eCOAST
MARINE RESEARCH

Development of hard substratum fauna in the Princess Amalia Wind Farm

Monitoring six years after construction

Thomas Vanagt and Marco Faasse

April 2014 – final

Vanagt T. and Faasse M.

Development of hard substratum fauna in the Princess Amalia Wind Farm.
Monitoring six years after construction.

eCOAST report 2013009

Commissioned by	Prinses Amaliawindpark
Status	final
Project number	2013009
Report number	2013009
Publication date	April 2014
Title	Development of hard substratum fauna in the Princess Amalia Wind Farm. Monitoring six years after construction.
Authors	Dr. T. Vanagt and Ir. Marco Faasse
Contributors	Koen Lock, Sietse Bouma (Bureau Waardenburg), Wals Diving
To be cited as	Vanagt T. and Faasse M. (2014). Development of hard substratum fauna in the Princess Amalia Wind Farm. Monitoring six years after construction. eCOAST report 2013009
Approved by	Dr. T.J. Vanagt – director
Checked by	Prof. Dr. J. Mees – director international development

Disclaimer

CONTENTS

Figures

Tables

Pictures

SUMMARY

As in 2011, four monopiles of the Princess Amalia Wind Farm were sampled for hard substratum fauna in 2013. At two sides of the monopiles, scrape samples were collected from the intertidal zone, at four different depths and from the scour protection stones. Additional video images were shot in order to assess the percentage cover of different species. While in 2011 the samples were taken at the end of autumn, the 2013 sampling took place in July.

A total of 88 species were recorded, four more than in 2011. The species-accumulation curves showed that for each depth level, a representative amount of species was found; however, taking samples at more depth levels would have significantly increased the species count. Most species were identified as crustaceans, polychaete worms, bryozoans or cnidarians. As for the 2011 study, large quantities of mussels were also found. This was again the dominant species in terms of biomass, except in the intertidal zone and on the scour protection stones. The most abundant species was the amphipod *Jassa herdmani*. Total density of fauna ranged between 142 and 1,5 million specimens per square meter (intertidal zone and depth 2m resp.), with up to 1,4 million amphipods. Densities were 3 to 10 times higher than in 2011. The highest biomass value was nearly 3 kg of ash-free dry weight per square meter. Biomass was similar to double the values found in 2011.

The fauna and flora could be divided into two distinct zones: the intertidal (here including the splash zone) and subtidal zone. The latter consisted of three different faunal groups: the shallow zone (2-10m), deep zone (17m) and the scour protection stones. No significant differences could be found between monopiles, nor between the different orientations.

The patterns in biodiversity, abundance and zonation of fauna are very similar to those found in 2011, and in comparison with other offshore wind farms in the region. The higher values of density and biomass compared to 2011 could indicate that the hard substratum community has matured, six years after the construction of the wind farm.

It is clear that the hard substratum, provided by the monopiles, creates new opportunities for a rich and valuable flora and fauna, previously absent from the area. This artificial reef results in a dramatic increase in biodiversity and especially biomass compared to the soft substratum which was present before the construction of the wind farm. The remarkable finding of a European flat oyster, a

species on the verge of extinction from the Southern North Sea, illustrates the potential role offshore wind farms could play in the revival of this species.

SAMENVATTING

Net als in 2011, werden in 2013 vier turbinepalen van het Prinses Amalia windmolenpark onderzocht op de aanwezigheid van fauna van harde substraten. Hiervoor werden op elke turbinepaal langs twee zijden schraapmonsters genomen in de intergetijdenzone, op vier verschillende dieptes en op de stortstenen. Daarnaast werden videobeelden verzameld op de bedekkingsgraad van diverse fauna en flora in te kunnen schatten. In tegenstelling tot in 2011, toen de monstername in het late najaar is gebeurd, vond de monstername in 2013 plaats in Juli.

In totaal werden 87 soorten geïdentificeerd, dit is één meer dan in 2011. Op basis van de soort-accumulatiecurves kan gesteld worden dat per diepteniveau een representatief beeld van de voorkomende fauna is verzameld; echter, monsteren op meer dieptes zou een significant hoger aantal soorten opleveren. De belangrijkste soorten behoorden tot de schaaldieren, borstelwormen, neteldieren en mosdiertjes. Net als in 2011 waren daarnaast ook nu weer grote hoeveelheden mosselen aanwezig. Deze soort was dan ook dominant qua biomassa, behalve in de intergetijdenzone en op de stortstenen. De meest abundante soort was de vlokreeft *Jassa herdmani*. De maximale totale dichtheid van fauna per monster bedroeg maar liefst anderhalf miljoen diertjes per vierkante meter, waarvan 1,4 miljoen vlokreeften (op diepte 2 meter). Dichtheden lagen 3 tot 10x hoger dan in 2011. De maximaal gevonden biomassa bedroeg bijna 3kg asvrij drooggewicht per vierkante meter. De biomassa was tot dubbel zo hoog als in 2011.

De fauna en flora kan opgedeeld worden in twee duidelijke verschillende zones: de intergetijden (hier inclusief de supralittorale) zone en de subtidale of sublittorale zone. Binnen deze laatste konden nogmaals drie klassen onderscheiden worden: de ondiepe monsters (2-10m), de diepe monsters (17m) en de stortstenen. Significante verschillen in fauna tussen de verschillende turbinepalen, of tussen verschillende oriëntaties werden niet gevonden.

De patronen qua biodiversiteit, abundantie en zonering komen erg overeen met de resultaten uit 2011 en in vergelijking met andere offshore windmolenparken in de regio. De hogere dichtheden en biomassa t.o.v. 2011 zouden erop kunnen wijzen dat de hard substraat fauna zes jaar na de constructie van het windmolenpark een volwassen samenstelling heeft bereikt. Het is duidelijk dat het harde substraat wat de turbinepalen aanreiken, een volledig nieuwe en waardevolle flora en fauna een

kans biedt te ontwikkelen tot een kunstmatig rif. Dit kunstmatige rif voegt een zeer grote toename aan biodiversiteit maar vooral biomassa toe aan het voorheen uitsluitend zacht substraat. De opmerkelijke vondst van de platte oester illustreert hoe windmolenparken een rol kunnen spelen bij de heropbouw van deze op de Noordzee bijna uitgestorven soort.

1. INTRODUCTION

As part of the Monitoring- and Evaluation Program (MEP) of the Princess Amalia Wind Farm (PAWP) a number of research topics were identified. One of these topics was to follow the development of epifauna on the hard substratum of the monopiles and the scour protection. The hypothesis is that the foundation piles of the wind turbines will serve as an artificial reef, attracting hard substratum epifaunal species to an area which previously only consisted of soft sandy sediments. This hypothesis was confirmed during the T4 monitoring in 2011: the structures were colonised by a variety of sessile organisms such as algae, mussels, barnacles, anemones, hydroids and bryozoans (Vanagt *et al*, 2013). This rich sessile community attracted mobile organisms such as small Crustacea, small Polychaeta, sea urchins, starfish, crabs and fish. A comparison between the hard and soft sediment benthos in the Amalia Wind Farm showed that only two species were found in common, indicating the formation of a hard substratum community that is totally different from the soft substratum communities previously present.

In the present study, the same four turbines that were monitored in 2011 (T4), were sampled in 2013 (T6) for hard substratum fauna, in order to assess the further development of the epifauna in the wind farm and to evaluate the artificial reef potential of the wind farm.

1.1 Princess Amalia Wind Farm

The Princess Amalia Wind Farm is the second offshore wind farm in the Dutch sector of the North Sea and the first to be located outside the 12 nautical mile limit. PAWP is located in Block Q7 of the DCS (Dutch Continental Shelf), at a distance of 23 to 26.4 km from the shore (IJmuiden, The Netherlands; Figure 1), and a water depth of 19 to 24 m. A total of 60 monopiles (diameter 4.0 m) are placed in an area of 14 km², with a minimum distance of 550 m between the turbines. The farm has an annual power production of 435 GWh.

The installation of the foundations and transition pieces took place between October 2006 and May 2007. Foundations measuring 54 metres in length, 4m in diameter and weighing 320 tons were sunk into the sea-floor. The transition pieces, weighing 115-tons, were placed on the foundations using the Jumping Jack. To support the turbine foundations, a 15 m diameter scour protection consisting of mixed size rocks was deposited on the soft sediment around the base of each monopile. Cables and wind turbines were installed from May 2007 to April 2008. The wind farm has been operational since July 2008.

All monopiles have a cathodic corrosion protection. The transition pieces have been painted during construction with two layers. The first layer consists of "Hempel's high protect 35650", a two-component epoxy paint. The outer layer consists of "Hempathane topcoat BS 381C356 55214", a two-component polyurethane paint. Both layers provide a very hard coating. Neither of the paint brands used has anti-fouling properties. Monopiles have not been cleaned in the period from installation up to and including the last monitoring survey.

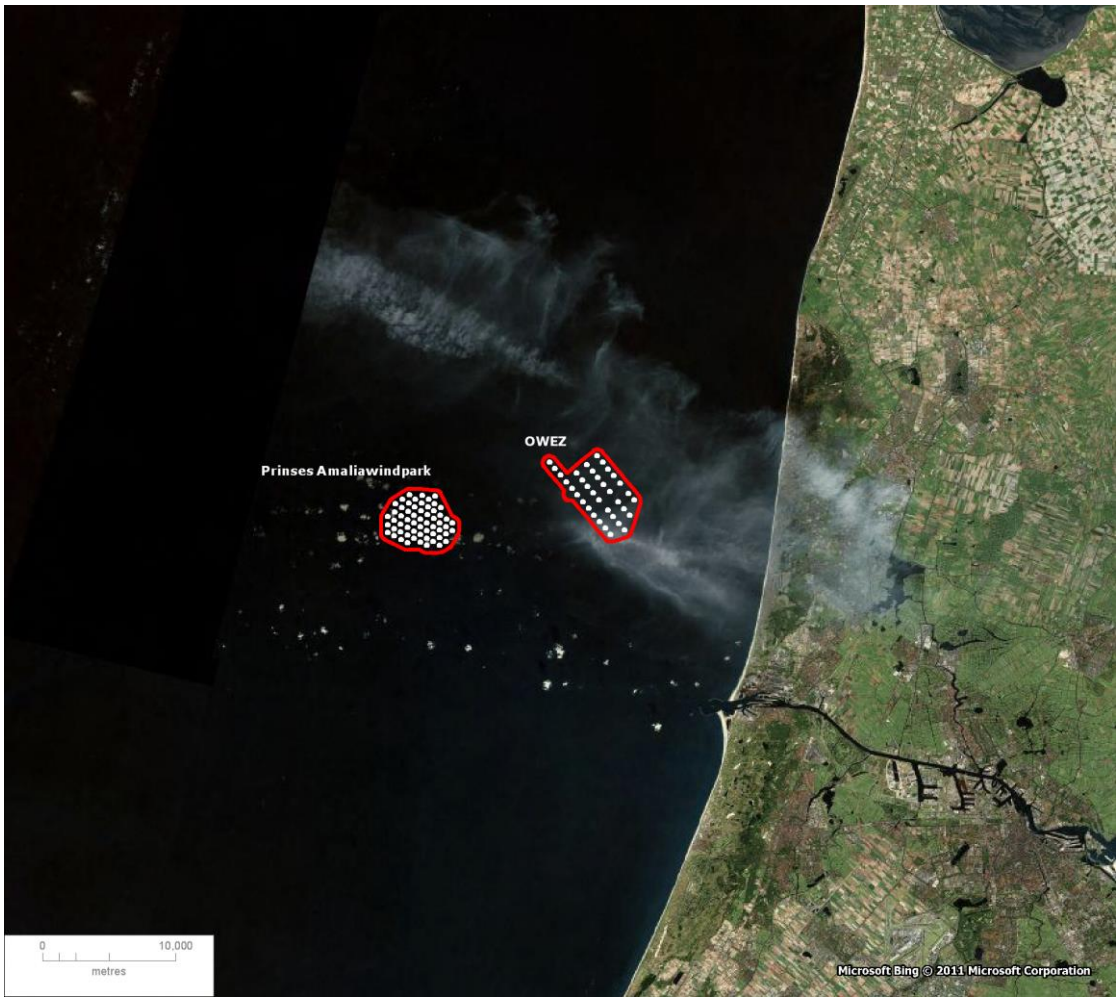


Figure 1: Location of the Princess Amalia Wind Farm off the Dutch Coast, some 23km off the coast of Ijmuiden

1.2 Objectives

The aims of this study were to investigate the development of hard substratum fauna in the Princess Amalia Wind Farm, six years after construction, and to evaluate the potential of the monopiles and scour protection to serve as an artificial reef.

2. MATERIAL AND METHODS

For the sampling of the hard substratum in PAWP, two methods were used: a qualitative method, using video footage, and a quantitative method, using scrape samples. For both methods, professional divers were deployed. An ecologist on board the 'Zeeland' vessel guided the divers using live-feed video and audio communication.

The sampling was conducted by divers of Wals Diving & Marine Service. Four wind turbine generators (WTG) were sampled during two days (Figure 2):

Table 1: Information on sampled WTG's

WTG no.	Placement monopile	construction WTG finished	sampling dates T4	sampling dates T6	Tide T4 and T6 sampling
1	23/01/2007	24/04/2008	28/10/2011	22/07/2013	High tide
20	21/11/2006	30/05/2008	28/10/2011	22/07/2013	Low tide
45	28/03/2007	06/05/2008	29/10/2011	23/07/2013	High tide
60	05/02/2007	28/04/2008	29/10/2011	23/07/2013	Low tide

These monopiles were selected to cover both the edges and the core of the wind farm, and to sample the North-South direction. To ensure optimal diving and sampling conditions, the dives were performed at slack tide.

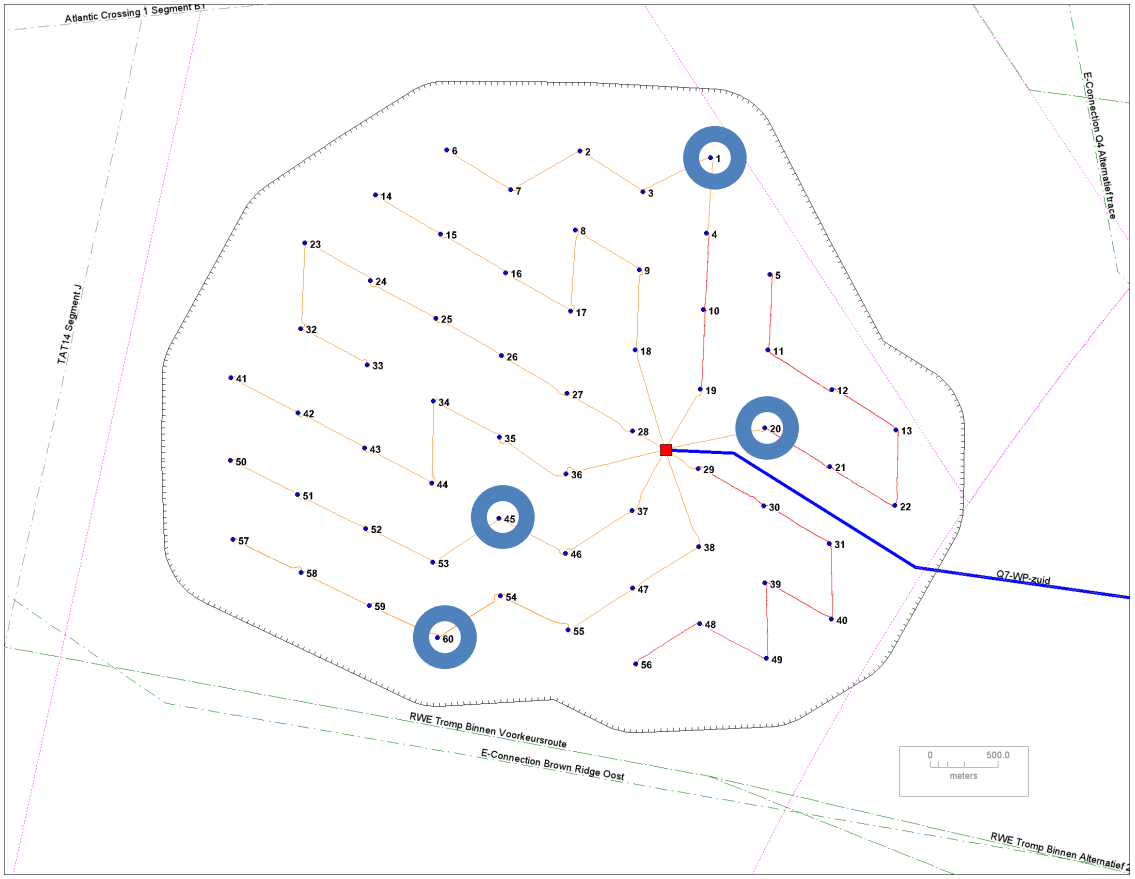


Figure 2: Map of the Princess Amalia Wind Farm indicating sampled monopiles

2.1 Sample collection

2.1.1 Video footage

Video footage of the monopiles and scour protection rocks provide a wider picture of the percentage cover of sessile epifaunal over the entire turbine foundation. Moreover, it provides more information on mobile fauna that is not collected in the scrape samples.

Video footage was taken during collection of the scrape samples. Video images were made using a HD headcam, operated by the diver. Depending on visibility, a distance of 50-100 cm from the monopile was respected.

Table 2: Video footage taken by divers. Some transects were not or partially filmed due to the strong current.

WTG	Video type	diver	not filmed
20	sampling	Bart	
20	transect SSW	Jeff	
20	transect NNE	Jeff	upper half not filmed
1	sampling	Peter	
1	transect NNE	Daan	
1	transect SSW		not filmed
60	sampling	Jeff	
60	transect SSW	Bart	
60	transect NNE	Bart	
45	sampling	Daan	
45	transect NNE	Peter	
45	transect SSW		not filmed

A different diver filmed a transect of the monopile and part of the scour protection. At each monopile two vertical video transects were made (SSW and NNE), from the surface to the seafloor (Table 2). The scour protection was also filmed on each side of the monopile. The diver descended slowly onto the scour protection and, having filmed the scour protection, ascended slowly along a transect on the opposite side, currents permitting. Filming of one transect took, on average, 10-15 minutes.

2.1.2 Scrape samples

Scrape samples were collected at five different depths (intertidal zone, 2, 5, 10 and 17 m depth) and at both sides of the monopile (NNE and SSW). In order to facilitate comparison of samples taken at different times according to the tidal level, sample depth was chosen relative to a fixed elevation (NAP). The NNE and SSW sides were chosen to sample sunlit as well as shadowed sides and sides receiving the ebb current as well as sides receiving the flood current. Differences, if any exist, would be expected between these two orientations. The intertidal zone is here the wet zone that is not permanently inundated (i.e. the strictly intertidal zone and the higher zone that receives wave splash). At each depth a sample surface of 28 cm x 20 cm was selected, and the marine growth was scraped off the monopile with a putty-knife, collecting the material in a specially designed fine-maze net (mesh size

0.25 mm). On board the ship each scrape sample was stored separately in a sample container and fixated with a buffered 5% formaldehyde solution.

Samples of the organisms present on the rocks of the scour protection were obtained via collection of several small rocks. These rocks were brought to the surface where they were stored and fixated in the same way as the scrape samples.

All samples were taken to the laboratory for further analyses.

2.2 Laboratory analyses

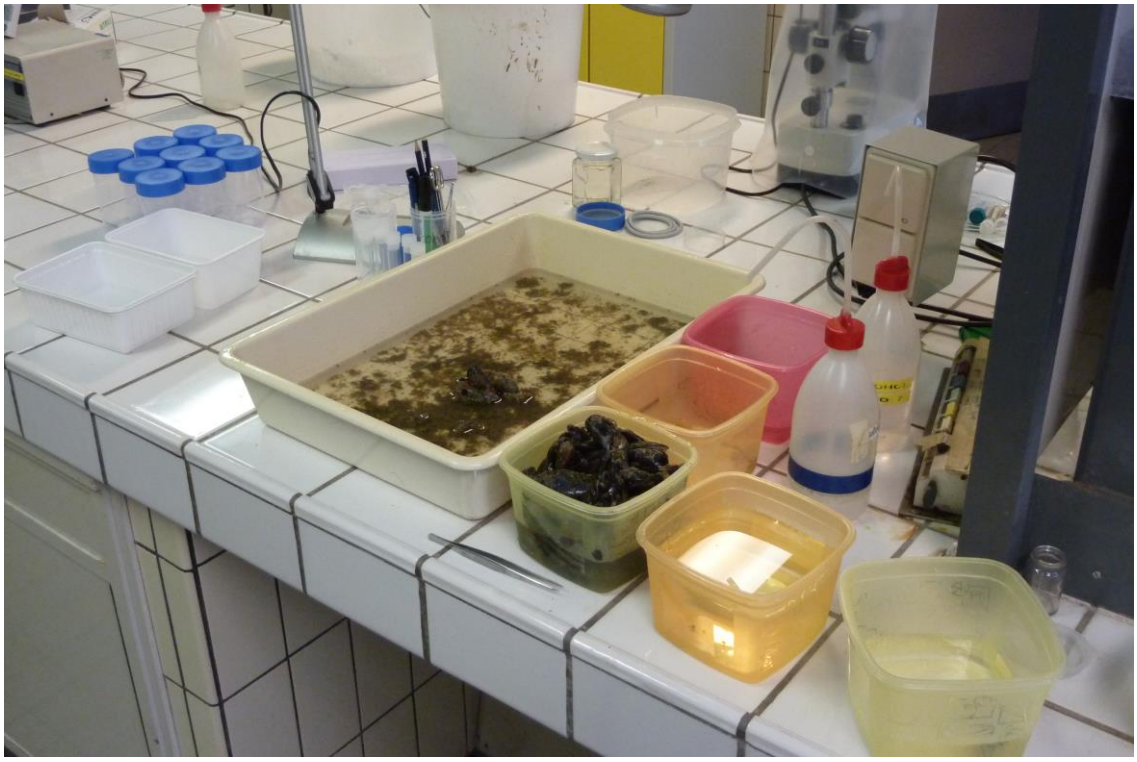
2.2.1 Video analysis

Percentages cover of different species were estimated from video footage taken at depths 17, 10, 5 and 2m during sampling. Percentage cover was estimated in 10% classes; differences of 5% were used to indicate slight differences observed. Additional videos of transects were used to supplement these estimates because quality of these videos was generally better due to less movements of the diver.

2.2.2 Scrape samples

Sorting

In the laboratory the collected samples were sieved on a 0.5 and 1mm mesh-size sieve, and sorted on higher taxon level. The fractions >1mm and 0.5-1 mm were analyzed separately: all 1mm fractions were analyzed, the smaller fraction was used for reference only. From this step onward, samples were preserved in 70% ethanol.



Picture 1: Sorting of a sample in the laboratory

Identification

All organisms present were identified to species level wherever possible, and counted. Identification was performed with a binocular microscope and based on the most recent systematic literature. For nomenclature and taxonomy the World Register of Marine Species (WoRMS) (http://www.marinespecies.org/) was followed.

Species of the genera *Jassa* and *Monocorophium* were present in very high densities in most samples. To assess presence of the different species within these genera, subsampling was performed: depending on the total sample volume it was divided in four once or several times, specimens were counted, and 25 random specimens of the subsample were identified to species level.

Biomass

An alternative means of biomass determination was used compared to the 2011 campaign to comply with new health and safety regulations.[1] Biomass was assessed using wet weights (instead of direct ash-free dry weight measurements). This method is equally accepted by the National Marine Biological Analytical Quality Controle Scheme (NMBAQCS) for biomass determination of benthic samples and has been proposed as the preferred method.

Biomasses were determined for all species except Algae, Hydrozoa and Bryozoa[2]. Wet weight (WW) was determined on a lab balance for larger species-samples (mostly large mussels, anemones and echinoderms) and on an analytical balance for most of the smaller species. Ash-free dry weight (AFDW) was calculated from wet weight with specific AFDW/WW conversion factors. For mussels a conversion factor from wet weight including shells was used. For a number of small species (mainly amphipods), an assigned value was used.

2.3 Data-analyses

Density and biomass data were standardised to the number of individuals per m^2 (ind./m^2) and ash-free dry weight per m^2 (AFDW/m^2), respectively. Density data for colony-forming species, such as Bryozoa and Hydrozoa, were counted as one ind./m^2 in the quantitative analyses. The coverage of these species was included in the qualitative analysis.

Density, biomass and diversity were calculated for each sample, the latter based on various diversity indices (Shannon-Wiener, Pielou's evenness and Simpson index[3]).

Multivariate analyses were carried out with the Primer v6 program (Clarke & Gorley, 2006). Prior to analyses the data were fourth-root transformed. Bray-Curtis similarity matrices were used to build up non-metric multidimensional scaling (MDS) plots. MDS plots provide information on relationships between data points.

[1] In accordance with health and safety regulations, the incineration of formaldehyde-preserved samples is no longer permitted.
[2] Biomass determination of these taxa is very difficult
[3] **Shannon-Wiener** is a general biodiversity measure. The lower the number, the lower the biodiversity; **Pielou's evenness** calculates the relative occurrence of species and is a measure for how evenly distributed different species are. The lower the value, the more dominant one species is; **Simpson index** determines the probability two random specimens of one sample belong to the same species. The lower the value, the higher the diversity.

SIMPER analyses detect which species contribute to the distance between certain communities (dissimilarity percentage) and the clustering in a community (similarity percentage). ANOSIM analyses (Analysis of Similarities) were performed to determine significant differences ($p<0.05$) between groups (nested and crossed designs, using the following four grouping variables: year, depth, WTG and orientation). Cluster diagrams, using group average clustering, were constructed using the same grouping variables.

3. RESULTS

3.1 Sampling conditions

Both sampling days were characterized by very good weather conditions. Meteorological conditions were perfect, with 100% sunshine, 25° C, almost no wind (wind force 1-3 Bf NNE) and a flat sea (wave height less than 0.5m). All samplings were carried out during daylight hours (Table 3). Sampling of the scour protection stones was not always possible, because at some locations no loose stones could be located within the limited time available for each dive.

Table 3: Overview of samples, sample depths, orientation and time of sampling; NR = not recorded; water level in reference to NAP

WTG	Date	Depth (m)	Turbine Scour Intertidal	Orientation	Time	Water level
20	22/07/2013	21	Scour	SSW	13:16	-56cm
	22/07/2013	17	Turbine	SSW	13:32	
	22/07/2013	17	Turbine	NNE	13:38	
	22/07/2013	10	Turbine	SSW	13:45	
	22/07/2013	10	Turbine	NNE	13:51	
	22/07/2013	5	Turbine	SSW	14:03	
	22/07/2013	5	Turbine	NNE	14:11	
	22/07/2013	2	Turbine	SSW	14:14	
	22/07/2013	2	Turbine	NNE	14:17	-36cm
	22/07/2013	0	Intertidal	SSW	NR	
	22/07/2013	0	Intertidal	NNE	NR	

WTG	Date	Depth (m)	Turbine Scour Intertidal	Orientation	Time	Water level
1	22/07/2013	23	Scour	NNE	19:00	17cm
	22/07/2013	17	Turbine	NNE	19:19	
	22/07/2013	17	Turbine	SSW	19:21	
	22/07/2013	10	Turbine	NNE	19:25	
	22/07/2013	10	Turbine	SSW	19:36	
	22/07/2013	5	Turbine	NNE	19:41	
	22/07/2013	5	Turbine	SSW	19:45	
	22/07/2013	2	Turbine	NNE	19:55	
	22/07/2013	2	Turbine	SSW	19:59	-6cm
	22/07/2013	0	Intertidal	NNE	NR	
	22/07/2013	0	Intertidal	SSW	NR	
60	23/07/2013	0	Intertidal	SSW	12:50	-57cm
	23/07/2013	0	Intertidal	NNE	NR	
	23/07/2013	23,5	Scour	SSW	13:30	
	23/07/2013	17	Turbine	SSW	13:40	
	23/07/2013	17	Turbine	NNE	13:43	
	23/07/2013	10	Turbine	SSW	13:46	
	23/07/2013	10	Turbine	NNE	13:48	
	23/07/2013	5	Turbine	SSW	13:53	
	23/07/2013	5	Turbine	NNE	13:56	
	23/07/2013	2	Turbine	SSW	13:59	
	23/07/2013	2	Turbine	NNE	14:02	-57cm
45	23/07/2013	0	Intertidal	NNE	NR	
	23/07/2013	0	Intertidal	SSW	NR	
	23/07/2013	24,5	Scour	NNE	19:50	8cm
	23/07/2013	24,5	Scour	SSW	19:57	
	23/07/2013	17	Turbine	NNE	20:04	
	23/07/2013	17	Turbine	SSW	20:08	
	23/07/2013	10	Turbine	NNE	20:16	
	23/07/2013	10	Turbine	SSW	20:20	
	23/07/2013	5	Turbine	NNE	20:30	
	23/07/2013	5	Turbine	SSW	20:33	
	23/07/2013	2	Turbine	NNE	20:36	
	23/07/2013	2	Turbine	SSW	20:39	-11cm

3.2 General diversity – species composition

During the sampling period in July 2013, a total of 88 species were identified on the offshore turbine foundation and the scour protection rocks. The full species list can be found in Annex 1. 86 species were identified in the scrape samples (>1mm), an additional two species were recorded by studying the video footage. Species belonged to 12 phyla, but the fauna was dominated by the following four phyla: Crustacea (Amphipoda, Decapoda, Cirripedia and Isopoda), Annelida, Bryozoa and Cnidaria (Hydrozoa, Anthozoa).

A 'species accumulation curve' was used to examine if the amount of analysed samples was sufficient to obtain a representative picture of the biodiversity present (Figure 3). In Figure 4, the same graphs are shown, but this time per depth group. For each depth group, the number of species comes close to an asymptotic value, indicating that the sampling effort per depth stratum was sufficient. The estimated total number of species, using Bootstrapping, is 99, compared to the 86 observed species in the scrape samples. Thus, 86% of the total species that one could expect were effectively observed.

However, none of the WTG curves (Figure 3) come close to an asymptotic value. It seems that collecting more samples per WTG, at different depth levels, could significantly increase the number of species found.

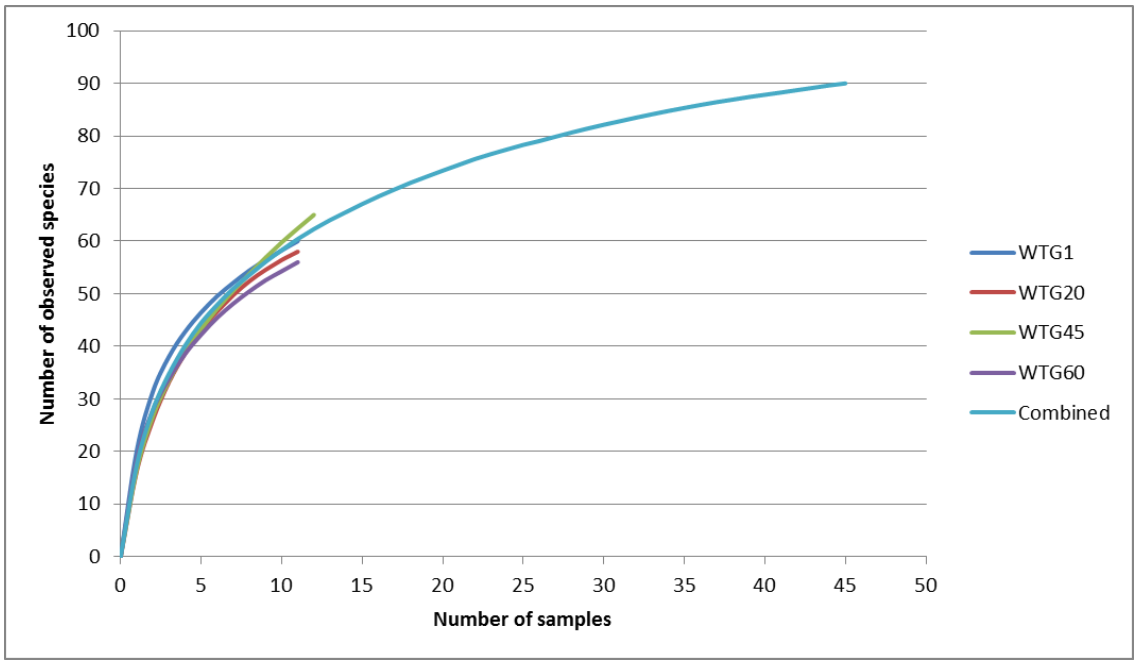


Figure 3: Observed number of species in relation to the number of samples, per WTG and for all samples combined.

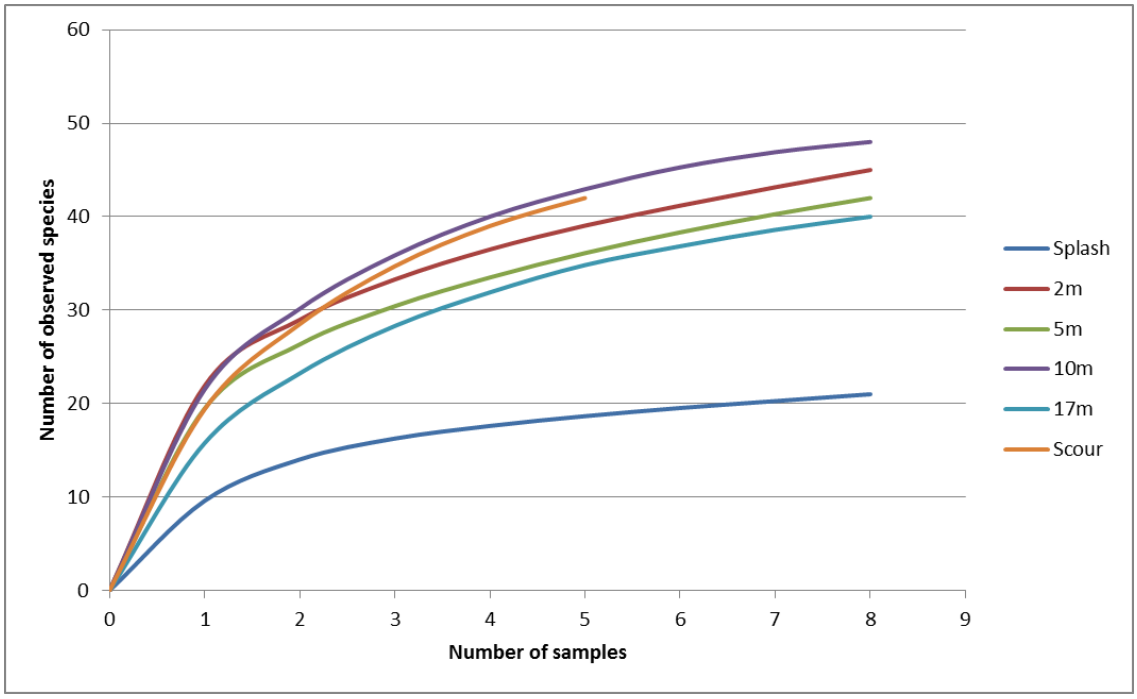


Figure 4: Observed number of species in relation to the number of samples, per depth group

3.3 Depth zones

3.3.1 Univariate analyses

The number of species found in the scrape samples was highest at depth 10m and lowest in the intertidal zone (resp. 48 and 21). The mean number of species in the subtidal scrape samples and scour rocks varied between 16 and 22 species; the average species count per sample in the intertidal zone was 10 (Table 4).

The generally low biodiversity indices (Pielou's Evenness, Shannon-Wiener Index and Simpson Index) indicate a clear dominance of one species. The very low Evenness values at depths 2 – 10m are due to the high dominance of *Jassa herdmani*.

Table 4: Biodiversity parameters of the different depth groups.

sample depth	# samples	number of species			Pielou's Evenness	Shannon-Wiener Index	Simpson Index (1-Lambda)
		total	mean	St. Dev			
Intertidal	8	21	10	5	0,3797	1,156	0,5817
2	8	45	22	3	0,1704	0,6488	0,2958
5	8	42	20	5	0,1279	0,4782	0,1863
10	8	48	22	4	0,1355	0,5246	0,236
17	8	40	16	7	0,2448	0,9032	0,4296
Scour	5	42	19	8	0,3222	1,204	0,4644

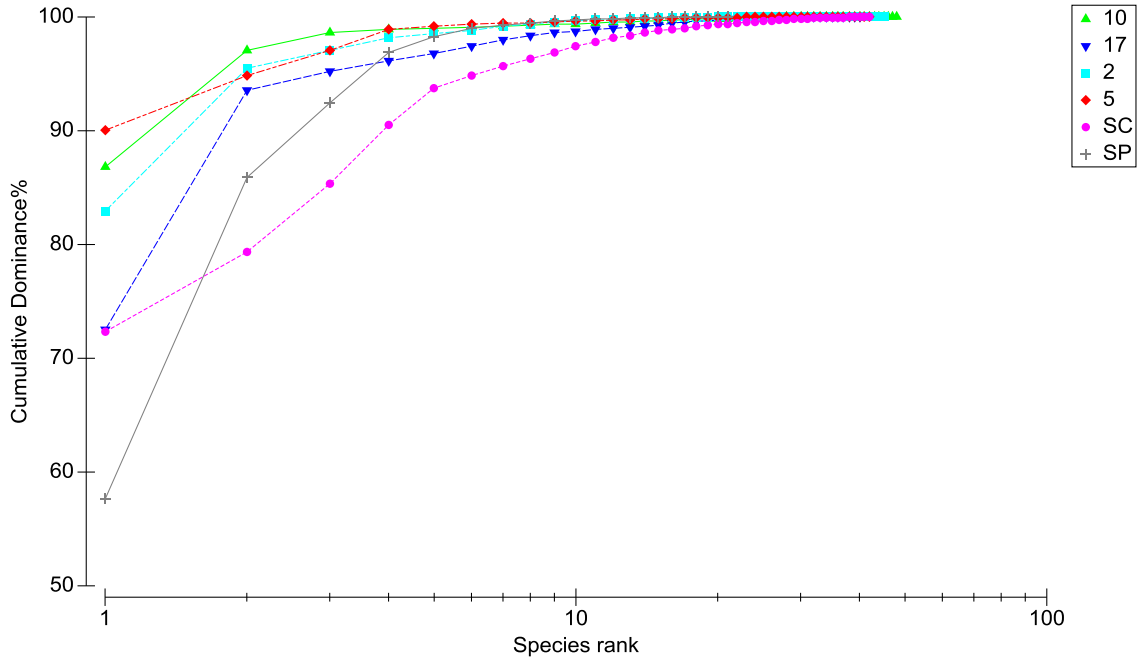


Figure 5: Dominance plot per depth level

This is confirmed in the dominance plot (Figure 5), in which it is clear that for depth levels 2, 5 and 10, more than 80% of specimens belong to a single species. In contrast, the intertidal zone is dominated by two species: *Jassa marmorata* and *Idotea pelagica* (combined contribution of 85%).

The highest density values were found at depths 2, 5 and 10m (Table 5). The difference between the intertidal zone and the 2m zone is striking: a factor 10. Although the density at depth 17m is notably lower than at depths 2, 5 and 10m, this depth level shows the highest biomass values, together with depth 2m. At

depths 2, 5 and 10m the biomass consist mostly of *Mytilus edulis* and *Jassa herdmani*; at 17m this is *Mytilus edulis* but especially *Metridium senile.*

Table 5: Density and biomass of the different depth groups. Colony-forming species are counted as 1 ind./m² and are not included in the biomass.

sample depth	Density (ind./m²)		Biomass (g AFDW/m²)	
	Mean	St. Dev	Mean	St. Dev
Intertidal	56.033	64.392	172,049	164,913
2	782.355	404.216	1.219,714	879,756
5	946.508	278.852	673,344	425,319
10	643.858	375.602	581,075	188,910
17	142.368	156.958	1.178,283	552,687
Scour	6.102	4.689	44,599	41,510

Figure 6 shows the distribution of the most dominant species over the depth levers, according to density and biomass. The intertidal zone is dominated by *Idotea pelagica* and *Jassa marmorata* (density) or *Mytilus edulis* (biomass). Depth zones 2, 5 and 10m show similar species distributions, with the largest density contribution for *Jassa herdmani*, *Jassa marmorata* (mainly at 2m) and *Caprella linearis* (at 5 and 10m). For biomass, this is *Jassa herdmani* and *Mytilus edulis*. Anemones dominate the lowest two depth levels, with a very high biomass of *Metridium senile.*

3.3.2 Multivariate analyses

Given the above listed univariate data, it is not surprising that the multivariate ANOSIM data-analyses showed a highly significant depth effect across all WTG's for both density and biomass. The ANOSIM-results are summarized in Table 6 (biomass results not shown). The dissimilarity between different depths was derived from the SIMPER results (Table 6). The differences between closely related depths were caused by differences in densities of the most abundant species (*Jassa herdmani*, *J. marmorata*, *Monocorophium acherusicum*, *Mytilus edulis*, *Caprella linearis, Idotea pelagica*), while the differences observed between more widely spaced depths it was a combination of density differences and the occurrence of some species. The dissimilarity percentage was the highest between scour and any other scrape sample depth on the WTG. This was caused by the high occurrence of Bryozoa species in the scour samples. When performing these analyses on the biomass data, similar

dissimilarity percentages were obtained, although there was a shift in characteristic species. The biomass indicator species were: *Mytilus edulis*, Anthozoa (*Metridium senile*, *Sagartia troglodytes*) and Echinodermata (*Psammechinus miliaris*, *Asterias rubens*).

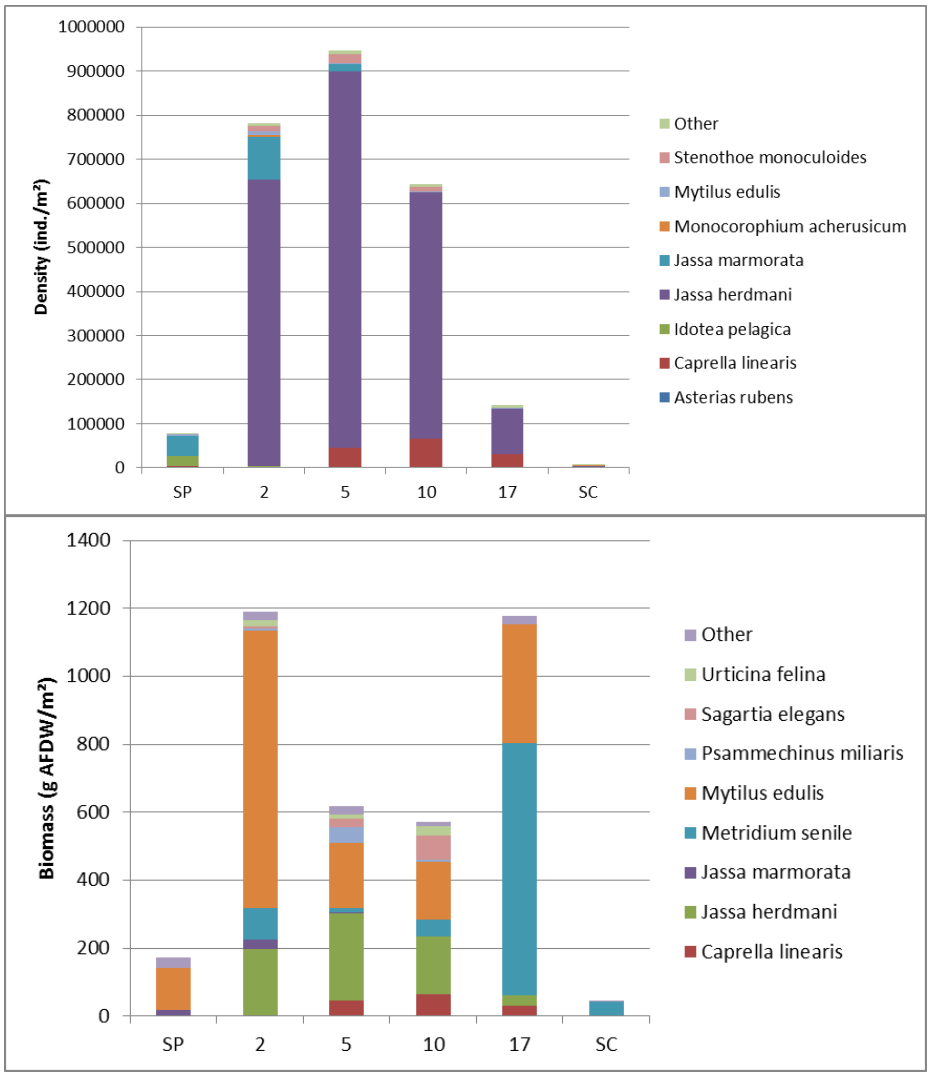
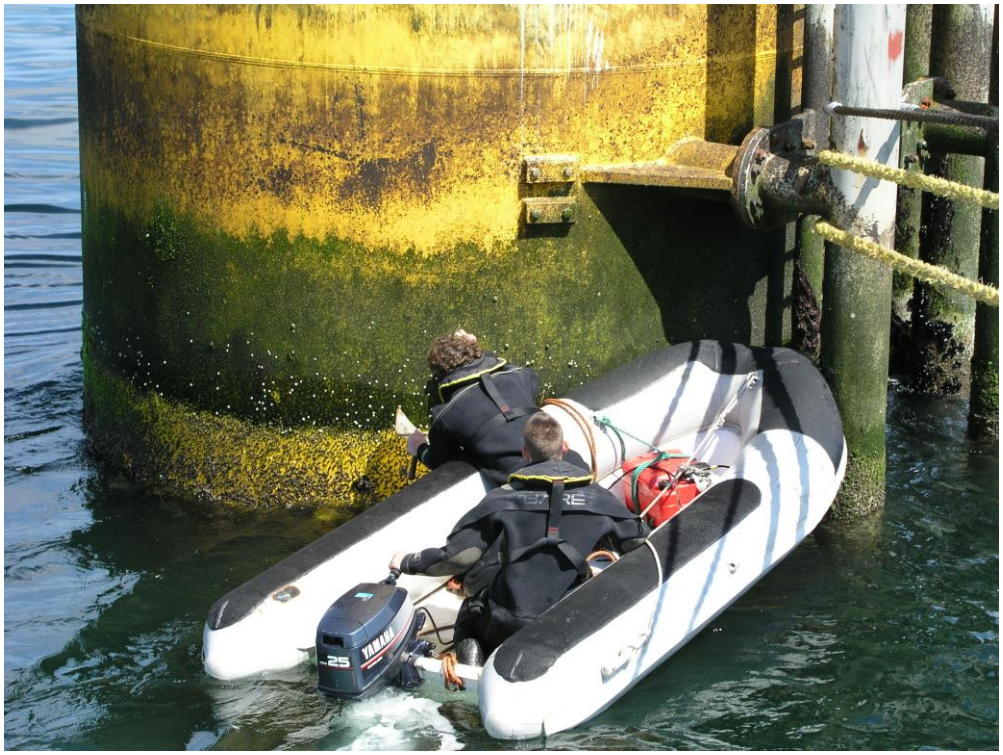


Figure 6: Density (above) and biomass (below) distribution of the most abundant species in the different depth zones



Picture 2: Sampling the intertidal zone; the algal growth is clearly visible

Picture 3: Bringing three samples on board with the sampling net

Table 6: Results ANOSIM and SIMPER analyses for densities; left column lists the pair wise compared groups

Depth zone	R-Statistic	p-value	Dissimilarity (%)	Indicator species (>5% dissimilarity)
2, 5	0,563	0,037	36,61	*Jassa marmorata, Mytilus edulis, Caprella linearis, Syllis prolifera*
2, 10	0,688	0,037	40,74	*Jassa marmorata, J. herdmani, Caprella linearis*
2, 17	1	0,001	56,97	*Jassa marmorata, J. herdmani, Stenothoe monoculoides*
2, Scour	1	0,001	75,43	*Jassa herdmani, J. marmorata, Mytilus edulis, Stenothoe monoculoides*
2, Intertidal	1	0,001	79,48	*Jassa herdmani, J. marmorata, Stenothoe monoculoides, Idotea pelagica*
5, 10	0,438	0,049	33,68	*Jassa marmorata, J. herdmani, Caprella linearis*
5, 17	1	0,001	55,08	*Jassa marmorata, J. herdmani, Stenothoe monoculoides*
5, Scour	1	0,001	76,47	*Jassa herdmani, J. marmorata, Stenothoe monoculoides, Caprella linearis*
5, Intertidal	1	0,001	87,92	*Jassa herdmani, Stenothoe monoculoides, Idotea pelagica*
10, 17	0,750	0,025	48,85	*Stenothoe monoculoides, Caprella linearis, Jassa herdmani*
10, Scour	1	0,001	73,95	*Jassa herdmani, Stenothoe monoculoides, Caprella linearis*
10, Intertidal	1	0,001	90,17	*Jassa herdmani, J. marmorata, Stenothoe monoculoides, Caprella linearis, Idotea pelagica*
17, Scour	0,808	0,001	63,68	*Jassa herdmani, Caprella linearis, Phtisica marina, Monocorophium acherusicum, Mytilus edulis*
17, Intertidal	1	0,001	86,94	*Jassa herdmani, J. marmorata, Metridium senile, Caprella linearis, Idotea pelagica*
Scour, Intertidal	1	0,001	92,80	*Jassa marmorata, Idotea pelagica, Mytilus edulis, Jassa herdmani, Semibalanus balanoides*

Cluster analysis showed four distinct groups: the intertidal zone, a subtidal zone between 2 and 10 meters, the 17 meter zone and the scour zone (Figure 7). The intertidal zone shows a similarity of less than 30% compared to all other samples. This intertidal zone is clearly very different from the subtidal samples.

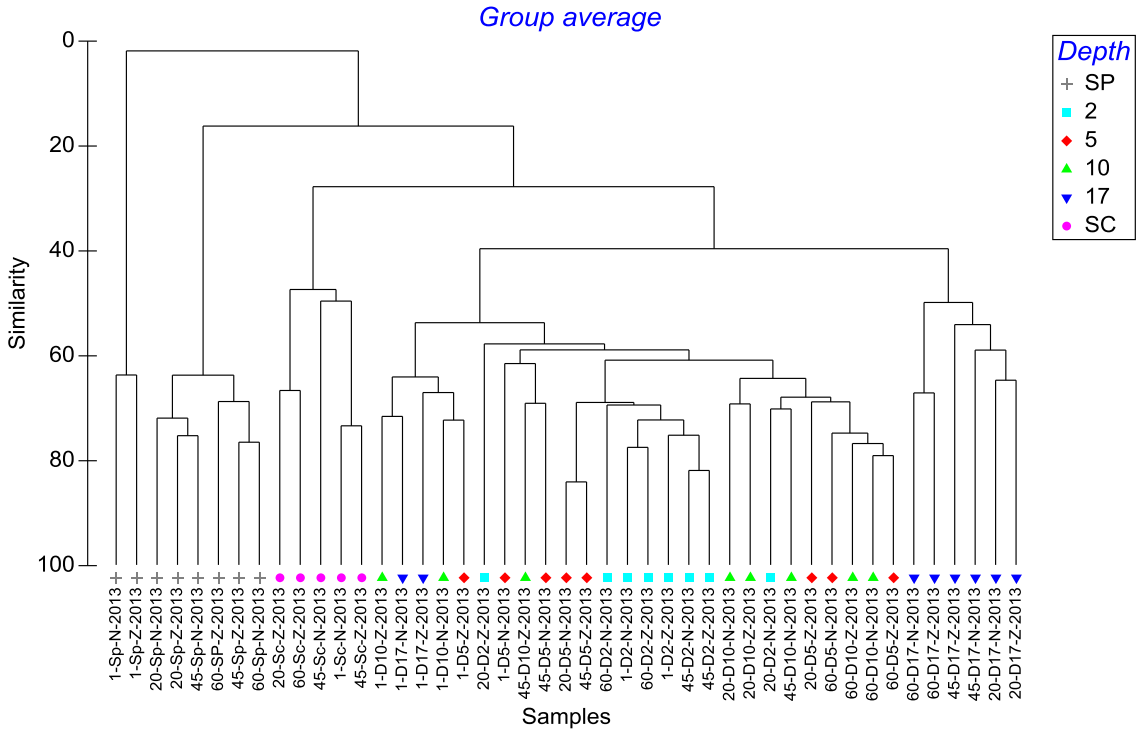


Figure 7: Cluster plot, indicating the depth zones

This pattern of depth zonation in four classes is also clearly visible in the MDS (Figure 8); however, within the intertidal zone, there is a clear difference between WTG1 and the other three WTGs. This is due to the very low number of species, with low densities, in the intertidal zone of WTG1. In 2011 the intertidal zone of WTG1 contained few species in low densities as well.

As is clear from Figure 9, some species only occur in the intertidal zone; other species are found over most of the depth range, such as *Caprella linearis* (Figure 10). The most dominant taxon is *Jassa*, a genus with two species present in the wind farm. It is interesting to note that the less abundant of the two, *Jassa marmorata*, is present at shallow depths, and even in the intertidal zone (Figure 11), whereas *Jassa herdmani*, by far the most dominant species on the hard substratum, can be found somewhat deeper (Figure 12).

Mytilus edulis shows a remarkable depth distribution in terms of biomass: it is present in large biomass from the intertidal zone to 17m, yet also absent in many of the 5

and 10m samples (Figure 14). Another dominant species in terms of biomass, *Metridium senile*, is typical for the deepest zone, 17m (Figure 13).

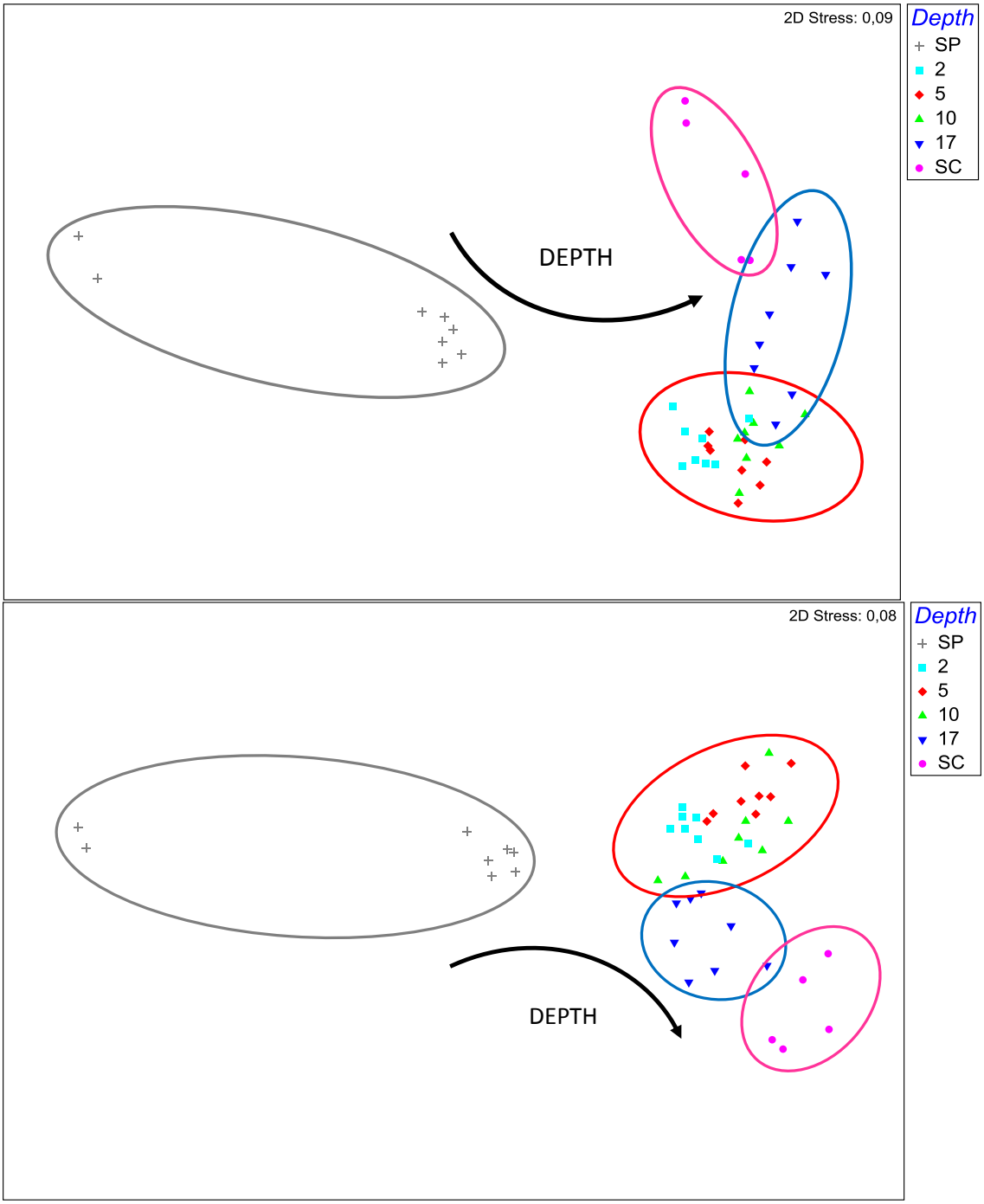


Figure 8: MDS of density (above) and biomass (below), with indication of the depth gradient and depth classes.

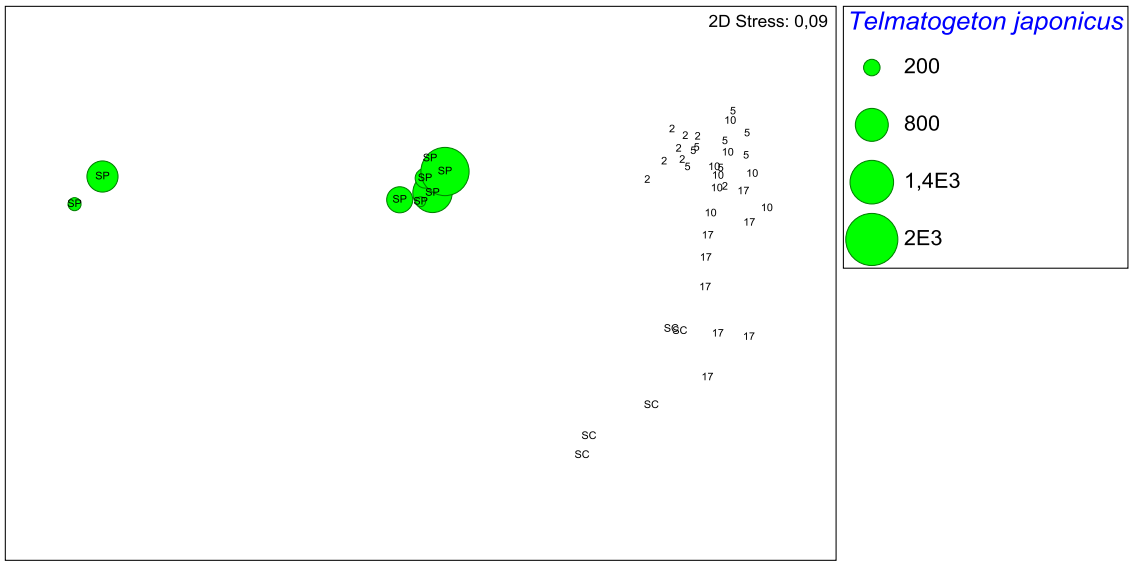


Figure 9: MDS of density of *Telmatogeton japonicus*

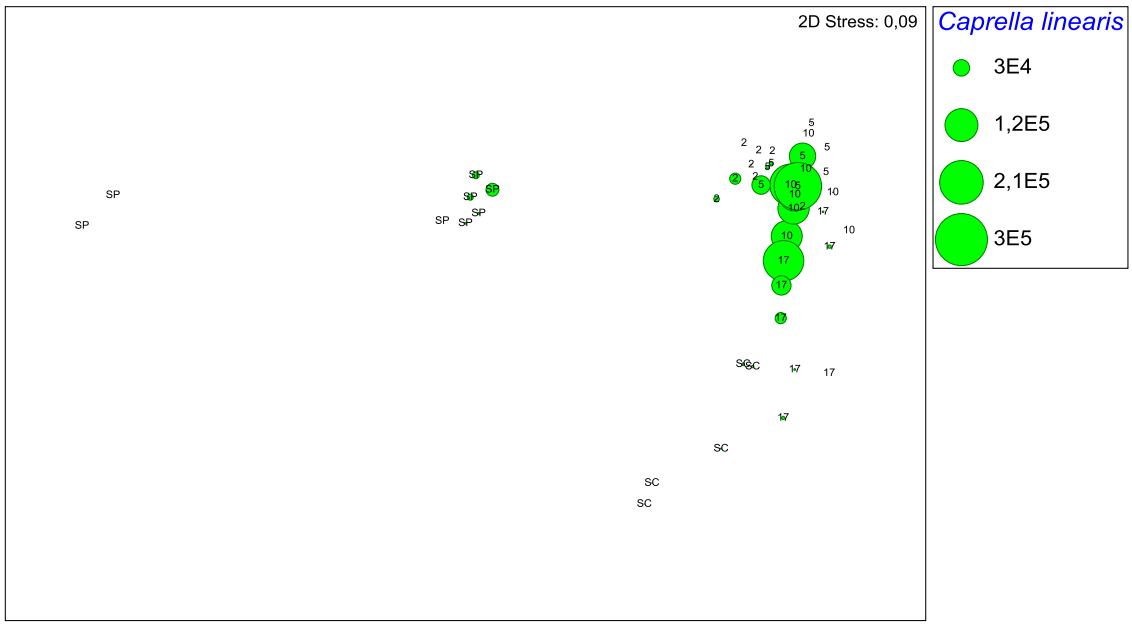


Figure 10: MDS of density of *Caprella linearis*

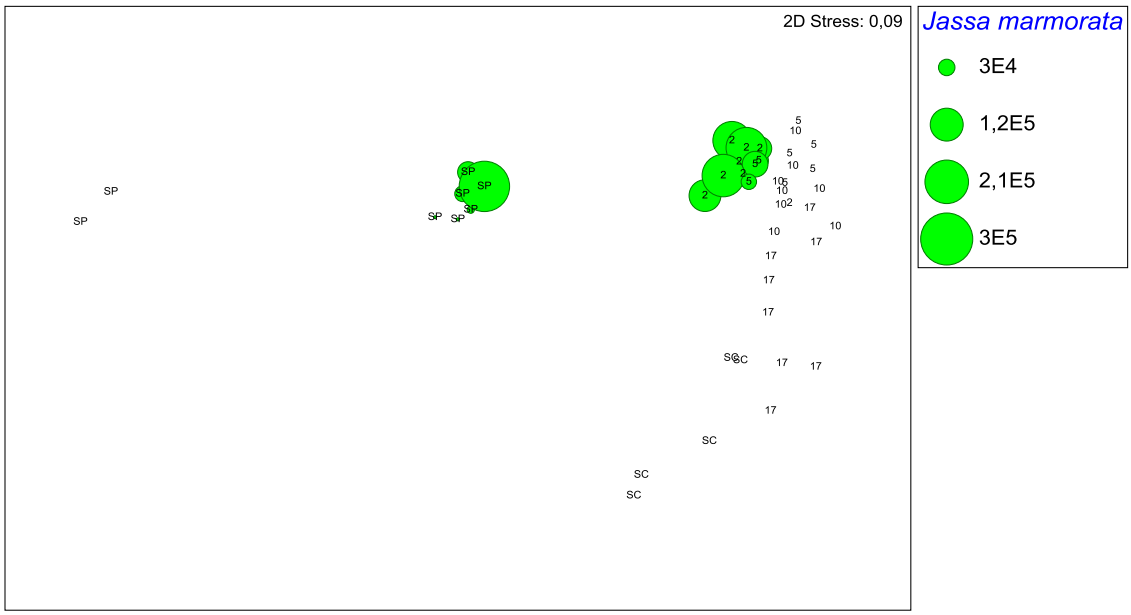


Figure 11: MDS of density of *Jassa marmorata*

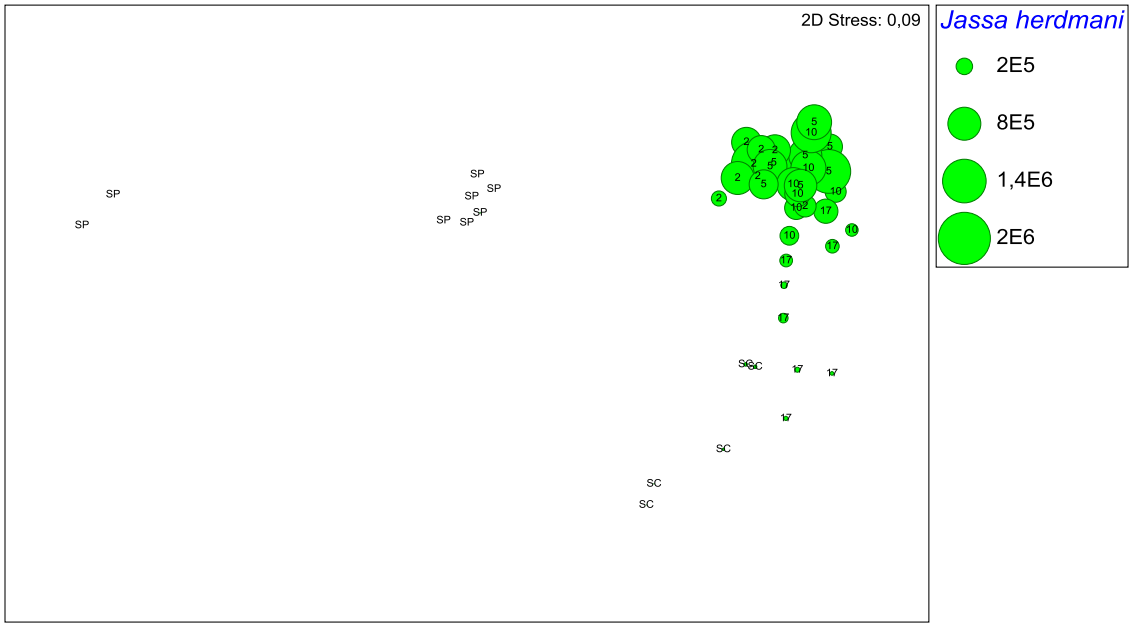


Figure 12: MDS of density of *Jassa herdmani*

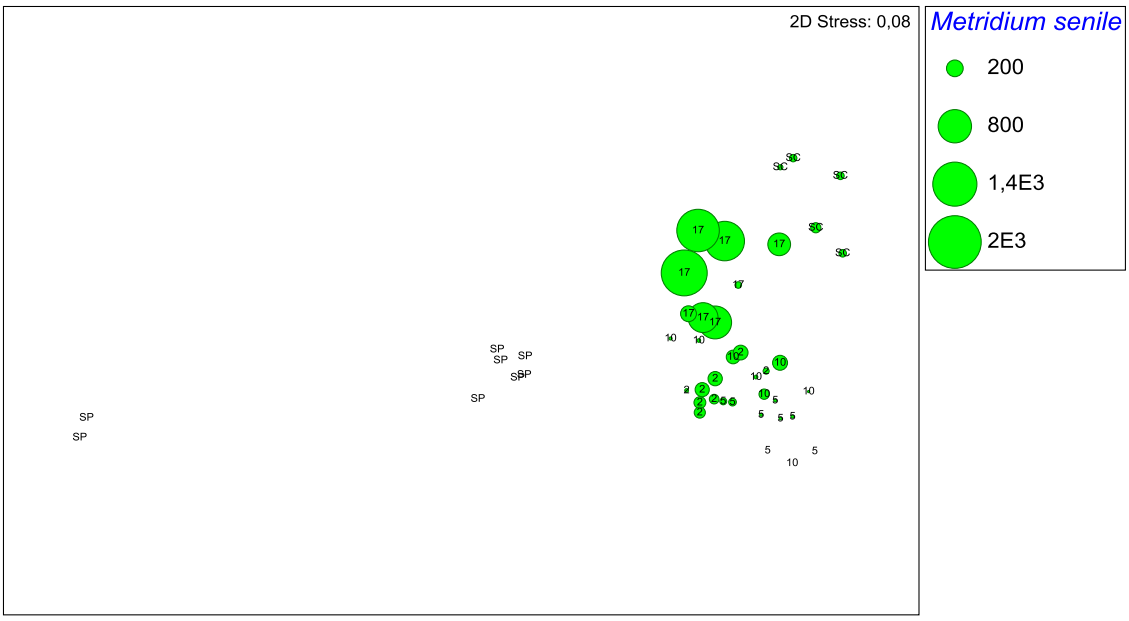


Figure 13: MDS of biomass of *Metridium senile*; samples are indicated with the depth value

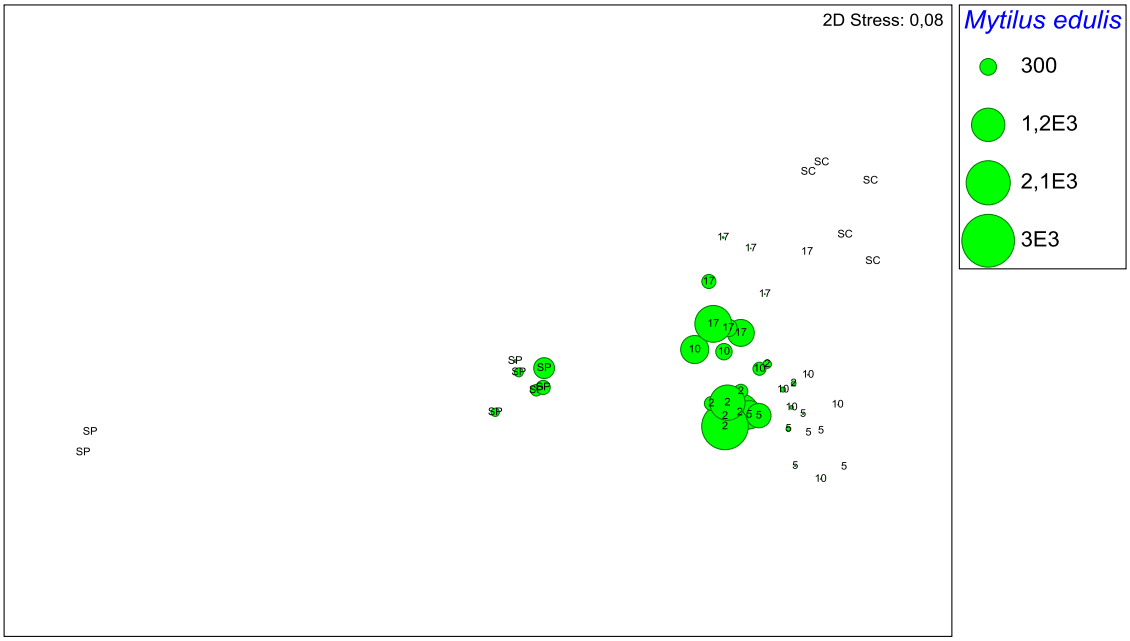


Figure 14: MDS of biomass of *Mytilus edulis*; samples are indicated with the depth value

3.4 Zonation pattern

Based on the quantitative results (densities and biomasses) and the qualitative data (percentage cover, video footage; see Annex 2) a zonation pattern could be postulated.

The intertidal zone consisted of several subzones. The upper zone consisted of encrusting green algae and *Telmatogeton japonicus*, which apparently feeds on them. Below this upper zone the green algae *Blidingia minima* and *Ulva* spp. became dominant, although much of the surface was bare. In the lower intertidal zone there was a band of barnacles (up to 6 species), sometimes with Pacific oysters *Crassostrea gigas* and small mussels *Mytilus edulis*. In the barnacle and small mussels bands high densities of *Idotea pelagica* and *Jassa marmorata* were found. At deeper water depths, this band gave way to a thick layer of small mussels, extending to about 1m below the low water mark. Certain species were found almost exclusively in the small mussel band, namely the bryozoan *Celleporella hyalina*, the hydrozoan *Obelia dichotoma* and the nudibranch *Doto coronata* feeding on the hydrozoan.

Subtidally, the percentage cover of *M. edulis* decreased to below 5% with increasing depth, while the presence of Hydrozoa (*Tubularia indivisa* and *Ectopleura larynx*) increased (up to 100% percentage cover). The latter were almost completely smothered by tube building amphipods (mainly *Jassa herdmani*). Also Actiniaria (*Metridium senile*, *Sagartia* spp. and *Urticina felina*) increased in occurrence and cover (up to 80% cover).

In the lower half of the subtidal zone in particular, large patches measuring up to at least 1 m^2 occurred. At first sight these patches appeared bare, but actually they consisted of the encrusting hydrozoan *Hydractinia echinata*, with a percentage cover of up to at least 15%, especially on WTG 1 and WTG20. Apparently *Hydractinia*-crusts were almost impossible to colonise by other organisms, except possibly *Metridium senile*, which occurred in very high densities in the same zone. In the lowest part of the subtidal zone (below 15m) mussel density increased again, with sometimes extensive clusters of extremely large mussels around 17m. Besides the sessile organisms, some mobile organisms occurred, such as *Asterias rubens*, *Psammechinus miliaris* and several Decapoda species (*Cancer pagurus*, *Pilumnus hirtellus* and *Pisidia longicornis*). Dense clusters of *Asterias rubens* could contain over 500 individuals per m^2.

During T6 only a limited amount of small scour protection rocks could be collected. The difficulties with collecting rocks during T6 were partly due to the accumulation of mud between the rocks, making it hard to extract these rocks. *Conopeum reticulum* was the most abundant bryozoan species present on the scour protection rocks, sometimes reaching well over 50% cover. Other Bryozoan species (*Electra pilosa*, *Callopora dumerilii*, *Microporella ciliata*) had a much lower percentage cover, in some cases less than 10%. Besides Bryozoa also Cnidaria (*Metridium senile* and *Alcyonium digitatum*), Bivalvia (*Mytilus edulis*), Amphipoda (particularly *Monocorophium* spp.) and Cirripedia (*Verruca stroemia*) were found on the scour protection rocks. On the video footage several mobile organisms were identified between the rocks: *Asterias rubens*, *Cancer pagurus*, *Necora puber*, *Pagurus bernhardus* and *Pholis gunnellus*. Very obvious was the large density of empty mussel shells close to the monopiles.

3.5 Comparison of different WTGs

Densities are largely similar between different wind turbines sampled, except for the lower densities in the intertidal zone on WTG1 (Table 7).

Table 7: Density (ind./m² ± St.Dev) per WTG

	WTG			
Depth	1	20	45	60
Intertidal	535 ± 556	41.607 ± 38.739	51.044 ± 43.954	223.517 ± 87.984
2	705.364 ± 212.245	950.515 ± 844.334	795.158 ± 10.758	678.382 ± 543.423
5	997.006 ± 679.062	982.372 ± 95.080	929.006 ± 2.639	877.649 ± 237.423
10	242.267 ± 163.493	442.400 ± 99.462	1.065.622 ± 205.869	825.140 ± 288.650
17	297.356 ± 209.631	55.910 ± 52.402	16.580 ± 3.371	199.624 ± 156.700
Scour	10.348 ± 9.190	928 ± 505	8.500 ± 6980	2.236 ± 1205
average	375.479 ± 357.504	412.289 ± 393.102	477.652 ± 451.989	467.758 ± 380.187

Total biomass on the different wind turbines was largely the same, except for WTG45, which was due to fewer mussels in the samples from depths 2 and 5m at this turbine (Table 8). The ANOSIM did not show a significant different species composition per WTG (density and biomass not significant).

Table 8: Biomass (g AFDW/m² ± St.Dev.) per WTG.

	WTG			
Depth	1	20	45	60
Intertidal	<0,001	311,434 ± 287,498	112,587 ± 16,843	264,173 ± 111,924
2	1.520,642 ± 436,505	1.618,721 ± 1.911,847	569,027 ± 137,231	1.170,465 ± 987,960
5	953,892 ± 892,400	416,241 ± 19,680	429,282 ± 35,632	893,960 ± 378,205
10	660,833 ± 349,982	619,953 ± 101,889	518,314 ± 318,391	525,199 ± 146,375
17	956,584 ± 1.044,025	1.235,258 ± 108,212	1.058,920 ± 965,124	1.462,369 ± 340,354
Scour	44,749 ± 37,286	39,387 ± 47,140	48,830 ± 40,904	41,200 ± 37,323
Average	689,450 ± 506,564	706,832 ± 569,986	456,194 ± 346,575	726,228 ± 478,196

3.6 Comparison of orientations

Average density was slightly higher on the SSW-side of the turbines and average biomass on the SSW-side was double the average biomass on the NNE-side. When considering individual samples per sublittoral WTG-depth combination, this turned out to be a consistent pattern. In most cases biomass on the SSW-side was (often considerably) higher than on the NNE-side. Only in two cases (WTG60 depth 5 and 10m) biomass was higher on the NNE-side.

Still, the multivariate analyses showed no significant pattern for orientation (ANOSIM density and biomass not significant). For the intertidal zone suitable video footage is not available. In this zone no differences between orientation could be noticed while taking the scrape samples.

Table 9: Comparison of density and biomass between orientation.

	Density (ind./m²)		**Biomass (g AFDW/m²)**	
Orientation	NNE	SSW	NNE	SSW
Depth				
Intertidal	39.459 ± 34.906	118.892 ± 87.885	206,063 ± 219,719	138,034 ± 145,468
2	576.454 ± 293.530	988.256 ± 426.649	605,672 ± 415,611	1.833,755 ± 941,132
5	801.770 ± 236.460	1.091.247 ± 263.928	585,266 ± 387,877	761,422 ± 557,901
10	669.810 ± 354.856	617.904 ± 448.844	470,795 ± 148,013	691,354 ± 202,058
17	142.870 ± 123.771	141.865 ± 205.338	743,816 ± 520,127	1.612,750 ± 201,672
Scour	7.710 ± 6.695	5.030 ± 3.374	32,588 ± 30,143	52,606 ± 48,423
Average	373.012 ± 332.876	493.866 ± 440.823	440,701 ± 276,849	848,337 ± 700,312

3.7 Comparison of sampling periods T4 and T6

3.7.1 Species composition

During T4, 84 species were identified from the hard substrata of the Princess Amalia Wind Farm and in the T6 samples 88 species were found (see Annex 1). About a quarter of these are different species: 23 species collected during T6 were not found during T4.

During T6 only a limited amount of small scour protection rocks could be collected. The associated fauna was largely the same as during T4. The rare nudibranch *Onchidoris muricata* was identified only in the T6 samplings, together with spawn. *Pagurus bernhardus* and *Pholis gunnellus,* both visible on the video recordings, were not observed during T4.

3.7.2 Density

Except for the intertidal zone, densities measured during T6 were 3-10 times as high as during T4 (Table 10). This is due to the much higher density of tube-building amphipods (*Jassa*). The pattern of very low density in the intertidal zone and very high density at depths 2 and 5 m, is the same in both sampling periods. The lower densities at depths 10 and 17m were much less obvious in the T6 sampling. At 10 and 17m depths much higher densities of *Jassa* were found during T6. Similarly on WTG 20 and WTG 60 very high densities of skeleton shrimps *Caprella linearis* were found. During T4 sampling this species was observed only in low densities.

Table 10: Density (ind./m²) by depth for T4 and T6. Note that for the T6, less scour samples were collected.

sample depth	density T4 (ind./m²)		density T6 (ind./m²)	
	mean	sd	mean	sd
Intertidal	63.031	82.666	56.033	64.392
2	158.824	109.916	782.355	404.216
5	154.134	88.681	946.508	278.852
10	52.799	32.766	643.858	375.602
17	41.750	23.134	142.368	156.958
Scour	1.552	1.326	6.102	4.689

3.7.3 Biomass

Biomass determined during T6 was higher than during T4 at depths 2m and 17m (Table 11). This was due to a number of samples with very high biomasses of mussels from depth 2m and a number of samples with very high biomasses of sea anemones *Metridium senile* and mussels from depth 17m.

Table 11: Biomass (g AFDW/m2) by depth during T4 and T6. Note that for the T6, less scour samples were collected.

	biomass T4 (g AFDW/m²)		biomass T6 (g AFDW/m²)	
	mean	sd	mean	sd
Intertidal	265,721	329,056	172,049	164,913
2	586,672	509,901	1.219,714	879,756
5	530,089	328,140	673,344	425,319
10	643,811	620,055	581,075	188,910
17	592,163	446,263	1.178,283	552,687
Scour	32,233	28,165	44,599	41,510

3.7.4 Multivariate analyses

When comparing the data from the T4 and the T6 sampling, for both density and biomass, the dominant pattern remains the depth stratification. For density, there is a clear difference between the two years, albeit with the same depth gradient (Figure 15). For biomass, there is much less difference between the two years, and the depth gradient is clearly visible (Figure 16). This is also illustrated by the cluster analysis, in which for the depth groups, each cluster contains samples from the two sampling years (Figure 18).

If we look at species level, we can see that for some species, there was a clear difference in occurrence between 2011 and 2013 (e.g. *Caprella linearis* Figure 17), for other species, no difference at all was observed (e.g. *Mytilus edulis* Figure 19).

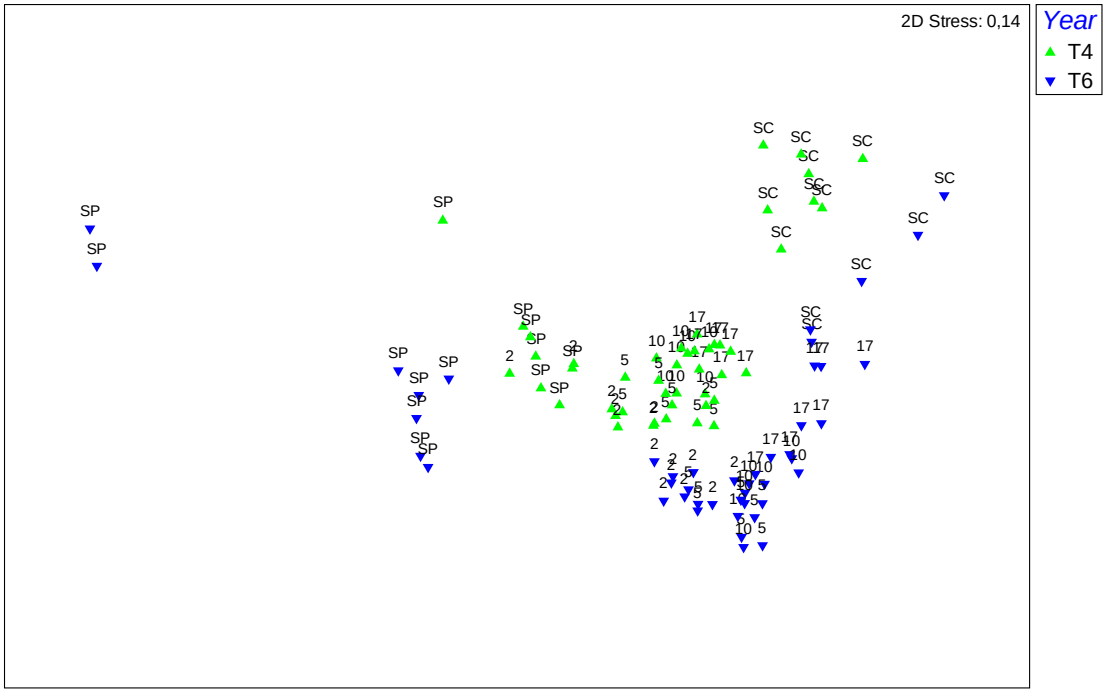


Figure 15: MDS of densities for T4 and T6. The depth zones are indicated

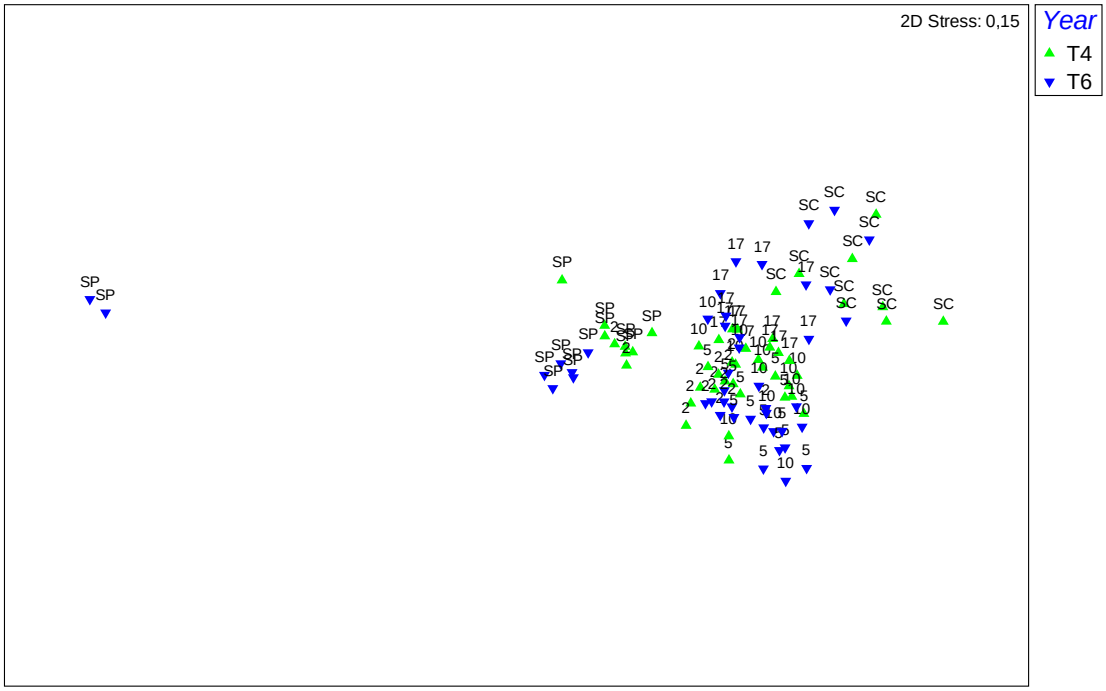


Figure 16: MDS of biomass for T4 and T6. The depth zones are indicated.

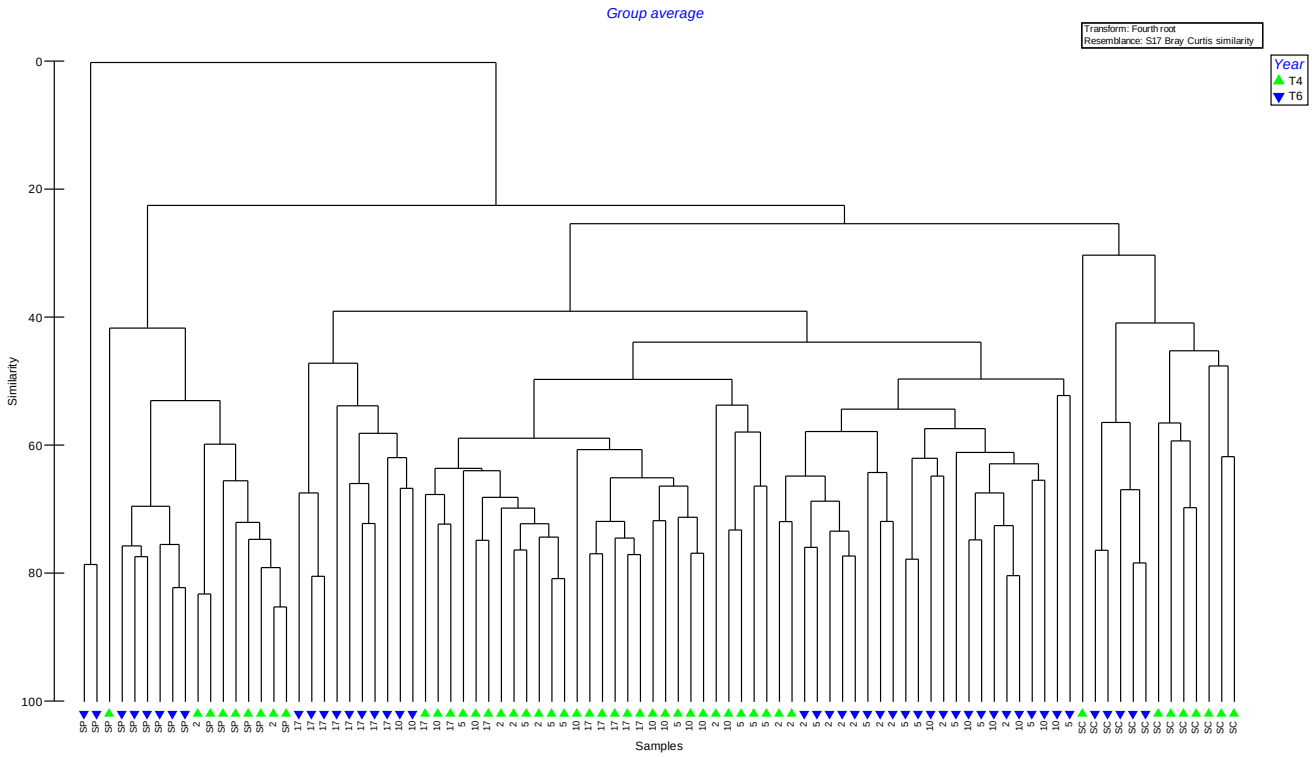


Figure 18: Cluster diagram of biomass for T4 and T6

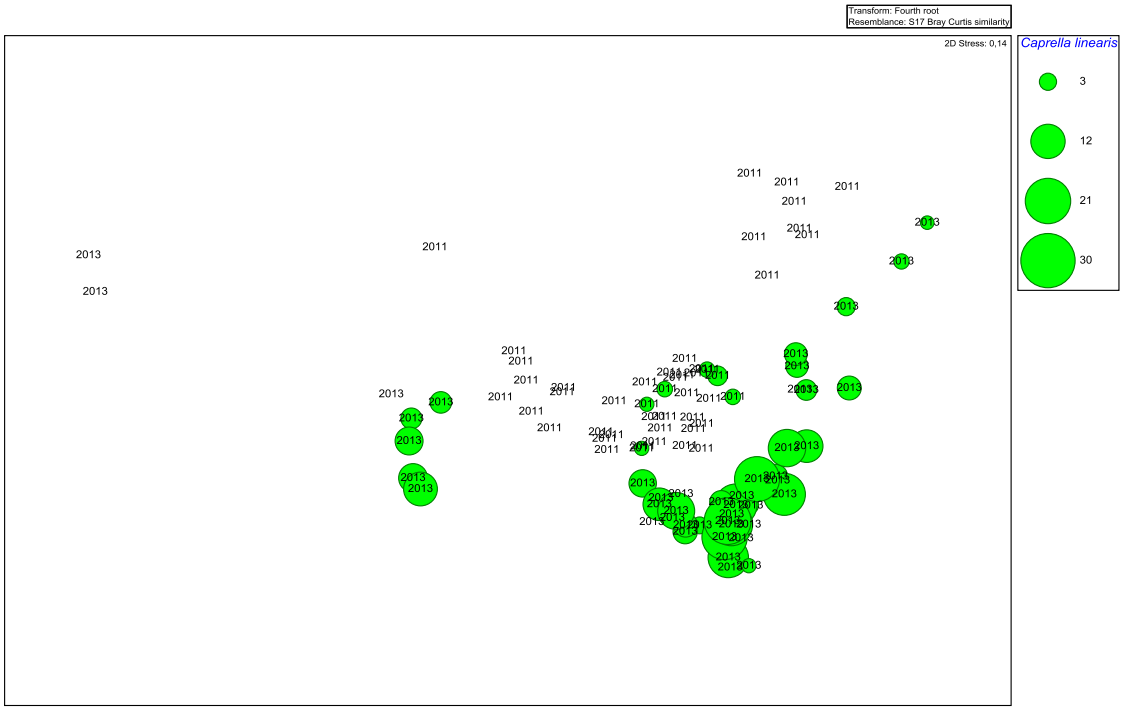


Figure 17: MDS for density of *Caprella linearis* during T4 and T6

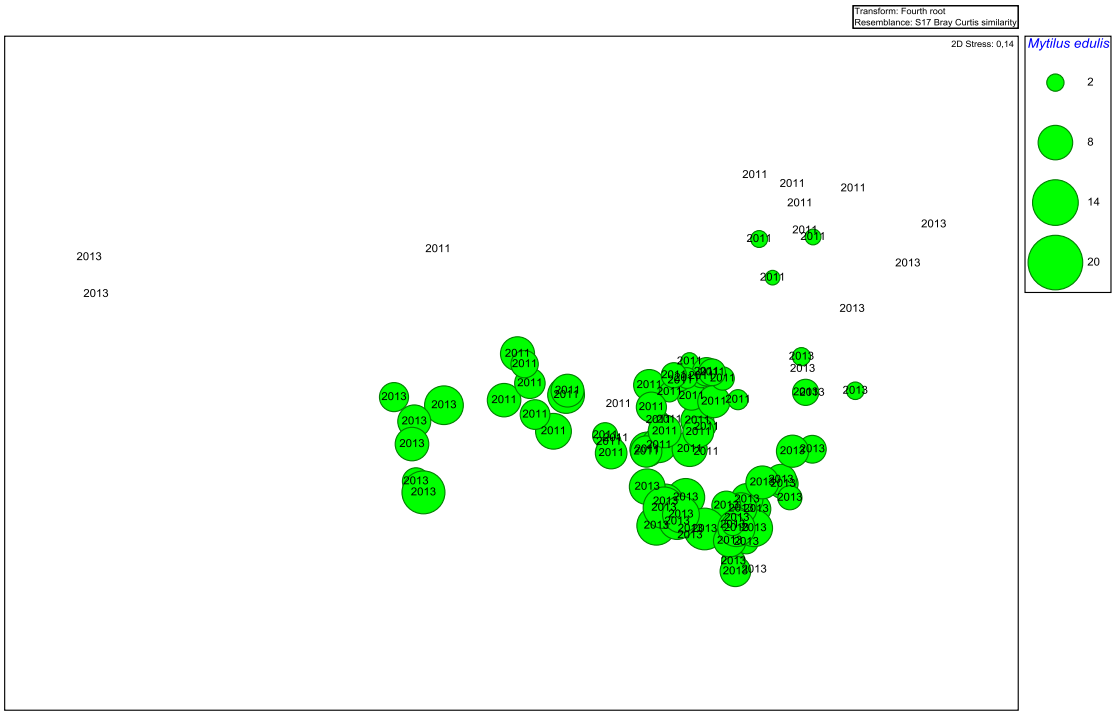


Figure 19: MDS for density of *Mytilus edulis* during T4 and T6

4. DISCUSSION

4.1 Discussion of methods

The surface of the monopiles form a large area with a diverse, patchy epifauna. Accurate assessment of species richness, density and biomass is difficult due to the limited dive time and the combination of different recording methods required. Video footage is required to determine percentage cover of communities over larger areas. Small and medium-sized species are impossible to distinguish on video. In low visibility conditions, as during T6, even larger species are sometimes difficult to identify. The aim of scrape samples is to collect smaller species and estimate densities and biomass. The subtidal communities occur in broad zones which gradually change with depth. Samples taken at either fixed depths below NAP or at specific depths below actual water level will always be taken from exactly the same communities. Samples from the intertidal zone were taken from a RIB, which allows sampling of exactly the same zone each time, that is between the *Telmatogeton* zone and the "small mussel band". It is extremely difficult for a diver to take a scrape sample from this zone due both to wave action and the fact that often the targeted zone is above water level. Because of the relatively small size of the samples it is easy to miss species. We assessed the sampling effort with species-accumulation curves and estimated the potential total number of species with a bootstrapping method (not shown in the results section). From these analyses, it was clear that a greater sampling effort would result in a much higher species count, particularly if more depth zones were sampled.

Due to the patchiness of the epifauna, density estimates should be treated as approximations, but with the combination of techniques used in this study, we are confident the best efforts were made to gather density information. The scour protection boulders, however, proved even more difficult to assess. Fauna between the boulders was invisible. During T6 one loose lobster *Homarus gammarus* cheliped containing flesh was found and one fish (*Pholis gunnellus*) was seen on video footage, which is unlikely to reflect real abundance of this fauna. In view of the patchiness of the sessile fauna on the boulders, sample size was very small. The fact that several species were found on one boulder only, reflects this small sample size. This means that particularly in this habitat the number of species recorded underestimates the real biodiversity present.

4.2 Development of hard substratum fauna in the Princess Amalia Wind Farm

The diverse community present on the monopiles and the scour protection rocks of the wind farm four years after construction has probably increased slightly in species-richness two years later. The division of the community in two major zones has stayed the same: an upper, **intertidal zone** dominated by algae, mussels and small arthropods, and a **sublittoral zone,** dominated by large clusters of tube dwelling amphipods (mainly *Jassa* spp.), mussels, large echinoderms (starfish and sea urchins) and large cnidarians (sea anemones and hydrozoans). This sublittoral zone is again divided into a shallow zone, up to 10m water depth, a deep zone, and the scour zone.

The species composition of the community has largely stayed the same since the T4 sampling, with the exception of a number of newly arrived species (see Annex 1 and Remarkable findings). The differences mostly concern species that were found in just a few samples. The dominant species (mussels, cnidarians, echinoderms and *Jassa*) have stayed the same, although densities and biomass were higher during T6.

On the video footage large masses of finger-like outgrowths became immediately apparent. In the scrape samples we found these to consist of hydrozoan colonies (mainly *Tubularia indivisa* with some *Ectopleura larynx*) completely covered with tubes of *Jassa herdmani*. This accounts for the much higher total densities found during T6 at all depths below the intertidal zone, as this species alone determines the majority of total density. Biomass determined during T6 was higher as well, but only at depths of 2m and 17m. The biomass figures indeed show that a higher biomass of mussels occurred at depth 2m and a higher biomass of mussels and sea anemones (*Metridium senile*) at depth 17m during T6.

The higher densities of *Jassa* are probably an ephemeral phenomenon, due to the abundance of hydrozoan colonies, which provide additional attachment surface. The hydrozoan *T. indivisa* usually largely disappears in summer, due to die-off and/or nudibranch predation. During T6 (2013) sampling was in July, as opposed to October during T4 (2011). Furthermore spring 2013 was relatively cold, delaying development of nudibranch populations and disappearance of *T. indivisa*. A meaningful comparison of development of functional groups between sampling years is impossible, due to seasonal differences between groups. During spring (summer) hydrozoans and their nudibranch predators show maximal development. Most bryozoans show maximal development during autumn, while mussels may exhibit losses during autumn and winter. The higher biomass of mussels and sea

anemones in 2013 may be a permanent phenomenon, but thick layers of mussels are vulnerable to storms.

4.3 Comparison with other wind farms in the Southern North Sea

We compared the results of the Princess Amalia Wind Farm with recent results from nearby wind farms, where similar studies have been performed. Horns Rev (Denmark) is excluded from this comparison because no recent hard substratum surveys from this wind farm are available.

The Netherlands first offshore wind farm was **OWEZ**, consisting of 36 monopiles located approximately 10 – 18 km offshore in water depths between 6 and 14 m. OWEZ wind farm was constructed between April and August 2006. The marine growth was sampled in February and September 2008, 2 years after construction of the wind farm (Bouma & Lengkeek, 2009) and again during the same months in 2011, i.e. 5 years after construction (Bouma & Lengkeek, 2012).

The **C-Power** wind farm is located on the Thornton Bank in the Belgian Part of the North Sea (BPNS) and consists of six turbines (constructed in 2008). The Thornton bank is located 30 km offshore in a water depth of 6 - 20 m. The marine growth was sampled in September 2008, only some months after construction (Kerckhof *et al.*, 2009) and during the period February 2009 – 2010 (Kerckhof *et al.*, 2010a; Kerckhof *et al.*, 2010b).

The **Belwind** wind farm is located on the Bligh Bank in the BPNS, close to C-Power, and the first phase, completed in 2010, consists of 55 turbines. The Bligh Bank is located about 40 km offshore in depths of 7 – 30 m. Samples were taken from February 2010 to November 2011 (Kerckhof et al., 2012).

The species number found for the hard substratum fauna in the PAWP for 2011 and 2013 together (110 species) was comparable, albeit slightly higher, to the number found in C-Power and Belwind combined (85 species). In the C-Power/Belwind survey scour protection boulders, which have a different fauna, were not taken into account, which may explain the different species number. Numbers of species found were considerable lower in OWEZ (55 species), which is located closer to shore. Also for differences between the C-Power and Belwind windfarms, which are located closely together, the distance to the shore, besides nature of the substratum, is suggested as one of the factors to explain the difference

in species composition (Kerckhof et al, 2012). More stable temperature and salinity further offshore are considered favourable for marine species richness.

In all four wind farms a distinct depth zonation in marine growth was present, although the pattern varies between the different farms. In all wind farms considered (PAWP, OWEZ, C-Power and Belwind) the algal band was restricted to a width of approximately 0.5 m, and it did not occur on every monopile. A monoculture of *Telmatogeton japonicus* was only recorded in the C-Power wind farm shortly after construction; a few years later the species was still present, but in combination with other species. In PAWP *Telmatogeton japonicus* was present in lower densities, although increasing from year 2011 to 2013. In OWEZ this species was recorded only in 2011. Particularly in the intertidal zone of PAWP high densities of the isopod *Idotea pelagica* were found; this species was also recorded from OWEZ in 2011.

The more species-rich sublittoral zone of the monopiles in the different wind farms was dominated by *Metridium senile*, tubulariids and *Mytilus edulis*. All were covered by *Jassa herdmani*, with a clear presence of *Asterias rubens* and *Psammechinus miliaris*. The densities, however, differed between the different wind farms. PAWP and C-Power showed comparable *Mytilus edulis* densities. OWEZ densities of *Mytilus edulis* were slightly lower. *Jassa* spp. occurred in high densities in the PAWP (up to 900.000 ind/m^2 in a sample) and the maximium density recorded in the C-Power/Belwind survey was 1 million ind/m^2. Biomass differences between seasons/years (T4 and T6 in PAWP) are larger than differences between wind farms. Some of the species that were recorded in much higher densities in the Belgian wind farms, such as *Pusillina inconspicua* and *Perforatus perforatus,* are typical southerly species, which demonstrates that part of the differences between wind farms should be ascribed to geographical location.

4.4 Comparison with other artificial hard structures in the southern North Sea

On artificial reefs along the Dutch coast 54 species were found during a more extensive survey (20 dives in 1993) (van Moorsel, 1994). This figure is not quite comparable, because the top of these reefs is 1.6 m or less above the sandy bottom and sand scour will limit the colonization of species. Not surprisingly, species richness on wind turbines and scour protection together is higher.

On wrecks off the coast of The Netherlands van Moorsel & Waardenburg (1992, table 2) found 66 species with a survey effort comparable to our T6. Over a longer period van Moorsel & Waardenburg (1992) mention 127 species/species groups on 22 objects off the Dutch coast. This research was conducted with Braun-Blanquet surveys by divers with identification skills for marine epifauna. Zintzen & Massin (2010) record 224 species from wrecks all over the BPNS (Belgian Part of the North Sea) over a longer period of years. Because of the limited present survey effort in windfarms and the limited area in which these were constructed it is impossible to use these data to compare the relative contribution of windfarms and wrecks, respectively, to the total species richness of the DCS (Dutch Continental Shelf) or the BPNS.

In 2013, an extensive survey of epifaunal growth on ship wrecks on the DCS was performed. Unfortunately, at the time of writing, no report was available yet.

4.5 Remarkable findings

Only four years after construction the wind farm had already been colonised by a diverse community, including several rare and unrecorded species. Two years later, during the T6 sampling, additional remarkable species were found to be present in the samples (Table 12).

Table 12: New and rare species in this study

Species	Remarks
Polychaeta	
Ctenodrilus serratus	Rare, not recorded from wind farms in area
Malacoceros fuliginosus	Rare on DCS
Crustacea	
Metopa alderi	Not recorded from wind farms in area
Mollusca	
Nassarius incrassatus	Rare on DCS
Hiatella arctica	Not recorded from wind farms in area
Ostrea edulis	Rare on DCS
Doto coronata	Not recorded from wind farms in area
Onchidoris muricata	Rare on DCS

Twenty-three species collected during T6 were not present in the T4 samples. Some additional species could now be identified to species level with certainty (*Alcyonidium mamillatum*, *Emplectonema gracile*). In part the presence of species found only during T6 and not during T4 could be ascribed to period of sampling, climate or sampling strategy. The remainder is either rare species or recent arrivals. The most important will be described below.

Several nudibranchs species, namely *Dendronotus frondosus*, *Cuthona gymnota*, *Doto coronata* and *Onchidoris muricata,* were found in the T6 samples but were not present in the T4 samples. The species concerned are, as most nudibranchs are, species which occur mainly in spring and early summer. This is probably related to a combination of two factors. First, T6 sampling was in July, while T4 sampling was at the end of October. Second, during spring 2013 sea water temperatures were considerably below average, delaying the development of nudibranch populations. These same factors combined probably caused the absence of some bryozoans and the much lower biomass of the tunicate *Diplosoma listerianum* species, with maximum development occurring in late summer and autumn.

Special attention was given to sampling of barnacles by deliberately taking samples from the middle of the intertidal zone where barnacles occur. This resulted in the collection of *Amphibalanus improvisus* and *Austrominius modestus* and, in additional unplanned samples, *Perforatus perforatus*. These were probably present during T4, but would have been easily missed during sampling because they only occur in a narrow zone.

Special attention in the form of additional, unplanned samplings was given to oysters. All oysters collected in the littoral zone were Pacific oysters *Crassostrea gigas*. One empty shell of a native oyster *Ostrea edulis* was found attached to turbine pile 20 at a depth of 9m. Findings like this may be important in view of the virtual disappearance of *O. edulis* from the southern North Sea. The disappearance is caused by the demise, mainly due to overfishing, of natural oyster banks which served as settlement sites for juveniles.

A loose first cheliped of the lobster *Homarus gammarus* (Picture 3) was collected from the scour protection by a diver. As the cheliped contained fresh lobster meat, the lobster was likely to have lived locally only days before. The occurrence of *H. gammarus* on wrecks and in stony areas in the southern North Sea is well known. However, its presence in windfarms has only recently been documented (De Mesel et al., 2013). The scour protection forms an excellent habitat for this species, which prefers cavities between stones for shelter.

Picture 3: Cheliped of *Homarus gammarus*

Species rare to the wind farm or possibly recently arrived will be dealt with below.

Nassarius incrassatus (Picture 4) is a seasnail, rarely found in the Dutch part of the North Sea. It is known from the Cleaver Bank and (before 1985) the Texel Rough (de Bruyne et al., 2013). Van Moorsel & Waardenburg (1992) recorded it once from a wreck about 70 km to the west of the Princess Amalia Wind Farm. Kerckhof *et al.* (2010) recorded it from wind turbine foundations off the Belgian coast. It has been found several times on wrecks off the Belgian coast (Zintzen & Massin, 2010). A fresh empty shell was found between the scrapings from 17m on pile 60, where water depth is 23.5m; the snail almost certainly lived there.

Picture 4: *Nassarius incrassatus*

The flatworm *Leptoplana tremellaris*, while common on the Dutch coast, had never been found in a wind farm in the Netherlands, but was recorded on wind turbines in Belgium (Kerckhof et al., 2010).

The polychaete *Ctenodrilus serratus* has not been recorded from wind farms in the area before and rarely from the southern North Sea. *Ctenodrilus serratus* is very small (3 mm). *Malacoceros fuliginosus* has been recorded previously from a windfarm only in the pre-construction phase (Degraer et al., 2013, Annex). *M. fuliginosus* is a southern species at the edge of its distributional area.

The amphipod *Metopa alderi* has not yet been reported from windfarms, but Zintzen & Massin (2010) recorded it from several wrecks off the Belgian coast.

An exotic species not found before in the Princess Amalia Wind Farm is the skeleton shrimp *Caprella mutica*, living on the Dutch coast since 1993, recently also found in the OWEZ windfarm (Bouma & Lengkeek, 2012) and now present over a large part of western European coasts (Cook et al., 2007).

4.6 Importance of the offshore wind farms for hard substratum fauna, and the relevance to the ecosystem

Artificial hard substrata close to the Dutch coast enable rapid development of a rich associated hard substratum fauna. This specific fauna is relatively scarce in the Netherlands: ship wrecks, offshore constructions and hard coastal defence structures are the only notable exceptions. A significant increase in species richness on hard substrata in the Princess Amalia Wind Farm since the T4 could not be demonstrated. During T4 in 2011 84 species were recorded; during T6 in 2013 88 species were recorded, 23 of which were not recorded in 2011. These 23 'new' species are in part the result of a different sampling season (at least 4 species of nudibranch), better sampling of the intertidal zone (4 species, mainly barnacles) and accidental soft bottom species (3). It is not clear whether increase of soft bottom species is caused by increased sedimentation since 2011, although certainly more soft sediment was noticed by divers and was visible on video footage. The absence of rapid unidirectional changes in species composition suggests that the community of this artificial reef may be approaching a certain stage of maturity. During the T4 and T6 samplings combined, 110 species were found on the hard substrata of the Princess Amalia Wind Farm (Annex 1). Several of these species are rare on the DCS

(see Remarkable findings), which demonstrates the value of artificial hard substrata serving as reefs off the Dutch coast for marine biodiversity of this region.

When wind turbines are compared with wrecks and platforms it is clear that wrecks will lack intertidal and very shallow water species, i.e. most seaweeds, barnacles, some snails (*Patella*) and certain crustaceans (e.g. *Idotea pelagica*, *Jassa marmorata*). The communities on North Sea platforms are dominated by *Metridium senile* and other sea anemones, tubulariids and mussels (Guerin et al., 2007) and are largely comparable to those on wind turbine piles. Most differences, such as presence of corals and other hard fouling species on platforms, are clearly related to depth and latitude. The greater abundance of macroalgae and soft corals (*Alcyonium digitatum*) on platforms may be related to physical properties of the surrounding sea water, as they are situated further offshore. Wind turbines offer hard substrata over a larger area when compared with wrecks and platforms. This means that it is easier for species to maintain a population; in case of local extinction recruits produced on nearby turbines enable quicker recovery. This stabilising effect of a larger area of hard substrata will increase in the future with the construction of additional wind farms.

The scour protection of wind farms harbors a community partly differing from the turbine piles and consisting of, amongst others, several bryozoans. This specific boulder fauna is lacking on wrecks and we can find no information about boulder fauna near platforms. On the other hand, wrecks and platforms usually have more nooks and crannies higher up in the water column for species needing shelter. In conclusion, wind farms contribute in a specific way to the hard substratum species richness on the Dutch Continental Shelf, compared to the hard substrata existing prior to their construction: both the intertidal zone and the scour protection are new and hence offer new opportunities for certain communities to develop.

In the report of the T4 sampling (Vanagt *et al.*, 2013), it was shown that the hard substratum fauna adds a significant contribution to the total biomass of invertebrates in the wind farm area. It was hypothesized that this epifaunal biomass would in part be even more available to fish and birds than the soft substratum biomass.

During T6 biomass on the turbines was found to be even higher than during the T4 sampling, mainly due to the higher mussel biomass. In the same period, biomass of the soft sediment fauna has not increased (Vanagt *et al*, in preparation). This means that the relative contribution of hard substratum biomass in the area is even higher than the 49% calculated in 2011. It is very likely that the invertebrate fauna growing

on the monopiles will provide the bulk of the available food source to higher trophic levels in the wider area of the wind farm, a hypothesis worth testing with more detailed research methods (stomach analyses, C14 determination, etc).

4.7 Suggestions for future research

Although for sublittoral scrape samples differences in water depth of about 1 m will not result in different communities being sampled, in the littoral zone this is not the case. The littoral zone consist of several subzones. For future research it would be advisable to take samples from the upper littoral as well as the lower littoral, although this would introduce some practical challenges.

Sampling in July or October proved to yield different species. Therefore, sampling in two different seasons during the same year (spring and autumn) is advisable to cover the complete fauna and flora.

In view of the increased amount of sediment between scour protection rocks the use of ecostructures for scour protection in new wind farms could be considered to improve conditions for lobsters and rock-dwelling fish.

CONCLUSIONS

Comparison of the epifaunal community on hard substrata in the Princess Amalia Wind Farm four and six years after construction showed that the dominant organisms on wind turbine foundation piles and their scour protection were already present in large number four years after construction, with limited further change in dominant species and zonation in the subsequent two years. The structure of the epifaunal community seemed to be defined and biomass and density were close to their maximum. The number of species recorded showed a small increase between the two monitoring years. However, newly arrived species were mostly insignificant with respect to density and biomass. Furthermore, the slight increase in number of species could be a result of the different sampling season between the two monitoring years. Also, between-season differences in densities (T4 in autumn and T6 in summer) were larger than differences between wind turbines and even between different wind farms.

Between T4 and T6 the amount of sediment between the scour protection increased. This effect may alter the community on the scour protection significantly in the future. It is important to know whether this increased sedimentation will also occur on surrounding soft substrate in the future.

The species that were recorded from the Princess Amalia Wind Farm during T6 were not new to the Dutch Continental Shelf; most had already been identified from ship wrecks, hard coastal defense infrastructure and boulder stones. However, the combination in a wind farm of an intertidal and shallow hard substrate zone, a large depth gradient and scour protection with holes and crevices makes for a unique range of habitats, resulting in a valuable diversity of hard substratum species and its associated fauna.

The measured density and biomass values were even higher in 2013 than in 2011, although this might have been a seasonal effect. The total biomass of hard substratum fauna in the Princess Amalia Wind Farm is remarkable, and adds a significant new source of easily accessible food for fish, birds and possibly even marine mammals. In view of the large number of planned wind turbines it is important to measure the actual flow of this biomass to higher trophic levels with different research methods.

Sampling could be improved by increasing the number of samples to account for patchiness of the epifauna. A distinction of the littoral zone into a higher and a

lower littoral zone would result in a better representation of the complete zonation pattern. The increasing amount of sediment between the scour protection hampered the collection of stones. As the scour protection harbours a different epifaunal community, it could be important to allocate more time to the collection of stones, e.g. partly at the expense of taking video.

In conclusion, a biologically interesting artificial reef has developed in the Princess Amalia Wind Farm, a reef that will give opportunities to both rare species and associated fauna to prosper.

BIBLIOGRAPHY

Bruyne, R.H. de, S van Leeuwen, A. Gmelig Meyling and R. Daan (2013). Schelpdieren van het Nederlandse Noordzeegebied. Ecologische atlas van de mariene weekdieren (Mollusca). Tirion Uitgevers, Utrecht en Stichting Anemoon, Lisse, 414 pp.

Cook, E., M. Jahnke, F. Kerckhof, D. Minchin, M. Faasse, K. Boos & G. Ashton (2007). European expansion of the introduced amphipod *Caprella mutica* Schurin 1935. Aquatic Invasions 2(4): 411-421.

Degraer, S., R. Brabant and B. Rumes (Eds.) (2013). Environmental impacts of offshore windfarms in the Belgian Part of the North Sea: learning from the past to optimise monitoring programmes. Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management Section. 239 pp.

Guerin, A.J., Jensen, A.C. and Jones, D. (2007). Artificial reef properties of North Sea oil and gas production platforms. Oceans 2007 Proceedings, Aberdeen, Scotland. 18-21 June, pp. 795-800.

Kerckhof, F., B. Rumes, T. Jacques, S. Degraer & A. Norro (2010). Early development of the subtidal marine biofouling on a concrete offshore windmill foundation on the Thornton Bank (southern North Sea): first monitoring results. Underwater Technology 29(3): 137-149.

Mesel, I. De, F. Kerckhof, B. Rumes, A. Norro, J.-S. Houziaux and S. Degraer (2013). Fouling community on the foundations of wind turbines and the surrounding scour protection. In: Degraer et al.(Eds.), Environmental impacts of offshore windfarms in the Belgian Part of the North Sea: learning from the past to optimise monitoring programmes. Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management Section. 239 pp.

Moorsel, G.W.N.M. van (1994). Monitoring kunstriffen Noordzee 1993. Bureau Waardenburg, rapport n0. 94.05

Moorsel G.W.N.M. van & H.W. Waardenburg (1992). De fauna op wrakken in de Noordzee in 1991. Rapport nr. 92.17 Bureau Waardenburg.

Bouma B. and Lengkeek W. (2009). Development of underwater flora- and fauna communities on hard substrates of the offshore wind farm Egmond aan Zee (OWEZ). Report Bureau Waardenburg nr 08-220.

Bouma B. and Lengkeek W. (2012). Benthic communities on hard substrates of the offshore wind farm Egmond aan Zee (OWEZ). Report Bureau Waardenburg nr 11-205.

Dunthorn A.A. (1971). The predation of cultivated mussels by eiders. *Bird Study* 18(2): 107-112.

Hilgerloh G. (1997). Predation by birds on blue mussel *Mytilus edulis* beds of the tidal flats of Spiekeroog (southern North Sea). *Marine Ecology Progress Series* 146: 61-72.

Jarvis S., Allen J., Proctor N., Crossfield A., Dawes O., Leighton A., McNeill L. and Musk W. (2004). North Sea wind farms: NSW Lot 1 Benthic fauna. Institute of Estuarine & Coastal Studies, Hull, UK. IECS rep. ZBB607.2-F-2004: 1-65.

Kerckhof F., Norro A., Jacques T.G. and Degraer S. (2009). Early colonisation of a concrete offshore windmill foundation by marine biofouling on the Thornton Bank (Southern North Sea), *in*: Degraer S. and Brabant R. (Eds.) (2009). Offshore wind farms in the Belgian part of the North Sea: State of the art after two years of environmental monitoring. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models. Marine Ecosystem Management Unit. pp. 39-51.

Kerckhof F., Rumes B., Norro A., Jacques T.G. and Degraer S. (2010a). Seasonal variation and vertical zonation of the marine biofouling on a concrete offshore windmill foundation on the Thornton Bank (Southern North Sea), *in*: Degraer S. and Brabant R. and Rumes B. (Eds.) (2010). Offshore wind farms in the Belgian part of the North Sea: Early environmental impact assessment and spatio-temporal variability. Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models. Marine Ecosystem Management Unit. pp. 53-68.

Kerckhof F., Rumes B., Jacques T.G., Degraer S. and Norro A. (2010b). Early development of the subtidal marine biofouling on a concrete offshore windmill foundation on the Thornton Bank (Southern North Sea): first monitoring results. *Underwater technology* 29 (3): 137-149.

Kerckhof, F., Rumes, B., Norro, A., Houziaux, J.-S. and Degraer S. (2012). A comparison of the first stages of biofouling in two offshore wind farms in the

Blegian part of the North Sea. In: Degraer, S., Brabant, R., and Rumes, B. Offshore wind farms in the Belgian part of the North Sea. Heading for an understanding of environmental impacts, pp. 17-39:

Leonhard S.B. and Pedersen P. (2009). Hard bottom substrate monitoring Horns Rev offshore wind farm. Annual status report 2004. Elsam Engineering May 2005.

Nehring S. (1999). Oyster beds and Sabellaria reefs, *in*: de Jong F., Bakker J.F., van Berkel C.J.M., Dankers N.M.J.A., Dahl K., Gätje C., Marencic H. and Potel P. (eds.), Wadden Sea Quality Status Report. Common Wadden Sea Secretariat Wilhelmshaven, Wadden Sea Ecosystem No. 9: 146-147.

Reubens J.T., Degraer S. and Vincx M. (2010). The importance of marine wind farms, as artificial hard substrata, for the ecology of the ichthyofauna. In: Degraer S. et al. (Ed.), Offshore wind farms in the Belgian part of the North Sea: Early environmental impact assessment and spatio-temporal variability. pp. 69-82.

Reubens J.T., Degraer S. and Vincx M. (2011). Aggregation and feeding behaviour of pouting (*Trisopterus luscus*) at wind turbines in the Belgian part of the North Sea. *Fisheries Research* 108(1): 223-227. dx.doi.org/10.1016/j.fishres.2010.11.025

Vanagt T. , Van de Moortel L. and Faasse M. (2013) Development of hard substrate fauna in the Princess Amalia Wind Farm. Monitoring 3.5 years after construction. eCOAST report 2011036

Vanagt T., Lock K. and Faasse M. (submitted). Assessment of the soft sediment fauna six years after construction of the Princess Amalia wind farm. eCOAST report 2013002.

Van Moorsel G.W.N.M. (2003). Ecologie van de Klaverbank. BiotaSurvey 2002. Ecosub, Doorn, 154 pp.

Zintzen V. (2007). Biodiversity of shipwrecks from the Southern Bight of the North Sea. PhD Thesis. Université Catholique de Louvain / Institut Royal des Sciences Naturelles de Belgique: Louvain –la-Neuve, Belgium, 343 pp.

Zintzen V., Norro A., Massin C. and Mallefet J. (2008). Temporal variation of *Tubularia indivisa* (Cnidaria, Tubulariidae) and associated epizoites on artificial habitat communities in the North Sea. *Marine Biology* 153: 405-420.

Annex 1. Species list T4 and T6. Video = only seen on video, x = present in scrape samples. [1]Present name of *Pomatoceros triqueter* is *Spirobranchus triqueter*.

	Class	species	T4	T6
Chlorophyta	Chlorophyceaea	*Blidingia minima*	x	x
		Prasiola stipitata		x
		Ulva intestinalis	*Ulva* spp.	x
		Ulva linza	*Ulva* spp.	x
Porifera	Calcarea	*Leucosolenia variabilis*	x	x
Cnidaria	Anthozoa	*Actinothoe sphyrodeta*	video	
		Alcyonium digitatum	x	x
		Diadumene cincta	x	x
		Metridium senile	x	x
		Sagartia elegans	x	x
		Sagartia troglodytes	x	x
		Sagartiogeton undatus	x	x
		Urticina felina	x	x
	Hydrozoa	*Campanulariidae spp.*	x	x
		Clytia hemisphaerica	x	x
		Ectopleura larynx	x	x
		Hydractinia echinata	x	x
		Laomedea flexuosa	x	
		Obelia dichotoma	x	x
		Obelia longissima	x	x
		Tubularia indivisa	x	x
	Scyphozoa	*Aurelia aurita*	video	
Platyhelminthes	Polycladida	*Leptoplana tremellaris*		x
Nemertea	Enopla	*Emplectonema gracile*	x	x
Annelida	Polychaeta	*Ctenodrilus serratus*		x
		Eulalia viridis	x	x
		Eunereis longissima	x	x
		Harmothoe extenuata	x	x
		Harmothoe impar	x	x
		Lagis koreni		x
		Lanice conchilega	x	x
		Lepidonotus squamatus	x	x
		Malacoceros fuliginosus		x
		Nereis pelagica	x	x
		Phyllodoce laminosa	x	x
		Phyllodoce maculata		x
		Phyllodoce mucosa	x	*P.* indet.
		Pomatoceros triqueter [1]	x	
		Sabellaria spinulosa	x	
		Spirorbidae	x	
		Syllis prolifera	x	x
Hexapoda	Diptera	*Telmatogeton japonicus*	x	x
Crustacea	Copepoda	*Calanoida*	x	
	Ostracoda	*Podocopida*	x	
	Cirripedia	*Amphibalanus improvisus*		x
		Austrominius modestus		x
		Balanus crenatus	x	x
		Megabalanus coccopoma	x	dead
		Perforatus perforatus		add. sample
		Semibalanus balanoides	x	x
		Verruca stroemia	x	x
	Amphipoda	*Abludomelita obtusata*	x	
		Amphipoda indet.		x
		Caprella linearis	x	x
		Caprella mutica		x
		Gitana sarsi	x	x
		Jassa herdmani	x	x
		Jassa marmorata	x	x

		Metopa alderi		x
		Monocorophium acherusicum	x	x
		Monocorophium sextonae	x	x
		Phtisica marina	x	x
		Stenothoe monoculoides	x	x
		Stenothoe sp.	x	
		Stenothoe valida	x	x
	Isopoda	*Idotea pelagica*	x	x
	Decapoda	*Cancer pagurus*	x	x
		Homarus gammarus		x
		Necora puber	x	x
		Pagurus bernhardus		video
		Pilumnus hirtellus	x	x
		Pinnotheres pisum	x	
		Pisidia longicornis	x	x
Mollusca	Bivalvia	*Crassostrea gigas*	as *Ostrea*	x
		Heteranomia squamula	x	x
		Hiatella arctica		x
		Mytilus edulis	x	x
		Ostrea edulis		dead
		Venerupis senegalensis	x	x
	Gastropoda	*Aeolidia papillosa*	x	x
		Crepidula fornicata		x
		Cuthona gymnota		x
		Dendronotus frondosus		x
		Doto coronata		x
		Epitonium clathratulum	x	
		Eubranchus sp.		x
		Odostomia scalaris	x	x
		Onchidoris muricata	As *O. bilamellata*	x
Bryozoa	Gymnolaemata	*Alcyonidium condylocinereum*	x	*A.* spec.
		Alcyonidium mamillatum	x	x
		Alcyonidium mytili		x
		Arachnidium fibrosum	x	x
		Bowerbankia sp.	x	
		Callopora dumerilii	x	x
		Celleporella hyalina	x	x
		Conopeum reticulum	x	x
		Electra pilosa	x	x
		Farrella repens	x	
		Fenestrulina delicia	x	x
		Microporella ciliata	x	x
		Schizomavella linearis	x	
		Scruparia ambigua	x	x
		Smittoidea prolifica	x	
Echinodermata	Asteroidea	*Asterias rubens*	x	x
	Echinoidea	*Echinocardium cordatum*		x
		Psammechinus miliaris	x	x
	Ophiuroidea	*Ophiothrix fragilis*		x
Tunicata	Ascidiacea	*Diplosoma listerianum*	x	x
Vertebrata	Pisces	*Pholis gunnellus*		video
		Trisopterus luscus	video	

Annex 2. Video footage data.

Percentage coverage of the monopiles. Hydrozoa and *Jassa* are taken together as almost all *Jassa* were on hydrozoan colonies and bare hydrozoan colonies almost absent. The presence of mobile organisms is indicated with 'i'. Where these mobile organisms blocked the view of the underlying structures, this is listed in the column 'invisible'.

WTG	orientation	depth	*Mytilus*	Actiniaria	Hydrozoa-*Jassa*	*Hydractinia*	algae	total	invisible	*Asterias*	*P. miliaris*
1	NNE	Intertidal					10	10			
		2		5	75			95	15	i	i
		5		10	60			85	15	i	i
		10	15	10	60	15		100			
		17		40	40	10		90			
		Scour		75	5			80		i	
	SSW	Intertidal					10	10			
		2	100					100			
		5		5	75			95	15	i	i
		10	50	50				100			
		17		40	40			80			
		Scour		75	5			80		i	
20	NNE	Intertidal					30	30			
		2	10	10	80			100			i
		5			90	10		100			
		10		65	20	10		95			
		17		90	10			100		i	
		Scour		80				80		i	
	SSW	Intertidal					30	30			
		2	10	10	80			100			i
		5			90	10		100			
		10		65	20	10		95			
		17		85		10		95		i	
		Scour		80				80		i	
45	NNE	Intertidal					10	10			
		2	30	35	35			100			
		5		10	90			100		i	i
		10		10	90			100		i	
		17		25	75			100		i	i
		Scour		90						i	
	SSW	Intertidal					10	10			
		2	30	35	35			100			
		5		10	90			100		I	i
		10		10	80			90			
		17	80	20				100			
		Scour		90						I	
60	NNE	Intertidal					20	20			
		2	50	25	25			100			
		5		10	90			100		i	i
		10		10	90			100			
		17	80	20				100		i	
		Scour		90				90		I	
	SSW	Intertidal					20	20			
		2	50	25	25			100			
		5		10	80			100	10	I	i
		10		10	90			100			
		17	80	20				100			
		Scour		90				90		I	

Annex 3. Raw density data (ind/m²)

	1-D10-N-2013	1-D10-Z-2013	1-D17-N-2013	1-D17-Z-2013	1-D2-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens				1071,4	17,9
Austrominius modestus					
Balanus crenatus	53,6	446,4	589,3	142,9	
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus			17,9		
Caprella linearis	35,7		1285,7	285,7	
Caprella mutica		3196,4	303,6		
Celleporella hyalina		35,7	285,7		17,9
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus	178,6	17,9	285,7		3553,6
Cuthona gymnota					71,4
Dendronotus frondosus					
Diadumene cincta	17,9	875,0	857,1	857,1	
Diplosoma listerianum	375,0	214,3			17,9
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx	71,4	160,7	71,4	107,1	53,6
Electra pilosa	392,9	767,9	642,9	500,0	660,7
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis		17,9			767,9
Eunereis longissima	2285,7	321,4		321,4	
Fenestrulina delicia					
Gitana sarsi	1160,7		875,0	285,7	1142,9
Harmothoe extenuata	232,1	142,9	125,0	321,4	696,4
Harmothoe impar	142,9	178,6	303,6	857,1	
Heteranomia squamula	35,7	71,4	53,6		53,6
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata			17,9	35,7	
Idotea pelagica					6982,1
Jassa herdmani	326856,4	115142,6	135999,7	431999,0	646855,6
Jassa marmorata					161142,5
Lagis koreni					
Lanice conchilega	35,7		607,1	35,7	17,9
Lepidonotus squamatus	35,7		17,9	142,9	
Leptoplana tremellaris			35,7		
Leucosolenia variabilis	53,6	71,4			125,0
Malacoceros fuliginosus		17,9			
Metopa alderi					
Metridium senile	142,9	196,4	232,1	535,7	2267,9
Microporella ciliata					
Monocorophium acherusicum		857,1	1714,3		
Monocorophium sextonae	2303,6	1142,9		285,7	
Monocorophium sp.					

	1-D10-N-2013	1-D10-Z-2013	1-D17-N-2013	1-D17-Z-2013	1-D2-N-2013
Mytilus edulis	1089,3	1321,4	1625,0	2107,1	10964,3
Necora puber			17,9		
Nereidae indet.					
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					35,7
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina	1178,6		1160,7		
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	35,7	17,9	17,9		107,1
Pisidia longicornis	17,9	71,4	35,7		142,9
Prasiola stipitata					
Psammechinus miliaris					89,3
Sagartia elegans					
Sagartia troglodytes	17,9				
Sagartiogeton undatus					17,9
Scruparia ambigua					
Semibalanus balanoides					
Stenothoe monoculoides	17196,4	910,7	1196,4	1821,4	19428,5
Stenothoe valida	2357,1	375,0	660,7	3785,7	
Syllis prolifera	1142,9				107,1
Telmatogeton japonicus					
Tubularia indivisa	410,7	89,3	71,4	89,3	107,1
Ulva intestinalis	17,9				
Ulva linza					
Urticina felina					
Venerupis senegalensis			17,9		
Verruca stroemia					

	1-D2-Z-2013	1-D5-N-2013	1-D5-Z-2013	1-Sc-N-2013	1-Sp-N-2013	1-Sp-Z-2013
Aeolidia papillosa				16,0		
Alcyonidium mamillatum						
Alcyonidium mytili						
Alcyonidium sp.						
Alcyonium digitatum						
Amphibalanus improvisus						
Amphipoda indet.						
Arachnidium fibrosum						
Asterias rubens	35,7	2375,0	142,9	8,0		
Austrominius modestus						
Balanus crenatus			142,9			
Blidingia minima					17,9	142,9
Callopora dumerilii						
Campanulariidae spp.				4,0		
Cancer pagurus			35,7			
Caprella linearis				640,0		
Caprella mutica			35,7			
Celleporella hyalina						
Clytia hemisphaerica						
Conopeum reticulum			35,7	20,0		
Crassostrea gigas						
Crepidula fornicata						
Ctenodrilus serratus						
Cuthona gymnota			35,7			
Dendronotus frondosus						
Diadumene cincta						
Diplosoma listerianum	35,7		107,1			
Doto coronata						
Echinocardium cordatum						
Ectopleura larynx	107,1	4000,0	321,4	12,0		
Electra pilosa	357,1		428,6	24,0		
Emplectonema gracile						
Eubranchus sp.						
Eulalia viridis	428,6	17,9	214,3	8,0		
Eunereis longissima						
Fenestrulina delicia						
Gitana sarsi		1142,9	2321,4			
Harmothoe extenuata	678,6		678,6	4,0		
Harmothoe impar						
Heteranomia squamula			321,4			
Hiatella arctica				4,0		
Homarus gammarus						
Hydractinia echinata						
Idotea pelagica						
Jassa herdmani	469659,6	467427,4	1410282,3	8704,0		
Jassa marmorata	64053,4					
Lagis koreni						
Lanice conchilega			71,4	36,0		
Lepidonotus squamatus	71,4		35,7	4,0		
Leptoplana tremellaris						
Leucosolenia variabilis	71,4	142,9	35,7			
Malacoceros fuliginosus						
Metopa alderi				4,0		
Metridium senile	1500,0	321,4	142,9	352,0		
Microporella ciliata						
Monocorophium acherusicum	2285,7			240,0		
Monocorophium sextonae			2285,7			
Monocorophium sp.						

	1-D2-Z-2013	1-D5-N-2013	1-D5-Z-2013	1-Sc-N-2013	1-Sp-N-2013	1-Sp-Z-2013
Mytilus edulis	8464,3	214,3	7142,8			
Necora puber						
Nereidae indet.			35,7	20,0		
Nereis pelagica						
Obelia dichotoma						
Obelia longissima				40,0		
Odostomia scalaris						
Onchidoris bilamellata						
Ophiothrix fragilis	35,7					
Phtisica marina			4642,8	64,0		
Phyllodoce laminosa						
Phyllodoce maculata				4,0		
Phyllodocidae indet.				4,0		
Pilumnus hirtellus	71,4	17,9	178,6			
Pisidia longicornis	35,7	17,9	285,7			
Prasiola stipitata						71,4
Psammechinus miliaris	35,7	35,7				
Sagartia elegans	107,1	696,4	71,4			
Sagartia troglodytes						
Sagartiogeton undatus						
Scruparia ambigua						
Semibalanus balanoides	107,1					
Stenothoe monoculoides	6892,8	33142,8	38964,2	68,0		
Stenothoe valida	142,9	6982,1	7964,3	44,0		
Syllis prolifera		17,9	35,7	4,0		
Telmatogeton japonicus					125,0	714,3
Tubularia indivisa	107,1	285,7	178,6	20,0		
Ulva intestinalis						
Ulva linza						
Urticina felina						
Venerupis senegalensis						
Verruca stroemia						

	20-D10-N-2013	20-D10-Z-2013	20-D17-N-2013	20-D17-Z-2013	20-D2-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.	1142,9				
Arachnidium fibrosum	71,4	53,6			
Asterias rubens	53,6	107,1			107,1
Austrominius modestus					
Balanus crenatus				71,4	
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus					
Caprella linearis	105856,9	108571,2	13821,4	1142,9	857,1
Caprella mutica					
Celleporella hyalina	89,3				
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata		17,9			
Ctenodrilus serratus					
Cuthona gymnota					
Dendronotus frondosus					
Diadumene cincta		17,9			125,0
Diplosoma listerianum	17,9	17,9	17,9		
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx					125,0
Electra pilosa	107,1	553,6	71,4		232,1
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	17,9	1392,9			125,0
Eunereis longissima					285,7
Fenestrulina delicia					
Gitana sarsi					17,9
Harmothoe extenuata	17,9	35,7			17,9
Harmothoe impar					
Heteranomia squamula					
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata	17,9	17,9		17,9	
Idotea pelagica					
Jassa herdmani	258285,1	395427,6	66857,0	12857,1	347427,7
Jassa marmorata					
Lagis koreni					
Lanice conchilega		35,7			
Lepidonotus squamatus		17,9			
Leptoplana tremellaris					
Leucosolenia variabilis	107,1	53,6			35,7
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	178,6	160,7	10303,5	4464,3	160,7
Microporella ciliata					
Monocorophium acherusicum	3428,6				
Monocorophium sextonae			571,4		
Monocorophium sp.					

	20-D10-N-2013	20-D10-Z-2013	20-D17-N-2013	20-D17-Z-2013	20-D2-N-2013
Mytilus edulis	232,1	2017,9	714,3	17,9	982,1
Necora puber					
Nereidae indet.					
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina		642,9	571,4	285,7	
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	17,9	89,3			17,9
Pisidia longicornis	71,4				
Prasiola stipitata					
Psammechinus miliaris		142,9			17,9
Sagartia elegans	35,7	1000,0			
Sagartia troglodytes					
Sagartiogeton undatus					
Scruparia ambigua		35,7			
Semibalanus balanoides					
Stenothoe monoculoides	2285,7	1160,7			2571,4
Stenothoe valida		1142,9			
Syllis prolifera					285,7
Telmatogeton japonicus					
Tubularia indivisa	17,9		35,7		71,4
Ulva intestinalis					
Ulva linza					
Urticina felina		17,9			17,9
Venerupis senegalensis					
Verruca stroemia	17,9				

	20-D2-Z-2013	20-D5-N-2013	20-D5-Z-2013	20-Sc-Z-2013	20-Sp-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					17,9
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens		303,6	35,7		
Austrominius modestus					392,9
Balanus crenatus	71,4				17,9
Blidingia minima					571,4
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus					
Caprella linearis	71,4	1303,6	76714,1	12,0	500,0
Caprella mutica					
Celleporella hyalina				20,0	
Clytia hemisphaerica					
Conopeum reticulum				64,0	
Crassostrea gigas					17,9
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota					
Dendronotus frondosus					
Diadumene cincta					
Diplosoma listerianum	35,7	35,7			
Doto coronata					142,9
Echinocardium cordatum					
Ectopleura larynx	35,7				
Electra pilosa	535,7	321,4	428,6		17,9
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	678,6	125,0	410,7		
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi			1142,9		
Harmothoe extenuata	750,0	125,0			
Harmothoe impar			53,6		
Heteranomia squamula	107,1				
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica	4571,4				47857,0
Jassa herdmani	1469710,8	995426,2	811426,6	44,0	214,3
Jassa marmorata		41142,8			5857,1
Lagis koreni	71,4				
Lanice conchilega	2285,7	71,4	1142,9		
Lepidonotus squamatus	142,9		17,9		
Leptoplana tremellaris					
Leucosolenia variabilis	321,4	35,7	35,7		
Malacoceros fuliginosus					
Metopa alderi		1142,9			
Metridium senile	1660,7	89,3		420,0	
Microporella ciliata				32,0	
Monocorophium acherusicum	21428,5			192,0	
Monocorophium sextonae					
Monocorophium sp.					

	20-D2-Z-2013	20-D5-N-2013	20-D5-Z-2013	20-Sc-Z-2013	20-Sp-N-2013
Mytilus edulis	18535,7		196,4		10214,3
Necora puber					
Nereidae indet.				8,0	
Nereis pelagica	35,7				
Obelia dichotoma					1446,4
Obelia longissima				124,0	
Odostomia scalaris					
Onchidoris bilamellata				4,0	
Ophiothrix fragilis					
Phtisica marina					
Phyllodoce laminosa	35,7				
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	178,6	17,9			
Pisidia longicornis	142,9				
Prasiola stipitata					
Psammechinus miliaris	71,4	107,1	196,4		
Sagartia elegans	35,7	89,3	267,9		
Sagartia troglodytes					
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides					553,6
Stenothoe monoculoides	25999,9	9142,8	22999,9		
Stenothoe valida	35,7	17,9			
Syllis prolifera					
Telmatogeton japonicus					1142,9
Tubularia indivisa		107,1	71,4		
Ulva intestinalis					
Ulva linza					35,7
Urticina felina					
Venerupis senegalensis					
Verruca stroemia				8,0	

	20-Sp-Z-2013	45-D10-N-2013	45-D10-Z-2013	45-D17-N-2013	45-D17-Z-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					17,9
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus	17,9				
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens		71,4	71,4		
Austrominius modestus	71,4				
Balanus crenatus					35,7
Blidingia minima	214,3				
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus					17,9
Caprella linearis				357,1	
Caprella mutica					
Celleporella hyalina					17,9
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota			125,0		
Dendronotus frondosus		321,4	303,6		
Diadumene cincta					
Diplosoma listerianum			89,3		
Doto coronata	17,9				
Echinocardium cordatum					
Ectopleura larynx					
Electra pilosa	17,9	125,0	142,9	17,9	17,9
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis		89,3	464,3	35,7	
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi			1142,9		
Harmothoe extenuata		160,7	214,3	35,7	89,3
Harmothoe impar					17,9
Heteranomia squamula					
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica	9785,7				
Jassa herdmani		906283,5	1177140,0	18000,0	9714,3
Jassa marmorata	946,4				
Lagis koreni					
Lanice conchilega		17,9	71,4		
Lepidonotus squamatus		17,9			
Leptoplana tremellaris					
Leucosolenia variabilis		53,6	160,7		
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile		142,9		410,7	892,9
Microporella ciliata					
Monocorophium acherusicum					
Monocorophium sextonae					
Monocorophium sp.					

	20-Sp-Z-2013	45-D10-N-2013	45-D10-Z-2013	45-D17-N-2013	45-D17-Z-2013
Mytilus edulis	1035,7	89,3	1535,7		446,4
Necora puber					
Nereidae indet.			2285,7		17,9
Nereis pelagica			17,9		
Obelia dichotoma	53,6				
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					
Ophiothrix fragilis			71,4		
Phtisica marina				71,4	2857,1
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus			53,6		35,7
Pisidia longicornis		17,9	17,9	17,9	17,9
Prasiola stipitata					
Psammechinus miliaris		17,9			
Sagartia elegans			2053,6		
Sagartia troglodytes					
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides	1321,4				
Stenothoe monoculoides		10285,7	25142,8		
Stenothoe valida				17,9	
Syllis prolifera	17,9	2321,4			
Telmatogeton japonicus	500,0				
Tubularia indivisa		35,7	89,3		
Ulva intestinalis					
Ulva linza	214,3				
Urticina felina					
Venerupis senegalensis					
Verruca stroemia					

	45-D2-N-2013	45-D2-Z-2013	45-D5-N-2013	45-D5-Z-2013	45-Sc-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum	35,7				
Alcyonidium mytili					
Alcyonidium sp.					4,0
Alcyonium digitatum				53,6	
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens	17,9	142,9	321,4	285,7	
Austrominius modestus					
Balanus crenatus					8,0
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus			17,9		
Caprella linearis			17,9	1142,9	128,0
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					12,0
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus			1142,9		
Cuthona gymnota		1142,9	1142,9		
Dendronotus frondosus	35,7		500,0	696,4	
Diadumene cincta			53,6		
Diplosoma listerianum				17,9	
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx	107,1	107,1			
Electra pilosa	214,3	339,3	803,6	142,9	64,0
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	35,7	107,1	2321,4	71,4	
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi	1142,9		1142,9		
Harmothoe extenuata	232,1	35,7	267,9	446,4	
Harmothoe impar					
Heteranomia squamula		35,7			
Hiatella arctica					
Homarus gammarus					4,0
Hydractinia echinata					0,0
Idotea pelagica		17,9			
Jassa herdmani	711998,3	580570,0	893712,1	842283,7	3968,0
Jassa marmorata	61714,1	183999,6		73142,7	
Lagis koreni					
Lanice conchilega	35,7				
Lepidonotus squamatus		17,9	17,9		64,0
Leptoplana tremellaris					
Leucosolenia variabilis	35,7		71,4	17,9	
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	2285,7	1535,7		232,1	116,0
Microporella ciliata					
Monocorophium acherusicum					640,0
Monocorophium sextonae					
Monocorophium sp.					

	45-D2-N-2013	45-D2-Z-2013	45-D5-N-2013	45-D5-Z-2013	45-Sc-N-2013
Mytilus edulis	5821,4	4321,4			
Necora puber				17,9	
Nereidae indet.					64,0
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina					
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	17,9	35,7	53,6	53,6	
Pisidia longicornis			53,6	17,9	
Prasiola stipitata					
Psammechinus miliaris		17,9	303,6	392,9	
Sagartia elegans					
Sagartia troglodytes			53,6		
Sagartiogeton undatus					
Scruparia ambigua			71,4		
Semibalanus balanoides					
Stenothoe monoculoides	9142,8	8000,0	28571,4	8000,0	
Stenothoe valida	1142,9	1142,9		35,7	
Syllis prolifera	8535,7	5910,7	71,4		
Telmatogeton japonicus					
Tubularia indivisa	214,3	71,4	142,9	89,3	
Ulva intestinalis					
Ulva linza					
Urticina felina			17,9		
Venerupis senegalensis					
Verruca stroemia					

	45-Sc-Z-2013	45-Sp-N-2013	45-Sp-Z-2013	60-D10-N-2013	60-D10-Z-2013
Aeolidia papillosa	12,0				
Alcyonidium mamillatum	12,0				
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum	16,0				
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens	4,0			35,7	35,7
Austrominius modestus		89,3			
Balanus crenatus		89,3	35,7		
Blidingia minima		339,3			
Callopora dumerilii	12,0				
Campanulariidae spp.					
Cancer pagurus					
Caprella linearis	768,0	392,9	5142,8	193142,4	118856,9
Caprella mutica					
Celleporella hyalina	4,0				
Clytia hemisphaerica					
Conopeum reticulum	16,0				
Crassostrea gigas			17,9		
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota				2285,7	
Dendronotus frondosus					
Diadumene cincta					
Diplosoma listerianum					
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx				71,4	214,3
Electra pilosa	8,0	142,9		857,1	2892,9
Emplectonema gracile		17,9			
Eubranchus sp.					
Eulalia viridis	8,0			107,1	142,9
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi					
Harmothoe extenuata	12,0			71,4	125,0
Harmothoe impar					
Heteranomia squamula					1142,9
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica		12357,1	25142,8		
Jassa herdmani	9216,0			817140,9	474284,6
Jassa marmorata		1071,4	48571,3		
Lagis koreni					
Lanice conchilega	4,0				107,1
Lepidonotus squamatus					
Leptoplana tremellaris					
Leucosolenia variabilis				71,4	232,1
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	776,0			196,4	125,0
Microporella ciliata	40,0				
Monocorophium acherusicum	384,0				
Monocorophium sextonae	256,0				
Monocorophium sp.					

	45-Sc-Z-2013	45-Sp-N-2013	45-Sp-Z-2013	60-D10-N-2013	60-D10-Z-2013
Mytilus edulis	24,0	2821,4	589,3	2482,1	7375,0
Necora puber					
Nereidae indet.	16,0			1142,9	
Nereis pelagica					
Obelia dichotoma		89,3			
Obelia longissima	24,0				
Odostomia scalaris					
Onchidoris bilamellata	8,0				
Ophiothrix fragilis					
Phtisica marina	8,0				1142,9
Phyllodoce laminosa					
Phyllodoce maculata	4,0				
Phyllodocidae indet.					
Pilumnus hirtellus				35,7	35,7
Pisidia longicornis					1178,6
Prasiola stipitata					
Psammechinus miliaris				53,6	35,7
Sagartia elegans					
Sagartia troglodytes				17,9	
Sagartiogeton undatus	4,0				
Scruparia ambigua					
Semibalanus balanoides		2482,1	2339,3		
Stenothoe monoculoides	256,0			10285,7	12571,4
Stenothoe valida	12,0				
Syllis prolifera	8,0			1142,9	107,1
Telmatogeton japonicus		71,4			
Tubularia indivisa	16,0			107,1	392,9
Ulva intestinalis			232,1		
Ulva linza			53,6		
Urticina felina					35,7
Venerupis senegalensis					
Verruca stroemia					

	60-D17-N-2013	60-D17-Z-2013	60-D2-N-2013	60-D2-Z-2013	60-D5-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili		107,1			
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens			35,7	53,6	178,6
Austrominius modestus					
Balanus crenatus	107,1	464,3	17,9	17,9	
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus	35,7			17,9	
Caprella linearis	181713,8	41142,8	3428,6	13714,3	37714,2
Caprella mutica					
Celleporella hyalina		321,4		17,9	
Clytia hemisphaerica					
Conopeum reticulum		35,7			
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota					
Dendronotus frondosus					
Diadumene cincta					
Diplosoma listerianum		214,3	17,9	71,4	35,7
Doto coronata					
Echinocardium cordatum	17,9				
Ectopleura larynx					
Electra pilosa	250,0	142,9	71,4	303,6	571,4
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	17,9	35,7		125,0	71,4
Eunereis longissima	17,9				
Fenestrulina delicia					
Gitana sarsi					
Harmothoe extenuata	285,7	357,1	1142,9	160,7	71,4
Harmothoe impar					
Heteranomia squamula				125,0	17,9
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica			2285,7	4571,4	
Jassa herdmani	118856,9	31428,5	166856,7	798855,2	619427,1
Jassa marmorata			111999,7	199999,5	26285,7
Lagis koreni					
Lanice conchilega	17,9				
Lepidonotus squamatus	17,9	35,7		35,7	17,9
Leptoplana tremellaris					
Leucosolenia variabilis				53,6	
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	1660,7	535,7	464,3	3303,6	714,3
Microporella ciliata					
Monocorophium acherusicum		4571,4			
Monocorophium sextonae					
Monocorophium sp.		2285,7			

	60-D17-N-2013	60-D17-Z-2013	60-D2-N-2013	60-D2-Z-2013	60-D5-N-2013
Mytilus edulis	2803,6	2321,4	5321,4	17928,5	6785,7
Necora puber					
Nereidae indet.	1142,9				
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris	1142,9				
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina	1142,9	1714,3			
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	17,9	71,4	17,9	107,1	17,9
Pisidia longicornis	35,7	35,7	17,9	53,6	35,7
Prasiola stipitata					
Psammechinus miliaris			17,9	53,6	35,7
Sagartia elegans			17,9		357,1
Sagartia troglodytes				17,9	
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides					
Stenothoe monoculoides	1142,9	3000,0	1142,9	22857,1	12571,4
Stenothoe valida			1142,9	35,7	
Syllis prolifera					4571,4
Telmatogeton japonicus					
Tubularia indivisa			107,1	125,0	267,9
Ulva intestinalis					
Ulva linza					
Urticina felina			17,9	17,9	17,9
Venerupis senegalensis					
Verruca stroemia				17,9	

	60-D5-Z-2013	60-Sc-Z-2013	60-Sp-N-2013	60-SP-Z-2013
Aeolidia papillosa				
Alcyonidium mamillatum				
Alcyonidium mytili				
Alcyonidium sp.				
Alcyonium digitatum		8,0		
Amphibalanus improvisus			53,6	
Amphipoda indet.				
Arachnidium fibrosum				
Asterias rubens	321,4	4,0		
Austrominius modestus				
Balanus crenatus			17,9	71,4
Blidingia minima			17,9	107,1
Callopora dumerilii		8,0		
Campanulariidae spp.				
Cancer pagurus				
Caprella linearis	249142,3	32,0	4000,0	18285,7
Caprella mutica				
Celleporella hyalina		12,0		
Clytia hemisphaerica		8,0		
Conopeum reticulum		44,0		
Crassostrea gigas				17,9
Crepidula fornicata				
Ctenodrilus serratus				
Cuthona gymnota				
Dendronotus frondosus				
Diadumene cincta				
Diplosoma listerianum				
Doto coronata				571,4
Echinocardium cordatum				
Ectopleura larynx				
Electra pilosa	2571,4	8,0		71,4
Emplectonema gracile				
Eubranchus sp.		4,0		
Eulalia viridis	17,9			
Eunereis longissima				
Fenestrulina delicia		4,0		
Gitana sarsi				
Harmothoe extenuata	303,6			
Harmothoe impar				
Heteranomia squamula				
Hiatella arctica		4,0		
Homarus gammarus				
Hydractinia echinata				
Idotea pelagica			32285,6	51428,4
Jassa herdmani	777141,0	136,0		
Jassa marmorata			27428,5	281142,2
Lagis koreni				
Lanice conchilega		4,0		
Lepidonotus squamatus	35,7			
Leptoplana tremellaris				
Leucosolenia variabilis				
Malacoceros fuliginosus				
Metopa alderi				
Metridium senile	178,6	484,0		
Microporella ciliata		108,0		
Monocorophium acherusicum		368,0		
Monocorophium sextonae				
Monocorophium sp.				

	60-D5-Z-2013	60-Sc-Z-2013	60-Sp-N-2013	60-SP-Z-2013
Mytilus edulis	107,1		3250,0	23428,5
Necora puber				
Nereidae indet.		4,0		571,4
Nereis pelagica				
Obelia dichotoma			142,9	53,6
Obelia longissima		12,0		
Odostomia scalaris				
Onchidoris bilamellata		4,0		
Ophiothrix fragilis				
Phtisica marina				
Phyllodoce laminosa				
Phyllodoce maculata				
Phyllodocidae indet.				
Pilumnus hirtellus	71,4			
Pisidia longicornis	53,6			
Prasiola stipitata				
Psammechinus miliaris	375,0	4,0		
Sagartia elegans				
Sagartia troglodytes				
Sagartiogeton undatus				
Scruparia ambigua				
Semibalanus balanoides			1250,0	839,3
Stenothoe monoculoides	11428,5			
Stenothoe valida	1142,9			
Syllis prolifera	2285,7			
Telmatogeton japonicus			285,7	1714,3
Tubularia indivisa	339,3	4,0		
Ulva intestinalis				
Ulva linza				
Urticina felina	17,9			
Venerupis senegalensis				
Verruca stroemia		972,0		

Annex 4. Raw biomass data (g AFDW/m²)

	1-D10-N-2013	1-D10-Z-2013	1-D17-N-2013	1-D17-Z-2013	1-D2-N-2013	1-D2-Z-2013
Aeolidia papillosa						
Alcyonidium mamillatum						
Alcyonidium mytili						
Alcyonidium sp.						
Alcyonium digitatum						
Amphibalanus improvisus						
Amphipoda indet.						
Arachnidium fibrosum						
Asterias rubens				4,464	40,163	0,448
Austrominius modestus						
Balanus crenatus	0,015	1,148	0,772	0,220		
Blidingia minima						
Callopora dumerilii						
Campanulariidae spp.						
Cancer pagurus			136,674			
Caprella linearis	0,036		1,286	0,286		
Caprella mutica		3,196	0,304			
Celleporella hyalina						
Clytia hemisphaerica						
Conopeum reticulum						
Crassostrea gigas						
Crepidula fornicata						
Ctenodrilus serratus	0,000	0,000	0,000		0,000	
Cuthona gymnota					0,079	
Dendronotus frondosus						
Diadumene cincta	0,014	0,074	0,041	0,163		
Diplosoma listerianum	0,755	0,020			0,000	0,017
Doto coronata						
Echinocardium cordatum						
Ectopleura larynx						
Electra pilosa						
Emplectonema gracile						
Eubranchus sp.						
Eulalia viridis		0,077			4,591	2,421
Eunereis longissima	0,064	0,543		0,011		
Fenestrulina delicia						
Gitana sarsi	0,000		0,000	0,000	0,000	
Harmothoe extenuata	2,809	0,557	2,140	0,083	2,948	6,825
Harmothoe impar	0,279	0,371	0,471	0,320		
Heteranomia squamula	0,017	0,069	0,033		0,023	
Hiatella arctica						
Homarus gammarus						
Hydractinia echinata						
Idotea pelagica					30,980	
Jassa herdmani	98,057	34,543	40,800	129,600	194,057	140,898
Jassa marmorata					48,343	19,216
Lagis koreni						
Lanice conchilega	0,290		0,214	0,320	0,000	
Lepidonotus squamatus	1,003		0,800	0,077		2,891
Leptoplana tremellaris			0,423			
Leucosolenia variabilis	0,077	0,027			1,183	3,753
Malacoceros fuliginosus		0,031				
Metopa alderi						
Metridium senile	9,504	6,900	30,885	778,837	100,541	66,536
Microporella ciliata						
Monocorophium acherusicum		0,171	0,343			0,457
Monocorophium sextonae	0,461	0,229		0,057		
Monocorophium sp.						

	1-D10-N-2013	1-D10-Z-2013	1-D17-N-2013	1-D17-Z-2013	1-D2-N-2013	1-D2-Z-2013
Mytilus edulis	289,964	850,177	0,651	780,382	768,034	1544,282
Necora puber			0,121			
Nereidae indet.						
Nereis pelagica						
Obelia dichotoma						
Obelia longissima						
Odostomia scalaris					0,002	
Onchidoris bilamellata						
Ophiothrix fragilis						0,724
Phtisica marina	1,179		1,161			
Phyllodoce laminosa						
Phyllodoce maculata						
Phyllodocidae indet.						
Pilumnus hirtellus	0,241	6,933	0,236		4,198	0,795
Pisidia longicornis	0,350	3,205	0,666		2,132	1,109
Prasiola stipitata						
Psammechinus miliaris					10,384	6,593
Sagartia elegans						32,185
Sagartia troglodytes	8,281					
Sagartiogeton undatus					4,319	
Scruparia ambigua						
Semibalanus balanoides						0,149
Stenothoe monoculoides	0,001	0,000	0,000	0,000	0,001	0,000
Stenothoe valida	0,000	0,000	0,000	0,000		0,000
Syllis prolifera	0,002				0,008	
Telmatogeton japonicus						
Tubularia indivisa						
Ulva intestinalis						
Ulva linza						
Urticina felina						
Venerupis senegalensis			0,327			
Verruca stroemia						

	1-D5-N-2013	1-D5-Z-2013	1-Sc-N-2013	1-Sp-N-2013	1-Sp-Z-2013	20-D10-N-2013
Aeolidia papillosa			0,012			
Alcyonidium mamillatum						
Alcyonidium mytili						
Alcyonidium sp.						
Alcyonium digitatum						
Amphibalanus improvisus						
Amphipoda indet.						0,343
Arachnidium fibrosum						
Asterias rubens	16,083	169,293	1,113			9,738
Austrominius modestus						
Balanus crenatus		0,422				
Blidingia minima						
Callopora dumerilii						
Campanulariidae spp.						
Cancer pagurus		71,175				
Caprella linearis						105,857
Caprella mutica		0,036				
Celleporella hyalina						
Clytia hemisphaerica						
Conopeum reticulum						
Crassostrea gigas						
Crepidula fornicata						
Ctenodrilus serratus						
Cuthona gymnota		0,014				
Dendronotus frondosus						
Diadumene cincta						
Diplosoma listerianum		0,077				0,031
Doto coronata						
Echinocardium cordatum						
Ectopleura larynx						
Electra pilosa						
Emplectonema gracile						
Eubranchus sp.						
Eulalia viridis	0,111	1,833	0,006			0,063
Eunereis longissima						
Fenestrulina delicia						
Gitana sarsi	0,000	0,000				
Harmothoe extenuata		3,706	0,006			0,031
Harmothoe impar						
Heteranomia squamula		0,529				
Hiatella arctica			0,000			
Homarus gammarus						
Hydractinia echinata						
Idotea pelagica						
Jassa herdmani	140,228	423,085	2,611			77,486
Jassa marmorata						
Lagis koreni						
Lanice conchilega		0,289	0,247			
Lepidonotus squamatus		1,431	0,001			
Leptoplana tremellaris						
Leucosolenia variabilis	0,241	0,992				2,986
Malacoceros fuliginosus						
Metopa alderi			0,001			
Metridium senile	6,246	34,391	40,606			134,203
Microporella ciliata						
Monocorophium acherusicum			0,048			0,686
Monocorophium sextonae		0,457				
Monocorophium sp.						

	1-D5-N-2013	1-D5-Z-2013	1-Sc-N-2013	1-Sp-N-2013	1-Sp-Z-2013	20-D10-N-2013
Mytilus edulis	24,715	858,459				183,453
Necora puber						
Nereidae indet.		0,002	0,005			
Nereis pelagica						
Obelia dichotoma						
Obelia longissima						
Odostomia scalaris						
Onchidoris bilamellata						
Ophiothrix fragilis						
Phtisica marina		4,643	0,064			
Phyllodoce laminosa						
Phyllodoce maculata			0,001			
Phyllodocidae indet.			0,001			
Pilumnus hirtellus	0,875	6,595				0,527
Pisidia longicornis	0,265	4,362				0,580
Prasiola stipitata						
Psammechinus miliaris	34,375					
Sagartia elegans	99,722	3,117				31,922
Sagartia troglodytes						
Sagartiogeton undatus						
Scruparia ambigua						
Semibalanus balanoides						
Stenothoe monoculoides	0,001	0,002	0,014			0,000
Stenothoe valida	0,001	0,001	0,013			
Syllis prolifera	0,008	0,003	0,000			
Telmatogeton japonicus				0,000	0,000	
Tubularia indivisa						
Ulva intestinalis						
Ulva linza						
Urticina felina						
Venerupis senegalensis						
Verruca stroemia						0,000

	20-D10-Z-2013	20-D17-N-2013	20-D17-Z-2013	20-D2-N-2013	20-D2-Z-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens	26,526			18,841	
Austrominius modestus					
Balanus crenatus			3,503		0,799
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus					
Caprella linearis	108,571	13,821	1,143	0,857	0,071
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata	10,267				
Ctenodrilus serratus					
Cuthona gymnota					
Dendronotus frondosus					
Diadumene cincta	0,268			0,200	
Diplosoma listerianum	0,012	0,029			0,002
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx					
Electra pilosa					
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	9,149			0,351	3,635
Eunereis longissima				0,000	
Fenestrulina delicia					
Gitana sarsi				0,000	
Harmothoe extenuata	0,577			0,286	2,374
Harmothoe impar					
Heteranomia squamula					0,062
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica					5,291
Jassa herdmani	118,628	20,057	3,857	104,228	440,913
Jassa marmorata					
Lagis koreni					0,156
Lanice conchilega	0,043				0,054
Lepidonotus squamatus	0,480				4,572
Leptoplana tremellaris					
Leucosolenia variabilis	0,153			0,103	1,078
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	76,775	1123,569	1299,765	26,466	88,892
Microporella ciliata					
Monocorophium acherusicum					4,286
Monocorophium sextonae		0,114			
Monocorophium sp.					

	20-D10-Z-2013	20-D17-N-2013	20-D17-Z-2013	20-D2-N-2013	20-D2-Z-2013
Mytilus edulis	14,179	0,578	3,222	23,780	2339,423
Necora puber					
Nereidae indet.					
Nereis pelagica					5,845
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina	0,643	0,571	0,286		
Phyllodoce laminosa					3,385
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	1,962			0,041	33,818
Pisidia longicornis					1,317
Prasiola stipitata					
Psammechinus miliaris	38,125			3,670	26,193
Sagartia elegans	175,241				8,435
Sagartia troglodytes					
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides					
Stenothoe monoculoides	0,000			0,000	0,001
Stenothoe valida	0,000				0,000
Syllis prolifera				0,003	
Telmatogeton japonicus					
Tubularia indivisa					
Ulva intestinalis					
Ulva linza					
Urticina felina	110,401			88,014	
Venerupis senegalensis					
Verruca stroemia					

	20-D5-N-2013	20-D5-Z-2013	20-Sc-Z-2013	20-Sp-N-2013	20-Sp-Z-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus				0,120	0,257
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens	30,266	11,612			
Austrominius modestus				1,116	0,564
Balanus crenatus				0,044	
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus					
Caprella linearis	1,304	76,714	0,054	0,500	
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas				1,390	
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota					
Dendronotus frondosus					
Diadumene cincta					
Diplosoma listerianum	0,002				
Doto coronata				0,018	0,017
Echinocardium cordatum					
Ectopleura larynx					
Electra pilosa					
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	0,040	1,549			
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi		0,000			
Harmothoe extenuata	0,498				
Harmothoe impar		0,183			
Heteranomia squamula					
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica				24,762	18,136
Jassa herdmani	298,628	243,428	0,013	0,064	
Jassa marmorata	12,343			1,757	0,284
Lagis koreni					
Lanice conchilega	0,489	0,086			
Lepidonotus squamatus		0,206			
Leptoplana tremellaris					
Leucosolenia variabilis	0,265	0,491			
Malacoceros fuliginosus					
Metopa alderi	0,343				
Metridium senile	5,383		39,280		
Microporella ciliata					
Monocorophium acherusicum			0,038		
Monocorophium sextonae					
Monocorophium sp.					

	20-D5-N-2013	20-D5-Z-2013	20-Sc-Z-2013	20-Sp-N-2013	20-Sp-Z-2013
Mytilus edulis		1,234		468,213	74,063
Necora puber					
Nereidae indet.			0,001		
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata			0,001		
Ophiothrix fragilis					
Phtisica marina					
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	0,687				
Pisidia longicornis					
Prasiola stipitata					
Psammechinus miliaris	46,271	90,625			
Sagartia elegans	5,807	4,030			
Sagartia troglodytes					
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides				16,740	14,821
Stenothoe monoculoides	0,000	0,001			
Stenothoe valida	0,000				
Syllis prolifera					0,001
Telmatogeton japonicus				0,000	0,000
Tubularia indivisa					
Ulva intestinalis					
Ulva linza					
Urticina felina					
Venerupis senegalensis					
Verruca stroemia			0,000		

	45-D10-N-2013	45-D10-Z-2013	45-D17-N-2013	45-D17-Z-2013	45-D2-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens	9,750	18,348			2,354
Austrominius modestus					
Balanus crenatus				0,114	
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus				5,549	
Caprella linearis			0,357		
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota		0,168			
Dendronotus frondosus	3,979	2,736			3,169
Diadumene cincta					
Diplosoma listerianum		0,056			
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx					
Electra pilosa					
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	0,334	1,923	0,137		0,107
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi		0,000			0,000
Harmothoe extenuata	0,451	0,720	0,197	0,074	1,113
Harmothoe impar				0,000	
Heteranomia squamula					
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica					
Jassa herdmani	271,885	353,142	5,400	2,914	213,599
Jassa marmorata					18,514
Lagis koreni					
Lanice conchilega	0,134	0,109			0,077
Lepidonotus squamatus	0,191				
Leptoplana tremellaris					
Leucosolenia variabilis	1,227	0,376			0,070
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	3,338		370,267	1516,818	156,383
Microporella ciliata					
Monocorophium acherusicum					
Monocorophium sextonae					
Monocorophium sp.					

	45-D10-N-2013	45-D10-Z-2013	45-D17-N-2013	45-D17-Z-2013	45-D2-N-2013
Mytilus edulis	0,109	0,421		212,592	75,256
Necora puber					
Nereidae indet.		0,000		0,003	
Nereis pelagica		1,089			
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					
Ophiothrix fragilis		0,000			
Phtisica marina			0,071	2,857	
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus		1,005		0,306	0,114
Pisidia longicornis	0,141	0,386	0,044	0,138	
Prasiola stipitata					
Psammechinus miliaris	1,611				
Sagartia elegans		362,971			
Sagartia troglodytes					
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides					
Stenothoe monoculoides	0,000	0,001			0,000
Stenothoe valida			0,000		0,000
Syllis prolifera	0,027				1,233
Telmatogeton japonicus					
Tubularia indivisa					
Ulva intestinalis					
Ulva linza					
Urticina felina					
Venerupis senegalensis					
Verruca stroemia					

	45-D2-Z-2013	45-D5-N-2013	45-D5-Z-2013	45-Sc-N-2013	45-Sc-Z-2013
Aeolidia papillosa					0,002
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum			0,087		
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens	75,092	51,192	41,362		0,009
Austrominius modestus					
Balanus crenatus				0,147	
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus		14,683			
Caprella linearis		0,018	1,143		
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus		0,000			
Cuthona gymnota	0,020	0,012			
Dendronotus frondosus		31,406	10,080		
Diadumene cincta		0,289			
Diplosoma listerianum			0,003		
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx					
Electra pilosa					
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	0,454	0,134	0,209		0,004
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi		0,000			
Harmothoe extenuata	0,094	0,963	1,380		0,010
Harmothoe impar					
Heteranomia squamula	0,132				
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica	0,089				
Jassa herdmani	174,171	268,114	252,685	1,190	2,765
Jassa marmorata	55,200		21,943		
Lagis koreni					
Lanice conchilega					0,036
Lepidonotus squamatus	0,217	0,163		0,001	
Leptoplana tremellaris					
Leucosolenia variabilis		0,013	0,029		
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	146,227		7,398	18,961	74,052
Microporella ciliata					
Monocorophium acherusicum				0,128	0,077
Monocorophium sextonae					0,051
Monocorophium sp.					

	45-D2-Z-2013	45-D5-N-2013	45-D5-Z-2013	45-Sc-N-2013	45-Sc-Z-2013
Mytilus edulis	208,642				0,001
Necora puber			3,760		
Nereidae indet.				0,001	0,001
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					0,001
Ophiothrix fragilis					
Phtisica marina					0,008
Phyllodoce laminosa					
Phyllodoce maculata					0,001
Phyllodocidae indet.					
Pilumnus hirtellus	1,176	2,169	1,314		
Pisidia longicornis		1,240	0,077		
Prasiola stipitata					
Psammechinus miliaris	3,439	45,342	62,619		
Sagartia elegans					
Sagartia troglodytes		1,009			
Sagartiogeton undatus					0,160
Scruparia ambigua					
Semibalanus balanoides					
Stenothoe monoculoides	0,000	0,001	0,000		0,051
Stenothoe valida	0,000		0,000		0,004
Syllis prolifera	1,111	0,000			0,001
Telmatogeton japonicus					
Tubularia indivisa					
Ulva intestinalis					
Ulva linza					
Urticina felina		37,731			
Venerupis senegalensis					
Verruca stroemia					

	45-Sp-N-2013	45-Sp-Z-2013	60-D10-N-2013	60-D10-Z-2013	60-D17-N-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens			10,571	8,402	
Austrominius modestus	1,074				
Balanus crenatus	1,863	0,407			0,211
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus					18,924
Caprella linearis	0,393	5,143	193,142	118,857	181,714
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas		16,470			
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota			0,782		
Dendronotus frondosus					
Diadumene cincta					
Diplosoma listerianum					
Doto coronata					
Echinocardium cordatum					0,026
Ectopleura larynx					
Electra pilosa					
Emplectonema gracile	0,093				
Eubranchus sp.					
Eulalia viridis			0,543	0,166	0,083
Eunereis longissima					0,183
Fenestrulina delicia					
Gitana sarsi					
Harmothoe extenuata			0,025	0,460	1,400
Harmothoe impar					
Heteranomia squamula				0,007	
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica	7,316	12,585			
Jassa herdmani			245,142	142,285	35,657
Jassa marmorata	0,321	14,571			
Lagis koreni					
Lanice conchilega				0,106	0,071
Lepidonotus squamatus					0,786
Leptoplana tremellaris					
Leucosolenia variabilis			0,008	0,111	
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile			160,760	10,005	643,498
Microporella ciliata					
Monocorophium acherusicum					
Monocorophium sextonae					
Monocorophium sp.					

	45-Sp-N-2013	45-Sp-Z-2013	60-D10-N-2013	60-D10-Z-2013	60-D17-N-2013
Mytilus edulis	86,014	7,692	0,784	27,373	335,963
Necora puber					
Nereidae indet.			0,018		0,018
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					0,343
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina				1,143	1,143
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus			0,420	0,684	0,902
Pisidia longicornis				0,530	0,781
Prasiola stipitata					
Psammechinus miliaris			15,669	2,442	
Sagartia elegans					
Sagartia troglodytes			0,820		
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides	27,424	44,216			
Stenothoe monoculoides			0,000	0,001	0,000
Stenothoe valida					
Syllis prolifera			0,018	0,017	
Telmatogeton japonicus	0,000				
Tubularia indivisa					
Ulva intestinalis					
Ulva linza					
Urticina felina				109,109	
Venerupis senegalensis					
Verruca stroemia					

	60-D17-Z-2013	60-D2-N-2013	60-D2-Z-2013	60-D5-N-2013	60-D5-Z-2013
Aeolidia papillosa					
Alcyonidium mamillatum					
Alcyonidium mytili					
Alcyonidium sp.					
Alcyonium digitatum					
Amphibalanus improvisus					
Amphipoda indet.					
Arachnidium fibrosum					
Asterias rubens		95,316	11,098	58,764	69,338
Austrominius modestus					
Balanus crenatus	0,978	0,002	0,019		
Blidingia minima					
Callopora dumerilii					
Campanulariidae spp.					
Cancer pagurus			7,039		
Caprella linearis	41,143	3,429	13,714	37,714	249,142
Caprella mutica					
Celleporella hyalina					
Clytia hemisphaerica					
Conopeum reticulum					
Crassostrea gigas					
Crepidula fornicata					
Ctenodrilus serratus					
Cuthona gymnota					
Dendronotus frondosus					
Diadumene cincta					
Diplosoma listerianum	2,161	0,005	0,038	0,004	
Doto coronata					
Echinocardium cordatum					
Ectopleura larynx					
Electra pilosa					
Emplectonema gracile					
Eubranchus sp.					
Eulalia viridis	0,022		0,734	0,743	0,161
Eunereis longissima					
Fenestrulina delicia					
Gitana sarsi					
Harmothoe extenuata	1,349	0,051	0,606	1,160	0,552
Harmothoe impar					
Heteranomia squamula			0,128	0,014	
Hiatella arctica					
Homarus gammarus					
Hydractinia echinata					
Idotea pelagica		0,487	4,057		
Jassa herdmani	9,429	50,057	239,657	185,828	233,142
Jassa marmorata		33,600	60,000	7,886	
Lagis koreni					
Lanice conchilega					
Lepidonotus squamatus	0,709		1,329	0,583	0,264
Leptoplana tremellaris					
Leucosolenia variabilis			0,841		
Malacoceros fuliginosus					
Metopa alderi					
Metridium senile	180,787	10,278	143,904	42,297	6,438
Microporella ciliata					
Monocorophium acherusicum	0,914				
Monocorophium sextonae					
Monocorophium sp.	0,457				

	60-D17-Z-2013	60-D2-N-2013	60-D2-Z-2013	60-D5-N-2013	60-D5-Z-2013
Mytilus edulis	1461,211	208,445	1346,318	640,713	0,874
Necora puber					
Nereidae indet.					
Nereis pelagica					
Obelia dichotoma					
Obelia longissima					
Odostomia scalaris					
Onchidoris bilamellata					
Ophiothrix fragilis					
Phtisica marina	1,714				
Phyllodoce laminosa					
Phyllodoce maculata					
Phyllodocidae indet.					
Pilumnus hirtellus	1,903	0,118	14,906	0,183	2,189
Pisidia longicornis	0,259	0,421	0,766	0,813	0,825
Prasiola stipitata					
Psammechinus miliaris		1,886	9,954	36,264	60,000
Sagartia elegans		2,559		90,682	
Sagartia troglodytes			0,937		
Sagartiogeton undatus					
Scruparia ambigua					
Semibalanus balanoides					
Stenothoe monoculoides	0,000	0,000	0,001	0,001	0,000
Stenothoe valida		0,000	0,000		0,000
Syllis prolifera				1,131	0,037
Telmatogeton japonicus					
Tubularia indivisa					
Ulva intestinalis					
Ulva linza					
Urticina felina		65,218	13,013	56,613	3,567
Venerupis senegalensis					
Verruca stroemia			0,000		

	60-Sc-Z-2013	60-Sp-N-2013	60-SP-Z-2013
Aeolidia papillosa			
Alcyonidium mamillatum			
Alcyonidium mytili			
Alcyonidium sp.			
Alcyonium digitatum	0,000		
Amphibalanus improvisus		0,274	
Amphipoda indet.			
Arachnidium fibrosum			
Asterias rubens	0,002		
Austrominius modestus			
Balanus crenatus		0,358	0,939
Blidingia minima			
Callopora dumerilii			
Campanulariidae spp.			
Cancer pagurus			
Caprella linearis		4,000	18,286
Caprella mutica			
Celleporella hyalina			
Clytia hemisphaerica			
Conopeum reticulum			
Crassostrea gigas			0,143
Crepidula fornicata			
Ctenodrilus serratus			
Cuthona gymnota			
Dendronotus frondosus			
Diadumene cincta			
Diplosoma listerianum			
Doto coronata			0,008
Echinocardium cordatum			
Ectopleura larynx			
Electra pilosa			
Emplectonema gracile			
Eubranchus sp.			
Eulalia viridis			
Eunereis longissima			
Fenestrulina delicia			
Gitana sarsi			
Harmothoe extenuata			
Harmothoe impar			
Heteranomia squamula			
Hiatella arctica	0,000		
Homarus gammarus			
Hydractinia echinata			
Idotea pelagica		19,263	11,401
Jassa herdmani	0,041		
Jassa marmorata		8,229	84,343
Lagis koreni			
Lanice conchilega	0,027		
Lepidonotus squamatus			
Leptoplana tremellaris			
Leucosolenia variabilis			
Malacoceros fuliginosus			
Metopa alderi			
Metridium senile	41,017		
Microporella ciliata			
Monocorophium acherusicum	0,074		
Monocorophium sextonae			
Monocorophium sp.			

	60-Sc-Z-2013	60-Sp-N-2013	60-SP-Z-2013
Mytilus edulis		143,461	215,214
Necora puber			
Nereidae indet.	0,001		0,000
Nereis pelagica			
Obelia dichotoma			
Obelia longissima			
Odostomia scalaris			
Onchidoris bilamellata	0,001		
Ophiothrix fragilis			
Phtisica marina			
Phyllodoce laminosa			
Phyllodoce maculata			
Phyllodocidae indet.			
Pilumnus hirtellus			
Pisidia longicornis			
Prasiola stipitata			
Psammechinus miliaris	0,000		
Sagartia elegans			
Sagartia troglodytes			
Sagartiogeton undatus			
Scruparia ambigua			
Semibalanus balanoides		9,447	12,983
Stenothoe monoculoides			
Stenothoe valida			
Syllis prolifera			
Telmatogeton japonicus		0,000	0,000
Tubularia indivisa			
Ulva intestinalis			
Ulva linza			
Urticina felina			
Venerupis senegalensis			
Verruca stroemia	0,038		