467
polychaeta	0.238	0.238	0.238	0.008	0.008	0.008	0.040	0.040	0.040	0.004	0.935	0.325	0.017	1.147	0.404	0.016	0.016	0.016	0.172	0.107
echinodermata	0.415	0.415	0.415	0.000	0.000	0.000	0.271	1.119	0.702	0.106	1.596	0.594	0.047	0.957	0.462	0.404	0.472	0.438	0.435	0.271
chaetognatha	1.054	1.949	1.857	1.494	7.367	5.144	0.226	31.198	10.609	0.396	14.959	5.602	0.661	30.023	10.557	0.203	37.208	4.186	6.326	3.937
jellies	2.842	2.842	2.842	0.043	0.793	0.388	0.056	32.714	7.991	0.024	16.368	5.772	0.022	0.409	0.167	0.019	17.709	4.760	3.653	2.274
malacostraca	1.663	26.896	25.318	2.387	24.875	12.238	0.484	417.046	123.733	0.226	230.418	73.543	0.458	50.373	19.294	1.491	25.931	12.228	44.392	27.626
Total	**12.490**	**102.929**	**57.032**	**18.929**	**37.903**	**26.357**	**19.108**	**845.942**	**137.836**	**7.296**	**485.217**	**134.862**	**24.555**	**255.310**	**137.275**	**10.027**	**755.302**	**112.977**	**101.057**	**100.000**
MesoZP	10.430	95.122	56.927	13.094	33.815	21.421	17.627	835.662	195.621	6.246	482.677	193.709	18.300	232.038	106.432	2.797	707.839	109.431	113.923	92.184
MicroZP	2.060	7.807	4.670	3.032	6.651	5.276	0.810	25.031	6.906	0.857	14.614	5.504	0.308	35.626	11.790	1.219	156.761	23.810	9.659	7.816

Table S6. Compilation of abundance and biomass estimates of different broad zooplankton groups over the North Sea and other temperate shelf seas.

Group	Taxa	Type	Estimates	Unit	Method, Mesh Size	Location	Area	Season	Reference
Microplankton									
	Diatoms	Abundance	80000.0	Ind L^{-1}	water sample	Stonehaven	North Sea	Autumn	Bresnan et al., 2015
	Diatoms	Abundance	129390.0	Ind L^{-1}	Time Series	Helgoland Roads	North Sea	Autumn	Yang et al., 2021
	Diatoms	Abundance	69767.0	Ind L^{-1}	water sample	Stonehaven	North Sea	Autumn	ICES, 2013
	Diatoms	Abundance	11628.0	Ind L^{-1}	water sample	Stonehaven	North Sea	winter	ICES, 2013
	Dinoflagellates	Abundance	950.0	Ind m^3	PUP net, 55µm	Buchan/Banks	North Sea	Autumn	This study
	Dinoflagellates	Abundance	2000.0	Ind L	Water sample	Stonehaven	North Sea	Autumn	Bresnan et al., 2015
	Dinoflagellates	Abundance	200000.0	Ind L	Time Series	Helgoland Roads	North Sea	Autumn	Yang et al., 2021
	Dinoflagellates	Abundance	1030.0	Ind m^3	PUP net, 55µm	Downs	North Sea	Winter	This study
	Dinoflagellates	Abundance	1123.8	Ind m^3	Water sample	Stonehaven	North Sea	Winter	Bresnan et al., 2015
	Tripos	Abundance	38080.0	Ind m^3	PUP net, 55µm	Buchan/Banks	North Sea	Autumn	This study
	Tripos	Abundance	1280.0	Ind m^3	PUP net, 55µm	Downs	North Sea	Autumn	This study
	Tripos	Abundance	600.0	Ind L	Time Series	Helgoland Roads	North Sea	Autumn	Yang et al., 2021
	Tinntinid	Abundance	4.2	Ind L^{-1}	PUP net, 55µm	Buchan/Banks	North Sea	Autumn	This study
	Tinntinid	Abundance	0.2	Ind L^{-1}	PUP net, 55µm	Downs	North Sea	Winter	This study
	Tinntinid	Abundance	4.6	Ind L^{-1}	Water sample	North Sea	North Sea	Winter	Bils et al., 2019
	Copepod nauplii	Abundance	5.5	Ind L	PUP net, 55µm	Buchan/Banks	North Sea	Autumn	This study
	Copepod nauplii	Abundance	4.0 - 20.0	Ind L^{-1}	Ring Net, 65 µm	Dove Station	North Sea	Autumn	Pitois et al., 2009
	Copepod nauplii	Abundance	3.8	Ind L^{-1}	PUP net, 55µm	Downs	North Sea	Winter	This study
	Copepod nauplii	Abundance	15.0 - 43.0	Ind L^{-1}	Ring Net, 65 µm	Dove Station	North Sea	Winter	Pitois et al., 2009
	Copepod nauplii	Biomass	0.8	mg C m^3	PUP net, 55µm	Buchan/Banks	North Sea	Autumn	This study
	Copepod nauplii	Biomass	0.6	mg C m^3	water sample	L4	North Sea	Autumn	Djeghri et al., 2018
	Copepod nauplii	Biomass	0.5	mg C m^3	PUP net, 55µm	Downs	North Sea	Winter	This study
	Copepod nauplii	Biomass	0.1	mg C m^3	water sample	L4	North Sea	Winter	Djeghri et al., 2018
	Total	Abundance	809.8	Ind L^{-1}	water sample	Buchan/Banks	North Sea	Autumn	This study
	Total	Abundance	64865.0	Ind L^{-1}	water sample	L4	North Sea	Autumn	ICES, 2013
	Total	Abundance	835.8	Ind L^{-1}	water sample	Downs	North Sea	winter	This study
	Total	Abundance	16216.0	Ind L^{-1}	water sample	L4	North Sea	winter	ICES, 2013
Mesozooplankton									
	Copepods	Abundance	685.0	Ind m^3	GULF V, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Copepods	Abundance	1831.1	Ind m^3	WP2, 200 µm	Stonehaven	North Sea	Autumn	ICES, 2013
	Copepods	Abundance	1143.0	Ind m^3	WP2, 200 µm	L4	North Sea	Autumn	Djeghri et al., 2018
	Copepods	Abundance	1098.3	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	Autumn	Morse et al., 2017
	Copepods	Abundance	346.0	Ind m^3	GULF V, 280 µm	Downs	North Sea	Winter	This study
	Copepods	Abundance	1500.0	Ind m^3	WP2, 200 µm	L4	North Sea	Winter	Eloire et al., 2010
	Copepods	Abundance	661.0	Ind m^3	WP2, 200 µm	L4	North Sea	Winter	Djeghri et al., 2018
	Copepods	Abundance	1500.0	Ind m^3	WP2, 200 µm	Belgium Coast	North Sea	annual ave.	Mortelmans et al., 2021
	Copepods	Abundance	281.4	Ind m^3	WP2, 200 µm	Stonehaven	North Sea	Winter	ICES, 2013
	Appendicularia	Abundance	17.4	Ind m^3	GULF V, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Appendicularia	Abundance	3.6	Ind m^3	GULF V, 280 µm	Downs	North Sea	Winter	This study
	Appendicularia	Abundance	24.9	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	annual mean	Kane, 2007
	Chaetognatha	Abundance	49.2	Ind m^3	GULF V, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Chaetognatha	Abundance	17.4	Ind m^3	GULF V, 280 µm	Downs	North Sea	Winter	This study
	Chaetognatha	Abundance	68.6	Ind m^3	WP2, 200 µm	Stonehaven	North Sea	Autumn	ICES, 2013
	Chaetognatha	Abundance	19.7	Ind m^3	WP2, 200 µm	L4	North Sea	winter	ICES, 2013
	Chaetognatha	Abundance	5.6	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	Autumn	Morse et al., 2017
	Chaetognatha	Abundance	29.7	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	annual mean	Kane, 2007
	Echinodermata larvae	Abundance	20.2	Ind m^3	GULF V, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Echinodermata larvae	Abundance	1.5	Ind m^3	GULF V, 280 µm	Downs	North Sea	Winter	This study
	Echinodermata larvae	Abundance	118.9	Ind m^3	WP2, 200 µm	L4	North Sea	Autumn	ICES, 2013
	Echinodermata larvae	Abundance	4.0	Ind m^3	WP2, 200 µm	L4	North Sea	Winter	ICES, 2013
	Echinodermata larvae	Abundance	5.3	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	Autumn	Morse et al., 2017
	Echinodermata larvae	Abundance	28.7	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	annual mean	Kane, 2007
	Gastropoda larvae	Abundance	5287.7	Ind m^3	GULF V, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Gastropoda larvae	Abundance	587.1	Ind m^3	GULF V, 280 µm	Downs	North Sea	Winter	This study
	Gastropoda larvae	Abundance	113.2	Ind m^3	WP2, 200 µm	L4	North Sea	Autumn	ICES, 2013
	Gastropoda larvae	Abundance	6.4	Ind m^3	WP2, 200 µm	L4	North Sea	Winter	ICES, 2013
	Gastropoda larvae	Abundance	2.6	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	Autumn	Morse et al., 2017
	Polychaeta	Abundance	6.8	Ind m^3	GULF V, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Polychaeta	Abundance	2.0	Ind m^3	GULF V, 280 µm	Downs	North Sea	Winter	This study
	Polychaeta	Abundance	0.8	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	Autumn	Morse et al., 2017
	Total	Abundance	902.0	Ind m^3	GULF VII, 280 µm	Buchan/Banks	North Sea	Autumn	This study
	Total	Abundance	4172.9	Ind m^3	WP2, 200 µm	L4	North Sea	Autumn	Eloire et al., 2010
	Total	Abundance	4800.0	Ind m^3	WP2, 200 µm	English Channel	North Sea	Autumn	ICES, 2013
	Total	Abundance	1239.0	Ind m^3	Bongo, 333 µm	Georges Bank	N Atlantic	Autumn	Morse et al., 2017
	Total	Abundance	354.9	Ind m^3	GULF VII, 280 µm	English Channel	North Sea	Winter	This study
	Total	Abundance	1500.0	Ind m^3	WP2, 200 µm	L4	North Sea	Winter	Eloire et al., 2010
	Total	Abundance	266.6	Ind m^3	GULF VII, 280	English Channel	North Sea	Winter	Dudeck et al., 2021

LITERATURE CITED

Bils F, Moyano M, Aberle N, van Damme CJG, Nash RDM, Kloppmann M, Loots C, Peck MA (2019) Broad-scale distribution of the winter protozooplankton community in the North Sea. J Sea Res 144:112–121.

Bresnan E, Cook KB, Hughes SL, Hay SJ, Smith K, Walsham P, Webster L (2015) Seasonality of the plankton community at an east and west coast monitoring site in Scottish waters. J Sea Res 105:16–29.

Djeghri N, Atkinson A, Fileman ES, Harmer RA, Widdicombe CE, McEvoy AJ, Cornwell L, Mayor DJ (2018) High prey-predator size ratios and unselective feeding in copepods: A seasonal comparison of five species with contrasting feeding modes. Prog Oceanogr 165:63–74.

Dudeck T, Rohlf N, Möllmann C, Hufnagl M (2021) Winter zooplankton dynamics in the English Channel and southern North Sea: Trends and drivers from 1991 to 2013. J Plankton Res 43:244–256.

Kane J (2007) Zooplankton abundance trends on Georges Bank, 1977-2004. ICES J Mar Sci 64: 909–919.

Kiørboe T (2013) Zooplankton body composition. Limnol Oceanogr 58:1843–1850.

Menden-Deuer S, Lessard EJ (2000) Carbon to volume relationships for dinoflagellates, diatoms, and other protist plankton. Limnol Oceanogr 45:569–579.

Morse RE, Friedland KD, Tommasi D, Stock C, Nye J (2017) Distinct zooplankton regime shift patterns across ecoregions of the U.S. Northeast continental shelf Large Marine Ecosystem. J Mar Syst 165:77–91.

Mortelmans J, Aubert A, Reubens J, Otero V, Deneudt K, Mees J (2021) Copepods (Crustacea: Copepoda) in the Belgian part of the North Sea: Trends, dynamics and anomalies. J Mar Syst 220:103558.

Pitois SG, Shaw M, Fox CJ, Frid CLJ (2009) A new fine-mesh zooplankton time series from the Dove sampling station (North Sea). J Plankton Res 31:337–343.

Saccà A (2016) A simple yet accurate method for the estimation of the biovolume of planktonic microorganisms. PLoS One 11.

O'Brien, T. D., Wiebe, P.H., and Falkenhaug, T. (Eds). 2013. ICES Zooplankton Status Report 2010/2011. ICES Cooperative Research Report No. 318. 208 pp.

Yang J, Löder MGJ, Wiltshire KH, Montagnes DJS (2021) Comparing the Trophic Impact of Microzooplankton during the Spring and Autumn Blooms in Temperate Waters. Estuar Coasts 44:189–198.