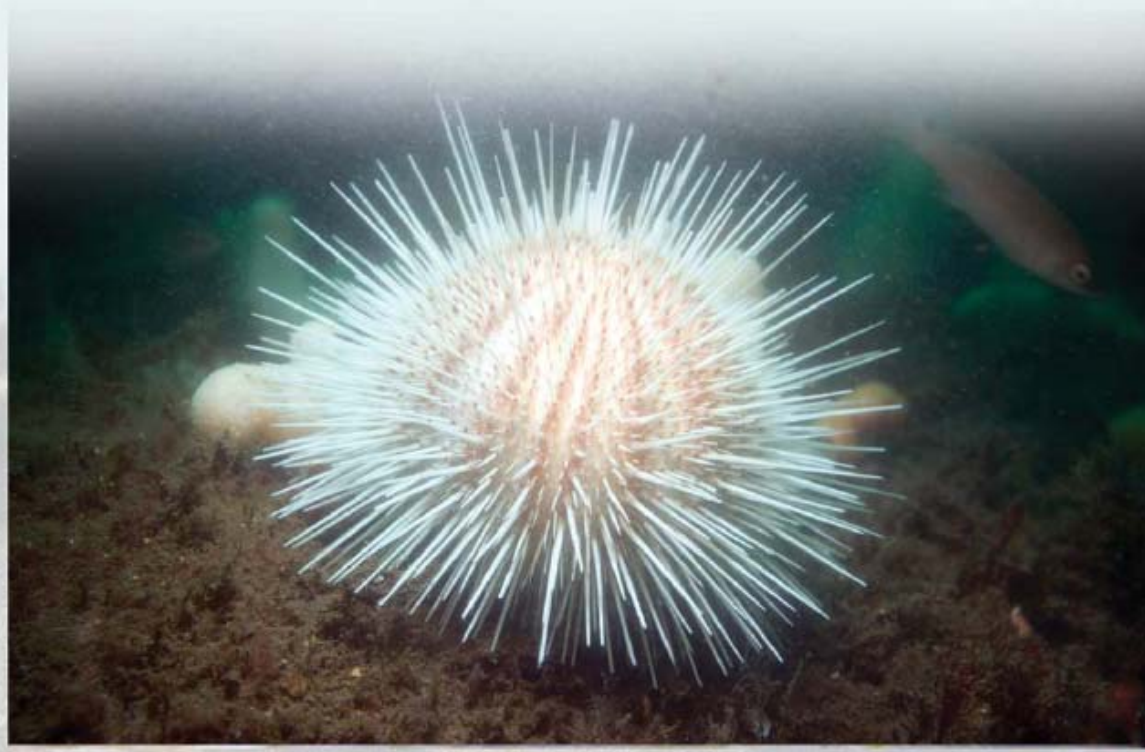
BALANCE Interim Report No. 15

Biodiversity on boulder reefs in the Kattegat



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Biodiversity on boulder reefs in central Kattegat	15

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Front page: *Echinus acutus* in the Kattegat, photo by Karsten Dahl, NERI

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Biodiversity on boulder reefs in the Kattegat

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ABSTRACT

The examined area contains newly found reefs with stones and boulders where the macroalgae and animals were studied for the first time. Some of the reefs contain dense cover of boulders below 20 m's water depth which is rare in Kattegat.

Eight sites were examined by diving. In four of them, collections were done for laboratory identification. Four species, *Neosiphonia elongella* (Rhodophyta), *Amphisbetia operculata* (Hydrozoa), *Chorizopora brongniartii* (Bryozoa) and *Nolella dilatata* (Bryozoa) have not previously been registered in Danish waters. *Amphisbetia operculata* was only found in the case study area in the central Kattegat as part of the BALANCE project. The other species have also been found at other more northern reef localities investigated as part of the Danish National Monitoring Programme. In addition new biogeographic boundaries within Kattegat were found for three other species: *Caryophyllia smithii* (Anthozoa), *Celleporina decipiens* (Bryozoa) and *Echinus acutus* (Echinodermata).

The newly mapped stone reefs host a very high biodiversity. Important factors contributing to the high species diversity are most likely formations of stones in relatively deep water with high salinity.

1 INTRODUCTION

This report describes the biodiversity at selected reef areas in the central part of Kattegat. They include new boulder and stone reefs discovered by acoustic mapping in the Danish part of Kattegat. A Swedish reef area is also included in the study. The reefs were investigated as part of a case study to map benthic habitats within pilot area 1 in the BSR INTERREG IIIB co-financed project "BALANCE". For more detailed information about the field survey, please see Dahl et al. 2008.

Several species were identified for the first time in Danish waters and new distribution ranges for other species were also observed. For this reason it was decided to publish the information in a separate BALANCE Interim Report.

More information and the BALANCE Interim Reports on BALANCE are available at www.balance-eu.org and more information on BSR INTERREG IIIB is available at www.bsrinterreg.net.

Steffen Lundsteen & Karsten Dahl

December 2007

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2 MATERIALS AND METHODS

2.1 Locations

Five stations located on four reefs were investigated by diving from 29/6 to 1/7 2006 as part of the BALANCE project. The stations included four relatively deep stations at Kilbladet, Krateret and "the Chinese Wall" in the study area "a" in the Danish part of Kattegat and one relatively shallow station at Lille Middelgrund in study area "b" in the Swedish part of Kattegat (*figure 1* and *table 1*). The precise dive sites in June/July were planned based on the video inspection described in Dahl et al. 2008.

In addition, relevant data collected from Kim's Top as part of the Danish National Monitoring Programme were included in the results (*figure 1* and *table 1*). They were collected on 18/8 2006. The locality names are "household" names except for Lille Middelgrund.

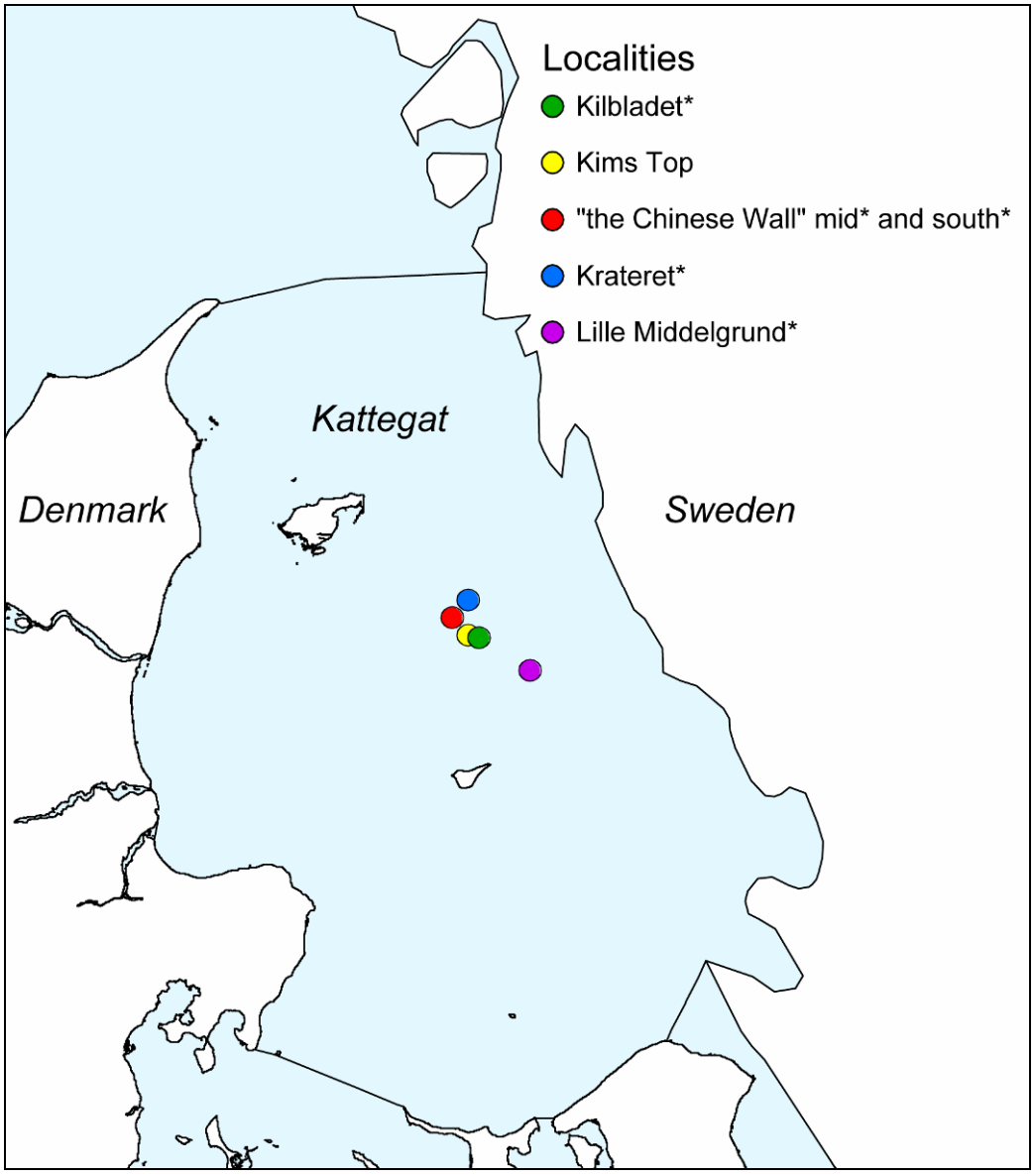


Figure 1 *Localities of stations. Stations sampled in this project are marked with a star in the legend. Lille Middelgrund is located in the Swedish part of Kattegat. The other localities are in Danish area (except for Lille Middelgrund the names are "household names").*

Table 1 *Sample stations, positions, sampling depth and study areas. Stations that are marked with an asterisk were examined as part of the BALANCE project. Kims Top stations were examined later in the National Monitoring Programme (Nat. Mon.). Study area "a" is in Denmark. Study area "b" is in Sweden.*

Locality	Initials	Pos. N	Pos. E	Date	Depth, m	Study area	Programme
Krateret*	Kr27	5705,287	1135,855	20060630	26,5	a, DK	BALANCE
"the Chinese Wall" mid*	Km21	5703,154	1131,817	20060701	20,5	a, DK	BALANCE
"the Chinese Wall" south*	Ks21	5703,154	1131,814	20060701	20,5	a, DK	BALANCE
Kims Top	Kt16	5700,773	1135,419	20060818	16,0	a, DK	Nat. Mon.
Kims Top	Kt18	5700,769	1135,416	20060818	18,4	a, DK	Nat. Mon.
Kims Top	Kt23	5701,036	1135,051	20060818	23,0	a, DK	Nat. Mon.
Kilbladet*	Ki17	5700,460	1138,038	20060629	17,1	a, DK	BALANCE
Lille Middelgrund*	Li12	5655,990	1149,700	20060629	11,9	b, SE	BALANCE

2.2 Sampling methods

The data were collected following the technical guidelines in the Danish National Monitoring Programme for monitoring of macroalgal vegetation (Krause-Jensen et al. 2004) and hard bottom fauna (*Lundsteen & Dahl 2004*).

A precondition for diver investigation of the stone reefs was that the cover of stable boulders and stones was 10% or more.

At each station the diver visually judged:

- sediment covers according to predefined sediment classes
- species present and their cover relative to substrate type.

The divers searched for species until further effort was considered not to reveal significantly more species at the site. In principal all identifiable or recognisable bottom-living species or species groups were recorded. This included macroalgae and -animals. Registered animals were both sedentary and errant species, which live exposed on the surface. Some groups of small animals such as *Amphipoda* and small snails, which are often numerous but difficult to register, were excluded.

In addition stones and sedentary species on hard substrate were collected for further identification of the sessile species in the laboratory. The collection at the site continued until the diver judged that it was representative of the place.

At Lille Middelgrund (12 m) the dive was interrupted. Here the estimate of species cover was incomplete with regard to identification of filamentous red algae species. They were only identified as a group. Neither was the collection of material for laboratory identification completed.

The dives at the eight sites were made in shift by four different divers.

Table 2 *Overview of species lists by diving and by laboratory examination per station. Laboratory examination of collected material from Kims Top in the National Monitoring Programme is still ongoing; but some results are referred to in the text. At Lille Middelgrund (12 m) the diver examination and collection was not completed.*

Locality	Initials	Diving species lists	Laboratory examination 2006
Krateret*	Kr27	x	X
"the Chinese Wall" mid*	Km21	x	
"the Chinese Wall" south*	Ks21	x	X
Kims Top	Kt16	x	Not completed
Kims Top	Kt18	x	Not completed
Kims Top	Kt23	x	Not completed
Kilbladet*	Ki17	x	X
Lille Middelgrund*	Li12	(x)	(x)

Species identification in the laboratory was mainly done for the sessile species. Identification of errant animals was done only to verify the divers' identifications and of course only in the cases where the errant animal had actually been collected. Small species were searched for on the collected stones and on selected pieces of macroalgae or larger animals using a stereomicroscope. Identification was done macroscopically when possible and otherwise with the use of stereomicroscope or light microscope. Identification was done to species level when possible, otherwise to a higher taxonomic level. Laboratory examination of samples from Lille Middelgrund at 12 m's depth with incomplete sampling was expected to show comparatively few species.

Laboratory examination of samples taken at Kims Top as part of the National Monitoring Programme, NOVANA, was still ongoing when this project was to be reported. However, reference has been made to present species records from Kim's Top as well as from other reef survey stations as defined by the Monitoring Programme. In the Monitoring Programme diver investigation and laboratory identification of macroalgae commenced in 1989. Laboratory identification of animals commenced in 2004. An overview of the species examinations from the eight sites are shown in *table 2*.

3 RESULTS

3.1 Sediment

The chosen stations investigated by divers had all a dense cover of hard stable stones and boulders (*table 3*). Thus the estimated percentage of stable stones ranged from 81% to 93%. At the deepest station, Krateret (Kr 27 m), the cover was 85%.

Table 3 *Pilot stations bottom types, relative cover percentage and estimated size limit between stable and unstable stones.*

Station initial with depth	Kr27*	Km21*	Ks21*	Kt16	Kt18	Kt23	Ki17*	Li12*
Mud, %	0	0	0	0	0	0	0	0
Sand, %	0	0	2	0	12	0	0	0
Gravel, %	7	15	0	2	5	20	15	5
Stones 2-5 cm, %	3	1	5		3	1	2	5
Stones 5-10 cm, %	5	3	5	5	5	1	20	5
Stones 10-30 cm, %	10	3	30	20	15	2	52	20
Stones 30-60 cm, %	65	48	42	30	30	16	10	40
Stones >60 cm, %	10	30	16	43	30	60	1	25
Lower limit stable stones, cm Ø	10	10	10	10	10	10	10	10
Softbottom, %	7	15	2	2	17	20	15	5
Unstable stones, %	8	4	10	5	8	2	22	10
Stable stones, %	85	81	88	93	75	78	63	85

3.2 Biota

3.2.1 Species diversity

In total 154 different species (or higher taxa or morphological groups) were recorded from the eight dives and four laboratory examinations in the two study areas. This included 64 macroalgae and 90 animals. A species list is shown in *Appendix 1*.

The divers identified 87 species (or higher taxa or morphological groups) at the eight stations. These consisted of 42 macroalgae and 45 animals. The number of species (or higher taxonomic groups) observed by diving at each station is shown in *figure 2* ordered in systematic groups. The number of species observed by diver varied from 45 species at Kims Top 18 m (Kt18) to 14 species at Krateret 27 m (Kr27). The total number of species at the stations mainly varied according to the number of macroalgae (Rhodophyta, Phaeophyta and *Chlorophyta*). The highest number of macro algal species seen by the diver was 29 species at Kims top 18 m (Kt18) and the lowest was only four species or species groups at Krateret 27 m (Kr27). At Lille Middelgrund 12 m (Li12) the identified number of species was relatively low because the red algal filamentous species were not identified at this station.

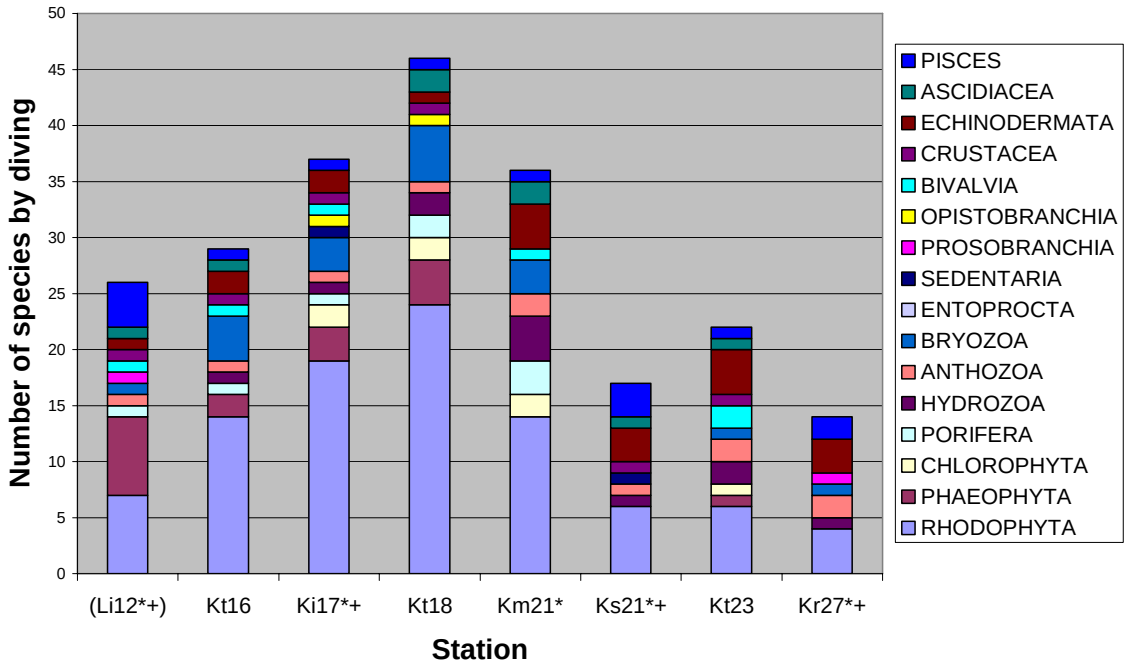


Figure 2 *Number of species observed by diving in systematic groups. Stations are arranged by depth. Note that at Lille Middelgrund 12 m (Li12) filamentous red algae bushes were not identified. An asterisk (*) in the station initials marks stations examined in the BALANCE project. A plus (+) marks stations with laboratory examination in the BALANCE project. Station names are: Li12: Lille Middelgrund 12 m, Kt16: Kims Top 16 m, Ki17: Kilbladet 17 m, Kt18: Kims Top 18 m, Km21: "the Chinese Wall" (mid) 21 m, Ks21: "the Chinese Wall" (south) 21 m, Kt23: Kims Top 23 m and Kr27: Krateret 27 m.*

A total of 136 different species (or higher taxa or morphological forms) was recorded including species observed by the diver at the four stations in the BALANCE project where laboratory identification was done (*figure 3*). The species consisted of 58 algal species and 78 animal species. The highest number of species was recorded at "the Chinese Wall" (south) 21 m (Km21) with 73 species and at Kilbladet 17 m (Ki17) with 72 species. At the deepest station, Krateret 27 m (Kr27), 31 species were recorded. At Lille Middelgrund 12 m (Li12) neither the dive nor the collection was completed. The species number at this station was also comparatively low with 60 species. Still, the number of species at Krateret 27 m (Kr27) is significantly less than at the more shallow depth stations.

The four stations showed a decline of algal species with depth with the highest number of about 37 algal species at Lille Middelgrund 12 m (Li12) to only seven algal species or other groups at Krateret 27 m (Kr27). This applies even if the collection at the former station was incomplete.

The highest number of animal species at the four stations is 51 species at "the Chinese Wall" south 21 m (Ks21) while the lowest numbers are 23 and 24 species at Lille Middelgrund 12 m (Li12) and Krateret 27 m (Kr27), respectively.

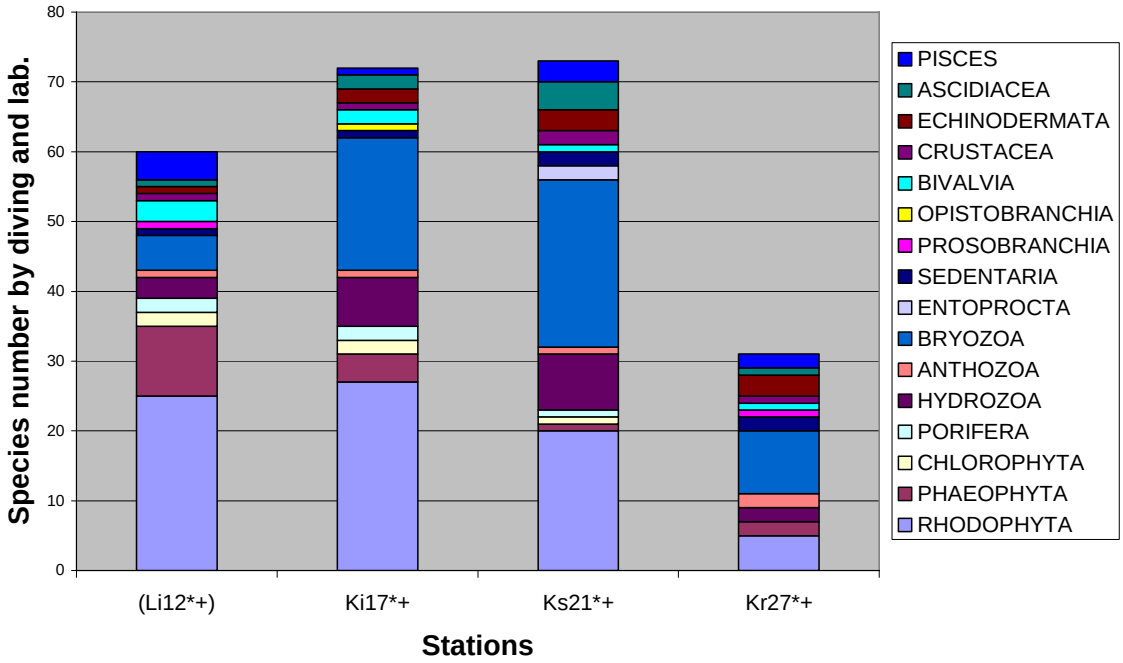


Figure 3 *Number of species observed by diving and in the laboratory. The species are arranged in systematic groups. Note that at Lille Middelgrund 12 m (Li12) filamentous red algae bushes were not identified during diving and the collection was incomplete. The asterisk (*) in the station initials marks that the stations were examined in the BALANCE project. The plus (+) marks that laboratory identification of species was done. Station names are: Li12: Lille Middelgrund 12 m, Ki17: Kilbladet 17 m, Ks21: "the Chinese Wall" (south) 21 m and Kr27: Krateret 27 m.*

Diver observations at the four stations in the BALANCE project, where laboratory identification was done, revealed 32 macroalgae and 28 fauna species (or species groups).When laboratory examination is added, the number of species was nearly two and three times as high, respectively. The addition of laboratory investigation of sessile species revealed a larger proportion of animals than found by the diving examination alone. Especially the sessile animal groups Bryozoa and Hydrozoa were quite numerous in the laboratory investigation compared to diver observations.

In the case of "the Chinese Wall" (south) 21 m (Ks21) the total species number was about four and a half times as big by diving and laboratory examination combined than by diving alone, namely 73 and 17 species, respectively. Indeed this station, which seems rather meagre with regard to species occurrence by the diver inspection alone, turned out to be quite rich in species when results from the laboratory investigations were included. The decline of algal species with depth found by diving and laboratory investigation combined at the four stations was also somewhat at odds with the diver observations alone from the eight stations in which the greatest number of algal species was found at mid depths and declining towards both lesser and greater depths.

3.2.2 Changes in bio-geographic species distribution

The results from this study and information from the National Environmental Monitoring Programme have provided new knowledge on species distributions in Kattegat. In particular the investigations in the Danish study area "a" in mid Kattegat have resulted in identification of several species either not previously recorded in Kattegat or found with a more southern distribution in Kattegat than already known.

Species not previously registered in Danish waters are:

Neosiphonia (Polysiphonia) elongella (Rhodophyta) (*figure 4* and *5*): The species was seen by the diver and in the laboratory from samples taken at Kims Top 16 m and 18 m. The species is new to Denmark, but has been observed in other places in Kattegat in the National Monitoring Programme. Besides Kims Top, it has been seen at Herthas Flak, Tønneberg Banke and Læsø Trindel. It has been registered from depths of 10.3 m to 23 m. The finds from Kims Top are presently the most southern and brackish for the species in Danish waters. It has been identified by Steffen Lundsteen following Maggs and Hommersand (1993, as *Polysiphonia elongella*). According to them, the most northern records are from South West England and Ireland.

Figure 4 Neosiphonia elongella *collected in the routine investigations. It is new to Denmark. Shown is the upper part of a plant with typical pseudodichootmous branching. The species has four pericentral cells and form cortex.*

Photo: Steffen Lundsteen. Herthas Flak 14.9 m, 21/08/2006.

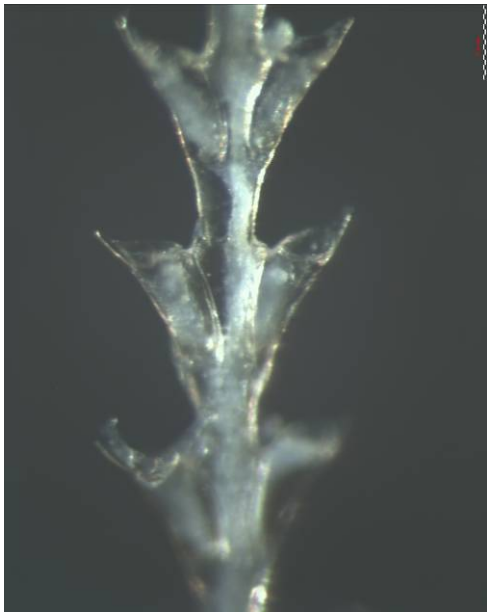
Figure 5 Neosiphonia elongella. *A branch with bispores which are typical for the species.*

Photo: Steffen Lundsteen. Herthas Flak 14.9 m, 21/08/2006.

Amphisbetia operculata (Hydrozoa) (*figure 6*): The find at Kilbladet at 17 m's depth is the only record of the species in Danish waters. It was identified by Steffen Lundsteen according to Cornelius (1995). In summaries of distribution, the species is listed as found south of Lofoten in Kramp (1938, as *Sertularia operculata*) and from the North Sea up to Bergen in Naumov (1969, as *Dynamena operculata*). Cornelius (1995) finds this to be unsubstantiated. According to him, its northern limit of distribution in the Atlantic is the Shetlands.

Figure 6 Amphisbetia operculata*, a new Hydrozoa species to Denmark. The hydrotheca shows a long spine at the outer rim and a pair of short lateral spines.*

Photo: Steffen Lundsteen. Kilbladet 17 m, 29/06/2006.



Chorizopora brongniartii (Bryozoa) (*figure 7*): The species was seen at Kilbladet 17 m. It is new to Denmark. However, during the National Monitoring Programme, it has been found at Kims Top in previous years as well as at Hethas Flak in the northern Kattegat and at Knudegrund and Lønstrup Rødgrund in Skagerrak north west of Jutland. It has been registered from 13 m to 22 m of depth. It has been identified by Steffen Lundsteen according to Marcus (1940) and Hayward & Ryland (1979). Marcus notes that the species has been found as close by as south west Norway and is to be expected in Danish waters also. The species is unrecorded for Sweden according to Matthias Obst (2007, pers. com.).

Figure 7 Chorizopora brongniartii, *a new Bryozoa species to Denmark.*

Photo: Steffen Lundsteen. Kilbladet 17 m, 29/06/2006.

Nolella dilatata (Bryozoa) (*figure 8*): Found in samples taken at "the Chinese Wall" (south) at 21 m's depth and at Kilbladet at 17 m's depth. It is a new species to Denmark. During the National Monitoring Programme it has also been found at Kims Top in 2006 and at Herthas Flak in depths of 18 m to 20 m. It has been identified by Steffen Lundsteen according to Marcus (1940) and Hayward (1985). Marcus (1940) refers to some probable finds of *Nolella dilatata* from the Swedish Skagerrak coasts and regards it as likely for Danish waters also. According to Matthias Obst (2007, pers. com.), it has not been recorded in the Swedish part of Kattegat.

Figure 8 Nolella dilatata, *a new Bryozoa species to Denmark.*
Photo: Steffen Lundsteen. Kilbladet 17 m, 29/06/2006.

In addition three species were found with extended distribution in Danish waters:

Three species identified in the Danish case study area in the central Kattegat have either not been registered in Kattegat before or were found with a more southern distribution in Kattegat than previously known.

Caryophyllia smithii (Anthozoa) (*figure 9*) identified by Karsten Dahl according to Køie et al. (2000). It has been seen at Krateret 27 m, "the Chinese Wall" (mid) 21 m and Kims Top 23 m in 2006 and at Herthas Flak in 2005-2006. In the National Monitoring Programme the species has only been collected one time in order to spare the population; otherwise identification has relied on the diver or on photos. The first cup coral from Danish waters was identified in the northern Kattegat off Frederikshavn in 1991 and 1992 and later from Herthas Flak in 1996 (Tendal 1996, Tendal & Nielsen 1997).

Figure 9 Caryophyllia smithii, (Anthozoa) *a newly recorded cup coral in Danish waters. Now also seen in the central part of Kattegat.*

Photo: Karsten Dahl. Kims Top 21 m, 29/06/2006.

Celleporina decipiens (Bryozoa) (*figure 10*): Found at "the Chinese Wall" (mid) 21 m and Kilbladet 17 m. In the Monitoring Programme the species has also been seen at Kims Top and at Herthas Flak in the northern Kattegat. It has been registered in depths of 13 m to 22.7 m.

The species has been identified by Steffen Lundsteen according to Hayward (1976) and Hayward and Ryland (1979). *Celleporina decipiens* was distinguished fairly recently from *Celleporina hassellii* (by Hayward 1976) and some questions remain regarding their distributional records. As in the descriptions of *Celleporina decipiens*, the colonies show a marked peristomal mucro. This is here considered as an easily recognisable characteristic of the species. Also vicarious avicularia have not been found. However, the proximal sinus of the primary orifice seems to be a little wider than shown for *Celleporina decipiens*. When found, the colonies of *Celleporina decipiens* were often plentiful. It has been seen growing on stems and branches of diverse red algae, Hydrozoa and Bryozoa.

The colonies of *Celleporina decipiens* in the examined material agree closely with the drawing of a colony from Jyske Rev (North Sea) in Marcus (1940 fig. 152 b) as *Siniopelta costazii var. tubulosa* even if the drawing shows part of a colony with recumbent zooids whereas the most usual in the present material was erect zooids. In Hayward & Ryland (1979), *Celleporina decipiens* is recorded south west of Britain. It also seems to be present in the Swedish part of the Skagerrak near Koster (Matthias Obst, Judith Fuchs 2007, pers. com.). As regards *Celleporina hassallii*, the species is listed for the Swedish Bohuslän, the Lofots, Faeroes, Britain, and west Norway to the Mediterranean, in Hansson (1999, p. 19).

Figure 10 Celleporina decipiens, *a new Bryozoa record to the Kattegat area.*

Photo: Steffen Lundsteen. Kilbladet 17 m, 29/06/2006.

Echinus acutus (Echinodermata) (*figure 11*), identified by Karsten Dahl according to Køie et al. (2000). It was seen at Kims Top 23 m. The species has also been observed repeatedly at the deeper stations at Kims Top and once at Store Middelgrund at 23 m's depth in October 2007 during the National Monitoring Programme. Mortensen (1924) mentions the species from the north-eastern part with Groves Flak in the mid part of Kattegat as the most southern extension and with a depth range of 45 m - 200 m mostly on clay-mixed sandy bottom. The new find at Store Middelgrund is much more southern and more shallow.

Figure 11 Echinus acutus (*Echinodermata) with extended distribution in Kattegat.*
Photo: Karsten Dahl.
Kims Top 23 m, 29/06/2006

In summary the new distribution records at the eight stations are:

- Krateret 27 m: *Caryophyllia smithii* (Anthozoa)
- "the Chinese Wall" (mid) 2 m: *Caryophyllia smithii* (Anthozoa); *Celleporina decipiens* (Bryozoa)
- "the Chinese Wall" (south) 2 m: *Nolella dilatata** (Bryozoa)
- Kims Top 18 m: *Neosiphonia elongella** (Rhodophyta); *Nolella dilatata**
- Kims Top 16 m: *Neosiphonia elongella** (Rhodophyta)

- Kims Top 23 m: *Caryophyllia smithii* (Anthozoa) in 2006; *Chorizopora brongniartii** (Bryozoa) at a depth of 22 m in previous studies; *Echinus acutus* (Echinodermata) hitherto the most southern locality but also found at Store Middelgrund 23 m in 2007

- Lille Middelgrund 12 m: None

- Kilbladet 17 m: *Amphisbetia operculata** (Hydrozoa); *Chorizopora brongniartii** (Bryozoa); *Nolella dilatata** (Bryozoa); *Celleporina decipiens* (Bryozoa)

* are new records to Denmark

4 CONCLUSIONS AND PERSPECTIVES

The species investigation of boulder and stone reefs included eight dives at different stations with collections and laboratory examinations from four of the stations. The sites are all located in the central part of Kattegat. In the Danish study area "a" in the BALANCE project (see Dahl et al. 2008), the sites included newly found reefs with dense cover of stones and boulders in deep waters that were previously unknown. This is especially the case of Krateret with dense stable stones from 14 m to 33 m water depth. The preceding video inspection even showed places with stones at depths of 40 m to 50 m (Dahl et al. 2008). These places, however, were not sampled. Dense cover of stone below 18-20 m's depth is rare in inner Danish waters. From the Swedish study area "b", sampling only took place at one location, Lille Middelgrund, at a depth of 12 m.

The dives and collections from the investigated reefs revealed a very high biodiversity. Thus from the four sites, where collections were performed, a total of 136 different species (or higher groups) were registered. From all the eight sites, a total of 154 species (or groups) were registered. Among the new investigated localities, the highest number of 51 animal species (or higher groups) was found at "the Chinese Wall" (south) at depths of 21 m.

Furthermore, several of the species in the area were either new to Danish waters or showed a more extended distribution towards the Baltic than previously known. Most were found at Kilbladet at a depth of 17 m. A factor contributing to the diversity at these stone reefs might be dense formations of stones in relatively deep water with high salinity. Also the varied topography of the area with the deep "channel" running all the way to Skagerrak in the vicinity of the reefs probably explains the high biodiversity.

In the parallel soft bottom investigation partly cited in Al-Hamdani & Reker (2007) in the Danish study area "a", there were also several rare species. Among them was an undescribed polychate species, identified by Ole Norden Andersen. Also present was a probably new Nordic record of the amphipod *Stenula rubrovittata* as well as two possibly undescribed amphipod species (Crustacea) all identified by Steffen Lundsteen. The soft bottom investigation supports the conclusion of this report that the investigated study area in the central part of Kattegat as a whole must be considered rich in species.

The diver not only registered the species but also estimated their cover. These results are used in Dahl et al. (2008) and compared with biological communities from other reef localities in Kattegat. In community analysis, species cover is a more reliable measurement rather then the mere registration of species presence. However, emphasis on the individual species and species diversity reveal aspects of species occurrence that tends to disappear in the quantitative data analysis.

In this investigation we focused on the presence of species alone. Not surprisingly, significantly more species are added to the species list generated by the divers when laboratory examinations are carried out on sampled material. Samples taken for laboratory examinations might serve as a quality check of the diver identifications, but can also reveal probable discrepancies in the number of species observed by the diver. The latter is obviously the case at "the Chinese Wall" (south) 21 m, where the diver examination indicated a relatively species poor station; which was found not to be the case after the laboratory examination.

The laboratory identification was mostly restricted to the sessile species. This simplifies both the work of collection and the identification. In terms of habitat mapping of the stone reefs, the identification of the sessile species seems a fitting delimitation. The sessile organisms can be regarded as a part of the physical structure of the reef which together with the geological substrate forms habitats for fish and other errant species. The sessile species also provide food for many of the errant species. In this investigation, however, free living animals were also included in the results.

The rather few stations examined for species composition and especially with regard to laboratory examination do not at all cover what these extensive reef areas have to offer.

Knowledge about the distribution on hard-bottom fauna in Danish waters is still very scattered. The expected change in climate will most probably have a profound effect on the marine ecosystem and it is urgent to gather information on the present biodiversity.

In future programmes on habitat mapping, it is recommended that a more fulfilling collection of species is done to serve as background information for marine hard-bottom community mapping.

Today, Kims Top is the only reef area in the central part of Kattegat that is appointed as a Natura-2000 site (Dahl et al. 2004). This investigation documents that the surrounding areas host reefs with a very high biodiversity and several rare species and those are worth to protect. It is recommended that the present Natura-2000 area at Kims Top is enlarged to include Kilbladet, “the Chinese Wall” and Krateret at Groves Flak as well.

Acknowledgements

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APPENDIX 1 - DIVER AND LABORATORY SPECIES RESULTS

In the table a number is percent substrate specific cover of the species, "x" is a simple diver's record and "+"is a laboratory record.

In the heading station names are listed by initials and depth with the following marks:

* = station in BALANCE project

+ = station with laboratory investigation of species in the BALANCE project

Station names are:

- Kr27: Krateret 27 m
- Km21: "the Chinese Wall" mid 21 m
- Ks21: "the Chinese Wall" south 21 m
- Kt16, 18, 23: Kims Top 16 m, 18 m and 23 m
- Ki17: Kilbladet 17 m
- Li12: Lille Middelgrund 12 m

Appendix 1: Diver and laboratory species results

Taxonomic group	Species / taxon	Station: init, m								Count +	Count
		Kr27*+	Km21*	Ks21*+	Kt16	Kt18	Kt23	Ki17*+	Li12*(+)		
RHODOPHYTA	Aglaothamnion bipinnatum			+				+		2	2
	Aglaothamnion byssoides			+						1	1
	Ahnfeltia plicata								+	1	1
	Audouinella efflorescens	+								1	1
	Audouinella membranacea		1						+	1	2
	Audouinella pectinata							+		1	1
	Bonnemaisonia / Spermothamnion		10	21		1		+	+		
	Bonnemaisonia asparagoides		<1	2		15		10		2	4
	Bonnemaisonia hamifera			1				+		2	2
	Brongniartella byssoides		<1	+	2			5	+	3	5
	Callithamnion corymbosum			+				15		2	2
	Callophyllis cristata					0.1					1
	Ceramium nodulosum								+	1	1
	Chondrus crispus				0.1	0.1			+	1	3
	Coccotylus truncatus								+	1	1
	Colaconema daviesii								+	1	1
	Cruoria pellita							+		1	1
	Cystoclonium purpureum								+	1	1
	Delesseria sanguinea		5	5	20	8	0.1	3	40	3	7
	Dilsea carnosa				2	10		+ <1		1	3
	Dumontia contorta								+	1	1
	Erythrodermis traillii	<1	3	+		1		+ <1		3	5
	Furcellaria lumbricalis								<1	1	1
	Haemescharia hennedyi								+	1	1
	Halarachnion ligulatum							<1		1	1
	Heterosiphonia plumosa					0.1					1
	Hildenbrandia								+	1	1
	Lithothamnion glaciale				1	0.1		<1		1	3
	Lomentaria clavellosa			+		0.1		+ <1		2	3
	Lomentaria orcadensis		2	+				+ <1		2	3
	Melobesia membranacea			+				+	+	3	3
	Membranoptera alata								+	1	1
	Neosiphonia elongella				2	3					2
	Odonthalia dentata		<1		10	0.1					3
	Peyssonnelia dubyi							+		1	1
	Phycodrys rubens	<1	3	2	10	1	10	1	5	4	8
	Phyllophora crispa		<1			0.1	0.1	<1		1	4
	Phyllophora pseudoceranoides		<1		2	75		+ <1	25	2	5

Appendix 1: Diver and laboratory species results

Taxonomic group	Species / taxon	Station: initials, depth (m)								Count +	Count
		Kr27*+	Km21*	Ks21*+	Kt16	Kt18	Kt23	Ki17*+	Li12*(+)		
	Plagiospora gracilis			+						1	1
	Plumaria plumosa								+	1	1
	Polysiphonia elongata					3			+	1	2
	Polysiphonia fibrillosa				2						1
	Polysiphonia fucoides							+	+	2	2
	Polysiphonia stricta			+	2	1		5	+	3	5
	Pterothamnion plumula		5	+		0.1		+ <1		2	4
	Red bush								50		
	Ptilota gunneri				0.1	0.1					2
	Red calcified crust	95	80	70	70	80	80	90	20	4	8
	Red crust	(5)	(<1)	(1)	(20)	(0.1)	(5)	(3)	(5)		
	Rhodochorton purpureum			+				+ <1		2	2
	Rhodochorton purpureum like					0.1	30				
	Rhodomela confervoides			+		0.1		1	+	3	4
	Rhodophyllis divaricata			+		5				1	2
	Scagelia pusilla							+		1	1
	Spermothamnion repens			20				+	+	3	3
	RHODOPHYTA dive count	4	14	6	14	24	6	19	7	21	32
	RHODOPHYTA count	5	14	20	14	24	6	27	25	44	50
PHAEOPHYTA	Brown crust	+				0.1	0.1	1	+	3	5
	Desmarestia aculeata				2			+ <1	+ <1	2	3
	Desmarestia viridis							1	<1	2	2
	Ectocarpus siliculosus								+	1	1
	Fucus serratus								3	1	1
	Halidrys siliquosa								5	1	1
	Laminaria digitata				(20)				(2)		
	Laminaria hyperborea					(5)					
	Laminaria digitata / hyperborea				20	5			2	1	3
	Laminaria saccharina					0.1			25	1	2
	Leptonematella fasciculata								+	1	1
	Sphacelaria caespitula	+		+				+		3	3
	Sphacelaria cirrosa					0.05			+ <1	1	2
	PHAEOPHYTA dive count	0	0	0	2	4	1	3	7	9	8
	PHAEOPHYTA count	2	0	1	2	4	1	4	10	11	11

Appendix 1: Diver and laboratory species results

Taxonomic group	Species / taxon	Station: initials, depth (m)								Count +	Count
		Kr27*+	Km21*	Ks21*+	Kt16	Kt18	Kt23	Ki17*+	Li12*(+)		
CHLOROPHYTA	Bryopsis plumosa		<1				0.1	<1	+	2	4
	Chaetomorpha melagonium								+	1	1
	Derbesia marina sporophyte		<1	+		30				1	3
	Derbesia marina gametophyte					(0.1)		(<1)		1	2
	CHLOROPHYTA dive count	0	2	0	0	1	1	2	0	2	2
	CHLOROPHYTA count	0	2	1	0	1	1	2	2	3	3
PORIFERA	Halichondria panicea		<1		0.1	5		<1	50	2	5
	Porifera indet.		<1	+				+	+		1
	Scypha ciliata		<1			0.1		+ x		1	3
	PORIFERA dive count	0	3	0	1	2	0	2	1	2	3
	PORIFERA count	0	2	1	1	2	0	2	2	2	3
HYDROZOA	Abietinaria abietina		<1								1
	Amphisbetia operculata							+			1
	Clava					0.1					1
	Clytia gracilis	+		+				+		3	3
	Clytia hemisphaerica								+	1	1
	Eudendrium aff. rameum			+						1	1
	Eudendrium arbusculum							+		1	1
	Gonothyraea loveni			+					+	2	2
	Halecium beanii			+				+		2	2
	Kirchenpauria pinnata			+			0.1	+		2	3
	Obelia dichotoma			+						1	1
	Obelia geniculata				5	0.1			+	1	3
	Obelia longissima							+		1	1
	Sertularella polyzonias			+				+		2	2
	Sertularella tenella			+						1	1
	Sertulariidae – Haleciida etc. indet.	(<1)	(<1)	(1)			(0.1)	(2)			
	Tubularia indivisa		5								1
	Tubularia larynx		2								1
	HYDROZOA dive count	1	4	1	1	2	1	1	0	1	6
	HYDROZOA count	2	4	8	1	2	1	7	3	12	16
ANTHOZOA	Alcyonium digitatum	<1	20	15	0.1	1	5	30		3	7
	Caryophyllia smithii *	<1	<1				0.1			1	3
	Metridium senile								x	1	1
	ANTHOZOA dive count	2	2	1	1	1	2	1	1	3	3
	ANTHOZOA count	2	2	1	1	1	2	1	1	3	3

Appendix 1: Diver and laboratory species results

Taxonomic group	Species / taxon	Station: initials, depth (m)								Count +	Count
		Kr27*+	Km21*	Ks21*+	Kt16	Kt18	Kt23	Ki17*+	Li12*(+)		
BRYOZOA	Aetea truncata	+		+				+		3	3
	Alcyonidium diaphanum		<1	+	2		0.1	<1		2	5
	Alcyonidium hirsutum								+	1	1
	Alcyonidium mammilatum	+		+				+		3	3
	Alcyonidium på alger					(0.05)					1
	Amphiblestrum flemingii			+						1	1
	Bicellaria ciliata			+						1	1
	Bryozoa gul på sten	(<1)	(<1)		(0.1)			(5)			
	Bryozoa indet.		(<1)								
	Buskia nitens			+				+		2	2
	Callopora craticula			+				+		2	2
	Callopora dumerilii	+								1	1
	Celleporella hyalina			+						1	1
	Celleporina decipiens			+				+		2	2
	Chorizopora brongniartii *							+		1	1
	Cribrilina cryptooecium			+						1	1
	Crisia eburnea	+							+	2	2
	Crisiidae indet.			+		0.1		+			
	Diplosolen obelia	+						+		2	2
	Electra pilosa			+	3	0.1		+	90	3	5
	Escharella immersa	+		+				+		3	3
	Lichenopora hispida	+		+						2	2
	Membranipora membranacea				10	0.1					2
	Membraniporella hispida			+						1	1
	Microporella ciliata			+						1	1
	Nolella dilatata *			+				+		2	2
	Parasmittina trispinosa			+						1	1
	Plagioesia patina			+				+	+	3	3
	Porella concinna							+		1	1
	Schizomavella linearis	+		+				+		3	3
	Scruparia ambigua			+				+		2	2
	Scrupocellaria indet.					(0.1)		(<1)		1	
	Scrupocellaria scruposa							+		1	1
	Smittina reticulata	+		+				+		3	3
	Tubulipora			+				+		2	2
	Tubulipora phalangea			+						1	1
	Walkeria uva								+	1	1
	BRYOZOA dive count	1	3	0	4	5	1	3	1	4	8
	BRYOZOA count	9	2	24	4	5	1	19	5	31	33

Appendix 1: Diver and laboratory species results

Taxonomic group	Species / taxon	Station: initials, depth (m)								Count +	Count
		Kr27*+	Km21*	Ks21*+	Kt16	Kt18	Kt23	Ki17*+	Li12*(+)		
ENTOPROCTA	Barentsia gracilis			+						1	1
	Pedicellina cernua			+						1	1
	ENTOPROCTA dive count	0	0	0	0	0	0	0	0	0	0
	ENTOPROCTA count	0	0	2				0	0	2	2
SEDENTARIA	Pomatoceros triqueter	+		+ <1				+ <1		3	3
	Spirorbis	+		+					+	3	3
	SEDENTARIA dive count	0	0	1	0	0	0	1	0	1	1
	SEDENTARIA count	2	0	2				1	1	2	2
PROSOBRANCHIA	Acmaeidae	<1								1	1
	Littorina littorea								x	1	1
	PROSOBRANCHIA dive count	1	0	0	0	0	0	0	1	2	2
	PROSOBRANCHIA count	1	0	0				0	1	2	2
OPISTOBRANCHIA	Nudibranchiata					0.1		<1		1	2
	OPISTOBRANCHIA dive count	0	0	0	0	1	0	1	0	1	1
	OPISTOBRANCHIA count	0	0	0	0	1	0	1	0	1	1
BIVALVIA	Anomia squamula	+								1	1
	Modiolarca tumida			+				+	+	3	3
	Modiolus modiolus								x	1	1
	Mya truncata		<1		0.1		0.1	<1		1	4
	Mytilus edulis								+	1	1
	Pecten maximus						0.1				1
	BIVALVIA dive count	0	1	0	1	0	2	1	1	2	3
	BIVALVIA count	1	1	1	1	0	2	2	3	5	6
CRUSTACEA	Balanus balanus								<1	1	1
	Cancer pagurus			<1	0.1		0.1	<1		2	4
	Galathea strigosa					0.1					1
	Verruca stroemia	+		+						2	2
	CRUSTACEA dive count	0	0	1	1	1	1	1	1	2	3
	CRUSTACEA count	1	0	2	1	1	1	1	1	3	4
ECHINODERMATA	Asterias rubens	<1	<1	<1	0.1		0.1		2	3	6
	Echinus acutus						0.1				1
	Echinus esculentus	<1	<1	<1			0.1	<1		3	5
	Martasterias glacialis	<1	<1	<1	0.1	0.1	0.1	<1		3	7
	Ophiura		<1								1
	ECHINODERMATA dive count	3	4	3	2	1	4	2	1	3	5
	ECHINODERMATA count	3	4	3	2	1	4	2	1	3	5

Appendix 1: Diver and laboratory species results

Taxonomic group	Species / taxon	Station: initials, depth (m)								Count +	Count
		Kr27*+	Km21*	Ks21*+	Kt16	Kt18	Kt23	Ki17*+	Li12*(+)		
ASCIDIACEA	Ascidiacea indet.		<1	<1		0.1		+	x		
	Ascidiella aspera			+						1	1
	Botrylloides leachi			+				+		2	2
	Botrylloides leachi like					0.1					
	Ciona intestinalis								+	1	1
	Clavelina lepadiformis		<1				0.1				2
	Corella parallelogramma			+				+		2	2
	Dendrodoa grossularia	+			1					1	2
	Didemnidae			+						1	1
	ASCIDIACEA dive count	0	2	1	1	2	1	0	1	1	4
	ASCIDIACEA count	1	2	4	1	2	1	2	1	6	7
PISCES	Ctenolabrus rupestris	<1	<1	<1	0.1	0.1	0.1	<1	x	4	8
	Gadus morhua			<1					x	2	2
	Labrus bergylta								x	1	1
	Labrus bimaculatus								<1	1	1
	Microstomus kitt			<1						1	1
	Pollachius virens	<1								1	1
	PISCES dive count	2	1	3	1	1	1	1	4	6	6
	PISCES count	2	1	3	1	1	1	1	4	6	6
DIVE ALL	MACROALGAE dive count	4	16	6	16	29	8	24	14	32	42
	ANIMALS dive count	10	20	11	13	16	13	14	12	28	45
	ALL dive count	14	36	17	29	45	21	38	26	60	87
ALL	MACROALGAE count	7	16	22	16	29	8	33	37	58	64
	ANIMALS count	24	18	51	13	16	13	39	23	78	90
	ALL count	31	34	73	29	45	21	72	60	136	154


BALANCE

About the BALANCE project:

The BALANCE project aims to provide a transnational marine management template based on zoning, which can assist stakeholders in planning and implementing effective management solutions for sustainable use and protection of our valuable marine landscapes and unique natural heritage. The template will be based on data sharing, mapping of marine landscapes and habitats, development of the blue corridor concept, information on key stakeholder interests and development of a cross-sectoral and transnational Baltic zoning approach. BALANCE thus provides a transnational solution to a transnational problem.

The work is part financed by the European Union through the development fund BSR INTERREG IIIB Neighbourhood Programme and partly by the involved partners. For more information on BALANCE, please see www.balance-eu.org and for the BSR INTERREG Neighbourhood Programme, please see www.bsrinterreg.net

The **BALANCE Report Series** includes:

BALANCE Interim Report No. 1 "Delineation of the BALANCE Pilot Areas"
BALANCE Interim Report No. 2 "Development of a methodology for selection and assessment of a representative MPA network in the Baltic Sea – an interim strategy"
BALANCE Interim Report No. 3 "Feasibility of hyperspectral remote sensing for mapping benthic macroalgal cover in turbid coastal waters of the Baltic Sea"
BALANCE Interim Report No. 4 "Literature review of the "Blue Corridors" concept and its applicability to the Baltic Sea"
BALANCE Interim Report No. 5 "Evaluation of remote sensing methods as a tool to characterise shallow marine habitats I"
BALANCE Interim Report No. 6 "BALANCE Cruise Report - The Archipelago Sea"
BALANCE Interim Report No. 7 "BALANCE Cruise Report - The Kattegat"
BALANCE Interim Report No. 8 "BALANCE Stakeholder Communication Guide"
BALANCE Interim Report No. 9 "Model simulations of blue corridors in the Baltic Sea"
BALANCE Interim Report No. 10 "Towards marine landscapes of the Baltic Sea"
BALANCE Interim Report No. 11 "Fish habitat modelling in a Baltic Sea archipelago region"
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BALANCE Interim Report No. 29 "Essential fish habitats and fish migration patterns in the Northern Baltic Sea"
BALANCE Interim Report No. 30 "Mapping of Natura 2000 habitats in Baltic Sea archipelago areas"
BALANCE Interim Report No. 31 "Marine landscapes and benthic habitats in the Archipelago Sea"
BALANCE Interim Report No. 32 "Guidelines for harmonisation of marine data"
BALANCE Interim Report No. 33 "The BALANCE Conference"

In addition, the above activities are summarized in four technical summary reports on the following themes 1) Data availability and harmonisation, 2) Marine landscape and habitat mapping, 3) Ecological coherence and principles for MPA selection and design, and 4) Tools and a template for marine spatial planning. The BALANCE Synthesis Report "Towards a Baltic Sea in balance" integrates and demonstrates the key results of BALANCE and provides guidance for future marine spatial planning.