

## **8. Appendix III: SAHFOS/Irish Sea Pilot – Plankton Communities initial report.**

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### **Introduction and methods**

#### **Background**

Modelled data from POL (stratified days and salinity), has been used to define four draft broad scale water column units for JNCC. In this preliminary report, data from the Continuous Plankton Recorder (CPR) survey has been used to further characterise these broad scale water column units in terms of their plankton/nekton communities.

SAHFOS have conducted a short preliminary report specifically examining the following areas requested by JNCC:

- examine the key species for the four broadscale water column units and characterise these areas by their species assemblages.
- Produce gridded maps for the Irish Sea to ascertain areas of high productivity/diversity.
- Identify key features of the plankton communities important for management e.g productive areas, potential harmful algal bloom areas, non-indigenous species.

#### **Sampling by the Continuous Plankton Recorder**

The Continuous Plankton Recorder (CPR) survey provides a unique long-term dataset of plankton abundance in the North Atlantic and North Sea. The survey has been running for almost 70 years, using ‘ships of opportunity’ to tow CPRs on regular, and incidental routes, sampling at a depth of 10 m. Each sample represents 18 km of tow and approximately 3 m<sup>3</sup> of filtered seawater. Over 450 taxa of plankton are routinely identified by a team of taxonomists. CPRs have been towed for over 4 million nautical miles, accumulating almost 200,000 samples. The design of the CPR has remained virtually unchanged since sampling started, thus providing a consistency of sampling that provides good historical comparisons. By systematically monitoring the plankton over a period, changes in abundance and long term trends can be distinguished. From this baseline data, inferences can be made, particularly concerning climate change and potential anthropogenic impacts.

#### **Definition of areas examined**

Both draft water column units and CPR sampling coverage determined the four areas for this initial study. Area 1 encompasses a frontal boundary zone in Liverpool Bay,

between stratified and low salinity and stratified and high salinity waters. Area 2 is centred in an area of stratified and high salinity waters. Area 3 is in the central Irish Sea, and is characterised by mixed and high salinity water. To facilitate the examination of oceanic influences another southern area has been further defined, area 4 is at the southern entrance to the Irish Sea, an area of stratified and high salinity (figure 8.1).

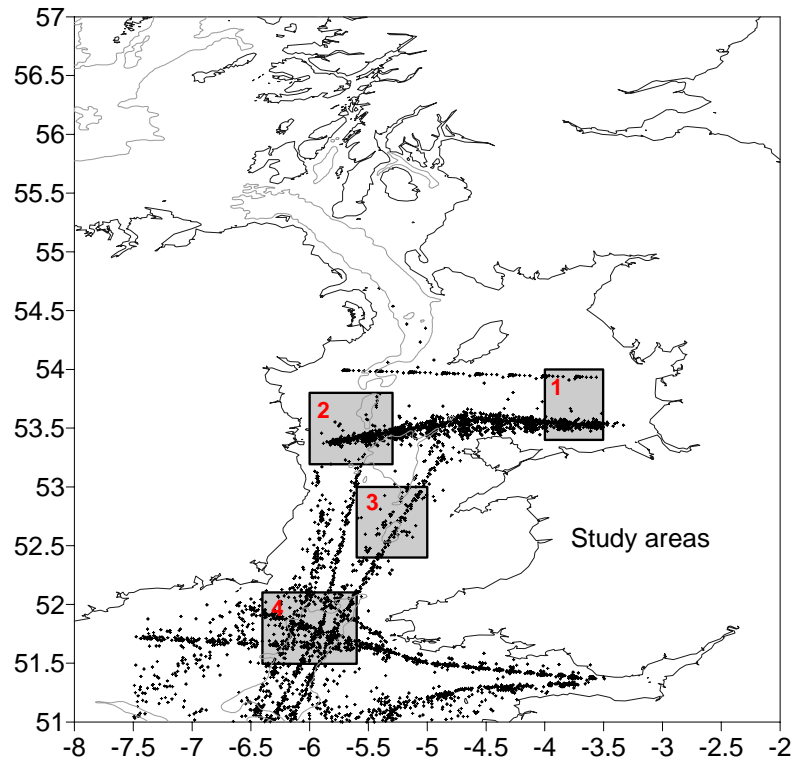


Figure 8.1: Map of the Irish Sea showing Continuous Plankton Recorder (CPR) samples and areas designated for the examination of plankton communities.

## 8.1. Results and discussion

### Key species and diversity

To address the question of what plankton species characterise the original areas chosen by Proudman Oceanographic Laboratory, community data from the CPR survey were analysed. Both the phytoplankton and zooplankton assemblage was analysed. For all four areas species/taxa were extracted based on their relative frequency of sampling, all species/taxa that have occurred over a frequency of 1% on CPR samples have been listed in tables 8.1 to 8.4.

### AREA 1

Dinoflagellates of the genus *Ceratium* are two of the most frequently sampled phytoplankters in area 1, with *C. fusus* (32.37%) being the most frequent, and *C. furca* (15.33%) the third most frequently recorded. The other three taxa in the top 5 most frequently recorded are all diatoms: *Thalassiosira* spp. (centric diatom, 15.67%), *Rhizosolenia imbrica shrubsolei* (pennate diatom, 12.95%) and *Chaetoceros* (*Phaeoceros*) (centric diatom, 12.78%). These are all ubiquitous phytoplankton taxa.

The phytoplankton community of area 1 has a number of taxa specific to it, that is they do not occur on over 1% of samples in the other 3 areas. These are all centric diatoms, *Eucampia zodiacus* (6.81%), *Skeletonema costatum* (3.07%), *Coscinodiscus wailesii* (2.73%), *Fragillaria* spp. (1.53%), *Bacteriastrum* spp. (1.19%), *Navicula* spp. (1.19%) and *Rhizosolenia fragilissima* (1.19%). This area also has the highest number of phytoplankton taxa occurring on >1% of samples.

In area 1, the most frequently recorded zooplankters are large (eyecount, greater than 6mm) chaetognaths (not speciated within the CPR survey), occurring on almost 50% of all samples. Three Calanoid copepods are in the top 5 most frequently sampled taxa, *Parapseudocalanus* spp. (47.7%), *Temora longicornis* (32.88%) and *Acartia* spp. (32.71%). The last taxa to complete the top 5 are decapoda larvae (47.02%).

As with the phytoplankton community, the zooplankton community of area 1 has a number of area – specific taxa. These are Mysidacea (3.75%), Caprellidea (1.87%), Cumacea (1.02%) and Harpacticoida (1.02%), taxa that are associated with neritic waters and are mainly benthic in ecology.

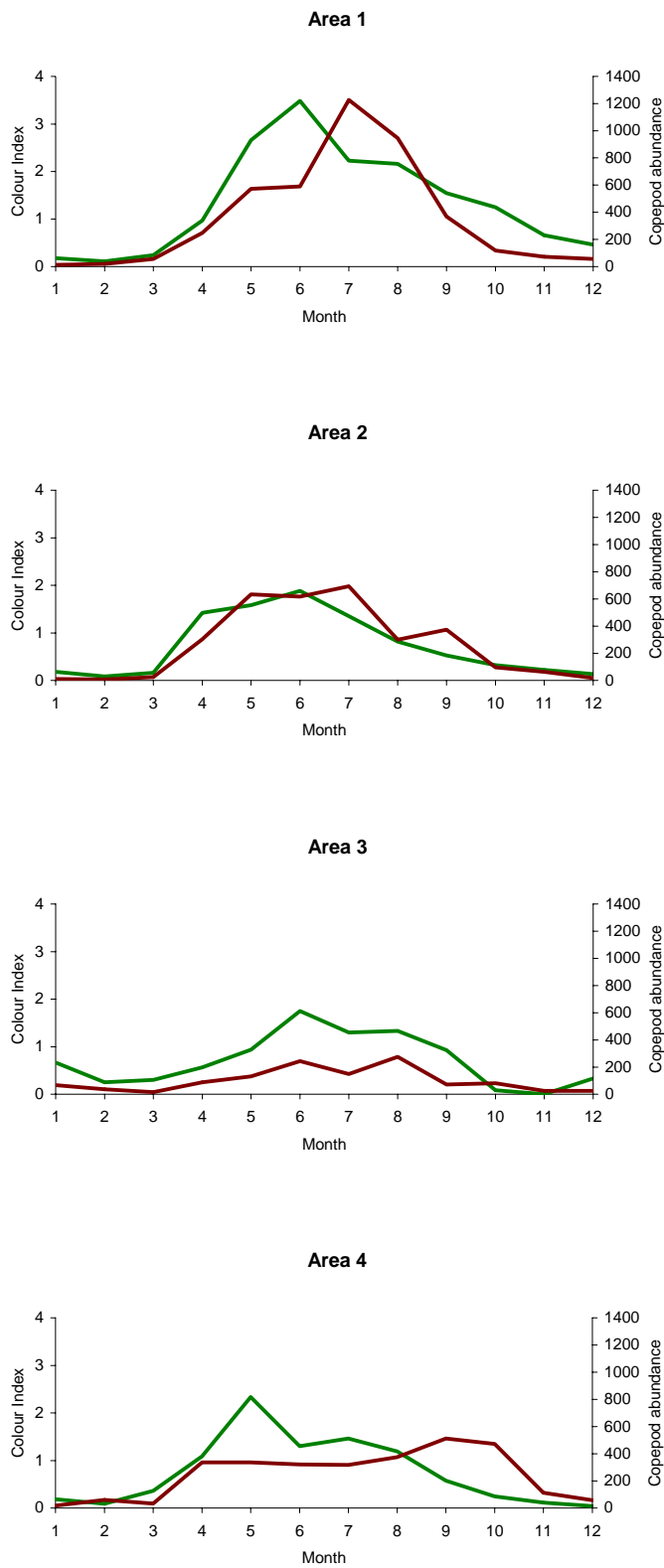


Figure 8.2: The seasonal cycles of phytoplankton colour (an assessment of phytoplankton biomass) (green) and total copepod abundance (brown) for all four areas.

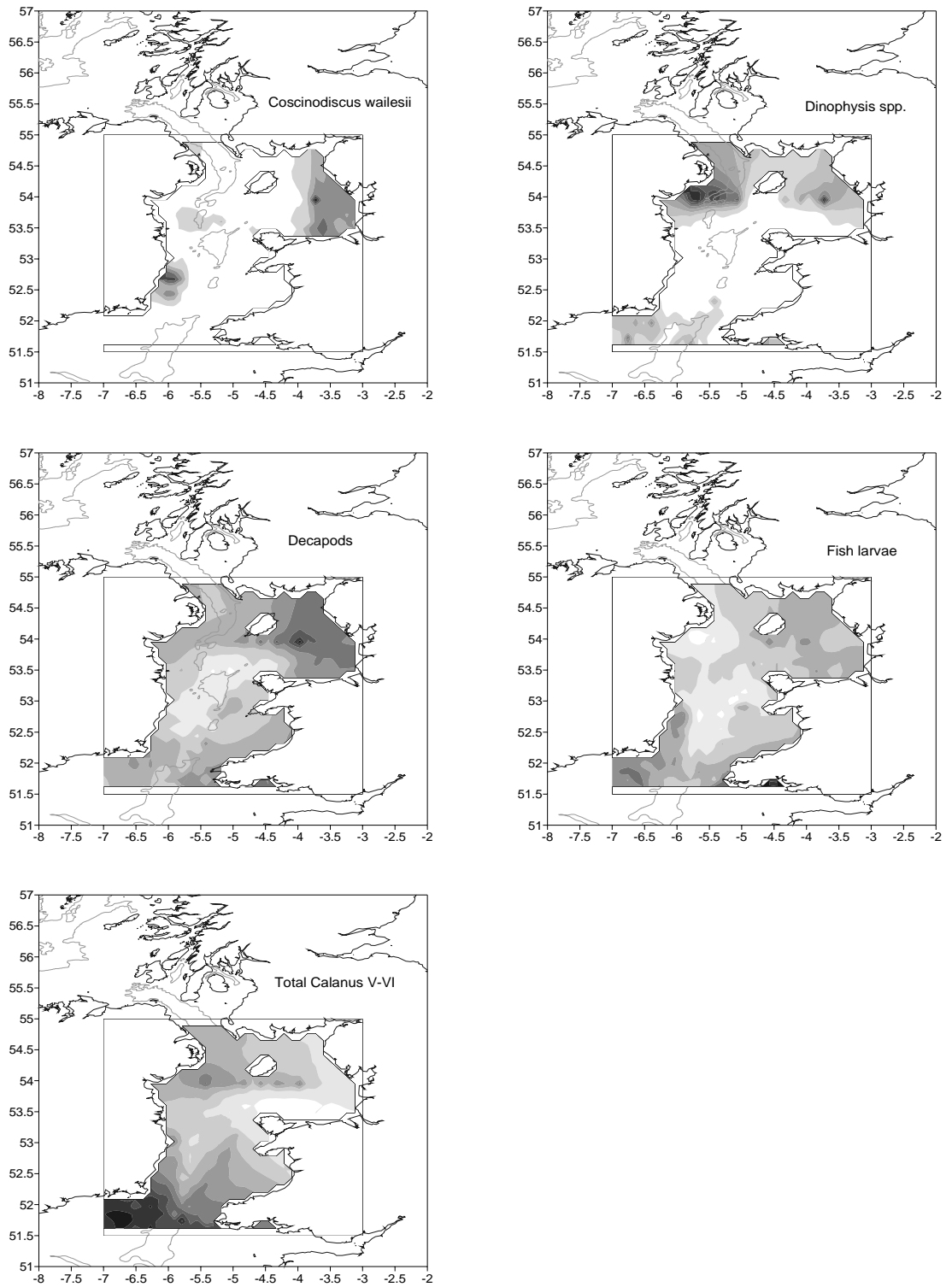


Figure 8.3: The spatial distribution and abundance of key ecological groups within the plankton in the Irish Sea: *Dinophysis* spp, *Coscinodiscus wailesii*, decapod larvae, fish larvae and Total *Calanus* spp.

## AREA 2

This area has fewer taxa recorded on >1% of samples, and in fact has the same 5 most frequently recorded phytoplankters as area 1: *Ceratium fusus* (19.08%), *Thalassiosira* spp. (17.98%), *Ceratium furca* (15.79%), *Chaetoceros* (*Hyalochaete*) spp. (11.4%) and *Rhizosolenia imbricata shrubsolei* (8.77%). The area contains no taxa that are area – specific on >1% of samples.

As in area 1, the top 5 most frequently recorded zooplankton taxa includes the Calanoid copepods *Para – pseudocalanus* spp (35.75%) and *Acartia* spp. (32.02%), as well as *Calanus* V-VI Total (32.89%). Decapoda larvae (32.89%) and *Chaetognatha* (eyecount, 30.26%). There are no area – specific taxa.

## AREA 3

This area has the fewest number of taxa recorded on >1% of samples. The 5 most frequently recorded phytoplankters are the diatoms *Rhizosolenia hebetata semispina* (pennate, 8.04%), *Thalassiosira* spp. (centric, 8.04%), *Bacillaria paxillifer* (centric, 6.25%) and *Chaetoceros* (*Phaeoceros*) (centric, 5.36%), and the dinoflagellate *Ceratium fusus* (7.14%). There are no area – specific taxa.

Area 3 has the Calanoid copepod groups *Calanus* V-VI Total (51.79%), *Calanus helgolandicus* (48.21%) and *Para – pseudocalanus* spp. (31.25%) as three of the most abundant taxa sampled. Decapoda larvae (44.64%) and *Chaetognatha* (eyecount, 28.57%) complete the top 5. Again, there are no area – specific taxa.

## AREA 4

This area has 4 diatoms in the top 5 most sampled, *Thalassiosira* spp. (20.59%), *Chaetoceros* (*Hyalochaete*) spp. (11.76%), *Rhizosolenia alata alata* (10.68%), *Rhizosolenia hebetata semispina* (10.68%) and 1 dinoflagellate, *Ceratium fusus* (15.02%). There are two area – specific taxa, *Coccolithaceae* (1.7%) and *Ceratium macroceros* (1.08%), the former being indicative of oceanic inflow.

The top 5 zooplankton taxa are as follows: *Calanus* V-VI Total (74.15%), *Calanus helgolandicus* (72.29%), *Para – pseudocalanus* spp. (43.65%), *Euphausiacea* (43.5%) and Decapoda larvae (42.57%). The large number of *Calanus* are indicative of oceanic influences, as is also the presence of the area – specific presence of *Radiolaria* (1.08%). Also area – specific area *Metridia* (traverse, 3.25%) and Echinoderm post – larvae (3.1%).

## **Community summary**

On examination of the 4 areas, it can be seen that diversity of the plankton community varies from area to area. Area 1 has the most diverse phytoplankton community, whereas area 4 has the most diverse zooplankton community, and both of these areas have considerably greater numbers of plankton taxa recorded on >1% of samples. It is apparent that a large number of planktonic organisms are endemic to more than one area. There are a number of area-specific organisms, both phytoplankton and zooplankton, found in the areas. Area 1 is highly indicative of neritic species with many area-specific diatom species and also the area has a high benthic component to the zooplankton assemblage (including such Crustacea as Mysidacea, Caprellidea and Cumacea). Areas 2 and 4 are indicative of higher salinity waters and have a numerous oceanic species within the plankton assemblage, Area 4 is particularly indicative of a more warmer and southerly assemblage.

## **Key features in terms of management**

Using the figures 2 and 3, areas have been defined in terms of their productivity and other ecological aspects. Figure 2 shows the annual cycle of phytoplankton colour (an assessment of total phytoplankton biomass) and the abundance of total number of copepods (an assessment of secondary biomass) for all the areas examined. Figure 3 shows the spatial distribution of key ecological groups within the plankton: Dinophysis spp is a representative of a Harmful Algal Bloom; *Coscinodiscus wailesii* is a representative of a non-indigenous species; decapod larvae is representative of the benthic component of the plankton assemblage (meroplankton); fish larvae are representatives of a higher trophic component in the plankton and Total Calanus spp. are one of the most important components of the zooplankton community (a principle food-source for higher trophic levels).

The area of highest phytoplankton biomass and zooplankton abundance is Area 1. Area 1 has a distinct maximum in copepod abundance along the Liverpool Bay front and nearly twice as much phytoplankton biomass as any other region in the Irish Sea. No distinct maximum in copepod abundance is evident along the western Irish Sea front, although it appears to be an important area for larger copepods such as Calanus spp. Throughout the Irish Sea, the peak in phytoplankton biomass occurs in June with the exception of Area 4 which occurs one month earlier. Area 4 is the most important area for Calanus populations and it is thought that most individuals of Calanus are advected into the Irish Sea from a reservoir stock in the Celtic Sea. An important aspect of the zooplankton of Areas 1 and 4 is that they contain the eggs and larvae of many commercially exploited fish species, predominately whiting and dab. It is also the area with the highest abundance of decapod larvae some of which are commercially exploited.

Area 1 seems to be an important area in the formation of Harmful Algal Blooms, the Liverpool Bay area is regularly an area of *Phaeocystis* bloom formation. In addition to *Phaeocystis*, two other species form exceptional blooms in this area. The dinoflagellate *Gyrodinium aureolum* produces 'red tides' and occurs in the inshore waters of south-east Liverpool Bay and the Solway Firth and the luminescent *Noctiluca scintillans* may also occasionally form blooms in this area. The red tides caused by *Gyrodinium aureolum* are of particular importance to the coastal manager

because they have been associated with invertebrate mortalities. As well as these aforementioned species *Dinophysis* spp. is also common in both Areas 1 and 2. *Dinophysis* spp. are associated with Diarrhetic Shellfish Poisoning. Of other note was the occurrence of *Cylindrotheca closterium* recorded in bloom proportions in Area 4 in 2001. Area 3 and other mixed central waters in the Irish Sea do not have any problems associated with Harmful Algal Blooms. In Area 1 and the east coast of Ireland, the non-indigenous diatom *Coscinodiscus wailesii* is an important member of the phytoplankton assemblage. This species was first recorded in UK coastal waters in the English Channel in 1977 (originating from the Pacific) and has subsequently spread into the Irish Sea.

This study forms the basis of a preliminary study of plankton communities in the Irish Sea. A more comprehensive study with detailed interpretation is needed to designate marine areas in a manner of those proposed by JNCC.

Table 8.2: All species/taxa that have occurred over a frequency of 1% on CPR samples I Area 1.

<b>Area 1</b>			
<b>Zooplankton</b>	<b>%</b>	<b>Phytoplankton</b>	<b>%</b>
Chaetognatha Eyecount	49.23	Ceratium fusus	32.37
Para-pseudocalanus spp	47.70	Thalassiosira spp	15.67
Decapoda larvae	47.02	Ceratium furca	15.33
Temora longicornis	32.88	Rhizosolenia imbrica shrubsolei	12.95
Acartia spp	32.71	Chaetoceros( Phaeoceros ) spp	12.78
Fish larvae	20.44	Odontella sinensis	12.78
Chaetognatha Traverse	20.27	Chaetoceros( Hyalochaete ) spp	10.05
Calanus V-VI Total	19.59	Rhizosolenia hebetata semispina	8.52
Calanus helgolandicus	15.50	Paralia sulcata	7.16
Euphausiacea Total	14.99	Thalassionema nitzschioides	6.98
Centropages hamatus	14.65	Ceratium horridum	6.81
Echinoderm larvae	12.95	Eucampia zodiacus	6.81
Pseudocalanus elongatus Adult	12.78	Noctiluca scintillans	6.47
Larvacea	12.61	Protoperidinium spp	5.11
Copepod nauplii	9.03	Nitzschia seriata	4.94
Euphausiacea Adult	8.18	Rhizosolenia delicatula	4.43
Calanus Total Traverse	7.67	Rhizosolenia styliformis	4.43
Cirripede larvae	6.64	Ceratium lineatum	4.09
Oithona spp	6.47	Nitzschia delicatissima	3.41
Calanus I-IV	6.13	Asterionella glacialis	3.24
Evadne spp	5.79	Rhizosolenia stolterfothii	3.07
Fish eggs	5.79	Skeletonema costatum	3.07
Calanus fin finmarchicus	4.94	Bacillaria paxillifer	2.90
Copepod eggs	4.94	Coscinodiscus wailesii	2.73
Polychaeta larvae	4.43	Ditylum brightwellii	2.39
Centropages typicus	3.75	Silicoflagellatae	2.21
Mysidacea	3.75	Ceratium longipes	2.04
Lamellibranchia larvae	3.58	Ceratium tripos	2.04
Podon spp	3.24	Cylindrotheca closterium	2.04
Euphausiacea Juvenile	3.07	Unidentified Coscinodiscus spp	1.87
Limacina retroversa	2.73	Fragilaria spp	1.53
Gammaridea	2.56	Dinoflagellate cysts	1.36
Tomopteris spp	2.21	Dinophysis spp	1.36
Caprellidea	1.87	Prorocentrum spp	1.36
Cyphonautes larvae	1.19	Bacteriastrum spp	1.19
Tintinnidae	1.19	Navicula spp	1.19
Cumacea	1.02	Rhizosolenia alata alata	1.19
Harpacticoida Total	1.02	Rhizosolenia fragilissima	1.19
Hyperiidia	1.02	Rhizosolenia setigera	1.19
		Gonyaulax spp	1.02
		Odontella aurita	1.02

Table 8.3: All species/taxa that have occurred over a frequency of 1% on CPR samples in Area 2.

<b>Area 2</b>			
<b>Zooplankton</b>	<b>%</b>	<b>Phytoplankton</b>	<b>%</b>
Para-pseudocalanus spp	35.75	Ceratium fusus	19.08
Calanus V-VI Total	32.89	Thalassiosira spp	17.98
Decapoda larvae	32.89	Ceratium furca	15.79
Acartia spp	32.02	Chaetoceros( Hyalochaete ) spp	11.40
Chaetognatha Eyecount	30.26	Rhizosolenia imbrica shrubsolei	8.77
Calanus helgolandicus	28.29	Thalassionema nitzschioides	7.46
Euphausiacea Total	24.34	Chaetoceros( Phaeoceros ) spp	5.92
Euphausiacea Adult	19.74	Ceratium horridum	5.70
Temora longicornis	17.76	Odontella sinensis	5.26
Fish larvae	15.35	Nitzschia seriata	4.82
Calanus Total Traverse	13.16	Rhizosolenia hebetata semispina	4.61
Echinoderm larvae	12.28	Ceratium lineatum	4.39
Pseudocalanus elongatus Adult	12.06	Protoperidinium spp	4.39
Oithona spp	11.40	Ceratium tripos	3.95
Calanus I-IV	10.75	Ceratium longipes	3.07
Calanus fin finmarchicus	10.31	Ditylum brightwellii	2.85
Larvacea	9.65	Paralia sulcata	2.85
Tomopteris spp	8.55	Rhizosolenia styliformis	2.63
Copepod nauplii	7.68	Asterionella glacialis	2.41
Chaetognatha Traverse	7.24	Silicoflagellatae	2.41
Evadne spp	5.92	Bacillaria paxillifer	1.97
Centropages hamatus	5.48	Rhizosolenia alata alata	1.97
Euphausiacea Juvenile	5.04	Lauderia borealis	1.75
Metridia lucens	4.17	Prorocentrum spp	1.54
Podon spp	4.17	Scrippsiella spp	1.32
Copepod eggs	3.73	Unidentified Coscinodiscus spp	1.32
Cirripede larvae	3.29	Noctiluca scintillans	1.10
Fish eggs	3.07	Rhizosolenia setigera	1.10
Cyphonautes larvae	2.63		
Tintinnidae	1.97		
Centropages typicus	1.75		
Lamellibranchia larvae	1.75		
Limacina retroversa	1.75		
Foraminifera	1.10		
Polychaeta larvae	1.10		

Table 8.4: All species/taxa that have occurred over a frequency of 1% on CPR samples in Area 3.

<b>Area 3</b>			
<b>Zooplankton</b>	<b>%</b>	<b>Phytoplankton</b>	<b>%</b>
Calanus V-VI Total	51.79	Rhizosolenia hebetata semispina	8.04
Calanus helgolandicus	48.21	Thalassiosira spp	8.04
Decapoda larvae	44.64	Ceratium fusus	7.14
Para-pseudocalanus spp	31.25	Bacillaria paxillifer	6.25
Chaetognatha Eyecount	28.57	Chaetoceros( Phaeoceros ) spp	5.36
Euphausiacea Total	27.68	Ceratium furca	4.46
Acartia spp	20.54	Ditylum brightwellii	4.46
Metridia lucens	18.75	Rhizosolenia alata alata	4.46
Calanus Total Traverse	11.61	Nitzschia delicatissima	3.57
Temora longicornis	11.61	Odontella sinensis	2.68
Fish larvae	10.71	Paralia sulcata	2.68
Calanus fin finmarchicus	9.82	Rhizosolenia imbrica shrubsolei	2.68
Pseudocalanus elongatus Adult	9.82	Thalassionema nitzschioides	2.68
Chaetognatha Traverse	8.04	Ceratium lineatum	1.79
Euphausiacea Adult	8.04	Protoperidinium spp	1.79
Larvacea	8.04	Rhizosolenia delicatula	1.79
Cirripede larvae	7.14	Rhizosolenia styliformis	1.79
Copepod nauplii	7.14		
Tomopteris spp	5.36		
Calanus I-IV	4.46		
Echinoderm larvae	4.46		
Euphausiacea Juvenile	4.46		
Limacina retroversa	4.46		
Centropages hamatus	3.57		
Centropages typicus	3.57		
Hyperiidia	3.57		
Oithona spp	3.57		
Candacia armata	2.68		
Copepod eggs	2.68		
Foraminifera	2.68		
Tintinnidae	2.68		
Evadne spp	1.79		

Table 8.5: All species/taxa that have occurred over a frequency of 1% on CPR samples in Area 4.

<b>Area 4</b>			
<b>Zooplankton</b>	<b>%</b>	<b>Phytoplankton</b>	<b>%</b>
Calanus V-VI Total	74.15	Thalassiosira spp	20.59
Calanus helgolandicus	72.29	Ceratium fusus	15.02
Para-pseudocalanus spp	43.65	Chaetoceros( Hyalochaete ) spp	11.76
Euphausiacea Total	43.50	Rhizosolenia alata alata	10.68
Decapoda larvae	42.57	Rhizosolenia hebetata semispina	10.68
Calanus Total Traverse	37.77	Thalassionema nitzschioides	10.06
Acartia spp	34.52	Protoperidinium spp	7.28
Chaetognatha Eyecount	34.37	Chaetoceros( Phaeoceros ) spp	6.97
Euphausiacea Adult	24.46	Ceratium lineatum	6.81
Metridia lucens	24.46	Ceratium tripos	6.50
Calanus I-IV	23.99	Nitzschia seriata	6.04
Fish larvae	18.73	Rhizosolenia imbrica shrubsolei	5.88
Echinoderm larvae	18.27	Nitzschia delicatissima	5.42
Euphausiacea Juvenile	17.80	Ceratium furca	5.26
Pseudocalanus elongatus Adult	14.24	Prorocentrum spp	4.64
Oithona spp	13.31	Asterionella glacialis	4.33
Centropages typicus	12.69	Ditylum brightwellii	3.87
Calanus fin finmarchicus	11.92	Rhizosolenia styliiformis	3.72
Copepod nauplii	11.61	Dinophysis spp	2.79
Limacina retroversa	10.06	Odontella sinensis	2.79
Chaetognatha Traverse	9.29	Paralia sulcata	2.32
Temora longicornis	9.29	Ceratium horridum	2.17
Larvacea	8.67	Scrippsiella spp	2.17
Tomopteris spp	5.57	Dinoflagellate cysts	2.01
Evadne spp	4.64	Rhizosolenia stolterfothii	2.01
Candacia armata	4.49	Coccolithaceae	1.70
Cirripede larvae	3.72	Lauderia borealis	1.70
Fish eggs	3.41	Bacillaria paxillifer	1.55
Hyperiid	3.41	Gonyaulax spp	1.55
Podon spp	3.41	Cylindrotheca closterium	1.39
Lamellibranchia larvae	3.25	Silicoflagellatae	1.39
Metridia Total Traverse	3.25	Ceratium macroceros	1.08
Echinoderm post-larvae	3.10		
Copepod eggs	2.94		
Tintinnidae	2.79		
Corycaeus spp	2.63		
Euphausiacea calyptopis	2.48		
Centropages hamatus	2.01		
Cyphonautes larvae	1.08		
Foraminifera	1.08		
Gammaridea	1.08		
Radiolaria	1.08		