Sampling programme intertidal macrozoobenthos Balgzand

Description of the programme

Aim: to study the (population) dynamics, in terms of densities and biomass, of intertidal invertebrate infauna and epifauna of the Wadden Sea, represented by the intertidal area called Balgzand.

Study area

At Balgzand, a muddy to sandy tidal flat area east of Den Helder, permanent sampled intertidal stations and transects were selected to study densities and biomass of infaunal and epifaunal macrobenthic invertebrate species. In the area 3 permanent quadrats and 12 transects were selected.

History

The Balgzand macrozoobenthos programme was set up initially to study the secondary production of the macrobenthic invertebrates of the Wadden Sea. This happened within the framework of the International Biological Programme (IBP) (1967), an initiative to study the biological productivity of various ecosystems worldwide.
The programma was initially meant to study the productivity of biomass of larger macrozoobenthic invertebrate in- and epifauna. The focus was on species that easily could be separated into cohorts (yearclasses). This meant that bivalve molluscs that deposit clear growth marks in their shells had priority. Small items, e.g. small polychaetes, were ignored as contributing very little to the total invertebrate benthic biomass.
To study the annual variability in benthic biomass, a frequent year-around sampling pogramme on 3 permanent quadrats was developed and started in 1967. These quadrats were selected based on sediment composition and tidal elevation, to cover a variety of sediments within Balgzand. Station Dk was nearshore with sandy mud, around mean tide level, station Sl was relatively near by Dk but closer to a tidal gully, on a sandy sediment and a tidal elevation of ± 10 cm above mean tide level, station Mz was on the northern tip of Balgzand, around mean low tide level with relatively course sand.
On these quadrats, sampled roughly once per month, boxes of ± 0.1 m^2 were dug out, and additionally round cores of 0.009 m^2 were taken. Based on the results of these frequent samplings an additional series of 12 transects, scattered over intertidal Balgzand, was chosen to cover the varialility of the study area. These 12 transects were sampled twice a year, in late winter to estimate the benthic biomass at the lowest level during the year, and in late summer at the moment of maximal benthic biomass values and to estimate the recruitment of the benthic invertebrates in the previous spring and early summer. The transects were explored first in summer 1968, the results are not incorporated in the database. The results from late winter 1969 onwards are included in the database. From summer 1969 onwards the frequency of sampling of the the 3 permanent quadrats was reduced to 4 times per year, from 1988 onwards to twice per year. The geographical positions of the permanent quadrats and the sampling locations of the transects are listed in a separate file (POSITIONS)

Permanent quadrats
The permanent quadrats are 30×30 m quadrats, divided in 9 10×10 m subquadrats. Prior to each field sampling, sampling positions within the quadrats were chosen at random. At each position one 0.1 m² box sample and one 0.009 m² core sample was taken. Both samples were taken to a depth of ± 30 cm, sieved over 1 mm square mesh sieve in the field and stored unpreserved in plastic bags for direct sorting in the laboratory. Up to July 1974 per sampling 16 positions were selected, in most subquadrat 2 positions, in two subquadrat only one, from August 1974 onwards 9, in each subquadrat one.
At permanent quadrat Mz, due to high water level, sampling with the 0.1 m² box sometimes was impossible. In such cases, the 9 box samples were replaced by in total 50 cores with a surface of 0.019 m² each, pooled to 9 samples of 5-6 cores.

Transects
Transects were series of 50 sampling points in a straight line, the sampling points 20 m from each other. So each transect measured 980 m. Only one transect (transect E) had 45 sampling points. At each sampling point one core sample was taken, the retained material was put in plastic bags, 5 subsequent cores were pooled to one sample. From summer 1998 onwards, the middle of the 5 subsequent cores of each sample was kept separate and was considered as a subsample for small or numerous species or year-classes.
In winter always cores of 0.019 m² were used, to a depth of 30-35 cm. In summer initially (1969, 1970) a same core as in winter was used. In 1969 summer sampling depth was shallow (± 20 cm), in 1970 deeper (± 30 cm). In 1971 and 1972, no summer sampling was done at all, from 1973 onwards summer sampling was resumed, but with a smaller core (0.009 m²) and initially shallow samples (± 15 cm depth) were taken. Gradually sampling depth in summer increased, and from 1989 the summer sampling depth was identical to the winter sampling depth.

Laboratory analyses

Sorting
All samples were transported unpreserved and cooled to the laboratory and sorted out as soon as possible. In the laboratory each sample was put into a 500 µm square-mesh sieve and rinsed under running seawater to remove remaining sediment. The samples were put in flat white trays and sorted out with the naked eye. All macrobenthic animals were picked out and sorted into species and, if possible, into year- or sizeclasses. All items picked out were counted. From summer 1998 subsampling was carried out on the transects (see above). Small species or numerous size/age classes of larger species were only sorted out of the subsamples and further treated, These items were not extracted from the larger samples. Bivalve molluscs were sorted into year-classes based on the presence of annual growth marks on the shells.

Identification
Up to winter 1995 identification was carried out by J.J. Beukema. Hard-substrate species (barnacles, sea anemones, bryozoans, hydroids etc.) were not sorted out and identified. Bivalve molluscs were always adequatly identified. Mudsnails (*Peringia ulvae*) were

properly counted from summer 1974 onwards. Small species like small Spionids (*Pygospio, Spio, Streblospio* etc.) and Oligochaetes were omitted, as was *Aphelochaeta marioni*. More Nereid polychaetes were grouped under *Hediste diversicolor*, only incidentally other Nereids were recognised. Juvenile polychaetes of the species *Scoloplos armiger* and *Heteromastus filiformis* were not sorted out, and the species *Capitella capitata* was not recognized at all, larger ones were included into *Heteromastus filiformis*. *Corophium* species (Crustacaea) were counted from winter 1973 onwards. From summer 1995 onwards identification was carried out by R. Dekker, and he gradually included more small polychaete species and individuals. Hard-substrate organisms were included as well. Nereids were correctly identified from summer 2003 onwards, *Aphelochaeta marioni* from summer 2005 onwards, *Capitella capitata* from winter 2008 onwards, small Spionids (see above) from winter 2009 onwards and Oligochaetes (not identified up to species level) from winter 2011 onwards. Nemerteans could not always be identified up to species level.

Counting and biomass determination

From each sample the numbers of species and/or year- or size-classes were counted and written on hand-written lists. For biomass determination the animals of all species and/or year-classes were combined per permanent quadrat or transect, and also put on hand-written lists. All hand-written lists were later tranferred into an ACCESS-database.

Biomass determination.

Biomass, expressed as ash-free dry weight (AFDW) of all species or year/size classes was determined by putting all animals of the species or size/age class in porcelain crucibles, drying them at 60 °C in a ventilated stove for 3 days and weighing them (crucibles + animals) after cooling. Next the crucibles were burned in a furnace for 3 h at 560 °C. After cooling the crucibles with ash were weighed again, and the substaction of post-burning weights from pre-burning weights is the biomass, expressed in grams AFDW.

Bivalve molluscs were treated in a slightly different manner. Bivalves of each year-class were treated separately. In case of large numbers of individuals of one yearclass per species in all samples of permanent quadrats or transects, a fraction of the total number was treated for biomass determination. The bivalves of each year-class were measured up to the nearest mm and immersed in boiling water for a short period. After boiling the flesh content of the shellls was removed and, per length class, put in porcelain crucibles. The empty shell were dried, stored in boxes or plastic bags per species and year-class, and kept and stored in the COS Balgzand shell-archive.

Description of the tables.

DATES

List all sampling events from 1967 up to 2019 with sampling nr, date of each sampling, station code (see table POSITIONS) and priority (default = 1, other values for permanent quadrat samplings with more than 2 samplings per year)

METHODS

Describes all different sampling methods used the Balgzand sampling programme. Most important is the heading **opp**, indicating the sampled surface with the

corresponding method, and **Nsamples**, indicating the total number of samples covering an entire transect or permanent quadrat.

SPECIES

Lists all species numbers (Nspec) used in the following tables. The species numbers are identical to the species numbers used in the SIBES-macrozoobenthos programme

BIO-Vj

Shows the **biomass values, as well as total numbers per PQ/transect** during the winter-spring campaigns

Sampling refers to sampling number in table DATES

Meth refers to sampling method nr in table METHODS

Nspec: species number (table SPECIES)

Yrclass: yearclass, age-class or size class of the animals. Nd = not defined.

n: number of specimens per cup

Mult: multiplication factor in case not all specimens are incorporated in biomass determination (default = 1)

L: maximum shell length (in molluscs), carapace width (in crabs), or body length (in shrimps). For brown shrimps (*Crangon crangon*) length is **including the scaphocerites**, which is slichtly more than the standard body length of shrimps (tip rostrum – tip telson).

afdw: ash-free dry weight (AFDW) of the specimens in the porcelain crucibles.

Remarks: no = no remarks, geschat = estimated (not measured), extrapol. = extrapolation of the biomass (not measured) based on length, CF per ycl: animals of different known lengths put in one cup, assuming an equal length-weight relationship.

BIO-Zo

Shows all biomass values per PQ/transect during the late-summer campaigns

For meaning of the headings see BIO-Vj

N-Vj

Shows the density values of all species, year, age and size-classes **in each sample** per sampling event during the winter-spring campaigns

Sampling refers to sampling number in table DATES

Meth refers to sampling method nr in table METHODS

Nspec: species number (Table SPECIES)

n: total number of individuals in the sample

Yrclass: yearclass, age-class or size class of the animals. nd=not defined.

N-Zo

Shows the density values of all species, year, age and size-classes **in each sample** per sampling event during the late summer campaigns

For meaning of the headings see N-Vj.

Links between the tables

In all tables sampling corresponds with the sampling number in table DATES

In all tables meth corresponds with meth number in the table METHODS

In all tables nspec corresponds with nspec in the table SPECIES

Extra tables, not linked to other tables

POSITIONS
Shows the positions of the permanent quadrats (PQ's) and the mean positions of the transects, as referred to the tables BIO-Vj and BIO-Zo. The positions of the transects with sampling points indicated the positions of the sampling points of a transect related to the table N-Vj and N-Zo.

SEDIMENT
From 2000 onwards on irregular basis sediments were taken on the transecs and permanent quadrats during the late winter samplings. Sediment samples were taken with a ± 1.5 cm ø corer down to ± 6 cm depth. The samples on the transects each consisted of two cores, each taken at the position of the middle core of one sample, and of two subsequent samples: e.g. sample 1-2, sample 3-4 etc. Thus per transect 5 sediment samples were taken. The sedments were analysed, after freeze-drying, with a coulter counter. The table includes median grain sizes (µm) and silt percentage (fraction < 16 µm).