P-05-45

Oskarshamn site investigation

Inventory of the marine fauna attached to hard substrates in the Simpevarp area

Ronny Fredriksson, University of Kalmar

February 2005

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-05-45

Oskarshamn site investigation

Inventory of the marine fauna attached to hard substrates in the Simpevarp area

Ronny Fredriksson, University of Kalmar

February 2005

Keywords: Sessile epifauna, Mytilus edulis, Biomass estimation, Hard bottom, Fauna, Map, GIS.

Abstract

The sessile macro fauna, with focus on *Mytilus edulis*, attached to hard substrates was studied in the Simpevarp area in November, 2004.

Usually, hard bottom substrate changed into a soft substrate at a water depth between ten and thirteen metres at the visited locations. If suitable substrate occurred at exceeding water depths the covering degree of *Mytilus edulis* was usually moderate. The covering degree of *M. edulis* decreased with water depth. Occurrence of red algae in the samples affected the size structure of *M. edulis*. The mean weight per *M. edulis* specimen decreased with an increasing biomass of red algae. Both the abundance and biomass of the sessile epifaunal community was dominated by the filter feeding bivalve *M. edulis*. Both parameters showed a linear trend towards the estimated covering degree of *M. edulis*. This made it possible to use the equations of the trend lines when calculating the total biomass and abundance of the studied area. The total estimated biomass of *M. edulis* in the area studied was approximately 4,500 metric tons, or 96% of the total sessile epifaunal biomass.

Sammanfattning

I november 2004 genomfördes en inventering av sessil epifauna inom SKB's regionala modellområde vid Simpevarp, Oskarshamn.

Vid de besökta lokalerna övergick hårt substrat till ett mjukt på ett djup av vanligtvis 10 till 13 meter. Om det fanns lämpligt substrat på större djup var täckningen av *Mytilus edulis* vanligtvis låg. Täckningen av *M. edulis* minskade med ökat djup. Förekomst av rödalger i proverna påverkade medelstorleken för *M. edulis*. Medelvikten per mussla minskade med ökad biomassa av rödalger. Både biomassan och abundansen dominerades av *M. edulis* och båda dessa parametrar visade ett linjärt samband mot täckningsgraden av *M. edulis*. Den totala biomassan av *M. edulis* i området beräknades till cirka 4 500 ton. Detta motsvarar 96 % av den totala biomassan av sessil epifauna.

Contents

1 Introduction

This document reports the data gained in the activity *Inventory of the marine sessile epifaunal community attached to hard substrates in the Simpevarp area* which is one of the activities performed within the site investigation at Oskarshamn. The work was conducted according to activity plan AP PS 400-04-098 (SKB internal controlling document).

The blue mussel, *Mytilus edulis*, dominates the animal biomass on sub-littoral rocky surfaces in the Baltic proper /Westerbom et al. 2002/. On hard substrates *M. edulis* occurs in fairly dense populations down to a depth of 30 metres /Tobiasson, 2003b/. The low salinity of the Baltic Sea excludes many of the predators feeding on *M. edulis*. Even though Eider ducks *(Somateria mollissima)* can graze to a relatively high extent on *M. edulis* populations, mainly food resources and intraspecific competition regulates the *M. edulis* population. On a regional scale the salinity is a strong restricting factor to the distribution of marine fauna in the Baltic Sea /Westerbom et al. 2002/. The low salinity in the Baltic Sea affects and restricts physiological functions in *M. edulis* which, among other things, results in a slower growth rate compared to e.g. the west coast of Sweden. On a local scale, availability of suitable substrate and different physical disturbances, like wave exposure and ice scouring, are important physical factors structuring populations on hard substrates /Gilek et al. 2001/. In the Baltic Sea, *M. edulis* produces less byssus than in a more marine environment /Littorin and Gilek, 1999/. Since the stability of *M. edulis* patches directly depends upon the strength of the attachment to the substrate, mussels in the Baltic Sea are more sensitive to wave exposure /Gilek et al. 2001/. Thus, wave exposure could be expected to play a significant part in structuring the *M. edulis* community, at least in more exposed and shallow areas. Another important factor structuring the *M. edulis* community is the availability of food particles. Since *M. edulis* is a filter feeder, water movement is important in that way that it increases the food availability. Increasing flow speed have been shown to favour intake and growth of *M. edulis* due to higher availability of phytoplankton /Gilek et al. 2001/.

In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB's internal controlling documents.

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	Number	Version
Inventering av marin hårdbottenfauna	AP PS 400-04-098	1.0

2 Objective and scope

The aim of the study was to estimate the distribution, composition, abundance and biomass of sessile epifauna associated to hard substrates within the regional study area in Oskarshamn Simpevarp. Focus was placed on the bivalve *Mytilus edulis*. Another objective was to illustrate the distribution of *M. edulis* in a GIS layer and by means of this layer and quantitative samples estimate the total abundance and biomass in the area studied.

3 Equipment

3.1 Description of equipment

- Sea terrier aluminium boat (6.5 m) with a Suzuki DF60 motor (Figure 3-1).
- dGPS, Raytheon L755.
- Standard Scuba diving equipment with a normal oxygen mixture.
- Measuring tape, 100 metres.
- Square shaped aluminium frame with an area of 0.04 m^2 (Figure 3-2).
- Scraping iron.
- Analytic sieves with mesh sizes 11.2; 5.6 and 1 mm.
- Check patterned vessel (30×22 cm) with 35 equally sized squares (Figure 3-3).
- Stereo microscope, zoom 0.5× – 4.0×.

Figure 3-1. *Sea terrier aluminium boat.*

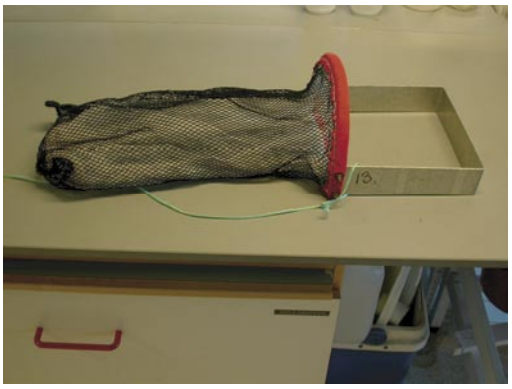

Figure 3-2. *Sampling frame.*

Figure 3-3. *Check patterned vessel.*

4 Execution

4.1 General

The inventory and sampling of the sessile epifaunal community was conducted along six diving transects and six complementary point dives. The location of transects and point dives is presented in Figure 4-1. The location of transects and point dives was chosen by means of topographic charts and previous reports, where occurrence of *Mytilus edulis* was noted /Tobiasson, 2003a,b Fredriksson and Tobiasson, 2003/.

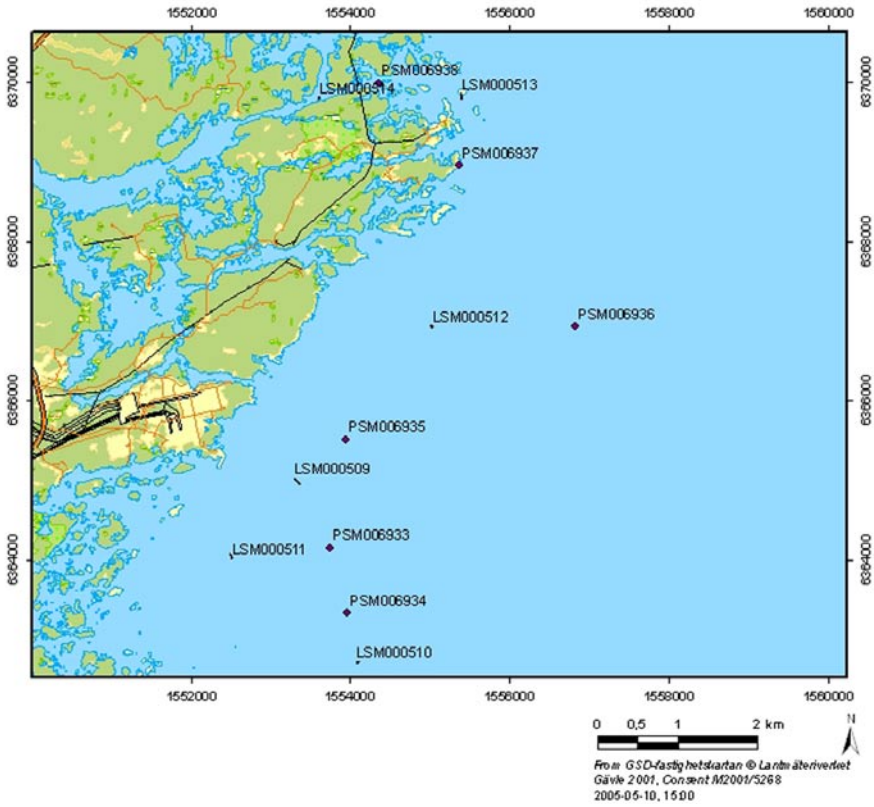

Figure 4-1. *Locations of transects and point dives.*

4.2 Execution of field work

The positions of each transect and point dive was determined by a dGPS. The dGPS displayed the positions in WGS84 with a precision of at least 8 metres. The received positions were transformed to RT90 using the software FME Universal Translator from Safe Software. Sampling was performed by means of a frame with an area of 0.04 square metres and a scraping iron. The scraping iron was used to remove the attached fauna from the substrate. Samples were collected on the basis of *M. edulis* covering degree. Ten samples were collected in covering degrees 5, 10, 25, 50 and 75%. Only eight samples were collected in *M. edulis* coverage of 100% due to difficulties in finding patches with this coverage degree. Samples were preserved by means of freezing. Five randomly chosen samples from each covering degree were analyzed regarding macro fauna. The remaining samples were kept frozen for future need. Before analysis, samples were sieved through three different mesh sizes, 11.2; 5.6 and 1 mm, where the 1 mm sieve functioned as a collector. Thus, any possible fauna passing this sieve were not analyzed. Each fraction was analyzed separately. When fractions contained a large amount of specimens they were sub-sampled. Sub-sampling was made in a checked patterned vessel with 35 equally sized squares. Fauna in seven squares were collected and the results were multiplied by five to obtain total abundance and biomass. Analyzed samples were dried in 60°C during a seven day period to obtain dry weight. Method for abundance and biomass estimations by means of GIS is presented in Appendix 1.

See Appendix 1 for more details regarding method.

4.3 Analyses and interpretations

The covering degree of *Mytilus edulis* was correlated against water depth. The covering degree of *M. edulis* has been shown to decrease with increased water depth /Tobiasson et al. 2004/. The equation gained from the correlation was used to calculate the *M. edulis* covering degree at different water depths. However, at water depths less than three metres a template value of 5% was used. At shallower water wave exposure decreases the amount of *M. edulis*. Wave exposure is an important structuring factor of *M. edulis* distribution /Gilek et al. 2001/. The abundance and biomass of *M. edulis* separately and all sessile epifauna together were correlated against the covering degree of *M. edulis*. The equations gained during correlations were used in the GIS modelling.

4.4 Nonconformities

No nonconformities to report.

5 Results

5.1 Field observations

In none of the examined diving transects did *M. edulis* occur, to a great extent, at depths below vegetation limit. Bottoms with suitable substrate, where *M. edulis* occurred, were also occupied by Red algae (Appendix 2). Thus, quantitative samples collected in this study did all contain Red algae to a various degree (Appendix 4).

The observations of *M. edulis* covering along transects showed a relation between covering and water depth. Figure 5-1 illustrates the percentage share of suitable substrate used by *M. edulis* at different observation depths. A mean from observations within a one metre depth interval was used. The percentage value for the amount of substrate used by *M. edulis* was calculated by dividing the *M. edulis* covering with the amount of suitable substrate presented in Appendix 2. The trend points toward a decreasing average *M. edulis* covering with increasing water depth. Figure 5-1 only presents observations from transects LSM000509 to LSM000513 and point dives PSM006933 to PSM006937 (Figure 4-1). Transect LSM000514 and point dive PSM006938 are not included in this analysis due to differences in environmental conditions. For example was much of the hard substrate at diving transect LSM000514 covered with a thick layer of decomposed organic matter. All observations from a water depth less than three metres were excluded due to effects from wave exposure.

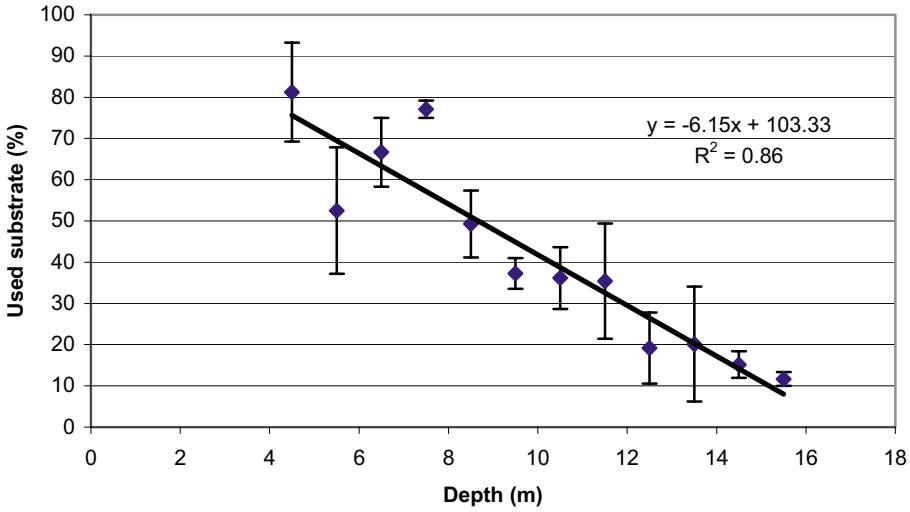

Figure 5-1. *The percentage share of suitable substrate used by* M. edulis*, at different water depth. This figure shows observations, deeper than three metres, from transects LSM000509 to 513 and point dives PSM006933 to 6937.*

5.2 Quantitative samples

5.2.1 Species

In total, 22 taxa were found in the samples from the studied area (Appendix 4). Taxa from all functional groups were represented in samples from all covering degrees. Because of the fact that the samples contained Red algae the number of species was a bit higher than expected. For example, *Gammarus* sp. and *Idotea* sp. are taxa that are likely to have come from the Red algae present in the samples since they normally live associated to this vegetation.

5.2.2 Abundance

Table A4-1 in Appendix 4 presents the mean abundance of epifauna in the different covering degrees. Abundance is presented both on species and trofic level, as well as a total mean for the different covering degrees. *Mytilus edulis* was the taxa with the highest abundance in all sampled covering degrees. However, the contribution from the gastropod *Hydrobiidae* was significant, especially in sites with lower *M. edulis* covering degrees. In the covering degrees between 25 and 100% the contribution from *M. edulis* to the total abundance was about 80%. The contribution from *M. edulis* in the lower covering degrees was less pronounced. Figure 5-2 presents the total *M. edulis* abundance and visualizes the distribution between different fractions. The major part of the specimens was consequently located in the 1 mm fraction.

The abundance showed a linear relation to the covering degree of *M. edulis* (Figure 5-3). This applies both to the total as well as to the *M. edulis* abundance. The abundance in the covering degree 50% is a bit low in relation to the other covering degree classes. The relation was strong with a regression coefficient of 0.91 for both the total abundance and the *M. edulis* abundance. The strong relation makes it possible to use the equations of the lines in the GIS model, estimating the total and *M. edulis* abundance in the studied area. These equations are presented in Figure 5-3.

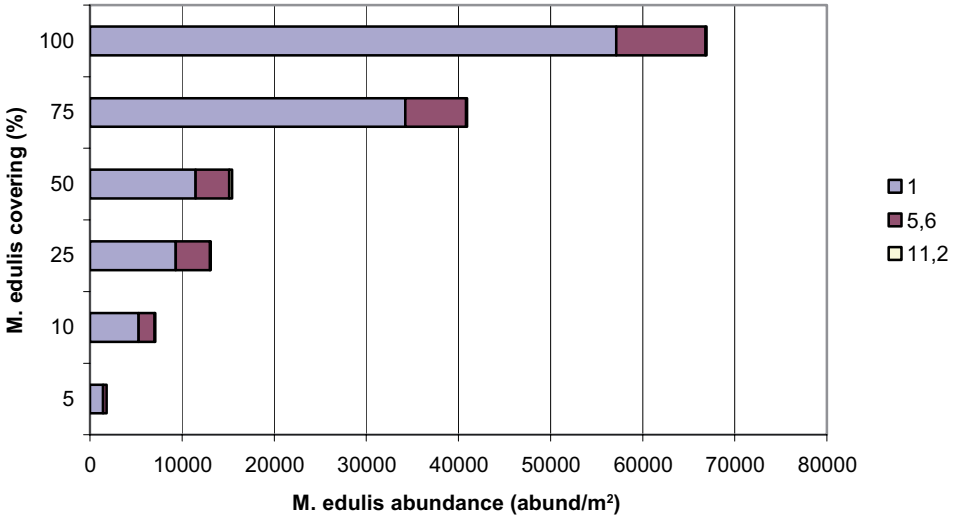

Figure 5-2. *Mean* M. edulis *abundance and distribution among the fractions in the different covering degrees.*

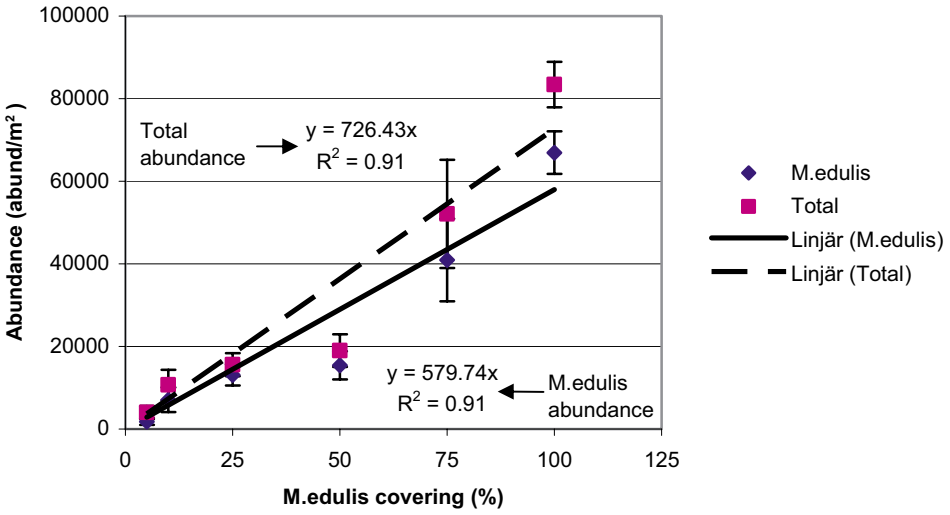

Figure 5-3. M. edulis *and total abundance correlated against* M. edulis *covering. Interception for trend line set to zero.*

5.2.3 Biomass

Table A4-2 in Appendix 4 presents the mean biomass in different covering degrees. Biomass is presented both on species and trophic level, as well as a total mean for the different covering degrees. *Mytilus edulis* completely dominated the biomass. Only in the covering degree 5% the contribution from *M. edulis* was below 90% (Appendix 4). Figure 5-4 presents the total *M. edulis* biomass and visualizes the distribution between different fractions. The major part of the biomass was found in the 5.6 mm fraction.

The relationship between the covering degree of *M. edulis* and the biomass was linear (Figure 5-5). This applies both to the total and the *M. edulis* biomass. The biomass in a covering degree of 10 and 25% are a bit higher in relation to the other covering degrees. However, as for the abundance the relation was strong with a regression coefficient of 0.95 both for the total biomass and the for *M. edulis* biomass. The strong relation makes it possible to use the equations in Figure 5-5 when estimating the total and *M. edulis* biomass in the studied area by means of the GIS model.

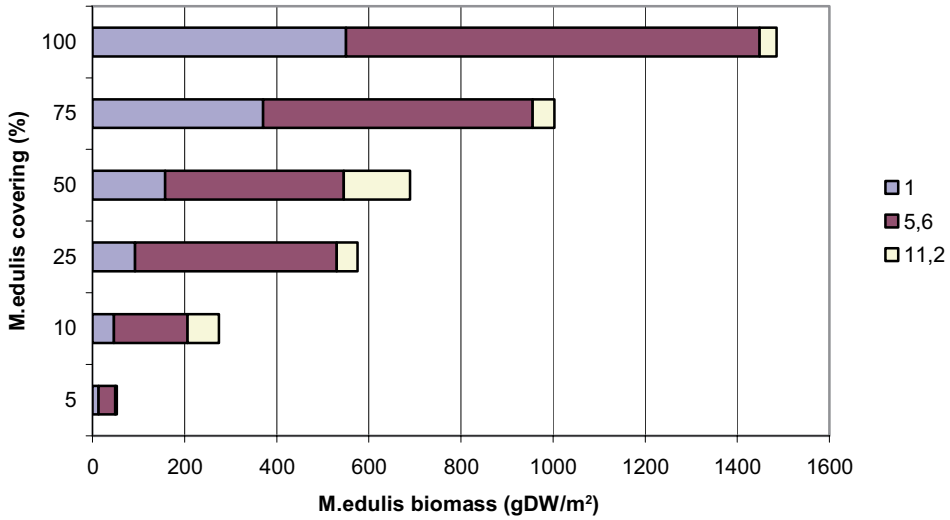

Figure 5-4. *Mean* M. edulis *biomass and distribution among the fractions in the different covering degrees.*

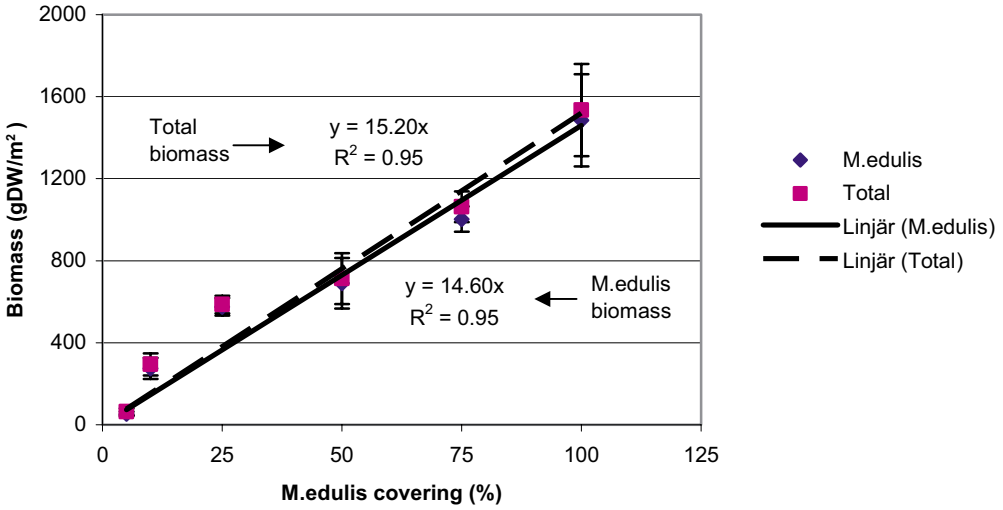

Figure 5-5. M. edulis *and total biomass correlated against* M. edulis *covering. Interception for trend line set to zero.*

5.2.4 Occurance of red algae

Since *M. edulis* occurred along with Red algae in the studied area the samples collected in this study contained Red algae to various extents. The presence of Red algae in the samples had a visible effect on *M. edulis* abundance. This was extra evident in the *M. edulis* covering degrees between 25 and 75%. The increase in abundance was mainly dependent on an increase of smaller specimens in the 1 mm fraction. Figure 5-6 shows how the average weight of *M. edulis* specimen decreased with increasing Red algae biomass in the samples from the covering degree 75%.

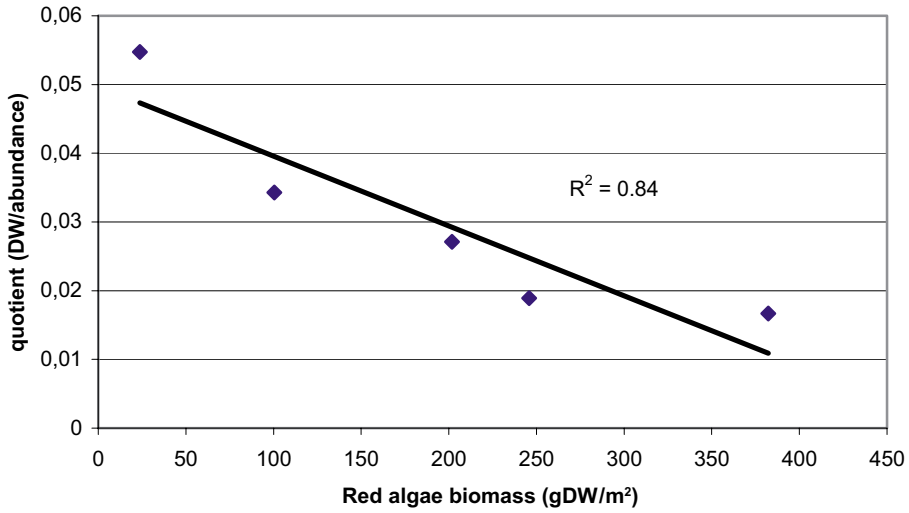

Figure 5-6. *Mean biomass per* M. edulis *specimen in samples with different biomass of Red algae. Example from the covering degree 75%.*

5.3 Comparison with other regional studies

For comparison a *Mytilus edulis* study on Utgrunden south east of Kalmar was used /Tobiasson et al. 2004/. The study was performed by the University of Kalmar in December, 2003. Utgrunden is an esker located between Degerhamn on Öland and Bergkvara on the main land. Quantitative samples of *M. edulis* were collected from six stations. Each station was sampled at three depths (8, 10 and 12 metres). Three samples were collected at each station and depth. Before analysis samples were sieved using mesh size of 4 mm. Specimens passing trough the sieve were sub-sampled and counted (not weight). Specimens not passing through the sieve were counted and the biomass was determined as wet weight.

Abundance

Since samples from Utgrunden were collected with the water depth as a starting point the number of samples among the different covering degrees varied. Twelve samples were collected from the covering degree 50%, nine from covering degrees 50–75, 75 and 75–100% respectively. From the covering degrees 25–50 and 25% respectively, six samples were collected and from 10% three samples. The resemblance between the study from Utgrunden and this study was good regarding abundance, although the abundance at higher covering degrees tend to be a bit higher in this study (Figure 5-7).

Biomass

Since the biomass of *M. edulis* in the study at Utgrunden was measured as wet weight, the two studies will not be fully concordant. To make the comparison possible a dry weight/wet weight index was calculated. Data from the SKB site investigation study of submerged vegetation by Fredriksson and Tobiasson in 2003 was used. Totally 34 samples were used in the calculation. The dry weight was calculated to be 40.4% of the wet weight (median) with a first and third quartile of 36.4 and 43.5 respectively. Furthermore, since the fraction passing through the four millimetre sieve, in the study on Utgrunden, was not analyzed regarding biomass, the comparison between the studies was even more difficult. Figure 5-8 presents the *M. edulis* biomass as the sum of the 11.2 and 5.6 millimetre fraction from this study and the specimens not passing through the four millimetre sieve in the study from Utgrunden. Thus, the smallest specimens from both studies are left out from the comparison. The biomass was consequently higher in the samples from the area around Simpevarp. Only for the covering degree 10% the *M. edulis* biomass from the two studies were on level.

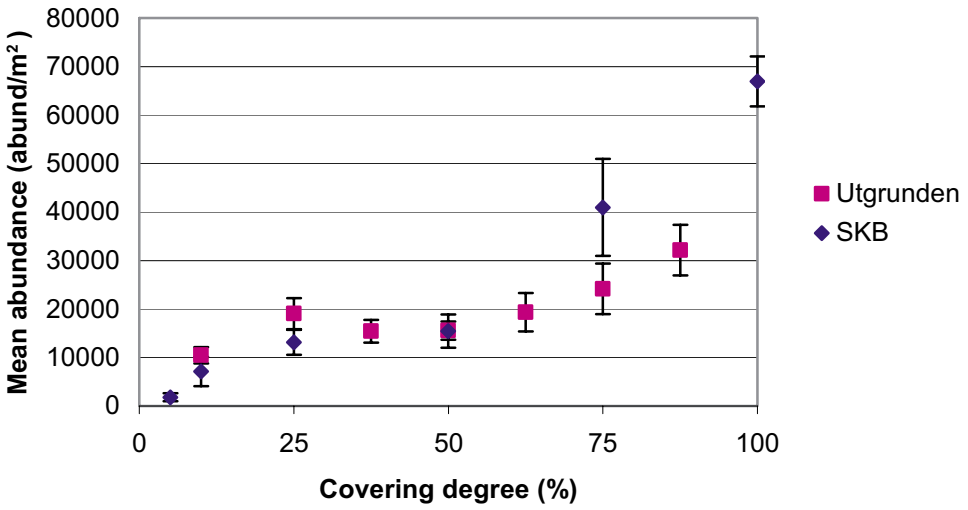

Figure 5-7. M. edulis *abundance at different covering degrees.*

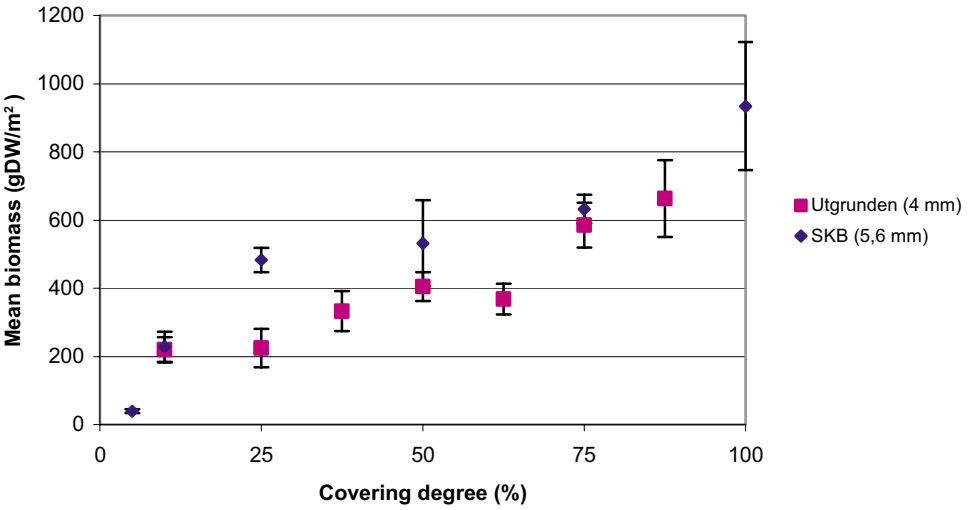

Figure 5-8. M. edulis *biomass (gDW/m²) at different covering degrees.*

5.4 GIS layer and total abundance and biomass estimation

When the total abundance and biomass in the area studied were calculated the equations presented in Table 5-1 were used.

Table 5-1. Equations used in the GIS model. Variables and purpose.

Equation	Input = X	Output =Y	Purpose
y = -6.15x + 103.33	Water depth (m)	*M. edulis* covering (%)	Estimating the *M. edulis* covering at different depths.
y = 726.43x	*M. edulis* covering (%)	Total abundance per square meter	Calculating the total abundance at different covering degrees.
y = 579.74x	*M. edulis* covering (%)	*M. edulis* abundance per square meter	Calculating the *M. edulis* abundance at different covering degrees.
y = 15.20x	*M. edulis* covering (%)	Total biomass (gDW) per square meter	Calculating the total biomass at different covering degrees.
y = 14.6x	*M. edulis* covering (%)	*M. edulis* biomass (gDW) per square meter	Calculating the *M. edulis* biomass at different covering degrees.

Figure 5-9 presents the distribution and covering degree of *M. edulis* in the area studied. According to the equation calculating the *M. edulis* covering degree at different depths, the covering degree should reach a zero value at a depth between 16 and 17 metres. Therefore the distribution of *M. edulis* was estimated to a depth of 16 metres maximum. This equation was not used at depths between zero and three metres due to effects from wave exposure. Instead a template (estimated from an earlier investigation /Fredriksson and Tobiasson, 2003/) value of 5% was used for this depth interval.

Table A5-1 in Appendix 5 presents the results from the estimation of abundance and biomass in the total area. The total biomass of sessile epifauna in the area was estimated to almost 4,500 metric tons dry weight. *Mytilus edulis* constituted approximately 96% of this biomass. Also the abundance was dominated by *M. edulis*, however not to the same extent as for the biomass. About 80% of the total abundance consisted of *M. edulis*. The estimated total abundance of *M. edulis* in the area was about 170 milliard specimens.

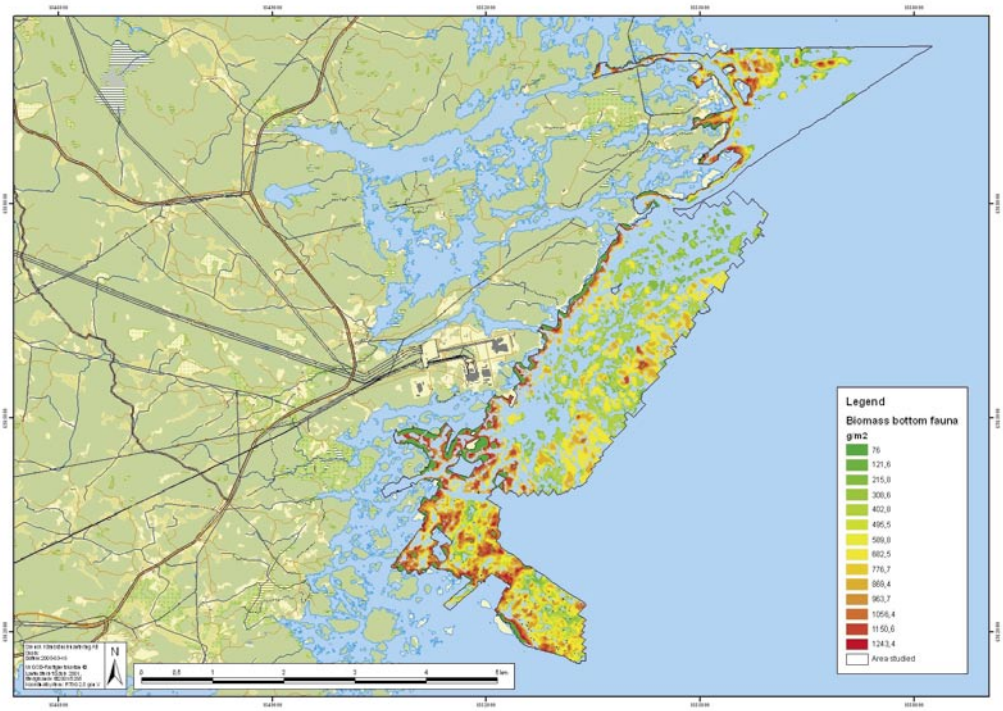

Figure 5-9. *Map of the Simpevarp and biomass of hard bottom fauna (gDW/m²). Black line indicates the area in which extrapolation of hard bottom fauna was made.*

6 Discussions

Both the abundance and biomass of sessile fauna attached to hard substrate in the Simpevarp area were dominated by *Mytilus edulis*. Especially the biomass consisted almost exclusively of *M. edulis*, which corresponds to what have been seen in earlier studies /Gilek et al. 2001; Westerbom et al. 2002/. However, in the lower *M. edulis* covering degrees the gastropods Hydrobiidae and *Theodoxus fluviatilis* made a substantial contribution to the total biomass (Appendix 4). The substantial contribution from these species in the lower *M. edulis* covering degrees was extra evident when looking on the abundance. For example did approximately 40% of the total abundance in the 5% covering degree consist of Hydrobiidae. Its difficult to point out any link between the amount of red algae with the amount of Hydrobiidae in the samples since this gastropod can appear both as epifauna and infauna, for example on sand bottoms /Boström and Bonsdorff, 1997/. All quantitative samples were collected by the same diver. This should guarantee a stringent assessment of the *M. edulis* covering degree at the sampling sites. On the other hand, assessment along transects and on point dives were made by three different divers. This might lead to a divergent assessment among readings and could affect the results presented in Figure 5-1. However, since the mean from several readings at a certain depth interval was used, this effect should be reduced.

The occurrence of red algae in the samples was relatively high. Furthermore, the biomass of red algae varied to a great extent among the samples. The presence of red algae resulted in a more diverse composition of species. For example it's likely that taxa like *Idotea* sp. and *Gammarus* sp. were found due to the presence of red algae since they normally live associated to vegetation /Pavia et al. 1999/. The red algae also co varied with the size composition of *M. edulis* in the samples. With increasing biomass of red algae the mean biomass of each *M. edulis* specimen decreased. This was probably due to an increased amount of small specimens associated with the algae present in the samples. This phenomenon was extra evident in the covering degrees between 25 and 75%.

The abundance in the 50% *M. edulis* covering was a bit low compared to the other covering degrees (Figure 5-3). This is a source of error when the equations of the trend lines presented in Figure 5-3 is used to estimate the total and *M. edulis* abundance in the studied area. Regarding biomass the values for the covering degrees 10 and 25% was a bit high compared to the other covering degrees (Figure 5-5). This, just as for abundance, can be considered as a source of error. This exemplifies the difficulty to compare the covering degree with the abundance and biomass separately since a low abundance can be compensated by large mussels covering more and vice versa. /Gilek et al. 2001/ reported that samples with low biomass of *M. edulis* mainly consisted of small mussels, while samples with a high biomass mainly consisted of large specimens. Thus, a high abundance of *M. edulis* does not necessarily result in a high biomass. Furthermore, the covering degree of *M. edulis* is a subjective assessment that could vary among those who collect samples. In this study one diver collected all samples which should minimize the discrepancy between assessments. Despite these difficulties the correlation between both abundance and biomass and the covering degree in this study was strong which should result in a reliable estimation of the total abundance and biomass.

The comparison with Utgrunden regarding *M. edulis* biomass is uncertain for several reasons. First, the biomass from Utgrunden is recalculated from the wet weight by means of a template value. This template value was calculated by means of data from a SKB site investigation /Fredriksson and Tobiasson, 2003/. The size of the mussels was not taken into consideration when calculating the index. This could be a source of error since different sizes of *M. edulis* has a different meat weight and shell weight ratio. Also, different sieving techniques were used in the two studies. Samples from the Utgrunden study was sieved through a four millimetre sieve. Specimens passing this sieve were only analyzed regarding abundance, not biomass. The closest mesh size used in this study was the 5.6 millimetre sieve. Despite the wider mesh size the *M. edulis* biomass was higher in the samples from the Simpevarp area. The uncertainties in the comparison make it hard to say what this discrepancy derives from. Furthermore, another possible source of uncertainty in the Utgrunden study is that several divers made the assessment about *M. edulis* covering degrees and collected samples. This makes the connection between the covering degree and biomass more uncertain.

The distribution of *M. edulis* was estimated down to a depth of 16 metres maximum. About nine percent of the suitable substrate was located at depths exceeding 16 metres and was therefore excluded. According to the field observations in Appendix 2, *M. edulis* is not so abundant at this depth. It can therefore be assumed that the loss should be minimal when excluding depths exceeding 16 metres. Another uncertainty in the interpretation was the merging of depth interval between 0 and 3 metres and the template value of a covering degree of five percent. Areas within this depth interval occur at many different locations in the area. Thus, these bottoms are exposed for a various amount of wave exposure, structuring the *M. edulis* community. The *M. edulis* abundance can certainly vary a great deal depending on the location.

The assessment on the amount of suitable substrate is a bit uncertain. The classification of the substrates from Geological Survey of Sweden was made from the dominating substrate from the surface down to a depth of 50 centimetres /Pers. comm. Ingemar Cato, Geological Survey of Sweden/. Therefore it's impossible to know if there is a, for example, thin layer of sand or clay on top of an area classified as hard substrate. This could lead to an overestimated amount of suitable substrate. The classification from Marin Mätteknik AB on the other hand was based on the surface substrate /Pers. comm. Olof Nilsson, Marin Mätteknik AB/. Regarding substrate estimation, approximately 60% of the area studied was estimated by Geological Survey of Sweden and 40% by Marin Mätteknik AB.

The area of the different covering degrees was calculated based on a two dimension image of the bottom. In reality, *M. edulis* also occur on vertical surfaces. Since the variation in bottom structure was not taken into consideration, the amount of suitable substrate in this perspective was somewhat underestimated.

In this study the covering degree of *M. edulis* was the parameter correlated against water depth which then in the long run was used to calculate the biomass and abundance of sessile epifauna. It was not suitable to correlate the biomass or abundance directly against the water depth since the samples were collected on the basis of the covering degree, not water depth. Thus, no effort was made to cover all water depth during sampling.

References

Boström C, Bonsdorff E, 1997. Community structure and spatial variation of benthic invertebrates associated with Zostera marina (L.) beds in the northern Baltic Sea. J. Sea Res. 37: 153–166.

Elhammer A, Sandkvist Å, 2005. Oskarshamn site investigation. Detailed marine geolocical survey of the sea bottom outside Simpevarp. SKB P-05-35, Svensk Kärnbränslehantering AB (in press).

Fredriksson R, Tobiasson S, 2003. Inventory of macrophyte communities at Simpevarp nuclear power plant – Area of distribution and biomass determination. SKB P-03-69, Svensk Kärnbränslehantering AB.

Gilek M, Littorin B, Saetre P, 2001. Spatial patterns of abundance and growth of *Mytilus edulis* on boulders in the Northern Baltic Sea proper. Hydrobiologica 452: 59–68, 2001.

Ingvarsson N, Palmeby A, Svensson O, Nilsson O, Ekfeldt T, 2004. Marine survey in shallow coastal waters. Bathymetric and geophysical investigation 2004. SKB P-04-254, Svensk Kärnbränslehantering AB.

Littorin B, Gilek M, 1999. A photographic study of the recolonization of cleared patches in a dense population of *Mytilus edulis* in the northern Baltic proper. Hydrobiologica 393: 211–219, 1999.

Naturvårdsverket, 1986. Recipientkontroll vatten. Del 1, Undersökningsmetoder basprogram. Naturvårdsverket Rapport 3108.

Pavia H, Carr H, Åberg P, 1999. Habitat and feeding preferences of crustacean mesoherbivores inhabiting the brown seaweed Ascophyllum nodosum (L.) Le Jol. And its epiphytic macroalgae. J. Exp. Mar. Biol. Ecol. 236, 15–32.

Tobiasson S, 2003a. Tolkning av undervattensfilm från Forsmark och Simpevarp. Mars 2003. Högskolan i Kalmar. Rapport 2003:6.

Tobiasson S, 2003b. Översiktlig inventering av vegetation, bottendjur och bottenförhållanden vid planerad vindkraftsanläggning vid Kårehamn, Öland. Rapport 2003:7, Högskolan i Kalmar.

Tobiasson S, Rosberg L, Engkvist R, Nilsson J, 2004. Blåmusslor och sjöfåglar vid Utgrunden. Finns det ett samband? Rapport 2004:1, Högskolan i Kalmar.

Westerbom M, Kilpi M, Mustonen O, 2002. Blue mussels, *Mytilus edulis*, at the edge of the range: population structure, growth and biomass along a salinity gradient in the north-eastern Baltic Sea. Marine Biology (2002) 140: 991–999.

Appendix 1

A brief description of method used

Diving transects

The method used is a modified variant of BIN V R112-113 /Naturvårdsverket, 1986/.

Environmental records

Besides direct sampling, following environmental factors were registered.

- Wind direction.
- Wind force (m/s).
- Wave altitude (m).
- Water temperature (°C).

Location of profile

The measuring tape was fastened at either the shore line or at the shallowest part of a shoal. It was then drawn out until the water depth was stable or to a maximum of 100 metres. Divers followed the measuring tape from the deepest part until reaching the zero point. The position at both starting and ending point was recorded.

Ocular records

All observations along the profile were made within a 3–5 metres wide zone at each side of the measuring tape, depending on the visibility.

Water depth and distance from starting point were registered for:

- The covering degree for *Mytilus edulis* according to a seven point scale, (+) for occurrence, 5, 10, 25, 50, 75 and 100%.
- The covering degree for dominating submerged vegetation according to the seven point scale described above.
- Substrate, sort and covering.

Sampling

Quantitative sampling was carried out by means of a 0.04 m^2 (20×20 centimetres) frame. From each covering degree, with *Mytilus edulis* as a starting point, ten samples were collected. All samples were collected by the same diver.

Point dives

The shallowest part of a shoal, identified by an echo sounder, or the water edge was used as a starting point. The diver swam towards deeper water, until the slope decreased or because of absence of suitable substrate. The same observations as for the diving transects were made, but within more broad depth intervals.

GIS

A polygon shape file describing the suitable substrate at different depth was created by means of polygon shape files describing the bottom substrate and grids describing the water depth. The original files were created by Geological Survey of Sweden /Elhammar and Sandkvist, 2005/ and Marin Mätteknik AB /Ingvarsson et al. 2004/. The new polygon shape file was created as follows. From the shape files describing the bottom substrate, suitable substrate for *M. edulis* was extracted. A depth grid was created by means of topographic lines. Depth grids were then converted into polygon shape files to obtain surfaces. By clipping the depth polygons based on the substrate polygons a new set of polygons describing suitable substrate at different water depths was created. Polygons with same depth were unified to a single polygon for which the area was calculated. This was made from three to sixteen metres within one metre intervals. Polygons representing a water depth less than three metres were unified to a separate polygon. The covering degree for a depth interval was calculated as a mean between the highest and lowest depth, e.g.the mean of the covering for eight and nine metres. By means of the polygon layer with substrate and depth, the total abundance and biomass for the area, shown in Figure A1-1, was estimated.

All operations were made in Arc View 3.3, by Environmental Systems Research Institute, Inc.

Field observations

AP PS 400-04-098

Högskolan i Kalmar
Inst för Biologi & Miljövetenskap

Fältprotokoll, transektdyk

Lokal (ID-nr och namn)	LSM 000509	profil 1	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1553307 6365018	**GPS-position :** (Yttre)	1553358 6364948	
Datum	2004-11-02	**Tid :**	9:55 - 10:35					**Vattentemp :**	8 °C
Dykare :	Tobias, Jonas, Sanna								
			vattenstånd	**-0,1**					
		vindrikt	W	Just.vatt.st.	J				
bäring	ca: 100	vindstyrka	1						
utg. pkt	0-punkt	våghöjd	0	landfoto :	N				
				UV-foto/film :	N				

prover :	avst	djup	storlek	myt.täckn
		13		5
		12,1		10
		11,8		10
		11,7		25
		10,3		5
		9,1		25
		9,4		50
		6,9		75
		6,2		50
		5,4		100

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

Linjetaxering
UNDRE GRÄNS för:

avstånd	djup	Substrat	Täckning	Fucus serratus	Sphacelaria	Pilayella			Polysiphonia fucoides	Phyllophora	Furcellaria lumbricalis	Ceramium	Cladophora rupestris			Mytilus		Anmärkning
0	4,7	H	100						10		1	75				50		+ block (stora)
8	5,4	H	100			1			10		1	75				75		+ block (stora)
16	7	H	100						50	1	1	25				75		
24	8,3	H	100			1			75	1	1					50		
30	9,1	H	100						75-100	1	1					10		
35	9,7	H	100	1		1			75	1	1					5-10		
50	9,8	Bl	100	1					75	1	1					5-10		
65	12,5	Bl+St	100	1	1				75	1	1					10		
68	12,8	Bl+St	100		1				10	1	1		1			1		sten 25% + block 75%, Polysiph fucoides lösliggande 75%
73	13,1	Bl+smSt	100						10							1		småsten + block 100%, Polysiph fucoides lösliggande 75%
85	13	smSt	75	1					10				1			1		småsten 75% i sand

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, transektdyk

Lokal (ID-nr och namn)	LSM 000510	profil 2	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1554086 6362724	**GPS-position :** (Yttre)	1554107 6362756
Datum	2004-11-02	**Tid :** 11:35 - 12:15					**Vattentemp :**	8 °C
Dykare :	Tobias, Jonas, Sanna		**vattenstånd**	-0,1				
		vindriktning	W	Just.vatt.st.	J			
bäring	ca 10	vindstyrka	1					
utg. pkt	0-punkt	våghöjd	0	landfoto :	N			
				UV-foto/film :	N			

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

prover :	avst	djup	storlek	myt.täckn
		18,2		5
		17,2		5
		13,2		10
		12,6		10
		10,6		10
		10,1		25
		9		75
		9,2		50
		5,8		75
		5,7		50

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Linjetaxering
UNDRE GRÄNS för:

avstånd	djup	Substrat	Täckning	Sphacelaria	Polysiphonia fucoides	Phyllophora	Furcellaria lumbricalis	Ceramium	Mytilus	Anmärkning
0	5,3	H	100		25		5	25	50	
11	9,2	H	100		25		5	25	50	
22	10	H+Bl	100		75		1		25	
30	13,2	H	100		75		1		10	
36	14,2	H+Bl	100		50		1		5-10	
43	16,9	H+Bl	100	10	10	10	1		5-10	
52	18,4	Bl	100	10	5-10	10			1	
53	18,4	Gr+smSt	75		5					lösa röda (Poly.fucoides dominerar) 100%

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, transektdyk

Lokal (ID-nr och namn)	LSM 000511	profil 3	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1552520 6364017	**GPS-position :** (Yttre)	1552481 6364098
Datum	2004-11-02	**Tid :** 13:35 - 14:15					**Vattentemp :**	8 °C

Dykare :	Tobias, Jonas, Sanna						
			vattenstånd	-0,1			
		vindriktning	NW	Just.vatt.st.	J		
bäring	ca 330	vindstyrka	2				
utg. pkt	0-punkt	våghöjd	0,1	landfoto :	N		
				UV-foto/film :	N		

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

prover :	avst	djup	storlek	myt.täckn
		12,1		5
		12,2		10
		9,8		5
		10		25
		8,6		25
		8,8		50
		6,6		75
		6,4		75
		4,3		75
		4,6		75

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Linjetaxering
UNDRE GRÄNS för:

avstånd	djup	Substrat	Täckning	Fucus serratus	Sphacelaria		Aglaothamnion roseum	Rhodomela confervoides	Polysiphonia fucoides	Phyllophora	Furcellaria lumbricalis	Ceramium				Mytilus	Anmärkning
0	4	Bl	100		5		1	1	5		1	50				100	
9	4,2	Bl	100		5		1	1	5		1	50				100	
24	5,6	Bl	100				1		10		5	75				75	
33	6,8	Bl	100				1		50	1	10	25				75	på lodräta sidor Myt 100%
37	7,4	Bl+St	100	1			1		50		10	25				75	
42	8	Bl+St	100	1					75	1	1	10				50	
45,5	8,7	Bl+St	100	1					75	1	1					25	
60	10,2	Bl+St	100						75		5					25	
67	12,6	H	100						75	1	5					10	
72	13,2	Bl	75						50	1	5					10	rel plan botten
90	14,4	St i S	50						5		1					5	småsten i hårt packad sand (plan botten), sten 50%

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, transektdyk

Lokal (ID-nr och namn)	LSM 000512	profil 4	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1555038 6366925	**GPS-position :** (Yttre)	1555004 6366952
Datum	2004-11-11	**Tid :** 9:10 - 9:55					**Vattentemp :**	5 °C
Dykare :	Tobias, Sanna, Frasse		**vattenstånd**	-0,2				
		vindrikt	SW	Just.vatt.st.	J			
bäring	ca 285	vindstyrka	2					
utg. pkt	0-punkt	våghöjd	0,1	landfoto :	N			
				UV-foto/film :	N			

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

prover :	avst	djup	storlek	myt.täckn
		13,6		10
		13,3		50
		11,6		25
		12		5
		10,6		75
		9,5		50
		8,4		100
		8,3		50
		7,2		75
		7,4		100

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Linjetaxering
UNDRE GRÄNS för:

avstånd	djup	Substrat	Täckning	Fucus serratus	Sphacelaria			Rhodomela confervoides	Polysiphonia fucoides	Phyllophora	Furcellaria lumbricalis	Ceramium				Mytilus	Anmärkning
0	7,1	Bl+St	100	5	10			5	5	1		10				75	
4,3	7,4	Bl+St	100	5	1			5	25	1	1					75-100	
19	9,2	Bl+St	100	1				5	25							75-100	
24	10,1	Bl+St	100	1					25		5					75	på blockens toppar Mytilus 100%
29	11,7	Bl+St i S	75					1	25		5					50	
40	13,6	Bl	100						50							75	stora Bl
48	14,8	St i S	75						10-25		1					10	
58	15,4	St i S	50						5		1					5	småsten (50%) i S

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar
Inst för Biologi & Miljövetenskap

Fältprotokoll, transektdyk

Lokal LSM 000513 profil 5
(ID-nr och namn)

Område : Simpevarp

GPS-position : (o-punkt) 1555407 6369852

GPS-position : (Yttre) 1555390 6369794

Datum 2004-11-11 **Tid :** 10:15 - 11:20

Vattentemp : 5 °C

Dykare : Tobias, Sanna, Frasse

vattenstånd -0,2

bäring	ca 180	vindrikt	SW
utg. pkt	0-punkt	vindstyrka	4
		våghöjd	0,1
Just.vatt.st.	J	landfoto :	N
UV-foto/film :	N		

prover :

avst	djup	storlek	myt.täckn
	13,3		5
	13		5
	11,4		10
	11		25
	9,6		25
	9,1		50
	7,3		50
	6,3		50
	4,6		25
	4,3		75

TÅNGOBSERVATIONER			
	Ögb.	Rekryt.	
Fuc. täckn. 1m	Ugb.	Lös, Fuc	
Sub/Täckn. 1m	UgF	Betn. skada	
	UgS	Slam	
	UgR	Påväxt	

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

Linjetaxering
UNDRE GRÄNS för:

avstånd	djup	Substrat	Täckning	Fucus serratus	Sphacelaria			Rhodomela confervoides	Polysiphonia fucoides		Furcellaria lumbricalis	Ceramium				Mytilus		Anmärkning
0	0,9	St	100															
2	0,8	St	100						1							1		organismer bortspolade i skvalpzon
10	2,2	Bl	100		1				1			25				25		
14	4,8	Bl	100					1	10		1	10				75		
17,5	6,6	Bl	100					1	10		1	10				75		Blockbrant börjar
26	8,7	St i S	25						10							5		25% småsten i sand
32	9,3	St i S	5						5							1		ren sand m lite sten (5%)
47	9,7	St i S	25	5					5							10		plan botten (25% småsten i sand), 75-100% lös Pol fuc o Rhodom
62	10,2	St+Bl i S	75	1					25		1					25		
68,5	11,9	St+Bl i S	50						25		1					10		uppe på block Mytilus 75% men totalt 10%
77	14,1	St i S	25						5							5		25% sten i sand, mkt slam

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, transektdyk

Lokal (ID-nr och namn)	LSM 000514	profil 6	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1553616 6369789	**GPS-position :** (Yttre)	1553608 6369817
Datum	2004-11-11	**Tid :** 11:35 - 12:20					**Vattentemp :**	6 °C
Dykare :	Tobias, Sanna, Frasse							

			vattenstånd	-0,2	
		vindrikt	SW	Just.vatt.st.	J
bäring	ca 5	vindstyrka	1		
utg. pkt	0-punkt	våghöjd	0	landfoto :	N
				UV-foto/film :	N

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

prover :

avst	djup	storlek	myt.täckn
	5,8		10
	5,7		5
	5,6		10
	2,3		25
	2		50

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Linjetaxering
UNDRE GRÄNS för:

avstånd	djup	Substrat	Täckning	Rivularia	Cladophora	Urospora	Mytilus	Anmärkning
0	0,5	H+Bl	100	10	25		5	
1,5	1,2	H+Bl	100				25	på lodräta blocksidor 50%
3,5	2,2	H+Bl	100		25	25	5	
8	4	H+Bl	100				5	mkt slam, gammalt fintrådigt täcker allt
12	6,4	H	100				10	mkt slam, gammalt fintrådigt täcker allt
14,5	7,9	H	100				10	häll börjar, längre ut gyttja (FG)
		FG						

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar
Inst för Biologi & Miljövetenskap

Fältprotokoll, punktdyk

Lokal (ID-nr och namn)	PSM 006933 punkt 1	**Område :**	Simpevarp
GPS-position : (o-punkt)	1553738 6364160	**GPS-position :** (Yttre)	
Datum	2004-11-02	**Tid :**	10:50 - 11:00
Dykare :	Tobias, Jonas, Sanna	**Vattentemp :**	8 °C

vattenstånd	-0,1
Just.vatt.st.	J
landfoto :	N
UV-foto/film :	N
vindrikt	W
vindstyrka	1
våghöjd	0
bäring	ca 300
utg. pkt	0-punkt

prover :

avst	djup	storlek	myt.täckn

TÅNGOBSERVATIONER		
Fuc. täckn. 1m	Ögb.	Rekryt.
Sub/Täckn. 1m	Ugb.	Lös, Fuc
	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

djupintervall övre	nedre	Substrat	Täckning	Fucus serratus					Polysiphonia fucoides	Phyllophora	Furcellaria lumbricalis	Ceramium				Mytilus		Anmärkning
5,2	7,5	H	100						25		1	25				75		
7,5	9	H+Bl	100	10					75	1	5	5				50		
9	12	Bl	100	5					50	1	5					25		
12	15	Bl	75						25		1					10		

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar
Inst för Biologi & Miljövetenskap

Fältprotokoll, punktdyk

Lokal (ID-nr och namn)	PSM 006934 punkt 2	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1553951 6363341
GPS-position : (Yttre)					
Datum	2004-11-02	**Tid :**	13:00 - 13:10	**Vattentemp :**	8 °C
Dykare :	Tobias, Jonas, Sanna	**vattenstånd**	-0,1	**prover :**	
bäring	ca 20	vindrikt	W	Just.vatt.st.	J
utg. pkt	0-punkt	vindstyrka	1	landfoto :	N
		våghöjd	0	UV-foto/film :	N

prover :	avst	djup	storlek	myt.täckn

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

djupintervall övre	djupintervall nedre	Substrat	Täckning	Polysiphonia fucoides	Phyllophora	Furcellaria lumbricalis	Ceramium	Mytilus	Anmärkning
4	6	H+Bl	100	25	1	5	50	50	
6	8	H+Bl	100	75	1	1	5	75	
8	10	H+Bl	100	75	1	1	1	25	
10	11	H+Bl	100	75	1	1	1	5	

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, punktdyk

Lokal (ID-nr och namn)	PSM 006935 punkt 3	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1553946 6365515	**GPS-position :** (Yttre)	
Datum	2004-11-02	**Tid :**	14:35 - 14:50			**Vattentemp :**	8 °C
Dykare :	Tobias, Jonas, Sanna						

				vattenstånd	-0,1		
		vindrikt	NW	Just.vatt.st.	J		
bäring	ca 150	vindstyrka	2				
utg. pkt	0-punkt	våghöjd	0,2	landfoto :	N		
				UV-foto/film :	N		

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

prover :

avst	djup	storlek	myt.täckn

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

djupintervall övre	djupintervall nedre	Substrat	Täckning	Fucus serratus			Aglaothamnion roseum		Polysiphonia fucoides		Furcellaria lumbricalis		bakteriefilm			Mytilus		Anmärkning
5	7	Bl+H	100				1		10		5		1			75		
7	10	Bl+H	100	1					75		1					50		
10	11	St i S	10-25	1					10		10					5		10-25% sten i sand

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar
Inst för Biologi & Miljövetenskap

Fältprotokoll, punktdyk

Lokal (ID-nr och namn)	PSM 006936 punkt 4	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1556831 6366933
				GPS-position : (Yttre)	
Datum	2004-11-11	**Tid :**	14:15 - 14:30	**Vattentemp :**	5 °C
Dykare :	Tobias, Sanna, Frasse	**vattenstånd**	-0,2		
vindrikt	SW	Just.vatt.st.	J		
bäring	ca 330	vindstyrka	4		
utg. pkt	0-punkt	våghöjd	0,3	landfoto :	N
				UV-foto/film :	N

prover :

avst	djup	storlek	myt.täckn
	7,1		100
	7,6		100
	7,3		100
	7		100
	7,4		100

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

djupintervall övre	djupintervall nedre	Substrat	Täckning	Fucus serratus	Sphacelaria		Aglaothamnion roseum	Rhodomela confervoides	Polysiphonia fucoides		Furcellaria lumbricalis					Mytilus		Anmärkning
6,2	8,1	H	100						10		1					75		
8,1	9,2	Bl	100	1			1	1	25		5					75		
9,2	12	Bl+H	100		1			1	50		5					50		
12	14,5	Bl+H	100						25		5					25		
		Bl	10						5							5		Block i sand

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, punktdyk

Lokal (ID-nr och namn)	PSM 006937 punkt 5	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1555368 6368955	**GPS-position :** (Yttre)	
Datum	2004-11-11	**Tid :**	13:10 - 13:20			**Vattentemp :**	5 °C
Dykare :	Tobias, Sanna, Frasse						

				vattenstånd	-0,2		
		vindrikt	SW	Just.vatt.st.	J		
bäring	ca 110	vindstyrka	2				
utg. pkt	0-punkt	våghöjd	0,1	landfoto :	N		
				UV-foto/film :	N		

prover :

avst	djup	storlek	myt.täckn

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

djupintervall övre	djupintervall nedre	Substrat	Täckning	Fucus serratus	Fucus vesiculosus		Aglaothamnion roseum	Rhodomela confervoides	Polysiphonia fucoides		Furcellaria lumbricalis	Ceramium	cladophora			Mytilus		Anmärkning
0	1	H	100		5							75	1			10		Fucus som stumpar + nyrekr
1	1,3	H	100		5				5		1	50				10		Fucus sliten
1,3	2,2	H+Bl	100		25-50				25		1	5				10		Fucus nyrekrytering frekvent
2,2	2,5	H+Bl	100		10				25		5					25		Fucus betad
2,5	2,8	Bl	100		5			1	50		5					25		Fucus betad
2,8	5,2	Bl	100	1	1		1	1	75-100		10					10		
5,2	8	Bl	100	10	1		1	1	75		10					25		
8	9,2	Bl	100	5	1			1	75		5					25		
9,2	10,3	Bl	50	1					50		5					10		
10,3	11,5	Bl i S	10						10		1					5		

Andra stationsobservationer :

AP PS 400-04-098

Högskolan i Kalmar

Inst för Biologi & Miljövetenskap

Fältprotokoll, punktdyk

Lokal (ID-nr och namn)	PSM 006938 punkt 6	**Område :**	Simpevarp	**GPS-position :** (o-punkt)	1554352 6369997	**GPS-position :** (Yttre)	
Datum	2004-11-11	**Tid :**	12:30 - 12:40			**Vattentemp :**	5 °C
Dykare :	Tobias, Sanna, Frasse						

				vattenstånd	-0,2	**prover :**	avst	djup	storlek myt.täckn
		vindrikt	SW	Just.vatt.st.	J				
bäring	ca 350	vindstyrka	2						
utg. pkt	0-punkt	våghöjd	0,1	landfoto :	N				
				UV-foto/film :	N				

TÅNGOBSERVATIONER	Ögb.	Rekryt.
Fuc. täckn. 1m	Ugb.	Lös, Fuc
Sub/Täckn. 1m	UgF	Betn. skada
	UgS	Slam
	UgR	Påväxt

Täckn i %. 0,1,5,10,25,50,75,100. Bedömning 0, 1, 2,

djupintervall övre	djupintervall nedre	Substrat	Täckning	Fucus vesiculosus	Pilayella	Polysiphonia fucoides	Furcellaria lumbricalis	Ceramium	cladophora	Mytilus	Anmärkning
0,4	1,3	H	100	75	5			5	5	5	
1,3	2,7	BI+H	75	5	10	5	1	1		10	
2,7	6,2	BI	25			5	1			5	på block Mytilus 25%
6,2		FG									

Andra stationsobservationer :

Appendix 3

Analyzed samples

Table A3-1. Information about analyzed samples.

Covering degree	Sample	Transect	Substrate	Sampling depth (m)
5	1	LSM000509	Boulder	10.3
”	2	LSM000510	Boulder	18.2
”	3	LSM000510	Flat rock	17.2
”	4	LSM000511	Boulder	12.1
”	5	LSM000513	Boulder	13.0
10	1	LSM000509	Boulder	12.1
”	2	LSM000511	Boulder	12.2
”	3	LSM000514	Flat rock	5.8
”	4	LSM000514	Flat rock	5.6
”	5	LSM000509	Boulder	11.8
25	1	LSM000512	Boulder	11.6
”	2	LSM000513	Boulder	11.0
”	3	LSM000513	Boulder	4.6
”	4	LSM000513	Boulder	9.6
”	5	LSM000509	Boulder	9.1
50	1	LSM000513	Boulder	9.1
”	2	LSM000514	Flat rock	2.0
”	3	LSM000509	Flat rock	6.2
”	4	LSM000511	Boulder	8.8
”	5	LSM000510	Boulder	9.2
75	1	LSM000511	Boulder	6.6
”	2	LSM000511	Boulder	4.3
”	3	LSM000513	Boulder	4.3
”	4	LSM000509	Flat rock	6.9
”	5	LSM000511	Boulder	4.6
100	1	PSM006936	Flat rock	7.1
”	2	PSM006936	Flat rock	7.6
”	3	LSM000509	Flat rock	5.4
”	4	PSM006936	Flat rock	7.0
”	5	PSM006936	Flat rock	7.3

Appendix 4

Quantitative samples

Table A4-1. *Mean abundance of sessile epifauna (number/m2) in the different covering degrees. Deviation presented as Standard error.*

	M.edulis covering degree	5		10		25		50		75		100	
		M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Carnivores	Nereis diversicolor											25	25,0
	MYSIS SP.	20	9,4	25	25,0	100	61,2	25	25,0	50	50,0	25	25,0
	Saduria entomon			10	6,1								
	Calliopius laeviusculus					25	25,0					25	25,0
	Crangon crangon	5	5,0										
	DONACIA SP.									25	25,0		
	Total	25	7,9	35	23,2	125	79,1	25	25,0	75	50,0	75	30,6
Detrivores	Corophium volutator			5	5,0								
	HYDROBIIDAE	1 350	664,1	2 690	1 385,7	1 450	392,5	2 160	823,9	6 475	3 156,2	14 325	1 511,2
	Macoma baltica	25	25,0	15	15,0	25	25,0			50	30,6	125	39,5
	Total	1 375	670,0	2 710	1 381,7	1 475	400,0	2 160	823,9	6 525	3 177,4	14 450	1 493,0
Filter feeders	Balanus improvisus					25	25,0			200	200,0		
	Leptocheirus pilosus	5	5,0					25	25,0				
	Mytilus edulis	**1 805**	**816,4**	**7 090**	**2 985,9**	**13 115**	**2 541,8**	**15 425**	**3 419,4**	**40 935**	**9 986,9**	**66 935**	**5 143,8**
	CERASTODERMA SP.	5	5,0	20	14,6	55	33,9	220	213,8	925	774,2	175	33,7
	Mya arenaria	5	5,0	15	15,0							25	25,0
	Total	1 320	822,0	7 125	2 967,2	13 195	2 509,7	15 670	3 212,1	42 050	9 526,3	67 135	5 142,9
Herbivores	Idotea baltica	35	10,0	60	48,5	180	127,1	55	25,9	325	151,0	50	30,6
	Idotea granulosa											50	50,0
	JAERA SP.									100	46,6	100	25,0
	Theodoxus fluviatilis	330	223,5	600	367,4	310	128,1	710	425,3	1 750	516,9	875	142,5
	LYMNAEA SP.	25	15,8	5	5,0			30	18,4	50	50,0		
	Total	390	233,3	665	412,6	490	237,8	795	413,9	2 225	651,2	1 075	145,8
Omnivores	Sphaeroma hookeri			15	10,0			25	25,0				
	GAMMARUS SP.	95	43,6	125	41,1	275	100,0	315	214,4	1 200	315,2	650	199,2
	CHIRONOMIDAE							25	25,0				
	Total	95	43,6	140	34,1	275	100,0	365	201,5	1 200	315,2	650	199,2
	∑	4 305	1 591,5	10 675	3 702,0	15 560	2 798,8	19 015	3 965,0	52 035	13 098,5	83 385	5 501,3

												Total	
Average number of taxa (M ± SE)	6,2	1,07	6,2	0,73	5,4	1,12	5,8	0,37	7,2	0,73	7,8	0,86	6,4	0,35
***M. edulis* abundance share (%)**	45		66		84		81		79		80			
Red algae biomass (gDW/m2)	31,7	17,96	31,2	12,64	43,6	17,32	53,0	17,44	190,8	61,60	99,4	21,39		

Table A4-1. *Mean biomass of sessile epifauna (gDW/m2) in the different covering degrees. Deviation presented as Standard error.*

M.edulis covering degree		5		10		25		50		75		100	
		M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Carnivores	Nereis diversicolor											0,04	0,040
	MYSIS SP.	0,01	0 011	0,00	0,001	0,16	0,134	0 02	0,020	0,03	0,033	0,00	0,001
	Saduria entomon			0,11	0,066								
	Callopius laeviusculus					0,01	0,010					0,02	0,018
	Crangon crangon	0,04	0 041										
	DONACIA SP.									0,05	0,053		
	Total	0,06	0 039	0,11	0,066	0,17	0,144	0 02	0,020	0,09	0,054	0,06	0,039
Detrivores	Corophium volutator			0,00	0,001								
	HYDROBIIDAE	6,63	2 654	12,33	6,579	6,22	1,849	10,45	4,120	24,70	11,892	37,77	4,639
	Macoma baltica	0,56	0 563	1,02	1,018	0,08	0,075			0,81	0,791	1,66	1,047
	Total	7,20	2 844	13,35	6,455	6,30	1,868	10,45	4,120	25,51	11,790	39,43	5,108
Filter feeders	Balanus improvisus					0,31	0,305			2,23	2,233		
	Leptocheirus pilosus	0,00	0 001					0 00	0,001				
	Mytilus edulis	**52,81**	**11,420**	**274,68**	**51,495**	**575,23**	**43,156**	**689,39**	**123,334**	**1002,65**	**61,695**	**1485,13**	**224,565**
	CERASTODERMA SP.	0,04	0 036	2,61	2,573	0,41	0,256	1 63	1,584	9,61	8,535	0,84	0,351
	Mya arenaria	0,04	0 040	0,49	0,492							1,36	1,360
	Total	52,89	11,476	277,79	49,593	575 94	42,922	691,03	122,630	1014,49	61,959	1487,33	223,870
Herbivores	Idotea baltica	0,16	0 073	0,30	0,193	1,06	0,703	0 41	0,295	1,07	0,373	0,49	0,401
	Idotea granulosa											0,00	0,003
	JAERA SP.									0,00	0,001	0,00	0,001
	Theodoxus fluviatilis	2,23	1 503	2,77	1,159	2,69	1,585	8 69	4,787	20,13	6,104	5,35	1,922
	LYMNAEA SP.	1,03	0 965	0,04	0,043			2 04	1,303	0,79	0,785		
	Total	3,41	2 410	3,11	1,284	3,55	2,255	11,14	4,758	21,98	6,028	5,84	2,100
Omnivores	Sphaeroma hookeri			0,02	0,013			0 00	0,001				
	GAMMARUS SP.	0,22	0 075	0,12	0,054	0,18	0,095	0 29	0,178	1,30	0,317	2,57	0,730
	CHIRONOMIDAE							0 00	0,001				
	Total	0,22	0 075	0,13	0,052	0,18	0,095	0 29	0,178	1,30	0,317	2,57	0,730
	∑	63,78	15,317	294,49	53,345	586 54	43,067	712,93	124,433	1063,36	74,750	1535,23	224,710

												Total	
Average number of taxa (M ± SE)	6,2	1,07	6,2	0,73	5,4	1,12	5,8	0,37	7,2	0,73	7,8	0,86	6,4	0,35

***M. edulis* biomass share (%)**	83	93	98	97	94	97

Red algae biomass (gDW/m2)	31,7	17,96	31,2	12,64	43 6	17,32	53,0	17,44	190,8	61,60	99,4	11,39

Abundance and biomass estimations

Table A4-1. Mean biomass of sessile epifauna (gDW/m2) in the different covering degrees. Deviation presented as Standard error.

	M.edulis covering degree	5		10		25		50		75		100	
		M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Carnivores	Nereis diversicolor											0,04	0,040
	MYSIS SP.	0,01	0 011	0,00	0,001	0,16	0,134	0 02	0,020	0,03	0,033	0,00	0,001
	Saduria entomon			0,11	0,066								
	Calliopius laeviusculus					0,01	0,010					0,02	0,018
	Crangon crangon	0,04	0 041										
	DONACIA SP.									0,05	0,053		
	Total	0,06	0 039	0,11	0,066	0,17	0,144	0 02	0,020	0,09	0,054	0,06	0,039
Detrivores	Corophium volutator			0,00	0,001								
	HYDROBIIDAE	6,63	2 654	12,33	6,579	6,22	1,849	10,45	4,120	24,70	11,892	37,77	4,639
	Macoma baltica	0,56	0 563	1,02	1,018	0,08	0,075			0,81	0,791	1,66	1,047
	Total	7,20	2 844	13,35	6,455	6,30	1,868	10,45	4,120	25,51	11,790	39,43	5,108
Filter feeders	Balanus improvisus					0,31	0,305			2,23	2,233		
	Leptocheirus pilosus	0,00	0 001					0 00	0,001				
	Mytilus edulis	**52,81**	**11,420**	**274,68**	**51,495**	**575,23**	**43,156**	**689,39**	**123,334**	**1002,65**	**61,695**	**1485,13**	**224,565**
	CERASTODERMA SP.	0,04	0 036	2,61	2,573	0,41	0,256	1 63	1,584	9,61	8,535	0,84	0,351
	Mya arenaria	0,04	0 040	0,49	0,492							1,36	1,360
	Total	52,89	11,476	277,79	49,593	575 94	42,922	691,03	122,630	1014,49	61,959	1487,33	223,870
Herbivores	Idotea baltica	0,16	0 073	0,30	0,193	1,06	0,703	0 41	0,295	1,07	0,373	0,49	0,401
	Idotea granulosa											0,00	0,003
	JAERA SP.									0,00	0,001	0,00	0,001
	Theodoxus fluviatilis	2,23	1 503	2,77	1,159	2,69	1,585	8 69	4,787	20,13	6,104	5,35	1,922
	LYMNAEA SP.	1,03	0 965	0,04	0,043			2 04	1,303	0,79	0,785		
	Total	3,41	2 410	3,11	1,284	3,95	2,255	11,14	4,758	21,98	6,028	5,84	2,100
Omnivores	Sphaeroma hookeri			0,02	0,013			0 00	0,001				
	GAMMARUS SP.	0,22	0 075	0,12	0,054	0,18	0,095	0 29	0,178	1,30	0,317	2,57	0,730
	CHIRONOMIDAE							0 00	0,001				
	Total	0,22	0 075	0,13	0,052	0,18	0,095	0 29	0,178	1,30	0,317	2,57	0,730
	∑	63,78	15,317	294,49	53,345	586 54	43,067	712,93	124,433	1063,36	74,750	1535,23	224,710

												Total	
Average number of taxa (M ± SE)	6,2	1,07	6,2	0,73	5,4	1,12	5,8	0,37	7,2	0,73	7,8	0,86	6,4	0,35
***M. edulis* biomass share (%)**	83		93		98		97		94		97			
Red algae biomass (gDW/m2)	31,7	17,96	31,2	12,64	43 6	17,32	53,0	17,44	190,8	61,60	99,4	11,39		