ECASA Reduced Study Site Report

Site n° 4
Baie des Veys, Normandy

France

ECASA Partner n°12:IFREMER

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Non Technical Summary

1. This report presents the results of a field study conducted in the ECASA test site n°4 in Normandy, France. The site is located on the east coast of the Cotention Peninsula, in the Baie des Veys. This bay is open to the English Channel, but is rather protected against westerly winds. The bay has been exploited for bivalve culture for the seventies.
2. Within the bay, oysters (*Crassostrea gigas*) and mussels (*Mytilus edulis*) are cultivated the same way, on net bags, fixed on iron trestles. Rearing facilities occupy the lower intertidal area of the bay, at its eastern part, for 1.6 km²; cultivated biomasses was estimated to be 10 000 tonnes of bivalves. The sediment is sandy, with a small fraction of mud. This allows vehicles to be used to access the parks at low tide.
3. The site is subject to several regular monitoring through the local implementation of national networks aiming at protecting the environment and marine resources, on pollutants (RNO), microbiological quality of the waters (REMI), phytoplanktonic toxic species (REPHY) and growth and mortality of molluscs (REMORA). Benthic macrofauna was recently studied in 2004, and sediments are regularly investigated.
4. Five sampling sations were chosen along a line, starting under the trestles, and at distances of 50, 100, 200, and 400 metres from the area cultivated. A reference station was chosen in a different direction at 750 metres of the cultivated area. Sampling methods are described in the text.
5. Sediments were sampled for different analyses: grain size, content in organic matter, total organic carbon and nitrogen, and phytic pigments (chlorophyll a and phaeopigments). Redox were measured in cores. The macrofauna living into the sediment was also sampled. The water column was sampled for physical (temperature, transparency) and chemical parametres, including oxygen content, salinity, organic matter, dissolved nitrogen forms, phosphates and silicates.
6. Results from benthic macrofauna surveys indicate that there were no significant differences between the different stations and the reference station, all being classified as slightly disturbed. The bay is submitted to freshwater runoffs from two adjacent rivers.
7. The sediment is slightly modified by the culture of bivalves. Total organic carbon, total nitrogen, Eh values and pheopigments were significantly higher under the trestles than in any other stations. These other stations often did not differ from the reference station.
8. The effects of shellfish culture on the water column were very weak and contradictory. However, it was observed a small decrease of the food available to the molluscs near the rearing
9. The DEB model was able to describe and predict adequately the growth of oysters, both in the Baie des Veys and in the Loch Creran. The parametres for its use in other environment are given, but a tuning of one parametre should be performed with the help of authors.
10. Among the indicators and models for use in areas of intertidal bivalve culture, it is recommended to use TOC (Total Organic Carbon), redox and pheopigments, in surficial sediment, AMBI for the macrofauna, chlorophyll a contents and nitrogen forms in the water column, and models describing the carrying capacity, filtration rate of molluscs, and a DEB model to predict the growth of molluscs.

Content

1. Introductory background statement .

- The present study aims at characterazing the mains aspects of the impact of intertidal shellfish culture on the environment, in order to derive indicators and models which are pertinent to describe such an impact in the given conditions. It is part of a global resarch programme ECASA (http://www.ecasa.org.uk/), on which all the types of the marine European aquaculture will be studied with the same objectif, i.e. the production of a toolbox of models and indicators.

- The site studied is a intertidal, public area divided in leases granted to the oyster farmers. As the area is homogeneous, and the rules for the exploitation are common for all farmers, it was considered that the study should include the whole area as a large farm, in which several farmers participate. This is also based on ecological backgrounds. All the leases are spatially joined, and the resulting impact of the shellfish culture therefore results from the biological activity of the whole area

- This report was prepared by a team from IFREMER, ECASA partner n° 12, with technical help from the CRELA (centre de recherche sur les ecosystemes marins anthropisés) http://www.ifremer.fr/crema/, a laboratory commonly established with IFREMER and CNRS, and the IFREMER Laboratory for environment and marine resources of Normandy (LERPC) http://www.ifremer.fr/lern/.

- The main information sources were gathered from colleagues, involved in research and monitoring activities of environment and resources, with informal talks with stakeholders (mainly the professional exploiting the site). Some of these informations are available at the following web addresse: http://www.ifremer.fr/littoralbasnormand/page.php?numpage=85

- The site was visited both at sea and in the facilities, the 18th and 19th October 2006. Samplings were performed at the same date. Other informations were obtained from the Administration for Marine Affairs, for the legal aspects.

- The methods used were those described in ECASA documents: book of protocols, indicator sheets, and model descriptors.

The main difficulties encountered were linked with rough weather conditions during the sampling. Also, the time available to sample the site was very restricted, at this period of the year. Some field operations were shortened because of the coming of the night, and completed later on. This report concentrated on the analysis of the impact of shellfish on the marine environnement. The aspects concerning the different carrying capacities of the site, the growth and production, and the establishment of management rules, are developped within a research programme, named OGIVE (http://www.ifremer.fr/lern/Pages/Programme/ogive.htm), which will last until 2012.

2- Site description and management strategies

2.1. Location of the site

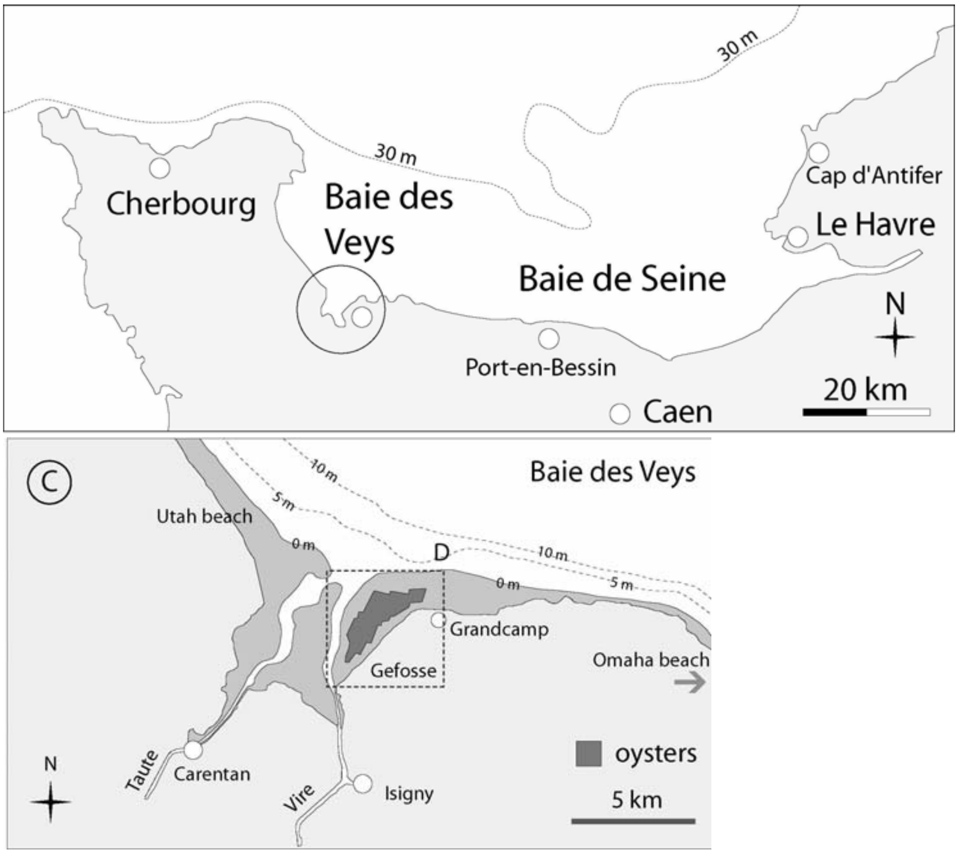


Figure 1 : Location of the Baie des Veys (zone C) along the French coasts

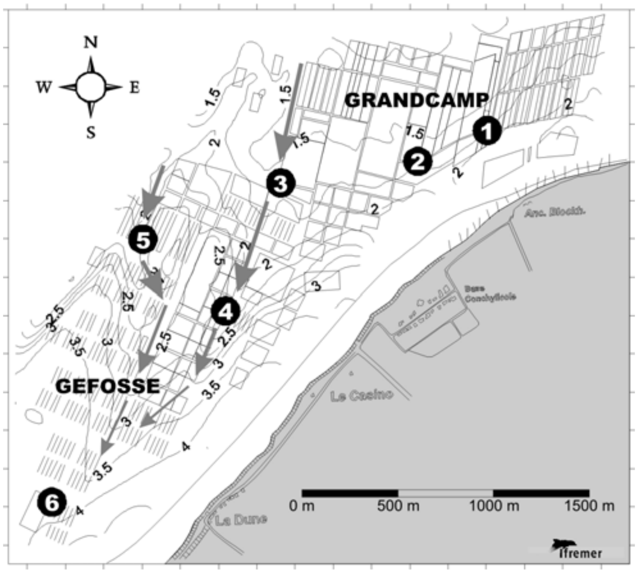


Figure 2 : Location of the area of mussel (Gefosse) and oysters (Grandcamp) culture in the Baie des Veys (Zone B)

The site is located on the Eastern part of Normandy, between two D-Day Beaches (Omaha beach and Utah Beach). A small river, the Vire, has a short estuary at the South of the area of molluscs culture (figure 1). The area itself is divided into two parts. At the North (Grancamp), the culture of oysters dominates, while at the south, (Gefosse), mussels are also cultivated following the same technique. The sediment is sandy, with a small fraction made of mud. Some rocks may appear on the Northern part of the site (figure 2).

2.2 Proposed management strategy: biomass, medicines, chemicals, rearing cycle, feed inputs, growth measurements.

The spat is usually obtained from other French sites or from hatcheries, during summer. After an ongrowing period of 18 months, the oyster are installed in bags, placed on trestles for the remaining of the growth.

Reared biomasse was assessed from field sampling in 2005, as being 10 000 tonnes of oysters, in an area of culture of 1.6 km². This corresponded to an average biomass of 6.25 kg of live oysters per m². The local density under the trestles can be even higher, since some space is allowed between the row of trestles to facilitate the circulation

The food being naturally produced in the surrounding water, a Food Conversion Ratio (FCR) is not generally computed for the bivalve culture. Instead the attention is paid to the carrying capacity of the site and its compatibility with the size of the rearing installations (Canada 2003).

No chemicals nor medicines are used during all the operations, from the settlement to the harvest.

The weight of oyster varies according to the rearing cycle, but it is generally included between 4 and 8 kg ,excepted for the very young individuals. The number of mollusks into the bags also fluctuates during the rearing cycle, both for the occurrence of usual mortalities, and as the result of the farmer to maintain an adequate density into theses bags.

The growth rate in the Baie des Veys varies from 25 to 35g per year. A life cycle would then lasts approximately three years, or 140 months, in order to reach a commercial weight between 75 and 90 g.

Harvest occurs mainly during November and December, when 40 % of the oysters are sold after two years, and the remaining after three years.

2.3 Physical farm logistics, including type of gear used (Cages, long lines, rafts…), moorings, access, lighting and anti-predator measures (use maps, and diagrams).

The intertidal culture of mollusks is conducted on oyster bags, 1 m long and 0.5 m wide. The mesh of the bag is chosen as a function of the size of the mollusks, in order to protect them from predators, and to ensure at the same time an efficient water circulation into the bag. Fouling can be controlled by returning the bags, once every month or two months. These bags are disposed on trestles, made of iron bars. A standart “table” is 3 m long and 1 m wide. It supports at least 6 oyster bags. The tables are arranged in rows of 10 to 20 tables. Rows are usually separated by paths facilitating the operations and reducing the average density of mollusks. A peculiarity of the culture in the Baie des Veys is that both oysters and mussels are reared in bags.

Figure 3 : Left: Row of tables, trestles and oyster bags. Right : Mechanized transport of products at low tide.

Access to the bags is possible at low tide, using vehicles to carry the products and the technical gears. However the time available for access is reduced to a maximum of three hours, during spring tides. During neap tides, the farmers could only access the products by diving, which has a prohibiting cost. An unpaved road allows the access from the shore, in order to avoid areas of softer sediments.

The area is protected by markers, which are wooden poles located around the mollusks grounds. Navigation is prohibited on these grounds excepted for the farmers themselves.

3. Results of ECASA field studies:

3.1 Background to field programme: dates, staff, boats, stations sampled, etc.

The sampling operations were performed during two days, the 18th and 19th October 2006. The sampling for sediment chemistry, meiofauna and macrofauna (six stations) were made at low tide the first day. The sampling for water column was made at high tide, on the morning of the next day, while the final sampling for sediment chemistry, meiofauna and macrofauna for the remaining two stations were made on the evening, at low tide. A small aluminum vessel was used for the hydrological samples, while for the sediment and fauna samples, all the work was done at low tide, using a four wheels vehicle to the transferts between the different stations.
The location of these station was determined by using aerial photographs and a GIS to compute the theoretical location along a transect. Six station were chosen, the first one being at the immediate contact of the cultivated area. The other station were determined as being as distances of 50, 100, 200, and 400 metres from the first one. The rows of trestles alongside were not used for molluscs culture. A reference station

was determined as being located outside the hydrological influence of the cultivated area (figure 4).

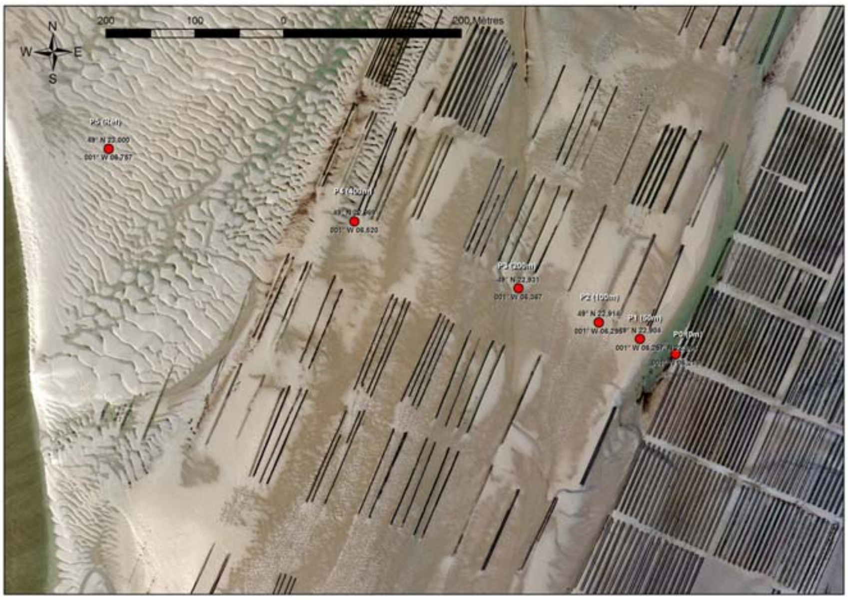


Figure 4 : localisation of the different stations along a transect, and of the reference station. These stations are located in the western part of the cultivated area of the Baie des Veys.

Due to the short distance between the station and the technical possibilities offered by walking on the ground at low tide, the different stations were placed along a transect made of a rope, which was previously marked for the adequate intervals between the stations. A confirmation of the location was made using a GPS. The reference station was only positioned by using a GPS, on a position previously determined by using aerial photographs spatially referenced and a GIS.

Table 1: true positions of the different stations sampled in the Baie des Veys. Geodesic system WGS 84.

Stations	Latitude North	Longitude West
0	49°22,894' N	001°06,218' W
50	49°22,904' N	001°06,257' W
100	49°22,914' N	001°06,295' W
200	49°22,931' N	001°06,367' W
400	49°22,969' N	001°06,520' W
Ref	49°23,007' N	001°06,763' W

3.2 Sampling methods and materials, analytical methods.

3.2.1 Sampling techniques

sediment

Samples for the analyses of chemical and biological parameters were taken in the intertidal sediments by using corer of 4 cm in diameter and 30 cm long. Three cores were taken at each station. These cores were sliced every centimetre, using a core plunger to push the sediment inside the core. The different samples were conserved in refrigerated conditions on plastic boxes. They were frozen once at the laboratory, after a delay not exceeding 3 hours.

Figure 5 : Manipulation of the corer (left) and slicing the sediment (right)

redox

Redox measurements were made with a special corers, with the same diameter (4 cm), but holes were bored, every centimetre from the bottom of the corer, in two parallel colons. The diameter of these holes was 0.7 cm, thus allowing to introduce the special electrode for redox measurements (0.5 cm in diameter). Before sampling, the holes were covered by a thin plastic tape, in order to avoid any linkage after the sample was taken. The operator then could drill the electrode through the tape to access the sediment, starting from the top of the corer.

Figure 6: Redox measurements.

Hydrology

The water column was sampled by bottle sampler at 3 depths; surface, mid-depth and near bottom. A CTD equipment was scheduled, but unfortunately, it ran out of use before the first field campaign. The bottle sampler was a Niskin Bottle (2 litres).

The water was collected in two cleaned flasks of 1 litre. Measurements of salinity, temperature and dissolved oxygen were made on board, using a conductimeter WTW

197i, and a oxymeter Hach portable LDO. A stirring time of 30 secondes was observed for the salinity and temperature. The oxygen probe computes by itself the time needed for a stable lecture. The probes were previously calibrated according to their specific procedures and good practices of laboratory. Then the flasks were kept refrigerated. They were frozen once at the laboratory, after a delay not exceeding 3 hours.

A Secchi disk was specially designed according to the recommendations of the ECASA Book of Protocol. It was used following the procedure described in this book.

fauna and flora

Samples for the determination of the composition of the benthic macrofauna and macroflora were made according with the general procedures agreed by international organisms (ICES, (Rumohr 1999) and the ECASA Book of Protocol. Samples per station were collected at low tide, by using cylinders of 0.1 m², which were sunk within the sediment at a depth of 10 centimetres. The sediment was collected into the sieve (1 mm). Sieving was performed immediately, by pouring sea water on the sieve. Several samples were taken at each station in order to ensure a good quality of these samples. The criteria used to accept or reject a sample were those given in the ECASA Book of Protocol. Four samples were selected as valid samples for each station.

Special samples were taken for the determination of meiofauna. The cores were different to those used for the biogeochemical samples (7.6 cm of diameter and 15 cm high). A particular attention was given to keep the core vertical during the removal from the sediment and after, during the processing. A special bucket was made containing 6 cores in a vertical position. The samples were preserved according to the procedure described in the ECASA Book of Protocol: A narcotic agent (7% Mg Cl2) was added to the samples. After stirring, the sample is fixed after ten minutes with a 4 % formaldehyde solution in adequate quantity to obtain the final concentration of 10%.

In all the samples, the macroflora was absent.

3.2.2 Analytical methods

Biogeochemical analyses were performed according to the ECASA book of protocol
The following parameters were analyzed on the samples:

Sediment

Fraction of sediment <63µ
Losses on ignition (labile and refractory organic matter)
Total Nitrogen (Analyser Carlo Erba)
Total organic carbon (Analyser Carlo Erba)
Chlorophyll a and phéopigments

redox

Hydrology

Secchi disk
Salinity
Temperature
Oxygen (%saturation)
Total particulate matter (TPM)
Particulate organic matter (POM) measured by losses on ignition (LOI)
% POM
Chlorophyll a
Pheopigments
Particulate OrganicNitrogen (PON) (Analyser Carlo Erba)
Particulate Organic Carbon (POC) (Analyser Carlo Erba)
C/N (Analyser Carlo Erba)
Silicates
PO4
NH4
NO2
NO3

The redox potential measurements were made with a Schotte-Gerate electrode model Pt 5900 A, diameter 5 mm, system Ag/AgCl, electrolyte KCl 3M. Calibration was made by reading the electrode previously to the measures against redox standards, and computing a calibration curve. Measurements were made on board, using a millivoltmetre Knigh Portamess 913 . The lectures were corrected to obtain Eh values according to the constant of the electrode and the temperature at the time of the measure (Hussenot & Martin 1995).

Macrofauna

The sediment were sieved through a 1 mm mesh sieve, fixed, stained, sorted and determined according the ECASA Book of Protocols. Densities were computed for each species.

3.3 Models used and their parameterization.

IFREMER has built several models which have an interest in the scope of ECASA.

The hydrodynamic model allows to compute the tidal currents in a given area for given periods of time? It only requires to obtain bathymetric data and boundaries conditions, these being potentially obtained from other models, on a wider spatial scale. Different uses can be made of these models when considering an EIA: They can basically serve as a description of the currents. They can also be use to trace the trajectories of particles, to assess the carrying capacity of shellfish sites (with other informations needed on, available food and productivity, or to compute various indices such the residence time of water bodies.

A model describe the effect of mussel longlines on the depletion of phytoplankton. This is of a primary interest to assess the effect of a shellfish farm on the pelagic ecosystem.

A Dynamic Energy Budget model is proposed. It is based on the computation of ecophysiological equations, and the resulting products allows to predict shellfish growth and production in a given environment. Details of the model equations and fundamentals can be found at the following addresse: http://w3.ifremer.fr/aquadeb/

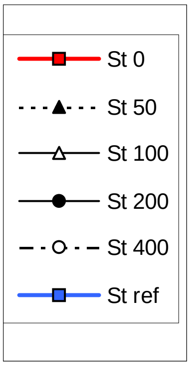
The Shellfish Production Model allows to compute the shellfish abundance and biomass, according to the quantity of individuals at the beginning, the mortality rate, and the results of DEB model.

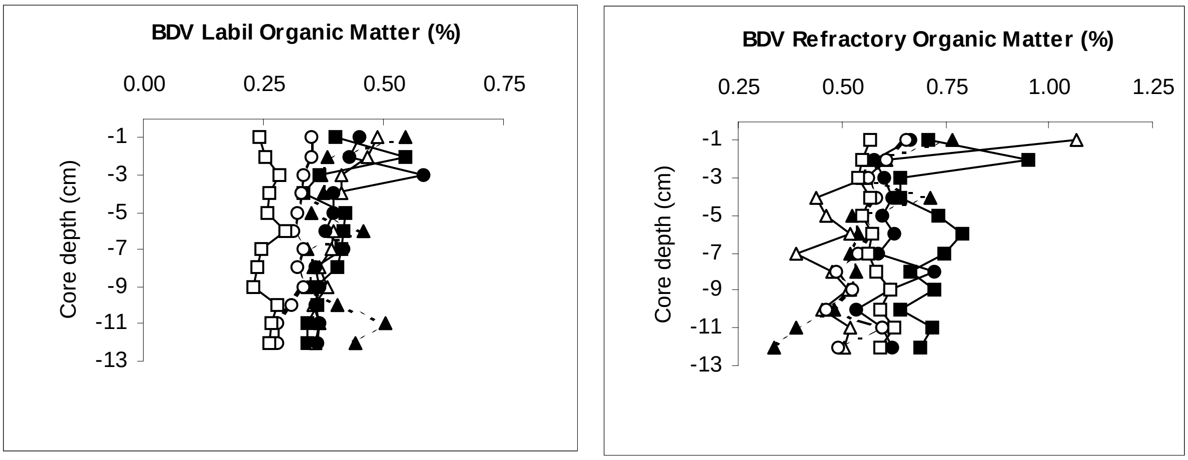
The model templates are given in Annexe 4. All the informations required for the use of these models are given there.

3.4 Results.

3.4.1. Sediment

<u>For all the curves describing the variation of a parameter according to the depth into the sediment and at different stations, a common legend was used (figure 6)</u>





<u>Figure 7:</u> Labile organic matter and refractory organic matter, at the different stations and for different depths within the sediment.

The labile organic matter seems to show a lower content near the farm, if compared to the refractory organic matter

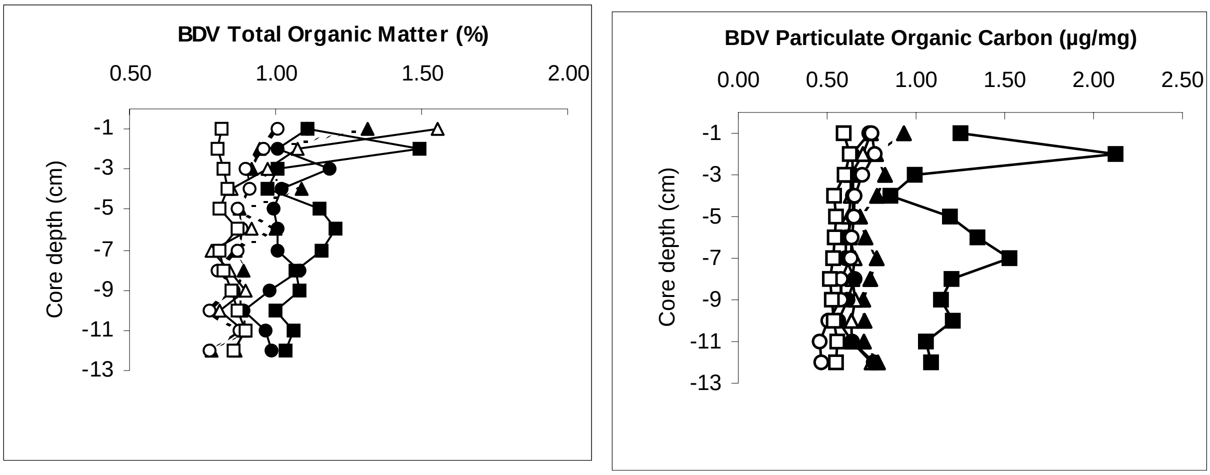


Figure 8: Total organic matter (measured by LOI) and particulate organic carbon (POC), at the different stations and for different depths within the sediment.

The total organic matter also show a lower content near the farm. The results for the Particulate Organic carbon are characterized by a better separation between the station (while they are still overlapping) with the exception of the reference station which is clearly separated. The values near the surface are also higher for that station.

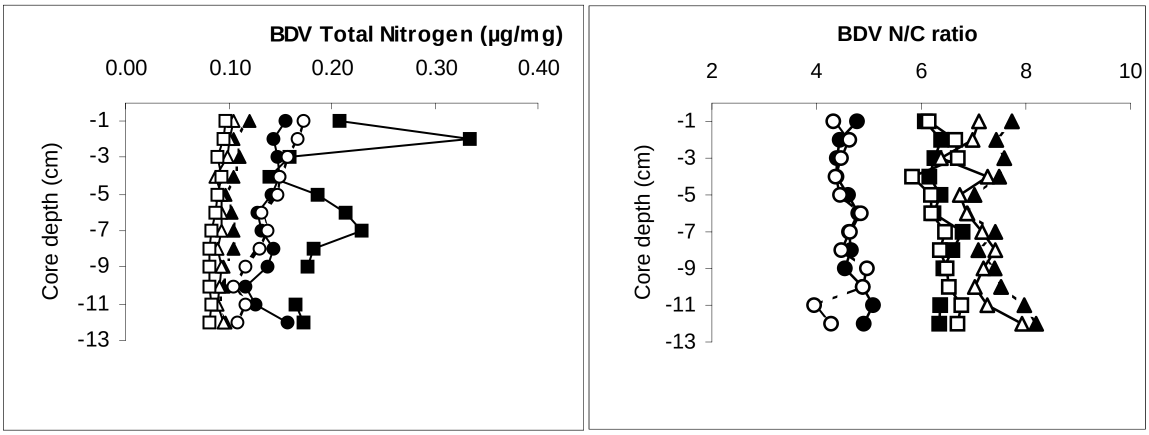
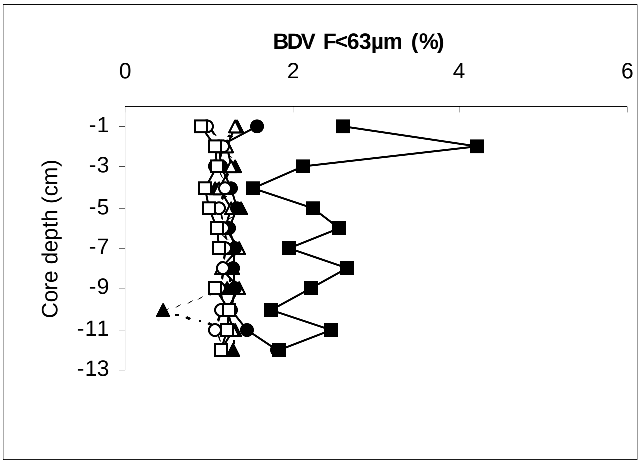


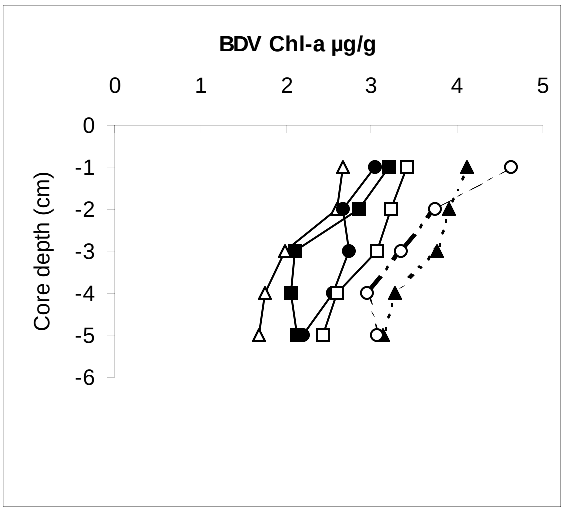
Figure 9: Total organic Nitrogen and Carbon/Nitrogen ratio, at the different stations and for different depths within the sediment.

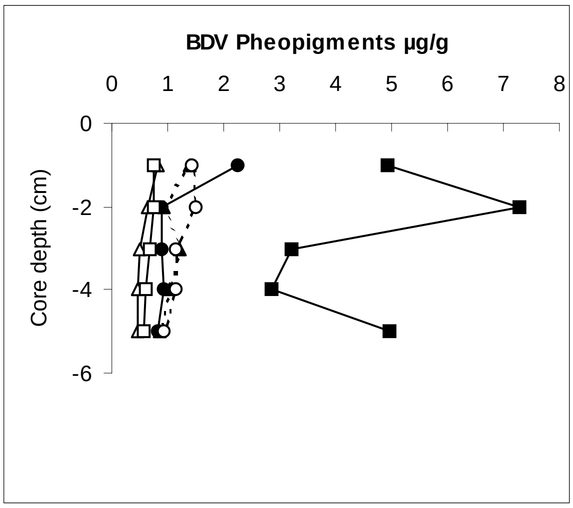
Depth profiles of total organic Nitrogen are very similar to these of the POC, with a clear separatrion between the reference station and the others. The ratio Carbon/Nitrogen is lower for the station located at a distance of 200 and 400 metres from the farm. No explanation can be given to this fact.



<u>Figure 10:</u> Mud fraction, < 63 µ, at the different stations and for different depths within the sediment.

The higher content in fine particles was found at the reference station, which is surprising. One may suspect that the station is exposed to slower, less dispersive currents.





<u>Figure 11:</u> Chlorophyll a and pheopigments contents at the different stations and for different depths within the sediment.

The pigments contents of the sediment may be of interest when characterizing an impact from molluscs culture, since the bivalve may reject some live phytoplanktonic cells. By sedimenting as feces, the cells may increase the amount of microphytes present at the surface and within the surficial layer of the sediment. The different curves are ranked without any clear link, for the chlorophyll, while the content in phéopigment is much higher at the reference station.

3.4.2. Hydrology

All the measures were made at high tide, since the site is uncovered at low tide. The molluscs are reared into the intertidal area. For all the figures, the reference station was arbitrary plotted at a theoretical distance of 1000 metres, for a better reading.

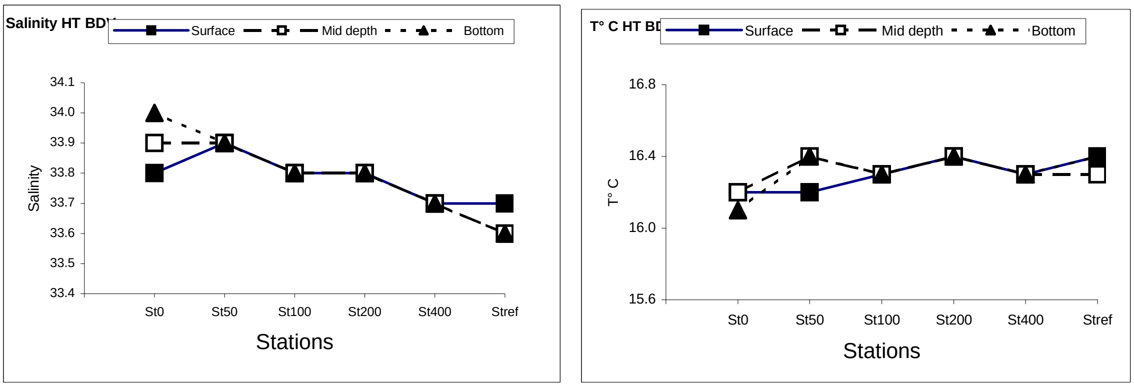


Figure 12: Salinity and temperature of the water (High Tide) at the different stations.

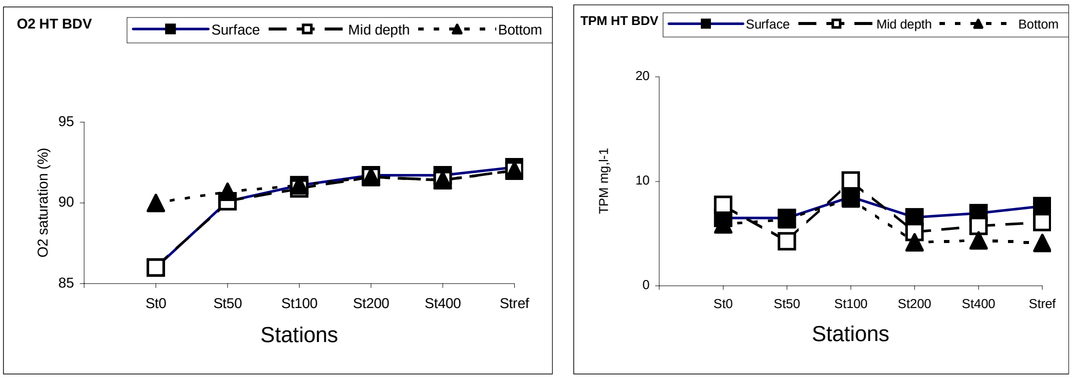
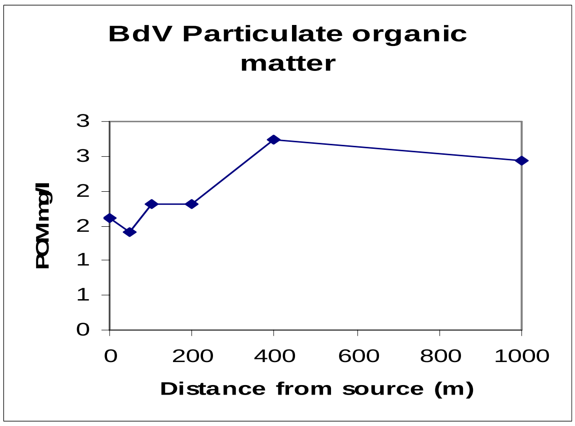


Figure 13: Oxygen (% saturation) and seston (TPM) (High Tide) at the different stations.

The content in oxygen was characterized by lower values at the vicinity (50 m) and under the longline. However, the last values was only depleted by 5 % . For the seston, the opposite is observed : higher values were observed at the stations located near the molluscs, (0, 100 and 200metres).



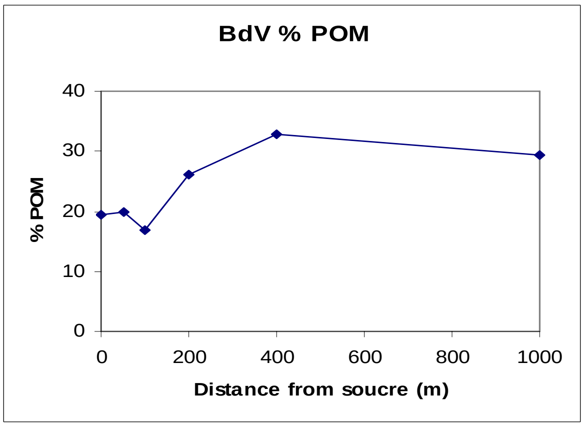


Figure 14: Particulate organic matter (POM) and percentage of POM in the seston (High Tide) at the different stations.

Quite surprisingly, the content in POM is lower at the vicinity of the molluscs. This can be viewed as a depletion effect due to the food consumption by the bivalves.

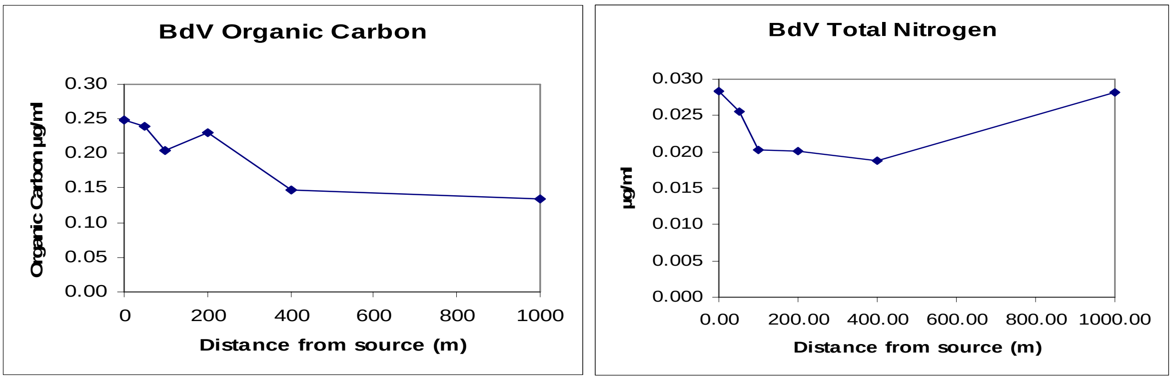


Figure 15: Total Organic Carbon and Total Nitrogen in the seston (High Tide) at the different stations.

The total organic carbon (TOC) and total Nitrogen contents of the seston are higher near the facilities. It can be noted that the reference station exhibited high values of total nitrogen

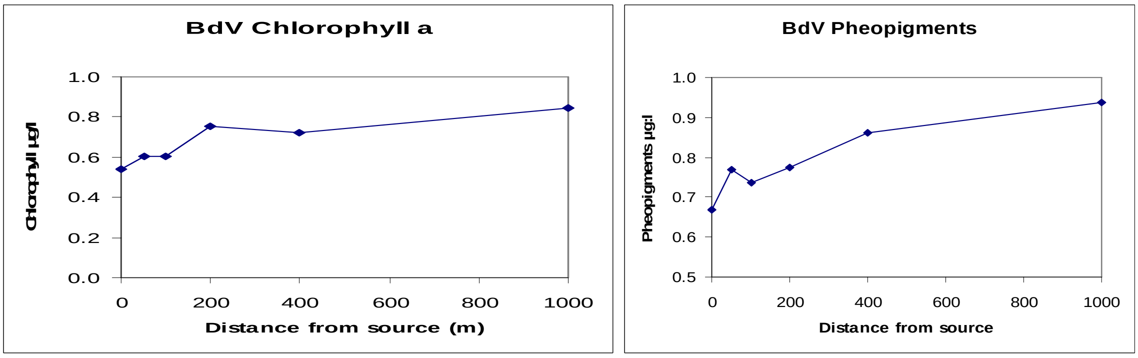


Figure 16: Chlorophyll a and phéopigments contents in the water (High Tide) at the different stations.

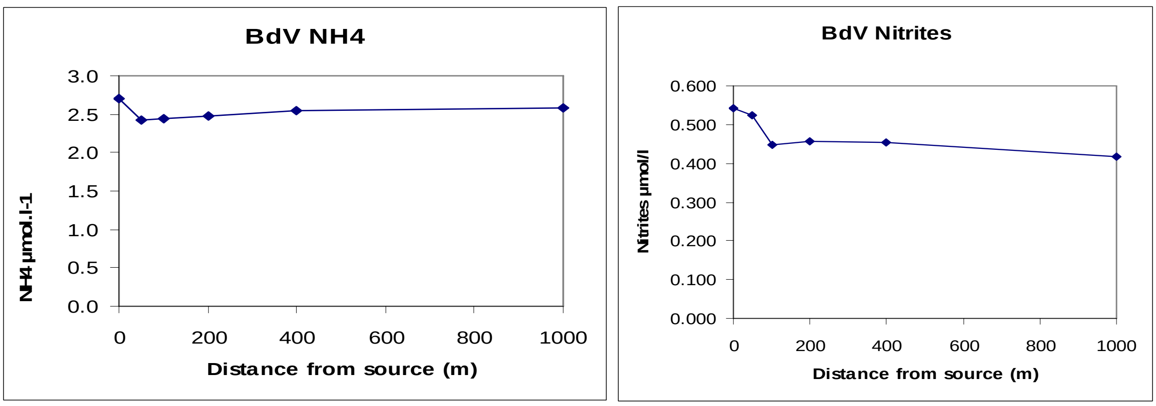


Figure 17: Ammonium and nitrites contents in the water (High Tide) at the different stations.

Both the contents in ammonium and nitrites are quite constant, excepted under the farm or at its immediate vicinity (ammonium), where they are slightly higher.

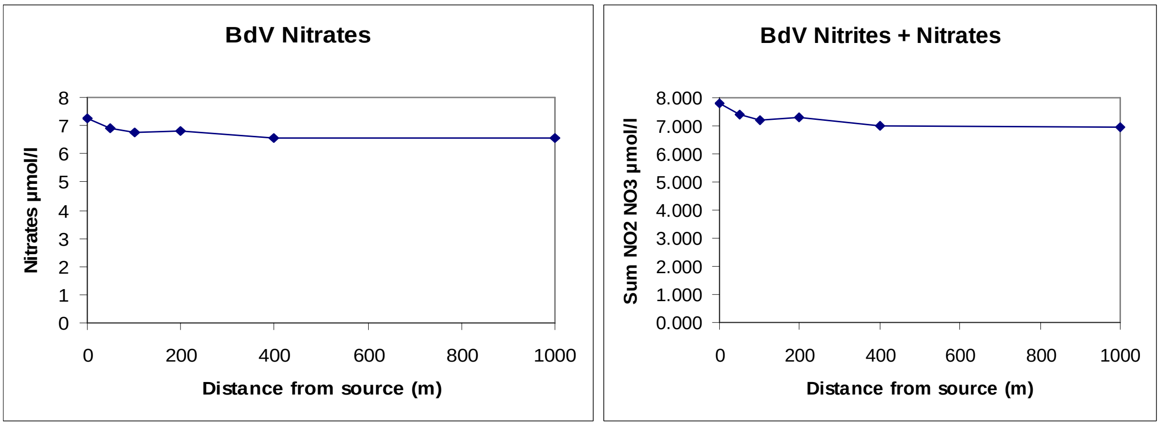


Figure 18: Nitrates and sum of nitrates and nitrites in the water (High Tide) at the different stations.

The same trend as previously observed was found for these two parameters.

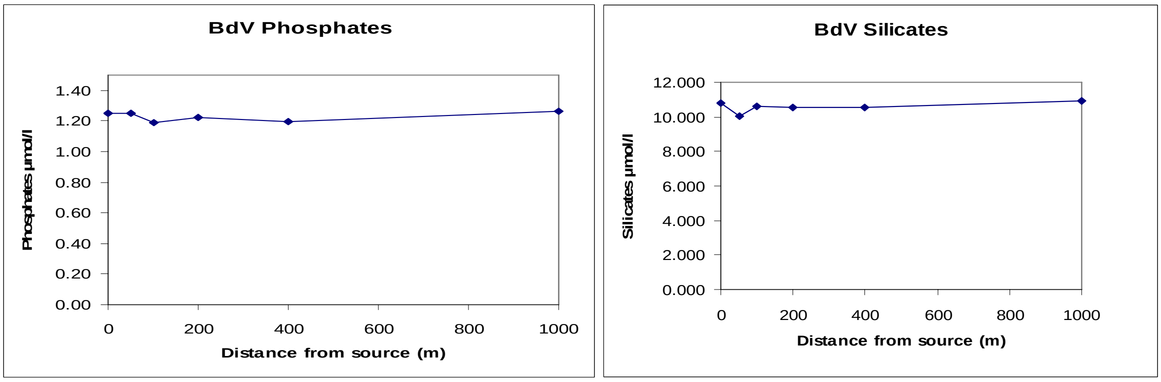


Figure 19: Phosphates and Silicates contents in the water (High Tide) at the different stations.

No clear trend could be detected for these two nutrients

3.4.3. Macrofauna

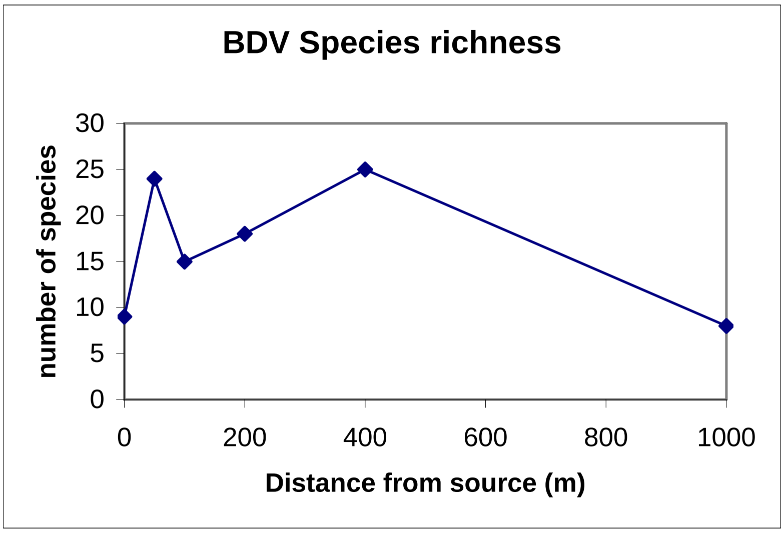


Figure 20: Species richness at the different stations.

Among the different replica, 50 different species were found in the samples. The list of the species and their occurrence in the 6 stations and replica are found in annexe 3.

The spatial repartition of the total number of species (figure 20) showed that a reduced number of species was found at the station 0, under the trestles, compare to the stations 50, 100, 200 and 400. However, the species richness at the reference station was very low, and in the same order of magnitude than at the station That reference station was located as far as possible of the bivalves culture , at the same bathymetric level. However, the sediment was more sandy then along the transect, and the proximity of a channel of deeper waters may have resulted in stronger continental influences. A comparison with previously published studies showed that no changes had occurredin the benthic fauna between 2004 (Sylvand et al. 2004), and the present study.

3.4.4. Modeles

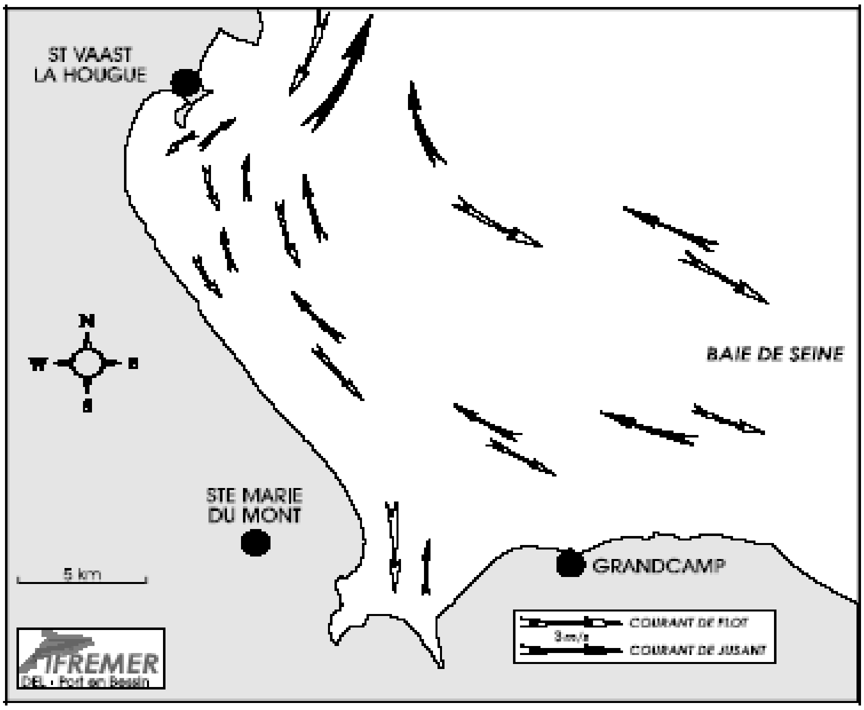


Figure 21: Main tidal currents as computed from the hydrodynamic model.

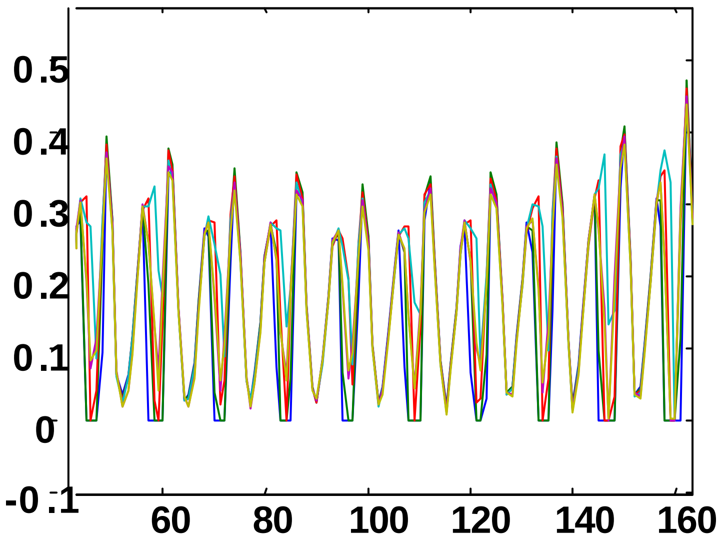


Figure 22: Currents speeds in the Baie des Veys as computed from the hydrodynamic model. Time unit in hours, current speed in m²/s.

The water currents in the Baie des Veys are alternative. They correspond to the tide regime. The maximum current speed is 0.47 m²/s

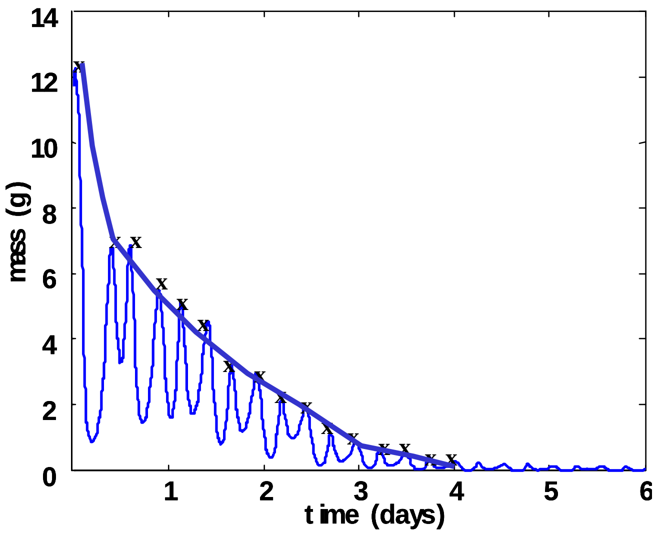


Figure 23: Residence time of waters in the Baie des Veys as computed from the hydrodynamic model.

The hydrodynamic model allowed to simulate the behaviour of a tracer (theoretical food) in order to compute a residence time. The residence time corresponded to the time needed to decrease two times the concentration of a tracer chosen as being a theoretical food. It varied between 0.4 and 1.2 days without oysters (according to the winds conditions, tidal range and freshwaters input. It varied between 0.3 and 0.45 days with the stock of oysters.

The use of DEB model is presented under the evaluation of model performance headline

3.5 Evaluation of Indicator Performance

For all the figures, the reference station was arbitrary plotted at a distance of 1000 metres, for a better reading. When apparent, the vertical bars correspond to the confidence intervals for a probability of 95 %.

3.5.1. Sediment

Sediment quality indicator

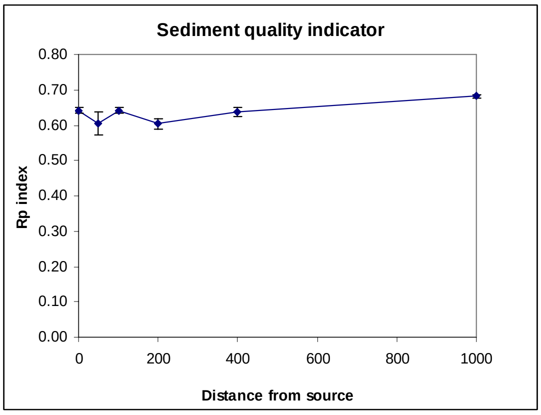


Figure 24: Spatial trend of the Sediment quality indicator in the Baie des Veys

The indicator was computed by averaging the 5 upper centimeters of each of the 3 cores taken at every station, and then the value is the average of the 3 cores. Significant differences were observed along the transect or between transect and the reference station. But no clear spatial trend could be detected from these results. Opposite results were found in another site of subtidal culture of mussels on longlines (Pertuis Breton, were the station located under the longline or at the shortest distance of them (50 metres) .had a significant lower value.

Total organic Carbon in the surficial sediment

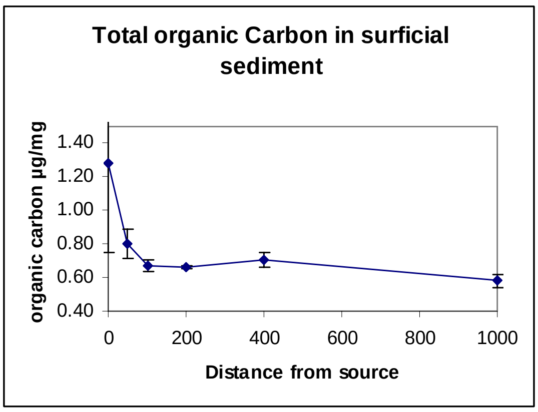


Figure 25: Spatial trend of the Total Organic Carbon in surficial sediment of the Baie des Veys

The total organic Carbon exhibited a clear and significant spatial trend along the transect. The station under the long line had the highest content in TOC, an then a sharp decrease is observed towards the next station. Further, the other stations along the transec had comparable values, suggesting that the impact, as expressed in TOC, did not extend further then 50 metres from the sources (longlines). However, the reference station had a value slightly lower then those located at 100 metres at least from the longlines.

Redox

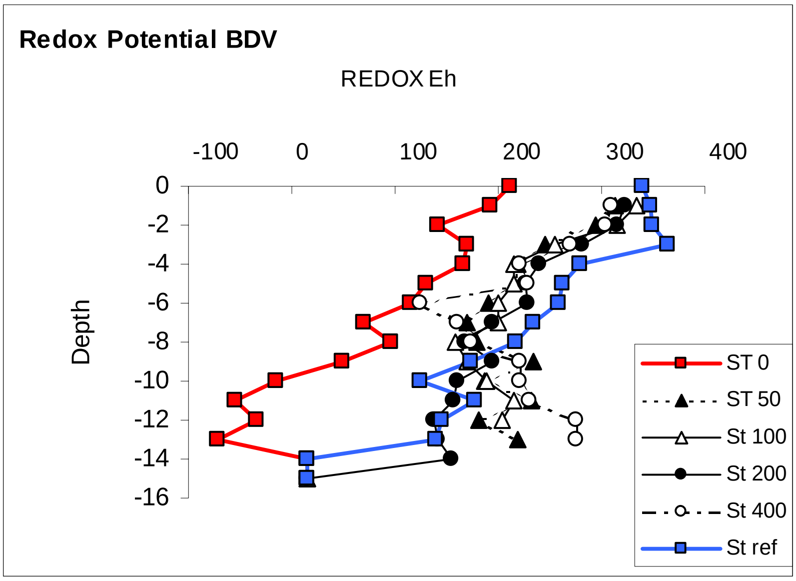


Figure 26: Eh potential (redox), in mV, in surficial sediments of the Baie des Veys, at the different stations and for different depths within the sediment.

The redox profiles are very similar. The only one which separated from others was made at the station beneath the longline. However, the surficial sediments in that station still exhibit positive values, for depths lower then 10 cm. The sediment is then only slightly affected by anaerobic conditions in all stations, which were never found in surficial sediments (5 upper centimetres of sediment). The only station which exhibited values of Eh lower than 0 was the station 0, under the trestles, deeper than 10 centimetres. Even so, the values were never lower than– 100 mV.

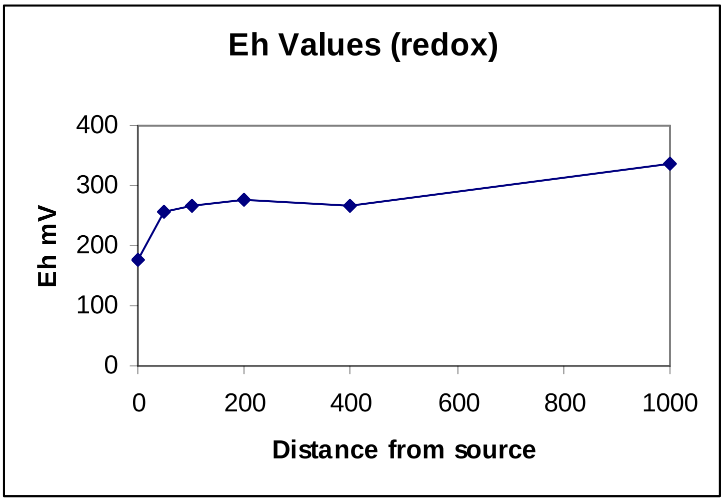


Figure 27: Spatial trend of the Eh values in surficial sediments of the Baie des Veys

The spatial trend observed for the Eh potentials in surficial sediment is pretty much the same then for the TOC (the shape of the curves being opposite). The Eh in surficial sediment seems to react to the impact of mussels culture. The high, positive value which was found under the longlines indicates that the potential impact is moderate.

Total nitrogen in surficial sediment

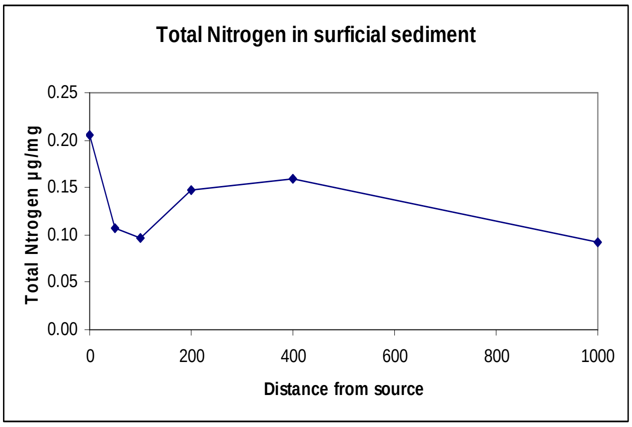


Figure 28: Spatial trend of the content in Total Nitrogen, in surficial sediments of the Baie des Veys

This indicator identified clearly the station beneath the mussels, with a higher value. The relative variations between the stations are large. But the stations 200 and 400m, the farthest, did not react as the nearest stations, 50 and 100m. No satisfactory explanation can be given , for this

Chlorophylle in surficial sediment.

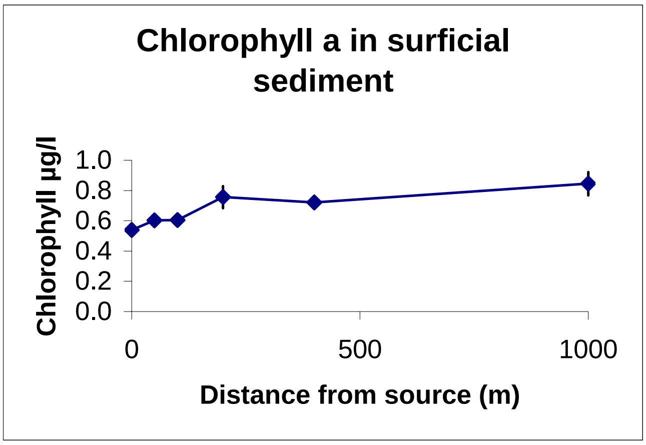


Figure 29: Spatial trend of the content in active Chlorophylle, in surficial sediments of the Baie des Veys

This indicator was not selected from the ECASA processus, but its interest for the bivalve culture could be tested, as the Chlorophyll is well represented in biodeposits, in some conditions. However, no spatial trend has been detected, and the values along the transect are erratic. Its interest as a potential indicator is low.

Pheopigments in surficial sediments

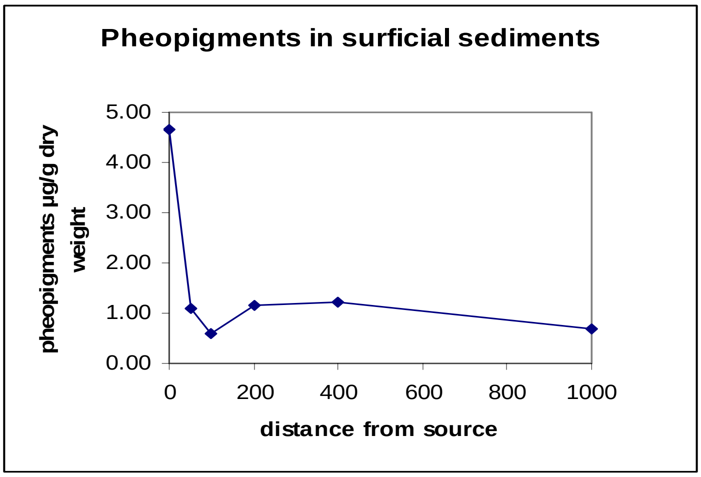


Figure 30: Spatial trend of the content in active Chlorophylle, in surficial sediments of the Baie des Veys

The pheopigments content in surficial sediment is particularly adequate in revealing the impact of shellfish culture in intertidal area. The spatial trend is very clear, and the the relative variations, corresponding to the sensitivity of the indicator, are the largest observed in this study.

This indicator is probably specific of the intertidal culture, as the microphytoplanktonic cells have the capability to concentrate near the surface of the sediment when this one is uncovered. At the same time, the food of bivalve is transformed during digestion, and chlorophyll is degraded partially into phéopigments which accumulate as faeces and fall into the sediment. From these results, the pheopigment content can be recommended as an indicator of impact for the conditions of intertidal culture of bivalve

Mud fraction of the sediment, lower then 63 microns

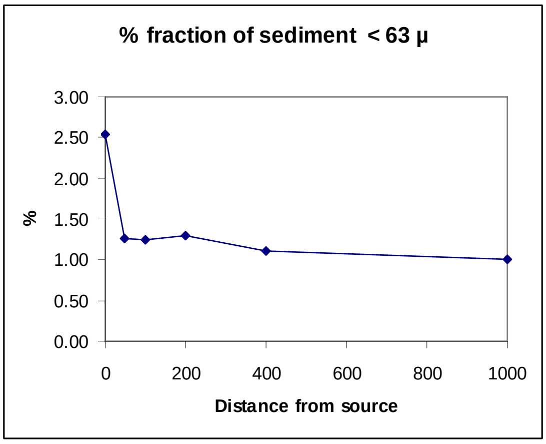


Figure 31: Spatial trend of the content in the fine fraction of the sediment, in surficial sediments of the Baie des Veys

This indicator also react positively under the conditions of intertidal culture, and discriminates well the different stations. While the relative variations between the stations are not the highest, its interest, lies on the facility of obtaining of the results

3.5.2. Hydrobiology

Secchi depth

This measurement was not be performed, since, during high tide, the water transparency allowed to distinguish the bottom. The maximum transparency could therefore not be measured.

Chlorophyll a in water column

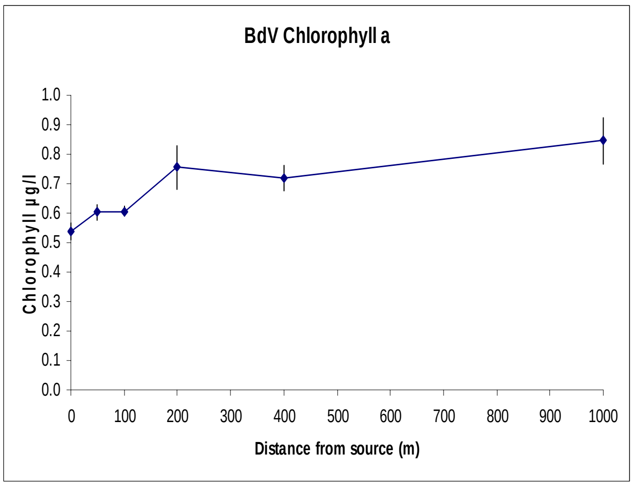


Figure 32: Spatial trend of the Chlorophyll a at different water depths, at high tide.

The contents in Chlorophyll a are low, with very few risk of eutrophication during this period.
The chlorophyll was depleted when approaching the area of molluscs culture, as a result of the grazing by oysters on phytoplanktonic food. Then ,the chlorophyll a content is an indicator of the food depletion by oyster. Here the depletion is limited to 36 %, from the reference station to the station above the trestles, at the contact of molluscs culture. Such a depletion can reach 80 % in sites were the currents are low and/or the available food is scarce

Particulate Organic Carbon

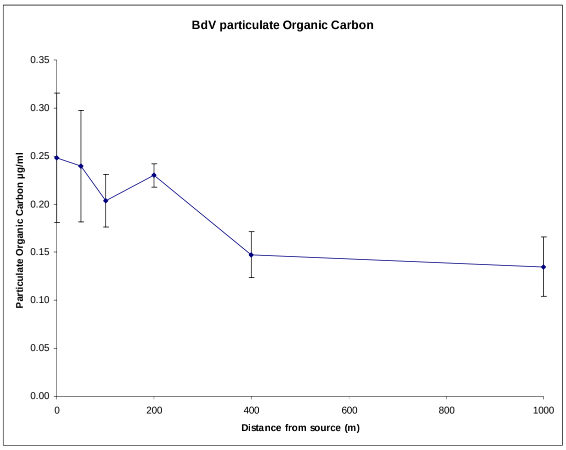


Figure 33: Spatial trend of the Particulate organic Carbon (POC) at different water depths, at high tide.
The POC is slightly enhanced when approaching the site of culture. However the differences are not significant (P>0.05). In this site, and with a given biomass of oysters, The POC content of the water did not seem to be efficient indicator of the impact of oysters culture on the water characteristics..

Infaunal Macrofauna

The shellfish culture is well known to produce changes in the structure of the benthic communities where it is practiced (Mattson & Linden 1983, Kaiser et al. 1996, De graave et al. 1998, Stenton-Dozey et al. 2001, Christensen et al. 2003, Hartstein & Rowden 2004, Smith & Shackley 2004), even in intertidal areas (Nugues et al. 1996). The intertidal area of the baie des Veys has been extensively studied for the macrofaunal assemblage on several occasions, notably in 1969 (sylvand & Savini 1991), 1985 and 2000 (Timsit et al. 2004). The results of the macrofaunal study conducted in 2006 in the Baie des Veys, as part of the ECASA project, are presented here by using a synthetic indicator, AMBI (Muxica et al. 2005). The full list of species and their abundance are in the annexe 2

Figure 34 : repartition of the different species among stations and replica (4) according to their ecological characteristics.

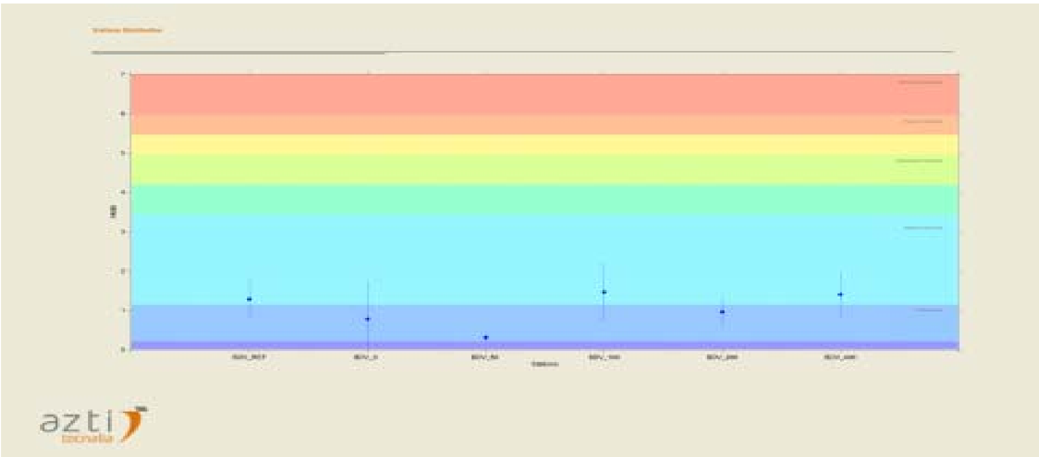


Figure 35 : values of the AMBI index for the different station from the reference station (left) to station 400 (right)

The figures 34 and 35 represent the results of the macrofauna study, on 6 stations with 4 replica. Very few species pertained to the ecological group V (first order opportunistic species), while the larger group was the one of species sensitive to pollution (group I). Values of the AMBI index are all less then 1.5. Quite interestingly, the reference station was not characterized by the lower AMBI value, which was found at station 50. The station 0, 50 and 200 were classified as undisturbed, and the other as slightly disturbed. From these results, one may consider that the impact of intertidal shellfish culture in the Baie des Veys have no significant impact on the macrofauna.

Macrofauna presence under the installations:

This indicator simply refer to the presence or absence of macrofauna under the rearing facilities. Herethere is a macrofauna presence under the longlines, and along the transect and the reference station (see above, AMBI index).

This indicator does not seem to be adequate for shellfish culture in open environments, as the surficial sediments are generally sufficiently oxygenated in such case, to meet the requirements of some benthic species. This should be checked in strictly confined environments, such as in poorly renewed waters of some fjords, where the dispersive capacity of the site is reduced, and organic matter may accumulate in large quantities beneath the shellfishes.

3.5.3. Coastal zone management

Aquaculture on shoreline

No other type of aquaculture are foud on the shoreline in this area.

Distance from sensitive areas.

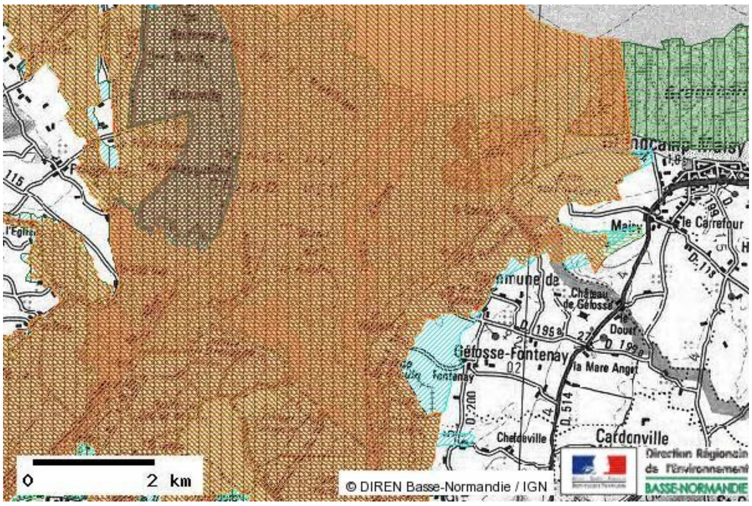


Figure 36 Sensitive areas, within the Baie des Veys. The marine protected area, (Reserve naturelle de Beauguillot) is located on the North-west part of the bay.

For the computation of this indicator, the safe distance was the one usually selected in the the case of aquaculture operations, that is 5 km. Within the Baie des Veys, the sensitive areas are numerous. The whole bay, including the rearing area, is concerned by a special protection zone, a RAMSAR area, Znieff type 1 and 2 , and a Bird directive area. But the only rule inconsistent with shellfish culture, a marine protected area, is located on the North-west part of the Bay (Reserve naturelle de Beauguillot). The area is located at 2.5 km from the oyster culture, and the indicator named "distance from sensitive area has a value of 25%, corresponding to a high risk level. Considering the nature of the shellfish culture, one can wonder about the value of the safe distance, depending on the type of culture. A "safe distance" of 2.5 km would have resulted in a risk level of Safe

3.5.4. Other indicators[1]

Oyster filtration time

The following indicator was derived by C Bacher, from the use of hydrodynamic models and DEB model. Basically it compares the filtration time (time needed for the population of oyster to suppress a given part of the available food), to the residence time (time needed for the same given part of the waters to be renewed within the bay). Its computation is as follows:

T1= Residence time without oysters (Varies between 0.4 and 1.2 days, average = 0.82 days)
T2= Residence time with oysters (Varies between 0.3 and 0.45 days, average=0.38)
The effect of oysters is measured by the comparison between the indicators:
F=(T1 x T2)/(T1-T2)
F varies between 0.68 and 0.98 days, average=0.77
This results show that filtration time is comparable to residence time.

A comparison was made with another system: the bay of Marennes oléron, where the residence time is 10 days and the Oyster standing stock is 10 times the stock of Baie des Veys.. The F indicator is comparable for the 2 sites which indicates the same level of potential food limitation. A potential application of this indicator could consists ino characterizing the potentialities of coastal areas for shellfish culture by combining residence time indicators with data on food concentration (satellite images) and ecophysiology models (response of oysters to environmental conditions) in space (Geographic Information System).

[1] The following indicator was no identified during the course of the WP 2. It results from the works on models carried out in the WP 4.

3.6 Evaluation of Model Performance

Application of the DEB model to the sites of Baie des Veys (Normandy, France) and Loch Creran (Scotland)

Introduction

The DEB (Dynamic Energy Budget) model describes the energy flows through an organism and also changes in the environment with varying food densities and temperature. The model allows to simulate individual growth rate and reproduction. The background of the DEB theory can be found in Kooijman (2000). This theory was recently applied to several bivalve species (van der Veer et al., 2006) and particularly, a parameterisation was specifically developed for the Pacific oyster, *Crassostrea gigas* (Pouvreau et al., 2006). The DEB model was proposed as a modelling tool within the ECASA project to assess *i*) the impact of bivalves on their environment (*e.g.* estimation of ingestion fluxes) and *ii*) the response of bivalves to modifications of their environment (*e.g.* modification of the individual growth rate). In this work, we applied the model to two study sites of the ECASA project: the Baie des Veys (France) and Loch Creran (Scotland). Both sites support the cultivation of *C. gigas*. Goodness of fit of the model was evaluated according to the procedure defined within the ECASA project (Portilla and Tett, 2007). This note aims to make a synthesis of results obtained through this application.

Readers are invited to consult the web site: http://w3.ifremer.fr/aquadeb/

Material and methods

Two datasets were available for the two sites.
Individual growth of oysters was followed in the Baie des Veys between March 2002 and August 2003. Flesh dry mass and shell length were measured at each sampling date and the oyster population was sampled 16 times during the survey. Water temperature and concentration in chlorophyll *a* were also followed near the growth site. Water temperature was recorded continuously and chlorophyll *a* concentration was determined every second week. In Loch Creran, individual growth was followed between May 2005 and July 2006. Flesh dry mass and shell length were also measured at each sampling date and the population was sampled 10 times during the survey. Water temperature and concentration in chlorophyll *a* were determined *ca.* each month.

For both sites, forcing variables of the DEB model were water temperature and chlorophyll *a*, which represents available food for oysters. Individual growth was simulated by the model and then compared to observed data. Three cases were studied:

- Case a : the model was calibrated for the Baie des Veys (see list of parameters in Annex 1),
- Case b: the model was validated on Loch Creran with parameters used for the Baie des Veys,
- Case c: the model was calibrated and a new simulation was conducted with a new set of parameters.

For case c, the calibration was done on the X_k and shape parameters. The X_k parameter is the half saturation coefficient of the functional response of assimilation to food concentration. The functional response is represented by the equation:

$$f = \frac{[X]}{[X] + X_K}$$

where X is food density (*i.e.* the concentration in chlorophyll *a* in $\mu g.l^{-1}$).

X_k depends on the site, reflecting the variable composition of food in different environment and modulates the food really usable by the oyster.

The shape parameter allows to convert the individual flesh dry mass into shell length. It is usually specific of the species but can vary according the site.

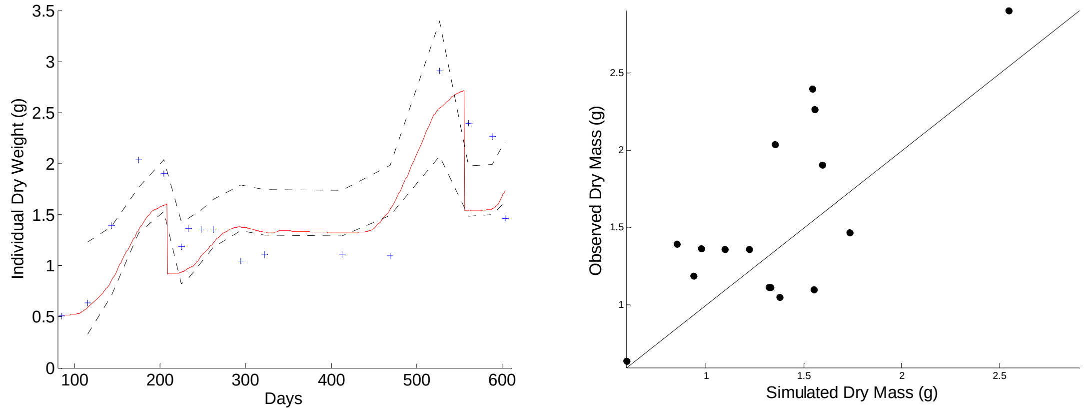
Both X_k and the shape are key parameters, classically used when a calibration has to be done.

For each simulation, the goodness of fit of the model was estimated by fitting a linear regression between observed and simulated values and comparing the resulting slope and intercept to 1 and 0, respectively. The regression equation was also used to show the reliability of model predictions through the estimation of 95% prediction limits.

Results

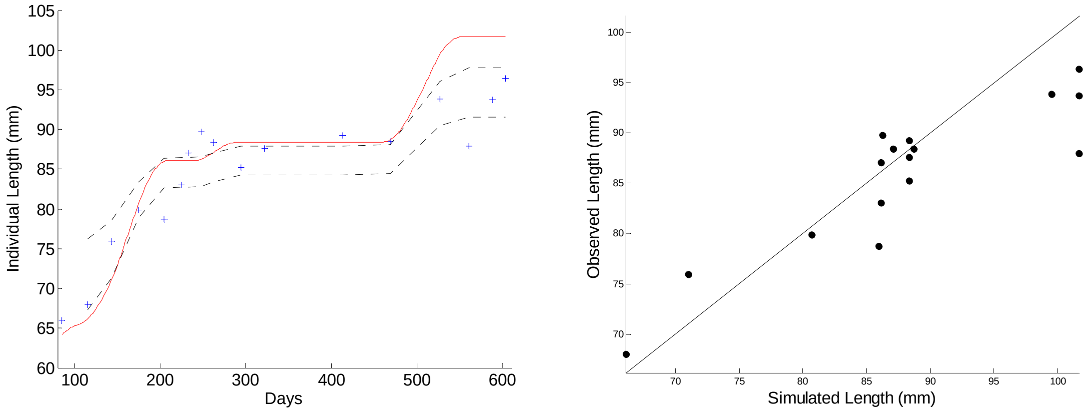
Case a: Calibration in the Baie des Veys

For individual dry mass as well as for shell length, the model explains a significant part of variance in observations (Table 1 and 2). However, if the model reliability was classified excellent for individual dry mass, it was classified fair for shell length. Concerning dry mass, the model simulated well two spawning periods, which occurred at the end of July-beginning of August in 2002 and 2003 (Figure 1). The model under estimated growth during the spring period and over estimated growth during the fall and winter periods (September to March). For shell length, misfit of the model essentially appeared for larger individuals for which shell length is over estimated by the model (Figure 2).



a) b)

Figure 1: Application of the model to the Baie des Veys. a) Variation of observed values of individual dry mass (blue crosses), simulated values (red line) and confidence interval at 95% of predictions obtained with the linear regression between observed and simulated values (black dotted lines). b) Simulated *vs.* observed values of flesh dry mass.



a) b)

Figure 2: Application of the model to the Baie des Veys. a) Variation of observed values of individual shell length (blue crosses), simulated values (red line) and confidence interval at 95% of predictions obtained with the linear regression between observed and simulated values (black dotted lines). b) Simulated *vs.* observed values of shell length.

Table 1: Results of model performance for individual dry mass in the Baie des Veys.

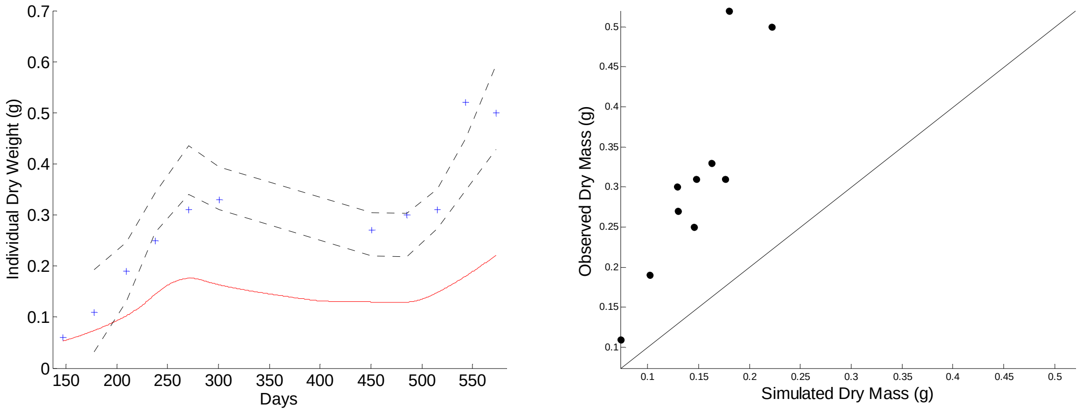
n, number of independent observations used in test		14	
Model performance			
r^2, % of variance	0.55	*p*, on null hypothesis	0.001
Regression intercept	0.19	*Standard error of intercept*	0.34
t (intercept different from 0)	0.56	*p (intercept different from 0)*	0.58
Regression slope	0.998	*Standard error of slope*	0.24
t (slope different from 1)	0.0048	*p (slope different from 1)*	0.99
Model conclusion			
Model explains a significant part of variance in observations		YES	
Model reliability class		Excellent	

Table 2: Results of model performance for individual shell length in the Baie des Veys.

n, number of independent observations used in test		14	
Model performance			
r^2, % of variance	0.80	*p*, on null hypothesis	3.2×10^{-6}
Regression intercept	29.07	*Standard error of intercept*	7.69
t (intercept different from 0)	3.78	*p (intercept different from 0)*	0.002
Regression slope	0.65	*Standard error of slope*	0.087
t (slope different from 1)	4.09	*p (slope different from 1)*	0.0011
Model conclusion			
Model explains a significant part of variance in observations		YES	
Model reliability class		Fair	

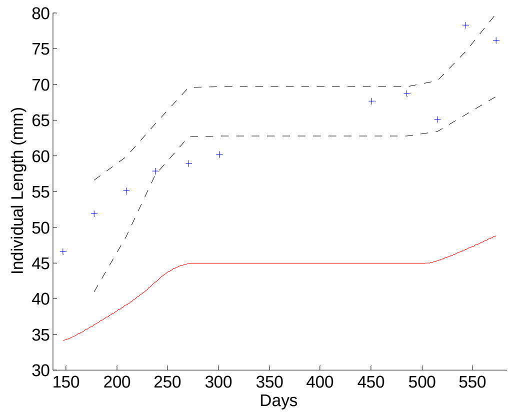
Case b: Validation in Loch Creran

Regression models explain a significant part of the variance in observations for dry mass as for shell length (Table 3 and 4). For dry mass, the model class is good because the intercept was not significantly different from 0. However, the model largely under estimated the observed values (Figure 3). For shell length, the model class is fair because both the slope and the intercept were significantly different from 1 and 0, respectively. Simulated values were also largely under estimated compared to observed values (Figure 4). For both variables, prediction limits showed that the regression model between observed and simulated variables was reliable despite the poor ability of the model to reproduce observations.

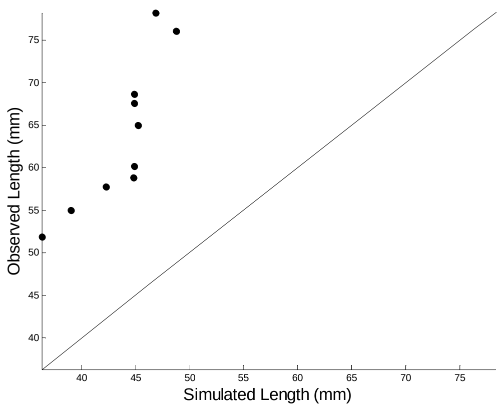


a) b)

Figure 3: Application of the model to Loch Creran with parameters from the Baie des Veys. a) Variation of observed values of individual dry mass (blue crosses), simulated values (red line) and confidence interval at 95% of predictions obtained with the linear regression between observed and simulated values (black dotted lines). b) Simulated *vs.* observed values of flesh dry mass.



a)



b)

Figure 4: Application of the model to Loch Creran with parameters from the Baie des Veys. a) Variation of observed values of individual shell length (blue crosses), simulated values (red line) and confidence interval at 95% of predictions obtained with the linear regression between observed and simulated values (black dotted lines). b) Simulated *vs.* observed values of shell length.

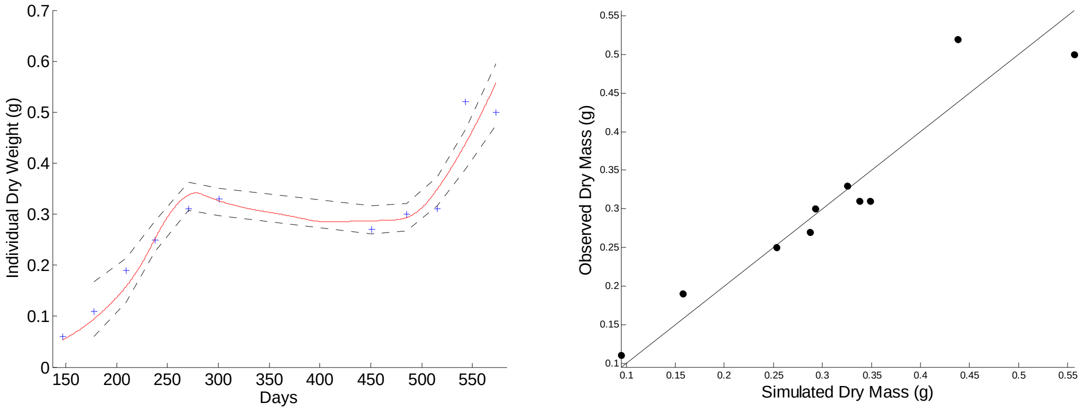
Table 3: Results of model performance for individual dry mass in Loch Creran with parameters from the Baie des Veys.

n, number of independent observations used in test		8	
Model performance			
r^2, % of variance	0.81	*p*, on null hypothesis	3.49×10^{-4}
Regression intercept	-0.09	*Standard error of intercept*	0.07
t (intercept different from 0)	1.26	*p (intercept different from 0)*	0.24
Regression slope	2.69	*Standard error of slope*	0.45
t (slope different from 1)	3.73	*p (slope different from 1)*	0.006
Model conclusion			
Model explains a significant part of variance in observations		YES	
Model reliability class		Good	

Table 4: Results of model performance for individual shell length in Loch Creran with parameters from the Baie des Veys.

n, number of independent observations used in test		8	
Model performance			
r^2, % of variance	0.73	*p*, on null hypothesis	0.0018
Regression intercept	-25.04	*Standard error of intercept*	19.43
t (intercept different from 0)	1.29	*p (intercept different from 0)*	0.24
Regression slope	2.03	*Standard error of slope*	0.44
t (slope different from 1)	2.33	*p (slope different from 1)*	0.048
Model conclusion			
Model explains a significant part of variance in observations		YES	
Model reliability class		Fair	

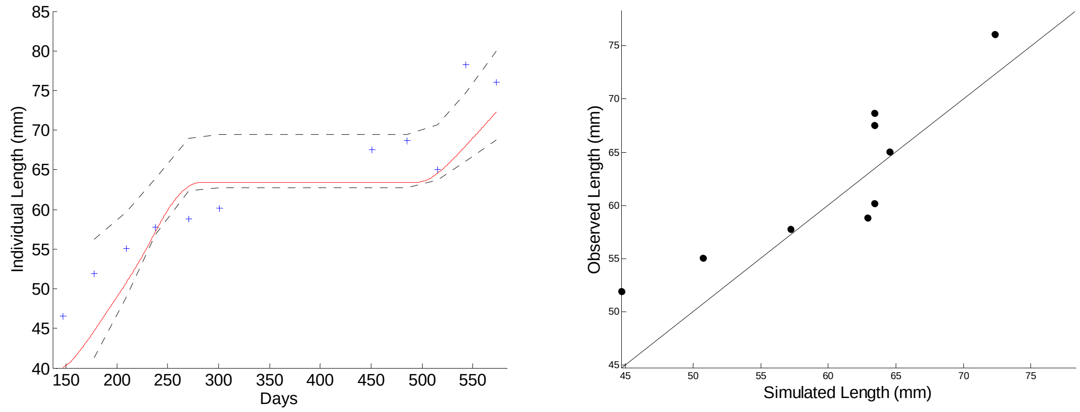
Case c: Calibration in Loch Creran



a) b)

Figure 5: Application of the model to Loch Creran after a new calibration. a) Variation of observed values of individual dry mass (blue crosses), simulated values (red line) and confidence interval at 95% of predictions obtained with the linear regression between observed and simulated values (black dotted lines). b) Simulated *vs.* observed values of flesh dry mass.

Results showed that the model was classified as excellent for dry mass and shell length. For both variables, the model reproduced well observations (Figure 5 and 6) and the regression models were highly significant with slopes and intercepts not significantly different from 1 and 0, respectively (Table 5 and 6).



a) b)

Figure 6: Application of the model to Loch Creran after a new calibration. a) Variation of observed values of individual shell length (blue crosses), simulated values (red line) and confidence interval at 95% of predictions obtained with the linear regression between observed and simulated values (black dotted lines). b) Simulated *vs.* observed values of shell length.

Table 5: Results of model performance for individual dry mass in Loch Creran after a new calibration.

n, number of independent observations used in test		8	
Model performance			
r^2, % of variance	0.91	*p*, on null hypothesis	1.89×10^{-5}

Regression intercept	0.027	*Standard error of intercept*	0.034
t (intercept different from 0)	0.80	*p (intercept different from 0)*	0.45
Regression slope	0.91	*Standard error of slope*	0.10
t (slope different from 1)	0.87	*p (slope different from 1)*	0.41
Model conclusion			
Model explains a significant part of variance in observations		YES	
Model reliability class		Excellent	

Table 6: Results of model performance for individual shell length in Loch Creran after a new calibration.

n, number of independent observations used in test		8	
Model performance			
r^2, % of variance	0.74	*p*, on null hypothesis	0.0013
Regression intercept	7.13	*Standard error of intercept*	11.86
t (intercept different from 0)	0.60	*p (intercept different from 0)*	0.56
Regression slope	0.93	*Standard error of slope*	0.19
t (slope different from 1)	0.36	*p (slope different from 1)*	0.73
Model conclusion			
Model explains a significant part of variance in observations		YES	
Model reliability class		Excellent	

DEB model- List of parameters and initial conditions used for the different case study.

Case a: Calibration of the model in the Baie des Veys.
Case b: Validation of the model in Loch Creran.
Case c: Calibration of the model in Loch Creran.

Parameters	**Symbol**	**Unit**	**Value Case a**	**Value Case b**	**Value Case c**
Half saturation coefficient	X_K	µg.l^{-1}	5.5	-	3.2
Max. surf. area-specific assimilation rate	$\{\dot{p}_{Am}\}$	J.cm^{-2}.d^{-1}	420	-	-
Volume-specific maintenance costs	$[\dot{p}_M]$	J.cm^{-3}.d^{-1}	24	-	-
Maximum storage density	$[E_M]$	J.cm^{-3}	2295	-	-
Volume-specific cost for structure	$[E_G]$	J.cm^{-3}	1900	-	-
Structural volume at puberty	V_p	cm^{-3}	0.3	-	-
Fraction of energy utilisation rate spent on maintenance plus growth	κ	-	0.45	-	-
Shape coefficient	δ_m	-	0.2	-	0.17
Arrhenius temperature	T_A	°K	5800	-	-
Reference temperature	T_1	°K	293	-	-
Lower boundary of tolerance range	T_L	°K	281	-	-
Upper boundary of tolerance range	T_H	°K	305	-	-
Rate of decrease at lower boundary	T_{AL}	°K	75000	-	-
Rate of decrease at upper boundary	T_{AH}	°K	30000	-	-
Fraction of reproduction energy fixed in eggs	κ_R	-	0.7	-	-
Energy content of reserves (in ash-free dry mass)	μ_E	J.mg^{-1}	17.5	-	-
Gonado-somatic threshold for triggering spawning	R_{GS}	%	37	-	-
Temperature for triggering spawning	T_s	°C	18.5	-	-
<u>Initial conditions</u>					
Structural volume	V	J	4000	600	600
Energy storage	E	J	1800	100	100
Energy for development and reproduction	E_R	J	2500	0	0

3.7 Site specific conclusions[2]

Indicators related with the organic matter and models revealed that the environment of the Bay des veys is only slightly perturbed at the sediment level by the intertidal culture of oysters and mussels. A similar conclusion is given by the macrofauna study, which could be considered as undisturbed by comparison with the reference station, when using the AMBI indicator. These perturbation are limited at the A spatial scale (corresponding to the facilities) . A depletion of the phytoplanktonic biomasse can be observed at the B Scale (the bay scale). No effects are observed at the C scale (open environment, regional scale).

The low organic content of the sediment, the low values of the AMBI index, and the very short residence time of the waters all indicate that the site has a large assimilative capacity for the wastes produced by the bivalves. The effect of shellfish culture on the ecosystem is difficult to assess, as the main potential consequence of oyster culture is a depletion of the phytoplanktonic biomasse, which can be assess only with comparison of the primary productivity of the waters. Such an information is not available in the site.The ecosystem mainly furnish oyster culture with available food (and space).

The culture of bivalve in the bay has a positive economic effect by creating employment and income.

The aesthetic aspects are negative only at low tide. However the lack of continuous access to the shoreline, and the absence of tourist interest (muddy shore) reduce this negative aspects to native people.

The activity of oyster culture in the Baie des Veys, seems to fulfill many conditions of the sustainability. The impacts are low, spatially limited, and reversible. However, any project of expansion should be carefully reviewed through complementary studies, in order to identify the carrying capacity of the bay.

In order to improve the management rules, a research programme is presently carried out : http://www.ifremer.fr/lern/Pages/Programme/ogive.htm. This programme will end by 2012. It is based on the use of tools such as GIS, and on the production of different models (hydrodynamics, bioenergetics and population dynamics) to address the main question related to an exploited ecosystem: What is the current carrying capacity, both in ecological and economical terms? What are the predicted growth, mortality and production of the system? Can we spatially optimize the rearing area, in order to maximize production and income? What should be the actions allowing to increase the sustainabilty of the system in the long term?

[2] These comments will be expanded in the final version, this document being prerpard for internal use.

4. Acknowledgements

Such a study cannot be implemented and finalised without the help of many people. Special thanks are due to Martine Bréret, Lucette Joassard and Françoise Mornet, who were responsible for the analytical part of that job. At sea, the technical staff of the Ifremer laboratory “Environment and Resources” for Normandy was of an invaluable help to guide us through the countless traps of the bay. Special thanks for fabienne Rauslet and Frank Maheux who spend their time in the field, on board and driving the four wheel vehicle, with the ECASA Team, and to Vincent Bouchet, whose help was appreciated.Thanks are due to the scientists who manipulate the models (Jean-Yves Stanisieres, Karine Grangeré, Sebastien Lefebvre) and to the students Rozenn Prud’homme, and Sandrine Le Noc whgo provided help in the taxonomic analysis of benthic macrofauna. Bénédicte Charrier and Annick Guilpain, from the administrative staff, had the charge of making all this running smoothly.

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Annexes

Annexe 1 Data gathered during the field campaign

DATA BAIE DES VEYS Sediment

Sample code	Sampling date	Season	Location	Site	Farm type	Distance (Station)	Latitude	Longitude	Depth (m)	Sampling gear	Sample size cm^2
3-France-BDV-0-mean-()	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(0-1)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(1-2)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(2-3)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(3-4)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(4-5)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(5-6)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(6-7)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(7-8)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(8-9)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(9-10)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(10-11)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
3-France-BDV-0-mean-(11-12)	18/10/2006	3	France	BDV	shellfish	0	49°22,894' N	001°06,218' W	3.7	corer	45.36
-----()											
3-France-BDV-50-mean-(0-1)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(1-2)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(2-3)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(3-4)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(4-5)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(5-6)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(6-7)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(7-8)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(8-9)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(9-10)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(10-11)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
3-France-BDV-50-mean-(11-12)	18/10/2006	3	France	BDV	shellfish	50	49°22,904' N	001°06,257' W	3.5	corer	45.36
-----()											
3-France-BDV-100-mean-(0-1)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(1-2)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(2-3)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(3-4)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(4-5)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(5-6)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(6-7)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(7-8)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(8-9)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(9-10)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(10-11)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36
3-France-BDV-100-mean-(11-12)	18/10/2006	3	France	BDV	shellfish	100	49°22,914' N	001°06,295' W	4.1	corer	45.36

DATA BAIE DES VEYS Sediment

Sample code	Sampling date	Season	Location	Site	Farm type	Distance (Station)	Latitude	Longitude	Depth (m)	Sampling gea	Sample size cm²
3-France-BDV-200-mean-(0-1)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(1-2)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(2-3)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(3-4)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(4-5)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(5-6)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(6-7)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(7-8)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(8-9)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(9-10)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(10-11)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-200-mean-(11-12)	39008	3	France	BDV	shellfish	200	49°22,931' N	001°06,367' W	3.5	corer	45.36
3-France-BDV-400-mean-(0-1)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(1-2)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(2-3)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(3-4)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(4-5)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(5-6)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(6-7)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(7-8)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(8-9)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(9-10)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(10-11)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-400-mean-(11-12)	39009	3	France	BDV	shellfish	400	49°22,969' N	001°06,520' W	3.9	corer	45.36
3-France-BDV-ref-mean-(0-1)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(1-2)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(2-3)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(3-4)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(4-5)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(5-6)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(6-7)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(7-8)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(8-9)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(9-10)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(10-11)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36
3-France-BDV-ref-mean-(11-12)	39009	3	France	BDV	shellfish	ref	49°23,007' N	001°06,763' W	7.5	corer	45.36

DATA BAIE DES VEYS Sediment

Sample code	Layer	T (°C)	Eh (mV)	% fine sand (2ϕ-3ϕ)	% silt-clay	TOC	TON	LOI	Labil Org Matter	Chl-a (µg /g dry)	Pheopigmen ts (µg/g dry
3-France-BDV-0-mean-()											
3-France-BDV-0-mean-(0-1)	0-1	16.3	211		2.60	1.25	0.21	1.11	0.40	3.20	4.94
3-France-BDV-0-mean-(1-2)	1-2	16.3	192.5		4.21	2.12	0.33	1.49	0.54	2.86	7.30
3-France-BDV-0-mean-(2-3)	2-3	16.3	141		2.12	0.99	0.16	1.01	0.37	2.11	3.23
3-France-BDV-0-mean-(3-4)	3-4	16.3	169.5		1.53	0.86	0.14	0.97	0.33	2.06	2.86
3-France-BDV-0-mean-(4-5)	4-5	16.3	165.5		2.24	1.19	0.19	1.15	0.42	2.14	4.95
3-France-BDV-0-mean-(5-6)	5-6	16.3	129.5		2.55	1.35	0.21	1.20	0.42		
3-France-BDV-0-mean-(6-7)	6-7	16.3	115		1.96	1.53	0.23	1.16	0.41		
3-France-BDV-0-mean-(7-8)	7-8	16.3	70.5		2.64	1.20	0.18	1.07	0.40		
3-France-BDV-0-mean-(8-9)	8-9	16.3	96		2.22	1.14	0.18	1.09	0.36		
3-France-BDV-0-mean-(9-10)	9-10	16.3	48.5		1.75	1.21		1.00	0.36		
3-France-BDV-0-mean-(10-11)	10-11	16.3	-15		2.46	1.06	0.17	1.06	0.34		
3-France-BDV-0-mean-(11-12)	11-12	16.3	-55		1.83	1.09	0.17	1.03	0.34		
-----()											
3-France-BDV-50-mean-(0-1)	0-1	16.3	313.5		1.35	0.93	0.12	1.31	0.55	4.11	1.39
3-France-BDV-50-mean-(1-2)	1-2	16.3	294		1.16	0.78	0.10	0.95	0.38	3.90	0.94
3-France-BDV-50-mean-(2-3)	2-3	16.3	246		1.33	0.83	0.11	0.92	0.37	3.75	1.23
3-France-BDV-50-mean-(3-4)	3-4	16.3	218		1.08	0.78	0.10	1.09	0.38	3.27	1.04
3-France-BDV-50-mean-(4-5)	4-5	16.3	214		1.39	0.69	0.10	0.87	0.35	3.13	0.85
3-France-BDV-50-mean-(5-6)	5-6	16.3	190		1.09	0.72	0.10	1.00	0.46		
3-France-BDV-50-mean-(6-7)	6-7	16.3	170		1.28	0.78	0.11	0.86	0.34		
3-France-BDV-50-mean-(7-8)	7-8	16.3	180		1.28	0.74	0.11	0.89	0.35		
3-France-BDV-50-mean-(8-9)	8-9	16.3	233.5		1.22	0.70	0.10	0.86	0.34		
3-France-BDV-50-mean-(9-10)	9-10	16.3	187		0.46	0.71	0.10	0.88	0.40		
3-France-BDV-50-mean-(10-11)	10-11	16.3	232.5		1.32	0.71	0.09	0.89	0.51		
3-France-BDV-50-mean-(11-12)	11-12	16.3	181		1.29	0.79	0.10	0.78	0.44		
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3-France-BDV-100-mean-(0-1)	0-1	16.3	334		1.31	0.75	0.11	1.55	0.49	2.67	0.83
3-France-BDV-100-mean-(1-2)	1-2	16.3	314.5		1.22	0.70	0.10	1.08	0.47	2.59	0.65
3-France-BDV-100-mean-(2-3)	2-3	16.3	254		1.27	0.63	0.10	0.97	0.41	1.99	0.51
3-France-BDV-100-mean-(3-4)	3-4	16.3	215		1.13	0.63	0.09	0.85	0.41	1.76	0.46
3-France-BDV-100-mean-(4-5)	4-5	16.3	215		1.26	0.62	0.09			1.69	0.46
3-France-BDV-100-mean-(5-6)	5-6	16.3	200.5		1.18	0.63	0.09	0.92	0.40		
3-France-BDV-100-mean-(6-7)	6-7	16.3	200.5		1.35	0.66	0.09	0.78	0.39		
3-France-BDV-100-mean-(7-8)	7-8	16.3	159		1.15	0.64	0.09	0.84	0.37		
3-France-BDV-100-mean-(8-9)	8-9	16.3	169		1.35	0.66	0.09	0.90	0.38		
3-France-BDV-100-mean-(9-10)	9-10	16.3	188		1.21	0.64	0.09	0.81	0.35		
3-France-BDV-100-mean-(10-11)	10-11	16.3	215		1.28	0.64	0.09	0.89	0.37		
3-France-BDV-100-mean-(11-12)	11-12	16.3	204		1.15	0.75	0.10	0.86	0.36		

DATA BAIE DES VEYS Sediment

Sample code	Layer	T (°C)	Eh (mV)	% fine sand (2ϕ-3ϕ)	% silt-clay	TOC	TON	LOI	Labil Org Matter	Chl-a (µg /g dry)	Pheopigmen ts (µg/g dry
3-France-BDV-200-mean-(0-1)	0-1	16.3	322.5		1.58	0.74	0.16	1.11	0.45	3.04	2.24
3-France-BDV-200-mean-(1-2)	1-2	16.3	316		1.11	0.64	0.14	1.01	0.43	2.67	0.89
3-France-BDV-200-mean-(2-3)	2-3	16.3	282		1.15	0.65	0.15	1.19	0.58	2.73	0.91
3-France-BDV-200-mean-(3-4)	3-4	16.3	239.5		1.27	0.65	0.15	1.02	0.40	2.54	0.93
3-France-BDV-200-mean-(4-5)	4-5	16.3	225.5		1.34	0.65	0.14	1.00	0.40	2.19	0.83
3-France-BDV-200-mean-(5-6)	5-6	16.3	229		1.25	0.61	0.13	1.01	0.38		
3-France-BDV-200-mean-(6-7)	6-7	16.3	195		1.31	0.60	0.13	1.01	0.42		
3-France-BDV-200-mean-(7-8)	7-8	16.3	167		1.30	0.66	0.14	1.08	0.36		
3-France-BDV-200-mean-(8-9)	8-9	16.3	194.5		1.31	0.62	0.14	0.98	0.37		
3-France-BDV-200-mean-(9-10)	9-10	16.3	160		1.27	0.56	0.12	0.89	0.36		
3-France-BDV-200-mean-(10-11)	10-11	16.3	156.5		1.45	0.64	0.13	0.97	0.37		
3-France-BDV-200-mean-(11-12)	11-12	16.3	138.5		1.81	0.76	0.16	0.99	0.36		
3-France-BDV-400-mean-(0-1)	0-1	16.3	309.5		0.97	0.75	0.17	1.01	0.35	4.62	1.42
3-France-BDV-400-mean-(1-2)	1-2	16.3	304.5		1.17	0.77	0.17	0.96	0.35	3.73	1.52
3-France-BDV-400-mean-(2-3)	2-3	16.3	270.5		1.07	0.70	0.16	0.89	0.33	3.34	1.15
3-France-BDV-400-mean-(3-4)	3-4	16.3	221		1.19	0.65	0.15	0.91	0.33	2.95	1.13
3-France-BDV-400-mean-(4-5)	4-5	16.3	228		1.12	0.65	0.15	0.87	0.32	3.06	0.92
3-France-BDV-400-mean-(5-6)	5-6	16.3	124.5		1.17	0.64	0.13	0.89	0.31		
3-France-BDV-400-mean-(6-7)	6-7	16.3	160		1.19	0.63	0.14	0.87	0.33		
3-France-BDV-400-mean-(7-8)	7-8	16.3	173.5		1.16	0.58	0.13	0.80	0.32		
3-France-BDV-400-mean-(8-9)	8-9	16.3	220		1.13	0.58	0.12	0.86	0.33		
3-France-BDV-400-mean-(9-10)	9-10	16.3	220		1.14	0.51	0.11	0.77	0.31		
3-France-BDV-400-mean-(10-11)	10-11	16.3	229.5		1.07	0.46	0.12	0.87	0.28		
3-France-BDV-400-mean-(11-12)	11-12	16.3	276		1.16	0.47	0.11	0.77	0.28		
3-France-BDV-ref-mean-(0-1)	0-1	16.3	340		0.90	0.59	0.10	0.81	0.24	3.42	0.74
3-France-BDV-ref-mean-(1-2)	1-2	16.3	347.5		1.07	0.63	0.09	0.80	0.25	3.22	0.76
3-France-BDV-ref-mean-(2-3)	2-3	16.3	349		1.11	0.60	0.09	0.82	0.28	3.06	0.70
3-France-BDV-ref-mean-(3-4)	3-4	16.3	365		0.96	0.54	0.09	0.83	0.26	2.60	0.61
3-France-BDV-ref-mean-(4-5)	4-5	16.3	278.5		1.00	0.55	0.09	0.81	0.26	2.43	0.59
3-France-BDV-ref-mean-(5-6)	5-6	16.3	263		1.11	0.54	0.09	0.87	0.29		
3-France-BDV-ref-mean-(6-7)	6-7	16.3	258		1.12	0.53	0.08	0.81	0.24		
3-France-BDV-ref-mean-(7-8)	7-8	16.3	234			0.52	0.08	0.82	0.24		
3-France-BDV-ref-mean-(8-9)	8-9	16.3	216.5		1.07	0.53	0.08	0.85	0.23		
3-France-BDV-ref-mean-(9-10)	9-10	16.3	174.5		1.24	0.54	0.08	0.87	0.28		
3-France-BDV-ref-mean-(10-11)	10-11	16.3	124.5		1.21	0.56	0.08	0.90	0.27		
3-France-BDV-ref-mean-(11-12)	11-12		178		1.15	0.55	0.08	0.86	0.26		

DATA BAIE DES VEYS Hydrology

Sample code	Sampling date	Season	Location	Site	Farm type	Distance (Station)	Latitude	Longitude	Bottom Depth (m)	Sampling gear	Replicate
3-BDV-Baie des Veys-0-A-	19/10/2006	3	BDV	Baie des Veys	Shellfish	0	49°22,894' N	001°06,218' W	3.7	Niskin	A
3-BDV-Baie des Veys-50-A-	20/10/2006	3	BDV	Baie des Veys	Shellfish	50	49°22,904' N	001°06,257' W	3.5	Niskin	A
3-BDV-Baie des Veys-100-A-	21/10/2006	3	BDV	Baie des Veys	Shellfish	100	49°22,914' N	001°06,295' W	4.1	Niskin	A
3-BDV-Baie des Veys-200-A-	22/10/2006	3	BDV	Baie des Veys	Shellfish	200	49°22,931' N	001°06,367' W	3.5	Niskin	A
3-BDV-Baie des Veys-400-A-	23/10/2006	3	BDV	Baie des Veys	Shellfish	400	49°22,969' N	001°06,520' W	3.9	Niskin	A
3-BDV-Baie des Veys-ref-A-	24/10/2006	3	BDV	Baie des Veys	Shellfish	ref	49°23,007' N	001°06,763' W	7.5	Niskin	A

3-BDV-Baie des Veys-0-A-	26/10/2006	3	BDV	Baie des Veys	Shellfish	0	49°22,894' N	001°06,218' W	3.7	Niskin	A
3-BDV-Baie des Veys-50-A-	27/10/2006	3	BDV	Baie des Veys	Shellfish	50	49°22,904' N	001°06,257' W	3.5	Niskin	A
3-BDV-Baie des Veys-100-A-	28/10/2006	3	BDV	Baie des Veys	Shellfish	100	49°22,914' N	001°06,295' W	4.1	Niskin	A
3-BDV-Baie des Veys-200-A-	29/10/2006	3	BDV	Baie des Veys	Shellfish	200	49°22,931' N	001°06,367' W	3.5	Niskin	A
3-BDV-Baie des Veys-400-A-	30/10/2006	3	BDV	Baie des Veys	Shellfish	400	49°22,969' N	001°06,520' W	3.9	Niskin	A
3-BDV-Baie des Veys-ref-A-	31/10/2006	3	BDV	Baie des Veys	Shellfish	ref	49°23,007' N	001°06,763' W	7.5	Niskin	A

3-BDV-Baie des Veys-0-A-	02/11/2006	3	BDV	Baie des Veys	Shellfish	0	49°22,894' N	001°06,218' W	3.7	Niskin	A
3-BDV-Baie des Veys-50-A-	03/11/2006	3	BDV	Baie des Veys	Shellfish	50	49°22,904' N	001°06,257' W	3.5	Niskin	A
3-BDV-Baie des Veys-100-A-	04/11/2006	3	BDV	Baie des Veys	Shellfish	100	49°22,914' N	001°06,295' W	4.1	Niskin	A
3-BDV-Baie des Veys-200-A-	05/11/2006	3	BDV	Baie des Veys	Shellfish	200	49°22,931' N	001°06,367' W	3.5	Niskin	A
3-BDV-Baie des Veys-400-A-	06/11/2006	3	BDV	Baie des Veys	Shellfish	400	49°22,969' N	001°06,520' W	3.9	Niskin	A
3-BDV-Baie des Veys-ref-A-	07/11/2006	3	BDV	Baie des Veys	Shellfish	ref	49°23,007' N	001°06,763' W	7.5	Niskin	A

DATA BAIE DES VEYS Hydrology

Sample code	Layer (m)	**Salinity**	**T°C**	**$O_{2\,(\%)}$**	**O2 mg/l**	**TPM (mg L^{-1})**	**POM (mg L^{-1})**	**% POM**	**Secchi (m)**	**CHl-a µg/L**	**Pheop µg/l**
3-BDV-Baie des Veys-0-A-	surface	33.8	16.2	86	6.88	6.48	1.64	20.20	N.S.(>3m70)	0.508	0.670
3-BDV-Baie des Veys-50-A-	surface	33.9	16.2	90.1	7.20	6.48	1.62	20.00	N.S.(>3m50)	0.609	0.752
3-BDV-Baie des Veys-100-A-	surface	33.8	16.3	91.1	7.27	8.50	1.77	17.23	N.S.(>4m10)	0.609	0.734
3-BDV-Baie des Veys-200-A-	surface	33.8	16.4	91.7	7.31	6.56	1.47	18.31	N.S.(>3m50)	0.698	0.727
3-BDV-Baie des Veys-400-A-	surface	33.7	16.3	91.7	7.33	6.94	3.10	30.88	N.S.(>3m90)	0.760	0.949
3-BDV-Baie des Veys-ref-A-	surface	33.7	16.4	92.2	7.35	7.62	2.98	28.11	6 M	0.816	0.952

3-BDV-Baie des Veys-0-A-	mid	33.9	16.2	86	6.88	7.75	1.83	19.10	N.S.(>3m70)	0.542	0.672
3-BDV-Baie des Veys-50-A-	mid	33.9	16.4	90.1	7.18	4.27	1.08	20.19	N.S.(>3m50)	0.626	0.818
3-BDV-Baie des Veys-100-A-	mid	33.8	16.3	90.9	7.26	10.07	2.05	16.91	N.S.(>4m10)	0.587	0.709
3-BDV-Baie des Veys-200-A-	mid	33.8	16.4	91.6	7.30	5.15	1.86	26.53	N.S.(>3m50)	0.732	0.794
3-BDV-Baie des Veys-400-A-	mid	33.7	16.3	91.4	7.30	5.72	2.71	32.15	N.S.(>3m90)	0.726	0.811
3-BDV-Baie des Veys-ref-A-	mid	33.6	16.3	92	7.36	6.10	2.36	27.90	6 M	0.788	0.921

3-BDV-Baie des Veys-0-A-	bottom	34	16.1	90	7.25	5.87	1.36	18.81	N.S.(>3m70)	0.564	0.667
3-BDV-Baie des Veys-50-A-	bottom	33.9	16.4	90.7	7.22	6.37	1.54	19.47	N.S.(>3m50)	0.575	0.738
3-BDV-Baie des Veys-100-A-	bottom	33.8	16.3	91.1	7.27	8.36	1.64	16.40	N.S.(>4m10)	0.620	0.764
3-BDV-Baie des Veys-200-A-	bottom	33.8	16.4	91.6	7.30	4.16	2.08	33.33	N.S.(>3m50)	0.838	0.806
3-BDV-Baie des Veys-400-A-	bottom	33.7	16.3	91.4	7.30	4.34	2.42	35.80	N.S.(>3m90)	0.676	0.820
3-BDV-Baie des Veys-ref-A-	bottom	33.6	16.4	92	7.34	4.11	1.94	32.07	6 M	0.933	0.940

DATA BAIE DES VEYS Hydrology

Sample code	Layer (m)	N Part µg/L	COP µg/L	C/N	Silicate µmol/l	PO4 µmol/l	NH4 (µmol L^{-1})	NO2 µmol/l	NO2 + NO3 µmol/l	NO3 µmol/l	Org N dis µmol/l
3-BDV-Baie des Veys-0-A-	surface	0.029	0.302	11.291	10.74	1.26	2.87	0.56	8.09	7.53	9.79
3-BDV-Baie des Veys-50-A-	surface	0.028	0.295	10.331	10.19	1.23	2.39	0.53	7.45	6.92	8.63
3-BDV-Baie des Veys-100-A-	surface	0.020	0.182	9.290	10.68	1.08	2.44	0.38	7.58	7.20	9.74
3-BDV-Baie des Veys-200-A-	surface	0.021	0.216	10.494	9.81	1.22	2.45	0.49	8.14	7.65	16.60
3-BDV-Baie des Veys-400-A-	surface	0.023	0.150	6.483	11.23	1.25	2.54	0.52	7.79	7.27	11.12
3-BDV-Baie des Veys-ref- A-	surface	0.037	0.149	4.088	10.66	1.22	2.61	0.41	7.20	6.79	9.66

3-BDV-Baie des Veys-0-A-	mid	0.030	0.173	5.558	10.35	1.26		0.53	7.71	7.18	9.57
3-BDV-Baie des Veys-50-A-	mid	0.034	0.244	9.294	9.96	1.16	2.40	0.50	7.03	6.53	8.31
3-BDV-Baie des Veys-100-A-	mid	0.019	0.235	12.184	10.38	1.22	2.44	0.47	6.92	6.45	9.00
3-BDV-Baie des Veys-200-A-	mid	0.018	0.240	13.519	10.66	1.26	2.47	0.49	7.52	7.03	8.80
3-BDV-Baie des Veys-400-A-	mid	0.021	0.170	8.018	10.95	1.08	2.54	0.40	6.23	5.83	8.18
3-BDV-Baie des Veys-ref-A-	mid	0.021	0.099	4.702	10.81	1.35	2.56	0.45	7.35	6.90	14.12

3-BDV-Baie des Veys-0-A-	bottom	0.026	0.270	10.282	11.32	1.23	2.53	0.54	7.55	7.01	8.76
3-BDV-Baie des Veys-50-A-	bottom	0.014	0.180	12.509	10.03	1.35	2.49	0.54	7.77	7.23	8.91
3-BDV-Baie des Veys-100-A-	bottom	0.021	0.195	11.204	10.81	1.26	2.43	0.49	7.10	6.61	11.97
3-BDV-Baie des Veys-200-A-	bottom	0.021	0.233	11.044	11.23	1.18	2.49	0.39	6.17	5.78	9.10
3-BDV-Baie des Veys-400-A-	bottom	0.012	0.122	10.456	9.52	1.26	2.56	0.44	7.01	6.57	10.29
3-BDV-Baie des Veys-ref-A-	bottom	0.027	0.156	5.751	11.38	1.22		0.39	6.31	5.92	14.80

Annexe 2 . Results of the macrofauna study

SITE	NAME	DISTANCE (m)	STATION	REPLICAT	MESH_SIZE (µm)	TAXO DATE	PHYLUM	Class-ERMS	Order-ERMS	Family-ERMS	Genus	Species	GenusSpecies	Author	Nb (0.1 m^2)
BDV	REF	720	BDV_REF	1	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Pontoporeiidae	*Bathyporeia*	*sarsi*	*Bathyporeia sarsi*	Watkin, 1938	1
BDV	REF	720	BDV_REF	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Pontoporeiidae	*Bathyporeia*	*sarsi*	*Bathyporeia sarsi*	Watkin, 1938	1
BDV	REF	720	BDV_REF	4	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Pontoporeiidae	*Bathyporeia*	*sarsi*	*Bathyporeia sarsi*	Watkin, 1938	1
BDV	REF	720	BDV_REF	1	1000	09/05/2007	Arthopoda	Insecta	Collembola	Isotomidae	*Axelsonia*	*lottoralis*	*Axelsonia littoralis*	(Moniez, 1890)	1
BDV	REF	720	BDV_REF	1	1000	09/05/2007	Arthopoda	Malacostraca	Tanaidacea	Nototanaidae	*Tanaissus*	*lilljeborgi*	*Tanaissus lilljeborgi*	(Stebbing, 1891)	2
BDV	REF	720	BDV_REF	2	1000	09/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Gastrosaccus*	*spinifer*	*Gastrosaccus spinifer*	(Goës, 1864)	1
BDV	REF	720	BDV_REF	2	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Portunidae	*Liocarcinus*	*marmoreus*	*Liocarcinus marmoreus*	(Leach, 1814)	1
BDV	0	0	BDV_0	1	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	2
BDV	0	0	BDV_0	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	5
BDV	0	0	BDV_0	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Corophiidae	*Corophium*	*volutator*	*Corophium volutator*	(Pallas, 1766)	1
BDV	0	0	BDV_0	4	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	4
BDV	50	50	BDV_50	1	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	1
BDV	50	50	BDV_50	1	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Pinnotheridae	*Pinnotheres*	*pisum*	*Pinnotheres pisum*	(Linnaeus, 1767)	2
BDV	50	50	BDV_50	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	1
BDV	50	50	BDV_50	3	1000	09/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Gastrosaccus*	*spinifer*	*Gastrosaccus spinifer*	(Goës, 1864)	1
BDV	50	50	BDV_50	3	1000	09/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	1
BDV	50	50	BDV_50	4	1000	09/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Gastrosaccus*	*spinifer*	*Gastrosaccus spinifer*	(Goës, 1864)	1
BDV	50	50	BDV_50	4	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	4
BDV	50	50	BDV_50	4	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Pontoporeiidae	*Bathyporeia*	*sarsi*	*Bathyporeia sarsi*	Watkin, 1938	1
BDV	100	100	BDV_100	2	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Pinnotheridae	*Pinnotheres*	*pisum*	*Pinnotheres pisum*	(Linnaeus, 1767)	1
BDV	100	100	BDV_100	3	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Crangonidae	*Crangon*	*crangon*	*Crangon crangon*	(Linnaeus, 1758)	1
BDV	200	200	BDV_200	1	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Crangonidae	*Crangon*	*crangon*	*Crangon crangon*	(Linnaeus, 1758)	1
BDV	200	200	BDV_200	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	1
BDV	200	200	BDV_200	2	1000	09/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Eocuma*	*dollfusi*	*Eocuma dollfusi*	Calman, 1907	1
BDV	200	200	BDV_200	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	*Pontoporeiidae*	*Bathyporeia*	*guilliamsoniana*	*Bathyporeia guilliamsoniana*	(Bate, 1857)	1
BDV	200	200	BDV_200	2	1000	09/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Praunus*	*neglectus*	*Praunus neglectus*	(G.O. Sars, 1869)	1
BDV	200	200	BDV_200	3	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Crangonidae	*Crangon*	*crangon*	*Crangon crangon*	(Linnaeus, 1758)	2
BDV	400	400	BDV_400	2	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	9
BDV	400	400	BDV_400	3	1000	09/05/2007	Arthopoda	Malacostraca	Decapoda	Crangonidae	*Crangon*	*crangon*	*Crangon crangon*	(Linnaeus, 1758)	1
BDV	400	400	BDV_400	3	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	24
BDV	400	400	BDV_400	3	1000	09/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Praunus*	*neglectus*	*Praunus neglectus*	(G.O. Sars, 1869)	1
BDV	400	400	BDV_400	3	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Gammaridae	*Gammarus*	*duebeni*	*Gammarus duebeni*	Liljeborg, 1852	1
BDV	400	400	BDV_400	4	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	8
BDV	400	400	BDV_400	4	1000	09/05/2007	Arthopoda	Malacostraca	Amphipoda	Gammaridae	*Gammarus*	*duebeni*	*Gammarus duebeni*	Liljeborg, 1852	1
BDV	400	400	BDV_400	4	1000	09/05/2007	Arthopoda	Malacostraca	Isopoda	Janiridae	-	-	JANIRIDAE	-	1
BDV	100	100	BDV_100	1(1000µm)	1000	11/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Praunus*	*neglectus*	*Praunus neglectus*	(G.O. Sars, 1869)	1
BDV	100	100	BDV_100	1(1000µm)	1000	11/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Gastrosaccus*	*spinifer*	*Gastrosaccus spinifer*	(Goës, 1864)	1
BDV	100	100	BDV_100	1(1000µm)	1000	11/05/2007	Bryozoa	Gymnolaemata	Cheilostomatida	Cryptosulidae	*Cryptosula*	*pallasiana*	*Cryptosula pallasiana*	(Moll, 1803)	1
BDV	100	100	BDV_100	2(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Tanaidacea	Nototanaidae	*Tanaissus*	*lilljeborgi*	*Tanaissus lilljeborgi*	(Stebbing, 1891)	1
BDV	100	100	BDV_100	3(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Amphipoda	Pontoporeiidae	*Bathyporeia*	*elegans*	*Bathyporeia elegans*	Watkin, 1938	1
BDV	100	100	BDV_100	4(1000µm)	1000	11/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Cumopsis*	*goodsir*	*Cumopsis goodsir*	(Van Beneden, 1861)	1
BDV	100	100	BDV_100	4(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Cumopsis*	*goodsir*	*Cumopsis goodsir*	(Van Beneden, 1861)	1
BDV	100	100	BDV_100	1(1000µm)	1000	11/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	4
BDV	100	100	BDV_100	3(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Cumopsis*	*goodsir*	*Cumopsis goodsir*	(Van Beneden, 1861)	1
BDV	400	400	BDV_400	3(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Cumopsis*	*goodsir*	*Cumopsis goodsir*	(Van Beneden, 1861)	2
BDV	400	400	BDV_400	4(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Tanaidacea	Nototanaidae	*Tanaissus*	*lilljeborgi*	*Tanaissus lilljeborgi*	(Stebbing, 1891)	12

Macrofauna

SITE	NAME	DISTANCE (m)	STATION	REPLICAT	MESH_SIZE (µm)	TAXO DATE	PHYLUM	Class-ERMS	Order-ERMS	Family-ERMS	Genus	Species	GenusSpecies	Author	Nb (0.1 m²)
BDV	50	50	BDV_50	4	1000	11/05/2007	Arthopoda	Maxillopoda	Sessilia	Balanidae	*Balanus*	*crenatus*	*Balanus crenatus*	Bruguière, 1789	1
BDV	50	50	BDV_50	4	1000	11/05/2007	Bryozoa	Gymnolaemata	Cheilostomatida	Cryptosulidae	*Cryptosula*	*pallasiana*	*Cryptosula pallasiana*	(Moll, 1803)	1
BDV	400	400	BDV_400	1(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	5
BDV	400	400	BDV_400	1(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Tanaidacea	Nototanaidae	*Tanaissus*	*lilljeborgi*	*Tanaissus lilljeborgi*	(Stebbing, 1891)	6
BDV	400	400	BDV_400	1(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	2
BDV	400	400	BDV_400	1(1000µm)	1000	11/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	6
BDV	400	400	BDV_400	1(1000µm)	1000	11/05/2007	Bryozoa	Gymnolaemata	Cheilostomatida	Cryptosulidae	*Cryptosula*	*pallasiana*	*Cryptosula pallasiana*	(Moll, 1803)	1
BDV	400	400	BDV_400	2(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Tanaidacea	Nototanaidae	*Tanaissus*	*lilljeborgi*	*Tanaissus lilljeborgi*	(Stebbing, 1891)	7
BDV	400	400	BDV_400	2(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Cumopsis*	*goodsir*	*Cumopsis goodsir*	(Van Beneden, 1861)	2
BDV	400	400	BDV_400	2(500µm)	500	11/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	1
BDV	400	400	BDV_400	2(1000µm)	1000	12/05/2007	Bryozoa	Gymnolaemata	Cheilostomatida	Cryptosulidae	*Cryptosula*	*pallasiana*	*Cryptosula pallasiana*	(Moll, 1803)	1
BDV	400	400	BDV_400	2(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	1
BDV	400	400	BDV_400	2(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Tanaidacea	Nototanaidae	*Tanaissus*	*lilljeborgi*	*Tanaissus lilljeborgi*	(Stebbing, 1891)	1
BDV	400	400	BDV_400	2(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	2
BDV	100	100	BDV_100	2(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	1
BDV	100	100	BDV_100	1(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*poseidonis*	*Urothoe poseidonis*	Reibish, 1905	1
BDV	100	100	BDV_100	1(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Mysida	Mysidae	*Gastrosaccus*	*spinifer*	*Gastrosaccus spinifer*	(Goës, 1864)	1
BDV	100	100	BDV_100	1(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Cumacea	Pseudocumatidae	*Pseudocuma (Pseudocuma)*	*longicorne*	*Pseudocuma (Pseudocuma) longicorne*	(Bate, 1858)	1
BDV	100	100	BDV_100	1(1000µm)	1000	12/05/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Cumopsis*	*goodsir*	*Cumopsis goodsir*	(Van Beneden, 1861)	1
BDV	100	100	BDV_100	2	1000	07/05/2007	Mollusca	Gastropoda	Mesogastropoda	Calyptraeidae	*Crepidula*	*fornicata*	*Crepidula fornicata*	(Linnaeus, 1758)	1
BDV	0	0	BDV_0	1	1000	07/05/2007	Mollusca	Bivalvia	Mytiloida	Mytilidae	*Mytilus*	*edulis*	*Mytilus edulis*	Linnaeus, 1758	1
BDV	0	0	BDV_0	1	1000	07/05/2007	Mollusca	Gastropoda	Mesogastropoda	Triviidae	*Trivia*	*monacha*	*Trivia monacha*	(da Costa, 1778)	1
BDV	50	50	BDV_50	1	1000	07/05/2007	Mollusca	Bivalvia	Veneroida	Cardiidae	*Cerastoderma*	*edule*	*Cerastoderma edule*	(Linnaeus, 1758)	1
BDV	400	400	BDV_400	4	1000	07/05/2007	Mollusca	Bivalvia	Veneroida	Cardiidae	*Cerastoderma*	*edule*	*Cerastoderma edule*	(Linnaeus, 1758)	1
BDV	400	400	BDV_400	3	1000	07/05/2007	Mollusca	Bivalvia	Veneroida	Cardiidae	*Cerastoderma*	*edule*	*Cerastoderma edule*	(Linnaeus, 1758)	1
BDV	400	400	BDV_400	2	1000	07/05/2007	Mollusca	Bivalvia	Veneroida	Cardiidae	*Cerastoderma*	*edule*	*Cerastoderma edule*	(Linnaeus, 1758)	1
BDV	400	400	BDV_400	1	1000	07/05/2007	Mollusca	Bivalvia	Veneroida	Cardiidae	*Cerastoderma*	*edule*	*Cerastoderma edule*	(Linnaeus, 1758)	1
BDV	100	100	BDV_100	2	1000	07/05/2007	Mollusca	Bivalvia	Veneroida	Cardiidae	*Cerastoderma*	*edule*	*Cerastoderma edule*	(Linnaeus, 1758)	1
BDV	400	400	BDV_400	1	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	3
BDV	400	400	BDV_400	1	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	1
BDV	400	400	BDV_400	2	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	400	400	BDV_400	2	1000	27/08/2007	Annelida	Polychaeta	Terebellida	Cirratulidae	*Aphelochaeta*	*sp.*	*Aphelochaeta sp.*	-	2
BDV	400	400	BDV_400	2	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*capitata*	*Glycera capitata*	Oersted, 1843	2
BDV	400	400	BDV_400	2	1000	27/08/2007	Annelida	Polychaeta	Terebellida	Cirratulidae	*Aphelochaeta*	*sp.*	*Aphelochaeta sp.*	-	1
BDV	400	400	BDV_400	2	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	3
BDV	400	400	BDV_400	2	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Syllidae	*Exogone (Exogone)*	*naidina*	*Exogone (Exogone) naidina*	Örsted, 1845	3
BDV	400	400	BDV_400	2	1000	27/08/2007	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	*Acrocnida*	*brachiata*	*Acrocnida brachiata*	(Montagu, 1804)	2
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*tridactyla*	*Glycera tridactyla*	Schmarda, 1861	2
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	3
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*tridactyla*	*Glycera tridactyla*	Schmarda, 1861	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Nemertina	-	-	-	-	-	NEMERTINA	-	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Eunicida	Lumbrineridae	*Scoletoma*	*impatiens*	*Scoletoma impatiens*	(Claparède, 1868)	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Syllidae	*Exogone (Exogone)*	*naidina*	*Exogone (Exogone) naidina*	Örsted, 1845	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Terebellida	Cirratulidae	*Aphelochaeta*	*sp.*	*Aphelochaeta sp.*	-	2

SITE	NAME	DISTANCE (m)	STATION	REPLICAT	MESH_SIZE (µm)	TAXO DATE	PHYLUM	Class-ERMS	Order-ERMS	Family-ERMS	Genus	Species	GenusSpecies	Author	Nb (0.1 m²)
BDV	400	400	BDV_400	3	1000	27/08/2007	Arthopoda	Maxillopoda	Sessilia	Balanidae	*Balanus*	*improvisus*	*Balanus improvisus*	Darwin, 1854	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	*Acrocnida*	*brachiata*	*Acrocnida brachiata*	(Montagu, 1804)	1
BDV	400	400	BDV_400	3	1000	27/08/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Arthopoda	Maxillopoda	Sessilia	Balanidae	*Balanus*	*perforatus*	*Balanus perforatus*	Bruguière, 1789	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	*Acrocnida*	*brachiata*	*Acrocnida brachiata*	(Montagu, 1804)	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*tridactyla*	*Glycera tridactyla*	Schmarda, 1861	2
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Terebellida	Terebellidae	*Lanice*	*conchilega*	*Lanice conchilega*	(Pallas, 1766)	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Capitellida	Capitellidae	*Capitella*	*giardi*	*Capitella giardi*	(Mesnil, 1897)	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Capitellida	Capitellidae	*Capitella*	*minima*	*Capitella minima*	Langerhans, 1880	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Phyllodocida	Syllidae	*Exogone (Exogone)*	*naidina*	*Exogone (Exogone) naidina*	Örsted, 1845	1
BDV	400	400	BDV_400	4	1000	27/08/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	1
BDV	200	200	BDV_200	1	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	1
BDV	200	200	BDV_200	1	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	3
BDV	200	200	BDV_200	1	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	200	200	BDV_200	1	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	2
BDV	200	200	BDV_200	2	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	8
BDV	200	200	BDV_200	2	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	-	-	SPIONIDAE	-	1
BDV	200	200	BDV_200	2	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	200	200	BDV_200	2	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Orbinia*	*latreillii*	*Orbinia latreilli*	(Audouin & Milne-Edwards, 1833)	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	15
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*capitata*	*Glycera capitata*	Oersted, 1843	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	200	200	BDV_200	3	1000	28/07/2007	Annelida	Polychaeta	Terebellida	Terebellidae	*Lanice*	*conchilega*	*Lanice conchilega*	(Pallas, 1766)	1
BDV	200	200	BDV_200	2	1000	28/07/2007	Annelida	Polychaeta	Terebellida	Terebellidae	*Lanice*	*conchilega*	*Lanice conchilega*	(Pallas, 1766)	1
BDV	200	200	BDV_200	4	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	6
BDV	200	200	BDV_200	4	1000	28/07/2007	Annelida	Polychaeta	Eunicida	Lumbrineridae	*Scoletoma*	*impatiens*	*Scoletoma impatiens*	(Claparède, 1868)	1
BDV	200	200	BDV_200	4	1000	28/07/2007	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	*Acrocnida*	*brachiata*	*Acrocnida brachiata*	(Montagu, 1804)	2
BDV	200	200	BDV_200	4	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	200	200	BDV_200	4	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	200	200	BDV_200	4	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*capitata*	*Glycera capitata*	Oersted, 1843	1
BDV	200	200	BDV_200	4	1000	28/07/2007	Nemertina	-	-	-	-	-	NEMERTINA	-	1
BDV	200	200	BDV_200	4	1000	28/07/2007	Annelida	Polychaeta	Capitellida	Capitellidae	*Capitella*	*minima*	*Capitella minima*	Langerhans, 1880	1
BDV	200	100	BDV_100	1	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	2
BDV	200	100	BDV_100	1	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	2
BDV	100	100	BDV_100	1	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Spio*	*decoratus*	*Spio decoratus*	Bobretzky, 1870	1
BDV	100	100	BDV_100	1	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	100	100	BDV_100	2	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	1
BDV	100	100	BDV_100	2	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	2
BDV	100	100	BDV_100	2	1000	28/07/2007	Nemertina	-	-	-	-	-	NEMERTINA	-	2
BDV	100	100	BDV_100	2	1000	28/07/2007	Annelida	Polychaeta	Capitellida	Capitellidae	*Heteromastus*	*filiformis*	*Heteromastus filiformis*	(Claparède, 1864)	1

SITE	NAME	DISTANCE (m)	STATION	REPLICAT	MESH_SIZE (µm)	TAXO DATE	PHYLUM	Class-ERMS	Order-ERMS	Family-ERMS	Genus	Species	GenusSpecies	Author	Nb (0.1 m²)
BDV	100	100	BDV_100	2	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	100	100	BDV_100	3	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	100	100	BDV_100	3	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	-	-	SPIONIDAE	-	1
BDV	100	100	BDV_100	3	1000	28/07/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	100	100	BDV_100	3	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	1
BDV	100	100	BDV_100	3	1000	28/07/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Bodotria*	*scorpioides*	*Bodotria scorpioides*	(Montagu, 1804)	1
BDV	100	100	BDV_100	4	1000	28/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	100	100	BDV_100	4	1000	28/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	1
BDV	100	100	BDV_100	4	1000	28/07/2007	Annelida	Polychaeta	Spionida	Magelonidae	*Magelona*	*mirabilis*	*Magelona mirabilis*	(Johnston, 1865)	1
BDV	REF	REF	BDV_REF	1	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	REF	REF	BDV_REF	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	REF	REF	BDV_REF	2	1000	29/07/2007	Arthopoda	Malacostraca	Cumacea	Bodotriidae	*Eocuma*	*dollfusi*	*Eocuma dollfusi*	Calman, 1907	1
BDV	REF	REF	BDV_REF	3	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	REF	REF	BDV_REF	4	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	1
BDV	50	50	BDV_50	1	1000	29/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	58
BDV	50	50	BDV_50	1	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	50	50	BDV_50	1	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	1
BDV	50	50	BDV_50	1	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*mucosa*	*Phyllodoce (Anaitides) mucosa*	Oersted, 1843	2
BDV	50	50	BDV_50	1	1000	29/07/2007	Annelida	Polychaeta	Spionida	Magelonidae	*Magelona*	*mirabilis*	*Magelona mirabilis*	(Johnston, 1865)	1
BDV	50	50	BDV_50	1	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Eteone*	*longa*	*Eteone longa*	(Fabricius, 1780)	1
BDV	50	50	BDV_50	1	1000	29/07/2007	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	*Acrocnida*	*brachiata*	*Acrocnida brachiata*	(Montagu, 1804)	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Eteone*	*longa*	*Eteone longa*	(Fabricius, 1780)	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	39
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*capitata*	*Glycera capitata*	Oersted, 1843	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	2
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*tridactyla*	*Glycera tridactyla*	Schmarda, 1861	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*maculata*	*Phyllodoce (Anaitides) maculata*	(Linnaeus, 1767)	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Eteone*	*foliosa*	*Eteone foliosa*	Quatrefages, 1865	1
BDV	50	50	BDV_50	2	1000	29/07/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Eteone*	*longa*	*Eteone longa*	(Fabricius, 1780)	1
BDV	50	50	BDV_50	3	1000	03/09/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	36
BDV	50	50	BDV_50	3	1000	03/09/2007	Annelida	Polychaeta	Spionida	Spionidae	-	-	SPIONIDAE	-	1
BDV	50	50	BDV_50	3	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*tridactyla*	*Glycera tridactyla*	Schmarda, 1861	1
BDV	50	50	BDV_50	3	1000	03/09/2007	Nemertina	-	-	-	-	-	NEMERTINA	-	2
BDV	50	50	BDV_50	3	1000	03/09/2007	Annelida	Polychaeta	Eunicida	Lumbrineridae	*Scoletoma*	*impatiens*	*Scoletoma impatiens*	(Claparède, 1868)	1
BDV	50	50	BDV_50	3	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*capitata*	*Glycera capitata*	Oersted, 1843	1
BDV	50	50	BDV_50	3	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*maculata*	*Phyllodoce (Anaitides) maculata*	(Linnaeus, 1767)	1
BDV	50	50	BDV_50	4	1000	03/09/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	52
BDV	50	50	BDV_50	4	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	*Phyllodoce (Anaitides)*	*maculata*	*Phyllodoce (Anaitides) maculata*	(Linnaeus, 1767)	1
BDV	50	50	BDV_50	4	1000	03/09/2007	Annelida	Polychaeta	Spionida	Spionidae	*Pygospio*	*elegans*	*Pygospio elegans*	Claparède, 1863	1
BDV	50	50	BDV_50	4	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*cirrosa*	*Nephtys cirrosa*	Ehlers, 1868	3
BDV	50	50	BDV_50	4	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	1
BDV	50	50	BDV_50	4	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Glyceridae	*Glycera*	*capitata*	*Glycera capitata*	Oersted, 1843	1
BDV	0	0	BDV_0	4	1000	03/09/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	12
BDV	0	0	BDV_0	4	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Nephtyidae	*Nephtys*	*hombergii*	*Nephtys hombergii*	Savigny, 1818	2
BDV	0	0	BDV_0	3	1000	03/09/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	7
BDV	0	0	BDV_0	2	1000	03/09/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	6
BDV	0	0	BDV_0	2	1000	03/09/2007	Annelida	Polychaeta	Phyllodocida	Sigalionidae	*Sigalion*	*mathildae*	*Sigalion mathildae*	Audouin & Milne Edwards in Cuvier, 1830	1
BDV	0	0	BDV_0	2	1000	03/09/2007	Annelida	Oligochaeta	Haplotaxida	Tubificoides	*Tubificoides*	*benedii*	*Tubificoides benedii*	(Udekem, 1855)	1
BDV	0	0	BDV_0	2	1000	03/09/2007	Annelida	Polychaeta	Capitellida	Capitellidae	*Capitella*	*capitata*	*Capitella capitata*	(Fabricius, 1780)	5
BDV	0	0	BDV_0	1	1000	03/09/2007	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos*	*armiger*	*Scoloplos armiger*	(O.F. Müller, 1776)	6
BDV	0	0	BDV_0	1	1000	03/09/2007	Annelida	Polychaeta	Capitellida	Capitellidae	*Capitella*	*capitata*	*Capitella capitata*	(Fabricius, 1780)	1

Annexe 3. List of species and occurrence
by stations and replica

Macrofauna Baie des Veys	BDV_REF				BDV_0				BDV_50				BDV_100				BDV_200				BDV_400			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Acrocnida brachiata	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	2	1	1
Aphelochaeta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0
Axelsonia littoralis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Balanus crenatus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Balanus improvisus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Balanus perforatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bathyporeia guilliamsoniana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Bathyporeia sarsi	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Bodotria scorpioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Capitella capitata	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitella giardi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Capitella minima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Cerastoderma edule	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1
Corophium volutator	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crangon crangon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	1	0
Crepidula fornicata	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cryptosula pallasiana	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Eocuma dollfusi	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Eteone foliosa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eteone longa	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exogone (Exogone) naidina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1
Gammarus duebeni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Gastrosaccus spinifer	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Glycera capitata	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	2	0	0
Glycera tridactyla	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3	2
Heteromastus filiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
JANIRIDAE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Lanice conchilega	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
Liocarcinus marmoreus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magelona mirabilis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Mytilus edulis	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEMERTINA	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	1	0	0	1	0
Nephtys cirrosa	1	2	1	1	0	0	0	0	2	2	0	3	0	1	1	1	2	2	1	2	0	2	1	2
Nephtys hombergii	0	0	0	0	0	0	0	2	1	1	0	1	2	0	0	0	0	0	1	0	3	0	0	0
Orbinia latreilli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Phyllodoce (Anaitides) maculata	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Phyllodoce (Anaitides) mucosa	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	1	1	1	0	1	3	0	0
Pinnotheres pisum	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Praunus neglectus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Pseudocuma (Pseudocuma) longicorne	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pygospio elegans	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	2	0	2	1	0	0	3	1
Scoletoma impatiens	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0
Scoloplos armiger	0	0	0	0	6	6	7	12	58	39	36	52	2	2	1	1	3	8	16	6	0	0	2	1
Sigalion mathildae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spio decoratus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
SPIONIDAE	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
Tanaissus lilljeborgi	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trivia monacha	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificoides benedii	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urothoe poseidonis	0	0	0	0	2	5	0	4	1	1	0	4	0	0	0	0	0	1	0	0	0	9	24	8
Species richness / replicates	4	5	1	2	5	6	1	3	10	9	9	11	4	8	6	3	5	9	9	8	3	8	15	14
Species richness / stations	8				9				24				15				18				25			

Annexe 4 models templates

ECASA - Model description template

1	Name of model	*Reporter/Institute (email address)*
1.a	***Hydrodynamic model***	C. Bacher/IFREMER (cbacher@ifremer.fr)
1.b	*date this form was completed or updated*	5 September 2007

2	Short DESCRIPTION of model	
2.a	*Main state variables:*	Current velocity, water level, temperature, salinity.
2.b	*Scale to which applicable:*	Coastal sea, Bay, lagoon, estuaries – spatial resolution between 50 and 5000 m.
2.c	*General description.* *NB: if the model is complicated, or has easily distinguishable components (such as a physical and a biological sub-models) that can be, or have been, used separately, it may be easier to complete one form for each of the main components.*	The hydrodynamic model solves the three dimensional Reynolds-averaged Navier–Stokes equations with hydrostatic approximation and free surface boundary condition. Density evolution is allowed and related to temperature and salinity variations through a state relationship. Bottom topography is taken into account via a s-transformation along the vertical axis (10 levels) of a Cartesian mesh. Horizontal computational domain is a regular grid.
2.d	*Key semi-universal parameters and example values (which should apply at least regionally or for at least one type of water body); summarize any restrictions or reservations about these parameters*	All parameters are universal and related to the Navier-Stokes equations.
2.e	*Main forcing data needed - initial values of state variables; boundary conditions; inputs; imposed environmental conditions; generalized loss terms. State whether single values or time-series needed.*	• Times series of air temperature, light, wind • Time series of freshwater discharge • Boundary conditions (water height)
2.f	*Restrictions to use of model*	None.

3	**possibly relevant INDICATORS and example EcoQOs**	
3.a	***D**river*	
3.b	***P**ressure*	Freshwater discharge.
3.c	***S**tate*	
3.d	***I**mpact*	
3.e	***R**esponse*	

4	**STATUS of model** *NB: refers to scientific theory and equation set; distinguish from implementation*	
4.a	*Origin(ator) of model concept and initial formulation:*	IFREMER (Lazure (1995) on Thau lagoon; Struski (2005) and Stanisière et al. (2006) on Marennes-Oléron).
4.b	*Present status of model, including scientific basis of claimed robustness and key matters still needing study:*	Several publications and applications for IFREMER projects on all types of ecosystem, including ecological applications (eutrophication).
4.c	*Present use:*	On Thau lagoon, assessment of the impact of shellfish aquaculture (anoxia, Chapelle et al., 2001) and impact of watershed on water quality (Fiandrino et al., 2003) and ecosystem functioning (Plus et al., 2003a, b, 2006). On Pertuis Charentais, the code has been applied to assess the extension of mussel longlines culture (see 'longline' template), for ecological and impact assessment studies and simulation of sediment dynamics (Stanisière et al., 2006; Struski, 2005). On Baie des Veys, it is under development to assess carrying capacity with a coupling between DEB, ecosystem dynamics and hydrodynamics
4.d	*Potential use and development in ECASA :*	Local impact of shellfish aquaculture, by coupling with an ecophysiologcal model (see DEB template).

5	**IMPLEMENTATION of model**	
5.a	*State of implementation :* *(This refers to realization of model theory in numerical algorithms, spreadsheets, computer programs, etc. to provide solutions of the model equations when supplied with appropriate forcing data.*	Fortran code and Matlab tools for post processing.
5.b	*State of documentation (which describes how to use an implementation as well as giving model theory)*	See 2 reports describing the model implementation in Marennes-Oléron Bay (Stanisière et al., 2006; Struski, 2005).

5.c	*Intellectual property concerns - if none stated here, model and implementation will be deemed to freely available on request*	IFREMER is the owner of this model and the software supporting it. ECASA participants need an agreement to apply it for their own needs when carrying the tasks identified within the ECASA contract.

6.	**TESTING of model**	
6.a	*Summary of conditions and measurements needed:* *Refer back to 2.e if necessary. Highlight observations needed for model testing.*	Air temperature and wind, freshwater discharge (when necessary), boundary conditions (water height), bathymetry.
6.b	*Criteria for model rejection*	None.

7	**OTHER models**	
7.a	*Used explicitly or implicitly with this model*	Longline model used to assess the effect of cultured mussels on particles and sediment. Anoxia model by coupling hydrodynamics and biological equations (mineralisation, biodeposition). Impact of freshwater inputs (bacteria, nutrients).
7.b	*Similar models (which might serve roughly the same purpose in relation to mariculture)*	Any 2D or 3D model (e.g. MIKE, COHERENS etc.).

8. REFERENCES cited *show in bold the most important paper describing the model*

Chapelle A., Lazure, P., Souchu, P., 2001. Modélisation numérique des crises anoxiques (malaïgues) dans la lagune de Thau (France). Oceanologica Acta 24, 87-97.

Fiandrino A., Y. Martin, P. Got, J.L. Bonnefont, M. Troussellier, 2003. Bacterial contamination of Mediterranean coastal seawater as affected by riverine inputs: simulation approach applied to a shellfish breeding area (Thau lagoon, France). Water Research 37, 1711–1722.

Lazure, P. 1992. Etude de la dynamique de l'étang de Thau par modèle numerique tridimensionnel. *Vie & Milieu* **42**, 137-145.

Plus M., I. La Jeunesse, F.al Bouraoui, J.M. Zaldıvar, A. Chapelle, P. Lazure, 2006. Modelling water discharges and nitrogen inputs into a Mediterranean lagoon. Impact on the primary production. Ecol. Modelling, 193, 69-89.

Plus, M., Chapelle, A., Lazure, P., Auby, I., Levavasseur, G., Verlaque, M., Belsher, T., Deslous-Paoli, J.-M., Zaldívar, J. M., Murray, C. N., 2003 a. Modelling of oxygen and nitrogen cycling as a function of macrophyte community in the Thau lagoon. Continental Shelf Research, 23: 1877-1898.

Plus, M., Chapelle, A., Ménesguen, A., Deslous-Paoli, J.-M., Auby, I., 2003 b. Modelling seasonal dynamics of biomasses and nitrogen contents in a seagrass meadow (*Zostera noltii* Hornem.): application to the Thau lagoon (French Mediterranean coast). Ecol. Model., 161: 149-252.

Stanisière, J.Y, Dumas, F., Plus, M., Maurer, D., Robert, S., 2006. Hydrodynamic characterization of a semi-enclosed coastal system : Marennes Oleron (France) basin.

Ifremer Report, http://www.ifremer.fr/docelec/notice/2006/notice2353-EN.htm
Struski C., 2005. Modélisation des flux de matières dans la baie de Marennes-Oléron : couplage de l'hydrodynamisme, de la production primaire et de la consommation par les huîtres. Thèse Univ. La Rochelle, http://www.ifremer.fr/docelec/notice/2005/notice554.htm

ECASA - Model description template

1	**Name of model**	*Reporter/Institute (email address)*
1.a	***Effect of mussel longlines***	C. Bacher/IFREMER (cbacher@ifremer.fr)
1.b	*date this form was completed or updated*	5 September 2007

2	**Short DESCRIPTION of model**	
2.a	*Main state variables:*	Mussel growth, food concentration, biodeposition.
2.b	*Scale to which applicable:*	Mussel longline area, ca. 5 km.
2.c	*General description.* *NB: if the model is complicated, or has easily distinguishable components (such as a physical and a biological sub-models) that can be, or have been, used separately, it may be easier to complete one form for each of the main components.*	It combines an ecophysiology model and a box model in order to simulate growth of mussels reared in long lines and advise for the appropriate size and mussel density of the cultivated area. The model was applied in Pertuis Breton for mussels. The growth model was adapted and calibrated from previously published model (Grant and Bacher, 1998) and food transport in the long line area was computed using outputs of a hydrodynamical model (see the related template). Simulations were carried out for different mussel densities and lease sizes to assess their effects on mussel growth. They demonstrated that actual mussel density and lease size had a minor impact on flows of particulate organic matter and phytoplankon and would not decrease food concentration for other cultivated areas. A threefold multiplication of either mussel density or lease size would therefore be a conservative recommendation for managers willing to increase mussel production without having deleterious effect on growth. Another application was carried out in China for scallops (*Chlamys farreri*) cultured on long lines. A detailed model of *C. farreri* feeding and growth and a one dimensional horizontal transport equation have been coupled. The model was applied to assess the effect of some environmental parameters (e.g. food availability, temperature, hydrodynamism) and spatial variability on growth, and to assess the effect of density according to a wide range of hydrodynamical and environmental conditions. The model suggests that scallop growth was correlated with maximum current velocity for a given density and current velocity below 20 cm s^{-1}.

2.d	*Key semi-universal parameters and example values (which should apply at least regionally or for at least one type of water body); summarize any restrictions or reservations about these parameters*	Ecophysiology parameters are not universal (in this case) but a generic version of this model exists (see related template). Spatial Box Model concept and equation are generic and based on simple mass conservation principle.
2.e	*Main forcing data needed - initial values of state variables; boundary conditions; inputs; imposed environmental conditions; generalized loss terms. State whether single values or time-series needed.*	• Water temperature. • Boundary conditions: food concentration, suspended particulate matter. • Hydrodynamical model or current velocity measurements to assess exchange of water between the longline area and the ecosystem.
2.f	*Restrictions to use of model*	None.

3	**possibly relevant INDICATORS and example EcoQOs**	
3.a	***D**river*	
3.b	***P**ressure*	Number of longlines, density of shellfish, size of the farm.
3.c	***S**tate*	Phytoplankton concentration and shellfish growth.
3.d	***I**mpact*	Shellfish growth and production.
3.e	***R**esponse*	Selection of sites suitable for shellfish culture.

4	**STATUS of model** *NB: refers to scientific theory and equation set; distinguish from implementation*	
4.a	*Origin(ator) of model concept and initial formulation:*	Incze et al. (1980).
4.b	*Present status of model, including scientific basis of claimed robustness and key matters still needing study:*	The ecophysiology model is specific, and must be adapted to site and species. Implementation of the model is also specific.
4.c	*Present use:*	The code has only been used in 2 case studies (see description). One of the case studies illustrated how to assess the risk of affecting carrying capacity due to the extension of mussel farms, using Risk Assessment methods in a panel of experts (GESAMP working group 31).
4.d	*Potential use and development in ECASA :*	Can be used to assess effect of animals density and lease size on food concentration, animal growth and biodeposition in shellfish culture.

5	IMPLEMENTATION of model	
5.a	*State of implementation :* *(This refers to realization of model theory in numerical algorithms, spreadsheets, computer programs, etc. to provide solutions of the model equations when supplied with appropriate forcing data.*	Matlab code.
5.b	*State of documentation (which describes how to use an implementation as well as giving model theory)*	Concepts and methods are explained in the literature. Examples of applications are given in Bacher et al. (2003), Bacher (2007).
5.c	*Intellectual property concerns - if none stated here, model and implementation will be deemed to freely available on request*	IFREMER is the owner of the software supporting it. ECASA participants have a free access to these tools, which is restricted to be used when carrying the tasks identified within the ECASA contract. Any other use requires the written consent of IFREMER.

6.	TESTING of model	
6.a	*Summary of conditions and measurements needed:* *Refer back to 2.e if necessary. Highlight observations needed for model testing.*	Hydrodynamic model (see the template on hydrodynamic model), growth data, boundary conditions (phytoplankton, suspended matter), forcing variable (temperature).
6.b	*Criteria for model rejection*	None

7	OTHER models	
7.a	*Used explicitly or implicitly with this model*	Ecophysiology model. Hydrodynamical model.
7.b	*Similar models (which might serve roughly the same purpose in relation to mariculture)*	Model by Ferreira et al. (2007).

8. REFERENCES cited *show in bold the most important paper describing the model*

Bacher C., S. Robert, P. Garen, S. Bougrier, E. Pallas. Using a box model to predict the growth of cultured mussels as a function of mussel density and lease size. Symposium of the American Fisheries Society, Québec, 10-14 août 2003, (summary only).

Bacher C., Grant J., Hawkins A.J.S., Fang C. , Zhu M., Besnard M., 2003. Modelling the effect of food depletion on scallop growth in Sungo Bay (China). Aquat. Living Resour, 16, 10-24.

Bacher, 2007. Risk assessment of the potential decrease of carrying capacity by shellfish farming. http://gesamp.net/page.php?page=24 , case study 6.2.

Ferreira J.G., Hawkins A.J.S, Bricker S.B., 2007. Management of productivity, environmental

effects and profitability 3 of shellfish aquaculture — the Farm Aquaculture Resource Management (FARM) model. Aquaculture 264, 160-174.
Grant J., Bacher C. 1998. Comparative models of mussel bioenergetics and their variation at field culture sites. J. Exp. Mar. Biol. Ecol. 219 (1-2) : 21-44.
Incze L.S., Lutz R.A. & Walting L. (1980) Relationship between effect of environmental temperature and seston on growth and mortality of *Mytilus edulis* in a temperate northern estuary. Marine Biology 57, 147-156.

ECASA - Model description template

1	**Name of model**	*Reporter/Institute (email address)*
1.a	***Ecophysiological model based on the DEB theory***	Aline Gangnery / Ifremer email: Aline.Gangnery@ifremer.fr
1.b	*date this form was completed or updated*	5 September 2007

2	**Short DESCRIPTION of model**	
2.a	*Main state variables:*	Structural volume, reserves and gonads of an organism.
2.b	*Scale to which applicable:*	Individual (fish or shellfish).
2.c	*General description.* *NB: if the model is complicated, or has easily distinguishable components (such as a physical and a biological sub-models) that can be, or have been, used separately, it may be easier to complete one form for each of the main components.*	The DEB (Dynamic Energy Budget) model describes the energy flows through an organism and also changes in the environment with varying food densities and temperature. The model allows to simulate individual growth rate and reproduction. Energy acquisition is represented by food uptake, which is proportional to the surface area of the feeding apparatus of the organism and which is converted into reserves. These reserves are then used and allocated to growth, maintenance & reproduction according to a generic rule. A fixed fraction, K, is allocated to somatic maintenance and growth while the remainder (1-K) is allocated to maturity maintenance & development or reproduction. Maintenance can be interpreted as the metabolic cost to maintain somatic & reproductive tissues. The DEB model relies on 10 primary parameters which

		control energy acquisition and allocation within the organism. Some extra parameters can be added.
2.d	*Key semi-universal parameters and example values (which should apply at least regionally or for at least one type of water body); summarize any restrictions or reservations about these parameters*	Some of the parameters (*i.e.* volume specific cost of maintenance and volume specific cost for growth) can be eventually considered as semi-universal in the way they are close for related species.
2.e	*Main forcing data needed - initial values of state variables; boundary conditions; inputs; imposed environmental conditions; generalized loss terms. State whether single values or time-series needed.*	* Temperature and food concentration (*e.g.* chlorophyll a) are the main forcing functions. * Initial value of structural mass, reserves and gonads should be known.
2.f	*Restrictions to use of model*	None

3	**possibly relevant INDICATORS and example EcoQOs**	
3.a	***D**river*	
3.b	***P**ressure*	
3.c	***S**tate*	
3.d	***I**mpact*	Assessment of ingestion flux from organisms.
3.e	***R**esponse*	Modifications of individual growth rate and reproduction in response to environmental changes (e.g. eutrophication, warming of water).

4	**STATUS of model** *NB: refers to scientific theory and equation set; distinguish from implementation*	
4.a	*Origin(ator) of model concept and initial formulation:*	Theoretical background of the DEB theory can be found in Kooijman (2000 - 2nd edition). First applications on bivalves were done by Ross and Nisbet (1990) and van Haren and Kooijman (1993) on the mussel *Mytilus edulis*.
4.b	*Present status of model, including scientific basis of claimed robustness and key matters still needing study:*	DEB theory has gained increasing popularity and several applications were successfully done on different aquatic (Cardoso et al. 2001, van der Veer et al., 2001, Ren and Ross, 2005) and non aquatic species. A large work was recently dedicated to the application of DEB theory and validation of the model for several bivalves species, among them the Pacific oyster *Crassostrea gigas* (see the special Volume 56 Issue 2 of the Journal of Sea Research: The DEBIB project:

		Dynamic Energy Budgets in Bivalves).
4.c	*Present use:*	Assessment of growth and reproduction energy fluxes in fish and shellfish species (when limited to aquatic organisms). Assessment of standing stock and marketable production of oyster when DEB model is coupled with an IBM population dynamics model. Assessment of carrying capacity when DEB is coupled with a 0D ecological model.
4.d	*Potential use and development in ECASA :*	Can be coupled with 2D ecosystem and/or population dynamics models in order to assess interactions between aquaculture and environment.

5	**IMPLEMENTATION of model**	
5.a	*State of implementation :* *(This refers to realization of model theory in numerical algorithms, spreadsheets, computer programs, etc. to provide solutions of the model equations when supplied with appropriate forcing data.*	Model algorithm is programmed in Matlab 7.0.1 and STELLA 8.1.
5.b	*State of documentation (which describes how to use an implementation as well as giving model theory)*	DEB theory is largely detailed in Kooijman (2000). Different papers present a summary of the model as well as a list of parameters and their values for each species tested (van der Veer et al., 2006, Pouvreau et al., 2006).
5.c	*Intellectual property concerns - if none stated here, model and implementation will be deemed to freely available on request*	ECASA participants have a free access to these tools, which is restricted to be used when carrying the tasks identified within the ECASA contract. The use of the most recent set of parameters concerning the species *Crassostrea gigas* requires the written consent of IFREMER.

6.	**TESTING of model**	
6.a	*Summary of conditions and measurements needed:* *Refer back to 2.e if necessary. Highlight observations needed for model testing.*	Times series of forcing functions are needed (water temperature and food density). Parameterization of the model needs to be carefully done for each species even if some parameters can be close for related species.
6.b	*Criteria for model rejection*	No specific rejection criteria were set.

7	OTHER models	
7.a	*Used explicitly or implicitly with this model*	An IBM population dynamics model was recently coupled to a DEB model for oysters cultivated in Thau Lagoon (Bacher and Gangnery, 2006).
7.b	*Similar models (which might serve roughly the same purpose in relation to mariculture)*	Other ecophysiological models have been developed based on the SFG theory (Scope For Growth) (*e.g.* Barillé et al. 1997, Ren and Ross 2001 for the Pacific oyster *Crassostrea gigas*). Presently, the more achieved model of this type is probably SHELLSIM, also proposed as a modeling tool in ECASA (Hawkins et *al.*, 2002).

8. REFERENCES cited *show in bold the most important paper describing the model*

Bacher, C., Gangnery, A. 2006. Use of dynamic energy budget and individual based models to simulate the dynamics of cultivated oyster population. J. Sea Res. 56, 140-155.

Barillé, L., Héral, M., Barillé-Boyer, A.L., 1997. Modélisation de l'écophysiologie de l'huître *Crassostrea gigas* dans un environnement estuarien. Aquat. Living. Resour. 10, 31-48.

Cardoso, J.F., van der Meer, J., van der Veer, H.W., 2001. Interspecies comparison of energy flow in some North Atlantic bivalve species by means of dynamic energy budget. J 43. C. ICES.

Hawkins, A.J.S., Duarte, P., Fang, J.G., Pascoe, P.L., Zhang, X.L., Zhu, M. 2002. A functional simulation of responsive filter-feeding and growth in bivalve shellfish, configured and validated for the scallop *Chlamys farreri* during culture in China. J. Exp. Mar. Biol. Ecol. 281, 13-40.

Kooijman, S.A.L.M., 2000. Dynamic energy and mass budgets in biological systems, Cambridge University Press, Cambridge.

Pouvreau, S., Bourles, Y., Lefebvre, S., Gangnery, A., Alunno-Bruscia, M. 2006. Application of a dynamic energy budget model to the Pacific oyster, *Crassostrea gigas*, reared under various controlled conditions. J. Sea Res. 56, 156-167.

Ren, J.S., Ross, A.H., 2001. A dynamic energy budget model of the Pacific oyster *Crassostrea gigas*. Ecol. Model. 142, 105-120.

Ren, J.S., Ross, A.H., 2005. Environmental influence on mussel growth: a dynamic energy budget model and its application to the greenshell mussel *Perna canaliculus*. Ecol. Model. 189, 347-362.

Ross, A.H., Nisbet, R.M., 1990. Dynamics models of growth and reproduction of the mussel *Mytilus edulis* L. Func. Ecol. 4, 777-787.

Van der Veer, H.W., Kooijman, S.A.L.M., van der Meer, J., 2001. Intra- and interspecies comparison of energy flow in North Atlantic flatfish species by means of dynamic energy **budgets. J. Sea Res. 45, 303-320.**

Van der Veer, H.W., Cardoso, J.F., van der Meer, J. 2006. Estimation of DEB parameters for various North Atlantic bivalve species. J. Sea Res. 56, 107-124.

Van Haren, R.J.F., Kooijman, S.A.L.M., 1993. Application of a dynamic energy budget model to *Mytilus edulis* (L.). Neth. J. Sea Res. 31, 119-133.

ECASA - Model description template

1	Name of model	Reporter/Institute *(email address)*
1.a	***Shellfish production model***	Aline Gangnery / Ifremer email: Aline.Gangnery@ifremer.fr
1.b	*date this form was completed or updated*	5 September 2007

2	Short DESCRIPTION of model	
2.a	*Main state variables:*	Shellfish abundance as a function of their individual mass.
2.b	*Scale to which applicable:*	Shellfish population.
2.c	*General description.* *NB: if the model is complicated, or has easily distinguishable components (such as a physical and a biological sub-models) that can be, or have been, used separately, it may be easier to complete one form for each of the main components.*	This model was specifically developed to assess temporal variations in the standing stock and marketable production of oysters cultivated in the Thau lagoon. It is based on the coupling between an Individual Based Model and a DEB model (see also DEB template). The population is divided into cohorts and its dynamics is reproduced by simulating the growth trajectories of numerous individuals. Shellfish growth is simulated with the DEB model. Population dynamics also includes harvest and mortality rates. Standing stock is then obtained by summing up individual mass and the size distribution of individuals. Marketable production is estimated as the cumulative harvest of cohorts. Inter-individual variability of growth between individuals was also taken into account in the population model: variation between each cohort was simulated with a random parameter X_k (*i.e.* saturation coefficient, which is a parameter of the DEB model).
2.d	*Key semi-universal parameters and example values (which should apply at least regionally or for at least one type of water body); summarize any restrictions or reservations about these*	Some of the parameters of the DEB model can be eventually considered as semi-universal in the way they are close for related species. The population model has no key semi-universal parameters.

	parameters	
2.e	*Main forcing data needed - initial values of state variables; boundary conditions; inputs; imposed environmental conditions; generalized loss terms. State whether single values or time-series needed.*	* Times series of water temperature and food concentration (*e.g.* chlorophyll a or particulate organic matter) are needed to simulate shellfish growth. A dataset of shellfish growth data is preferable to calibrate the individual growth model. * Observed mass distributions of the standing stock are required to make simulations with real initial conditions. * Knowledge of rearing strategies (seeding or recruitment / harvesting) used by farmers as well as an estimate of the mortality rate are also required.
2.f	*Restrictions to use of model*	There is no specific restriction but special attention should be given when determining the seeding interval to which the number of cohorts is related.

3	**possibly relevant INDICATORS and example EcoQOs**	
3.a	***D**river*	
3.b	***P**ressure*	
3.c	***S**tate*	
3.d	***I**mpact*	
3.e	***R**esponse*	Modification of shellfish standing stock and marketable production in response to environmental changes (*e.g.* eutrophication, warming of water).

4	**STATUS of model** *NB: refers to scientific theory and equation set; distinguish from implementation*	
4.a	*Origin(ator) of model concept and initial formulation:*	Conceptual background of IBM and DEB models can be found in DeAngelis and Gross (1992) and Kooijman (2000), respectively.
4.b	*Present status of model, including scientific basis of claimed robustness and key matters still needing study:*	The model is not validated because of a lack knowledge concerning the numbers of shellfish seeded in the system per unit of time.
4.c	*Present use:*	Assessment of shellfish marketable production and its sensitivity to environmental conditions.
4.d	*Potential use and development in ECASA :*	Estimating potential impact of environmental modifications on aquaculture (shellfish populations).

5	**IMPLEMENTATION of model**

5.a	*State of implementation :* *(This refers to realization of model theory in numerical algorithms, spreadsheets, computer programs, etc. to provide solutions of the model equations when supplied with appropriate forcing data.*	Equations and parameters are listed in Bacher and Gangnery (2006). Model algorithms are programmed in Matlab 7.0.1.
5.b	*State of documentation* *(which describes how to use an implementation as well as giving model theory)*	Equations, parameters and theoretical background can be found in Bacher and Gangnery (2006).
5.c	*Intellectual property concerns - if none stated here, model and implementation will be deemed to freely available on request*	IFREMER is the owner of the code coupling DEB and IBM. Any use requires the written consent of IFREMER.

6.	**TESTING of model**	
6.a	*Summary of conditions and measurements needed:* *Refer back to 2.e if necessary. Highlight observations needed for model testing.*	Measurements needed concern: environmental data (water temperature, available food), shellfish growth data, distributions of the shellfish standing stock, estimate of the shellfish mortality rate, knowledge of rearing strategies.
6.b	*Criteria for model rejection*	No specific rejection criteria were set.

7	**OTHER models**	
7.a	*Used explicitly or implicitly with this model*	See DEB template.
7.b	*Similar models (which might serve roughly the same purpose in relation to mariculture)*	No similar model to our knowledge.

8. REFERENCES cited *show in bold the most important paper describing the model*

Bacher, C., Gangnery, A. 2006. Use of dynamic energy budget and individual based models to simulate the dynamics of cultivated oyster population. J. Sea Res. 56, 140-155.

DeAngelis, D.L., Gross, L.J. 1992. Individual-based models and approaches in ecology: populations, communities and ecosystem. Chapman & Hall, New York.

Kooijman, S.A.L.M., 2000. Dynamic energy and mass budgets in biological systems, Cambridge University Press, Cambridge.