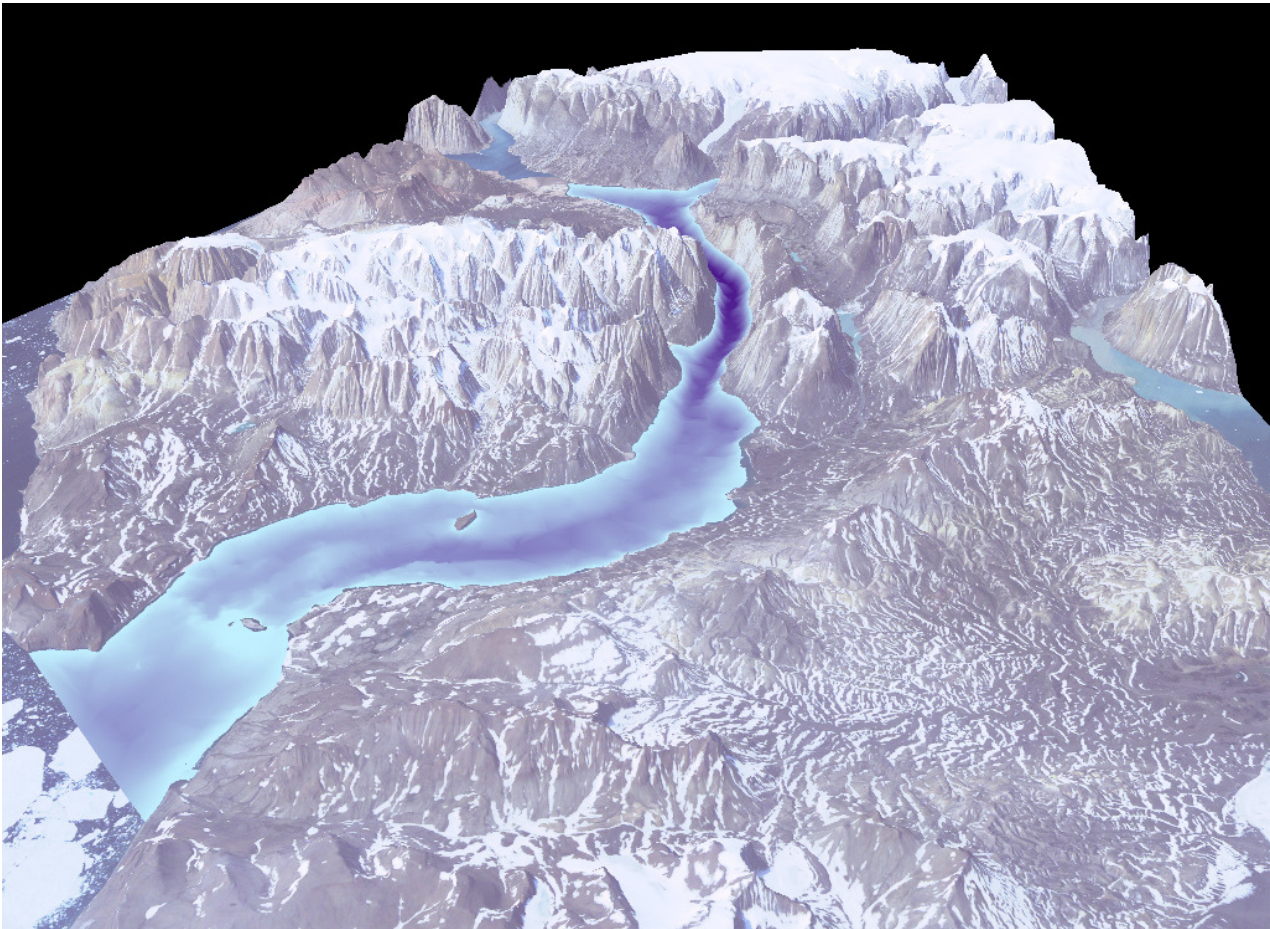


# MarineBasis

*The Zackenberg marine monitoring programme*



Sampling manual for the annual summer field campaign

MarineBasis

8th edition, 2009

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**Front cover illustration**

Relief model of Young Sound.

<b>INTRODUCTION .....</b>	<b>4</b>
<b>1 SEA ICE .....</b>	<b>5</b>
1.1 DAILY MEASUREMENTS OF SEA-ICE COVER AND SNOW THICKNESS: .....	5
1.2 SEA-ICE THICKNESS AND SNOW THICKNESS: .....	6
<b>2 WATER COLUMN.....</b>	<b>7</b>
2.1 CONTINUOUS MEASUREMENTS OF TEMPERATURE, SALT, PRESSURE AND SEDIMENTATION.....	7
2.2 MEASUREMENTS ON SEDIMENT TRAP MATERIAL (12 SAMPLES).....	10
2.3 CONTINUOUS MEASUREMENTS OF TEMPERATURE, SALT AND PRESSURE.....	11
2.4 VERTICAL MEASUREMENTS OF SALT, TEMPERATURE AND FLUORESCENCE (CHL A) AND SURFACE PCO <sub>2</sub> ALONG 3 TRANSECTS.....	12
2.5 LIGHT, TEMPERATURE, SALT, NUTRIENTS (NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>3-</sup> & SiO <sub>4</sub> ), PH, DIC/ALKALINITY, PLANKTON COMPOSITION AND CHLOROPHYLL CONCENTRATION .....	15
<b>3. SEDIMENT .....</b>	<b>17</b>
3.1 OXYGEN, CARBON (DIC) AND NUTRIENT EXCHANGE BETWEEN WATER COLUMN AND SEDIMENT.....	17
3.2 VERTICAL SEDIMENT OXYGEN PROFILES. ....	18
3.3 VERTICAL SULPHATE REDUCTION PROFILES IN THE SEDIMENT. ....	19
3.4 COMPOSITION AND DISTRIBUTION OF INDICATOR SPECIES – BENTHIC FAUNA.....	20
3.5 MEASUREMENT OF ANNUAL GROWTH OF LAMINARIA SACCHARINA .....	22
<b>4 WALRUS AND FISH.....</b>	<b>23</b>
4.1 MONITORING OF WALRUSES AT THE HAUL-OUT ON THE ISLAND SANDØEN. ....	23
4.2 SAMPLING OF TISSUE FROM ARCTIC CHAR.....	23

## *Introduction*

A long-term monitoring program, ZackenbergBasic, monitors the area around Zackenberg, Northeast Greenland. ZackenbergBasic aims at an increased understanding of low-arctic ecosystems and consists of five components – BioBasis, ClimateBasis, GlacioBasis, MarineBasis and GeoBasis. The program is carried out by Greenland Institute of Natural Resources, Asiaq, National Environmental Research Institute (Denmark), Danish Polar Center and several others. A similar program, NuukBasic, was initiated in Southwest Greenland in 2005.

MarineBasis is carried out by “Center of Marine Ecology and Climate Effects” at Greenland Institute of Natural Resources and the Danish National Environmental Research Institute. The goal of the program is to establish long-term stable data series of key parameters in the marine environment. The program will contribute to an increased understanding of the coupling between physical parameters (i.e. temperature, currents, precipitation) and biological processes (i.e. primary production, grazing, food web composition).

MarineBasis consists of pelagic and benthic sampling, sea ice monitoring and marine mammal monitoring at several stations in Young Sound as well as oceanographic transects.

*Dates and times are in GMT*

*Geographic positions are in WGS-84*

*UTM, zone 27 and geographic co-ordinates in DD MM.MMMM (degrees & minutes & decimal minutes)*

## 1 Sea ice

### 1.1 Daily measurements of sea-ice cover and snow thickness:

#### *Geographic position*

Camera 1 (Behind the Weather Station) 74°18.594'N, 20°12.59,8'W – 115 m above sea level

#### *Equipment:*

Automatic digital camera system, see Fig. 1.

#### *Procedure:*

(1) 1 digital camera is placed behind the Weather Station, along with 3 measuring sticks for determination of snow thickness. The camera is mounted on a tripod (height 1.6 m) inside a weather resistant translucent box providing protection from wind and rain. Power is supplied by a rechargeable 12-V battery charged via 2 small solar panels on top of the camera box. The camera is equipped with a 128-Mb PCMCIA card with capacity for saving 365 digital photos.

(2) The camera is programmed to take 1 photo a day all year round at 13:20.

(3) Photos are saved at the highest possible resolution.

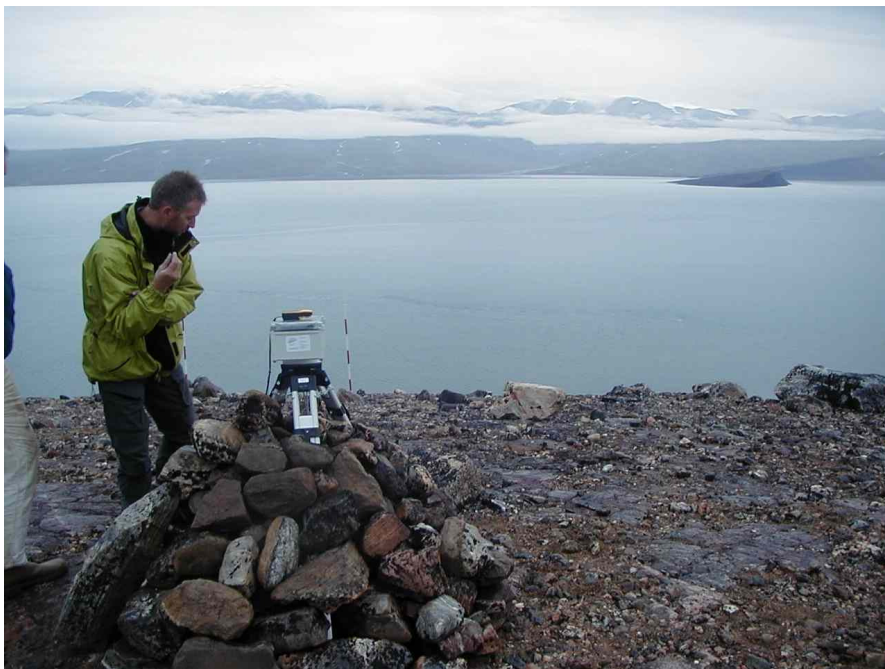


Figure 1: automated camera system

*Materials:* 1 camera, 1 tripod, 1 turnbuckle, 1 x 2 m wire (ø5 mm), 2 wire locks (ø5 mm), mooring kit (ø12 mm), stone drill (ø12 mm), 1 variable-voltage power supply, measuring sticks for snow (including mooring).

### **1.2 Sea-ice thickness and snow thickness:**

*Geographic position:* 74°18.59'N, 20°15.04'W – water depth 36 m

*Equipment:* Ice drill, measuring stick. (Figure 2).

*Procedure:* Members of the military sledge patrol SIRIUS measure sea-ice thickness and snow thickness once every 2-3 weeks and email the data to GINR. These data are not yet secured in the long term. For the present, collection of data is arranged by GINR and SIRIUS from year to year.



Figure 2: sea ice drilling

*Materials:* Ice drill, measuring stick.

## 2 Water column

### 2.1 Continuous measurements of temperature, salt, pressure and sedimentation

Geographic position: 74°18.909'N, 20°16.730'W – depth 75 m

Equipment: Hydrographic mooring system: 2 SeaBird (Microcat 37) and 1 sediment trap. Diagram of hydrographic mooring system:

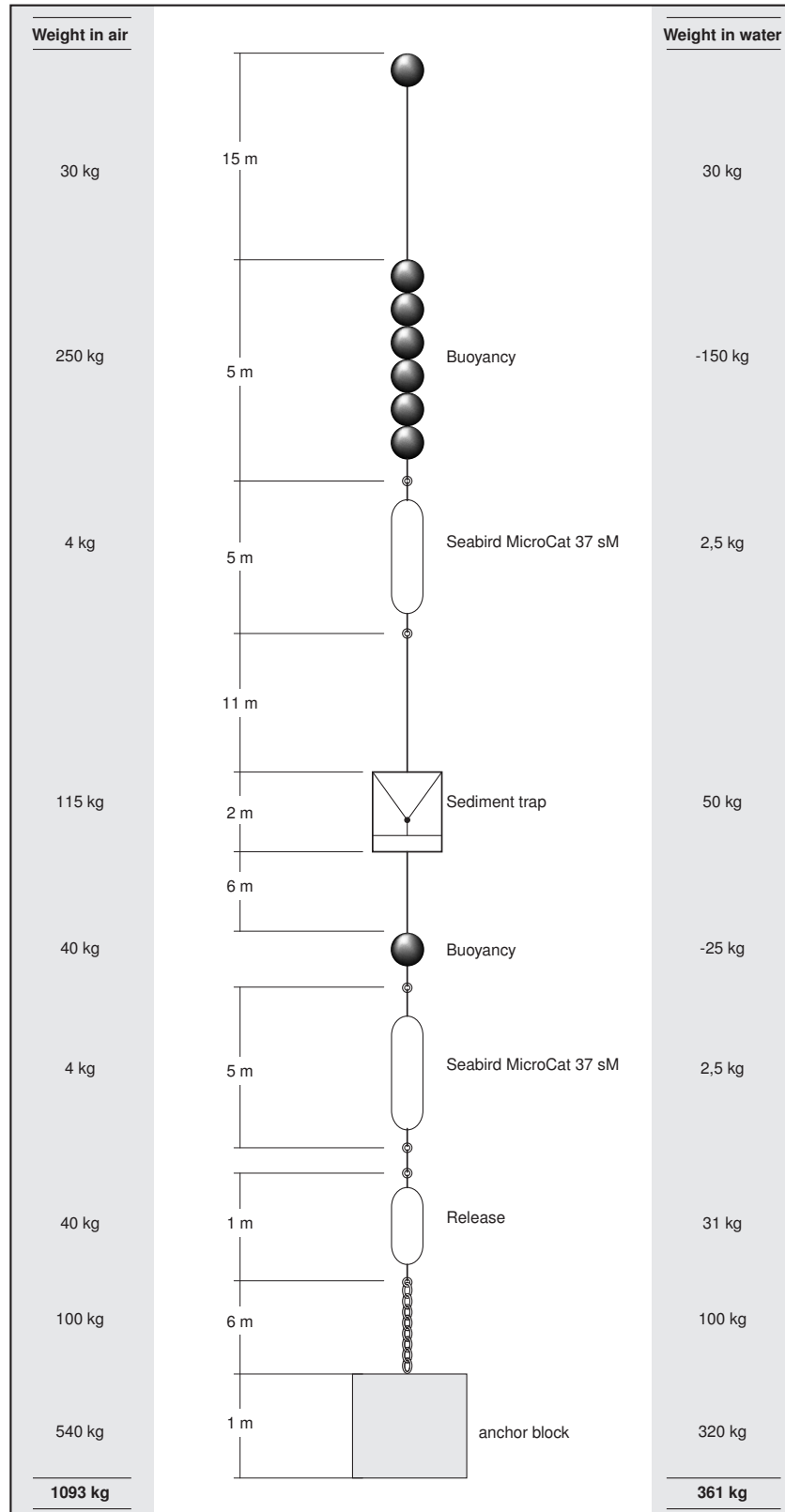


Figure 3. diagram of mooring system

*Procedure:*Launching, sediment trap:

Prior to launching, the collector cups of the sediment trap were filled with GF/F filtered bottom water and HgCl<sub>2</sub> is added (1 ml saturated solution per 100 ml water). NaCl was also added to the cup solution to increase salinity to ~40 psu.

The trap is programmed with appropriate intervals, e.g.:

Sample cup#	Date of rotation
1	20/8-06 kl 12:00
2	20/9-06 kl 13:00
3	20/10-06 kl 14:00
4	20/1-07 kl 15:00
5	20/4-07 kl 16:00
6	20/5-07 kl 17:00
7	20/6-07 kl 18:00
8	30/6-07 kl 19:00
9	7/7-07 kl 20:00
10	14/7-07 kl 21:00
11	21/7-07 kl 22:00
12	28/7-07 kl 23:00
End	4/8-07 kl 12:00

Figure 4: example of programmed sediment trap

Remember to save/note the actual programmed times.

After recovery, another 0.5 ml of the HgCl<sub>2</sub> solution was added per 100 ml cup volume and samples were stored at 4 °C. The filled sediment trap sampling flasks are sealed tightly (screw caps) and kept cool during transport to the laboratory.

Launching, releaser:

After battery replacement, check compatibility between the releaser and the acoustic telecommand unit.



## Launching SBE37

Prior to launching the two SMP SBE37 are programmed as follows:

```

do not output sound velocity with each sample
store time with each sample
number of samples to average = 1
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump is installed
temperature = 19.00 deg C
S>outputsal=y
S>outputsv=y
S>ds
SBE37-SM V 2.6 SERIAL NO. 3804 07 Aug 2008 17:38:27
not logging: received stop command
sample interval = 1200 seconds
samplenummer = 0, free = 190650
do not transmit real-time data
output salinity with each sample
output sound velocity with each sample
store time with each sample
number of samples to average = 1
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump is installed
temperature = 19.01 deg C
S>startlater
start time = 09 Aug 2008 18:00:00
SBE37-SM
S>ds
SBE37-SM V 2.6 SERIAL NO. 3804 07 Aug 2008 17:39:01
not logging: waiting to start at 09 Aug 2008 18:00:00
sample interval = 1200 seconds
samplenummer = 0, free = 190650
do not transmit real-time data
output salinity with each sample
output sound velocity with each sample
store time with each sample
number of samples to average = 1
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump is installed
temperature = 19.07 deg C
S>

```

Figure 5: example of programmed SMP SBE37

Remember to save/note the actual programmed times.

### Materials:

- 1 concrete block (500 kg)
- Steel wire
- 1 acoustic release system with data sheet
- 1 Technicap sediment trap (PPS4/3)
- 2 Seabird SMP SBE-37
- 14 trawl buoys
- 1 release ring
- 2 swivels (sediment trap)
- 7 rings
- shackles
- 8 mm steel wire (Seabird)
- HgCl<sub>2</sub> for preservation of trap flask contents
- Laboratory gloves
- Sediment trap manual
- Cables for data transfer
- Batteries
- Seabird manual
- Acoustic telecommand unit incl. manual
- 12 flasks for sediment trap

## **2.2 Measurements on sediment trap material**

### *Laboratory:*

In the laboratory, zooplankton “swimmers” are removed from all samples prior further treatment. Samples are then freeze-dried to determine total fluxes (dry weight, dw), from which homogenized sub-samples of known weight were taken to analyze for particulate organic carbon (POC), particulate organic nitrogen (PON), chlorophyll (Chl.) and calcium carbonate (CaCO<sub>3</sub>). Total carbon contents (TC) are determined on an elemental analyzer (Europa Scientific RoboPrep). The POC and PON content results from analyzing decalcified samples. Decalcification is done with H<sub>2</sub>SO<sub>3</sub> and heating to 80 °C. The CaCO<sub>3</sub> content is calculated as TC - POC.

Dry weight. A sub-sample of a known wet weight is freeze-dried.

Chlorophyll. An adequate amount of material is extracted (acetone) for determination of total Chlorophyll. Add a little deionized water ca. 1 ml to 1 g dried sediment shake and wait 4 h before extraction with acetone (NICE handbook procedure).

Organic content. An adequate amount of material is weighed into tin capsules (acid treated + non-acid treated) and analysed for C and N. Remember to remove copepods and other “swimmers”.

Isotope composition. <sup>13</sup>C and <sup>15</sup>N in organic material. An adequate amount of material is weighed into tin capsules, acid treated and analysed by mass spectrometry for natural composition of <sup>13</sup>C and <sup>15</sup>N.

Equivalent measurements are made on material collected in the Zackenberg River (collected by GeoBasis – app. 50 samples).

Reserve. The remaining material is saved for possible analysis of other trace elements.

*Materials:* Insulated bag + cooler brick. 21 500-ml plastic flasks with tight-fitting lids.

### 2.3 Continuous measurements of temperature, salt and pressure

*Geographic position:* 74°18.866'N, 20°14.782'W – water depth 29 m

*Equipment:* Hydrographic mooring system: 1 SeaBird (Microcat 37). mooring system (Fig. 6).

*Temporal resolution:* Deployed during field study period.

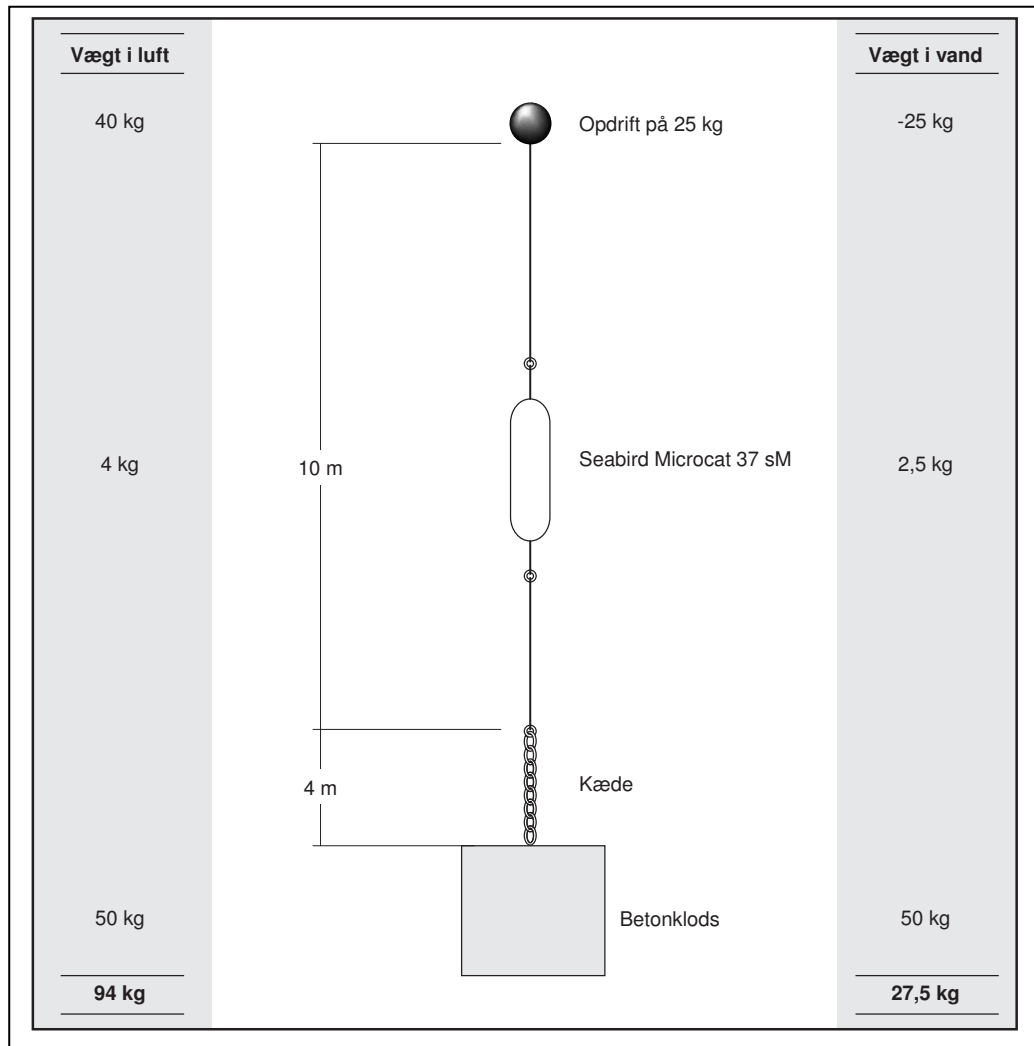


Figure 6: example of short-term mooring

*Materials:* 1 shovel anchor, 4 m of chain (50kg), 10 m of steel wire (10 mm), 1 SeaBird SMP SBE37, 3 trawl buoy balls, 2 rings, 4 shackles, SeaBird data sheet, SeaBird manual.

## 2.4 Vertical measurements of salt, temperature and fluorescence (Chl a) and surface pCO<sub>2</sub> along 3 transects

Geographic positions: (see Figure 7 and tables below)

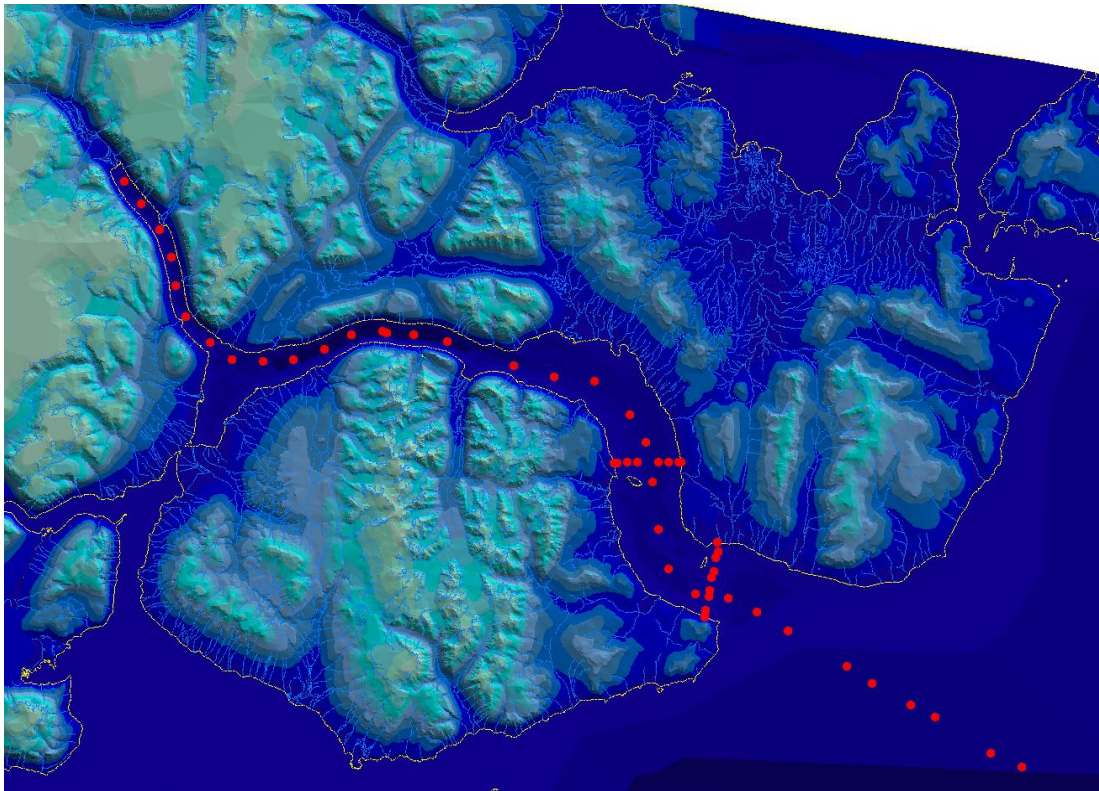


Figure 7: transects in Tyrolerfjord/Young Sound/Greenland Sea

### I. transect Sandø:

ID #	DEPTH (m)	UTM_X	UTM_Y	LATITUDE	LONGITUDE
1,01	14	526955	8242691	74°16.3768'N	20°06.5436'W
1,02	5	526643	8242125	74°16.0754'N	20°07.1774'W
1,03	5	526545	8240820	74°15.3741'N	20°07.4109'W
1,04	16	526233	8240255	74°15.0727'N	20°08.0442'W
1,05	67	526134	8238949	74°14.3714'N	20°08.2773'W
1,06	72	526025	8238387	74°14.0700'N	20°08.5101'W
1,07	46	525724	8237078	74°13.3686'N	20°09.1427'W
1,08	5	525614	8236516	74°13.0672'N	20°09.3750'W

### II. transect Basaltø:

ID#	DEPTH (m)	UTM_X	UTM_Y	LATITUDE	LONGITUDE
2,01	12	523077	8251352	74°21.0636'N	20°14.0114'W
2,02	89	522061	8251338	74°21.0627'N	20°16.0360'W
2,03	139	521045	8251324	74°21.0616'N	20°18.0606'W
2,04	85	519013	8251296	74°21.0588'N	20°22.1098'W
2,05	88	517997	8251282	74°21.0571'N	20°24.1344'W
2,06	45	516981	8251269	74°21.0552'N	20°26.1590'W

III transect Length:

ID#	DEPTH (m)	UTM_X	UTM_Y	LATITUDE	LONGITUDE
TYRO_01	106	468435	8278360	74°35.5160'N	22°03.8617'W
TYRO_02	128	470068	8276200	74°34.3697'N	22°00.4842'W
TYRO_03	102	471882	8273734	74°33.0597'N	21°56.7400'W
TYRO_04	122	473061	8271013	74°31.6063'N	21°54.2771'W
TYRO_05	128	473515	8268291	74°30.1466'N	21°53.2815'W
TYRO_06	95	474513	8265298	74°28.5448'N	21°51.1880'W
TYRO_07	50	476871	8262848	74°27.2451'N	21°46.3877'W
TYRO_08	157	479048	8261216	74°26.3818'N	21°41.9831'W
TYRO_09	223	482132	8261034	74°26.3021'N	21°35.7997'W
TYRO_10	290	485126	8261216	74°26.4145'N	21°29.8050'W
TYRO_11	336	488120	8262214	74°26.9632'N	21°23.8199'W
TYRO_12	347	490841	8263574	74°27.7036'N	21°18.3776'W
TYRO_13	339	493834	8263937	74°27.9057'N	21°12.3735'W
Dybet	342	494296	8263709	74°27.7840'N	21°11.4450'W
TYRO_14	325	496919	8263574	74°27.7148'N	21°06.1822'W
TYRO_15	282	500275	8262939	74°27.3748'N	20°59.4476'W
YOUNGSU_3.18	229	506834	8260612	74°26.1162'N	20°46.3090'W
YOUNGSU_3.16	149	510804	8259484	74°25.4991'N	20°38.3702'W
YOUNGSU_3.14	150	514766	8259095	74°25.2745'N	20°30.4446'W
YOUNGSU_3.12	165	518261	8255859	74°23.5169'N	20°23.5169'W
YOUNGSU_3.10	171	519845	8253223	74°22.0906'N	20°20.4106'W
YOUNGSU_3.08	172	520497	8249421	74°20.0420'N	20°19.1965'W
YOUNGSU_3.06	105	521059	8244829	74°17.5692'N	20°18.1839'W
YOUNGSU_3.04	115	522051	8241016	74°15.5119'N	20°16.3076'W
YOUNGSU_3.02	46	524691	8238682	74°14.2387'N	20°11.1397'W
GH01	96	527959	8238227	74°13.9686'N	20°04.6887'W
GH02	158	530708	8236891	74°13.2260'N	19°59.2960'W
GH03	219	533812	8235111	74°12.2388'N	19°53.2272'W
GH04	200			74°11.250'N	19°47.674'W
GH05	229	539586	8231712	74°10.3484'N	19°41.9763'W
GH06	233	542127	8230030	74°09.4133'N	19°37.0458'W
GH07	260	545950	8227995	74°08.2693'N	19°29.6223'W
GH08	308	548347	8226813	74°07.6004'N	19°24.9725'W
GH09	302	553741	8223353	74°05.6595'N	19°14.5759'W
GH10	258	556869	8221976	74°04.8680'N	19°08.5285'W

*Equipment:* CTD probe equipped with fluorometer, oxygen sensor and irradiance. Equilibrator (membrane), EGM4 CO<sub>2</sub> sensor equipped with oxygen sensor, tygon tubing, water sampler/peristaltic pump, syringe with Drierite, PC

*Temporal resolution:* Performed once during the investigation period.

*Procedure:*

(1) Leave equipment suspended at 2 metres for at least 5 min before profiles are measured (from the surface to a few metres above the bottom). Lower equipment at 1 m/s.

(2) Surface water from the pump is directed through the equilibrator and out. The EGM-4 is likewise connected to the equilibrator. The flow of gas and seawater are opposite in the equilibrator. Check that drierite and sodalime are fresh. No water must enter the EGM-4! The EGM-4 is connected to a PC with "PP systems Transfer" software. Note "station X, start" as comment when the CO<sub>2</sub> measurements are stable. Note "station X, end" when measurement is complete.

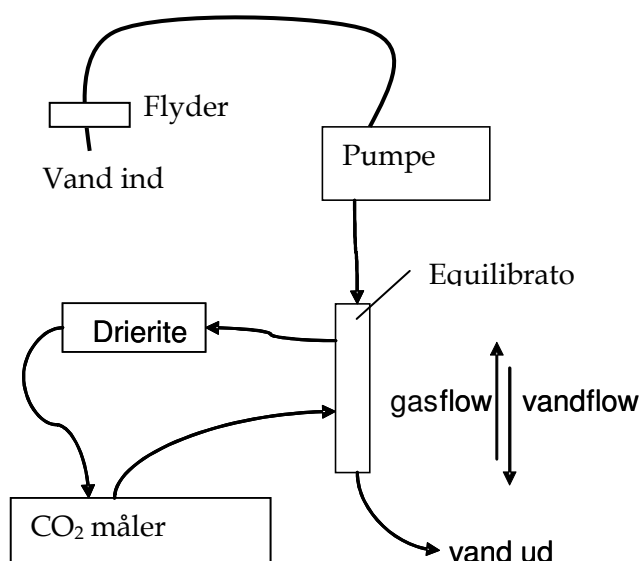


Figure 8: pCO<sub>2</sub> measurement

SBE19plus selection of data:

```
# name 0 = timeJ: Julian Days
# name 1 = prdM: Pressure, Strain Gauge [db]
# name 2 = tv290C: Temperature [ITS-90, deg C]
# name 3 = c0S/m: Conductivity [S/m]
# name 4 = flSP: Fluorescence, Seapoint
# name 5 = par: PAR/Irradiance, Biospherical/Licor
# name 6 = sbeox0Mm/Kg: Oxygen, SBE 43 [umol/Kg]
# name 7 = seaTurbMtr: OBS, Seapoint Turbidity [FTU]
# name 8 = scan: Scan Count
# name 9 = depSM: Depth [salt water, m], lat = 64
# name 10 = sal00: Salinity [PSU]
# name 11 = potemp090C: Potential Temperature [ITS-90, deg C]
# name 12 = sigma-é00: Density [sigma-theta, Kg/m^3]
# name 13 = density00: Density [density, Kg/m^3]
```

Save all files, including \*.hex and \*.con files

## **2.5 Light, temperature, salt, nutrients ( $\text{NO}_3^-$ , $\text{PO}_4^{3-}$ & $\text{SiO}_4$ ), pH, DIC/alkalinity, plankton composition and chlorophyll concentration**

*Geographic position (off the Weather Station):*

74°18.58'N, 20°18.00'W – depth 163 m.

*Sampling equipment:* CTD equipped with irradiance, oxygen and fluorescence sensors, Niskin water sampler + weight messenger, 9 plastic containers (min. 5 liter). 20- $\mu\text{m}$  and 45- $\mu\text{m}$  plankton net with cod ends. Samples are brought to the field laboratory where they are shaken well and transferred to suitable containers for transport. DIC & TA samples are taken and preserved on location.

*Vertical resolution:* 1, 5, 10, 15, 20, 30, 50, 100 and 150 m water depth.

*Temporal resolution:* Collected three times (beginning, middle and end of the investigation period). Measurements of light, temperature, salt and Chl. *a* is performed app. every 2nd day throughout the field period

Temperature, salt and Chl. *a*: Measured by CTD and from water samples (chl). Leave the device suspended at two metres for at least 5 min before profile measurement (0-150 m). Remember to calibrate fluorometer for Chl. *a* concentrations. Samples for Chl. *a* determination are filtered and stored frozen on 10-ml ethanol until analysis, on the three sampling dates.

Nutrients: 3 x 4 x 10 ml from each sampling depth are frozen in plastic vials (-18°C) for later nutrient analyses. Samples are frozen in 12 separate vials.

DIC/alkalinity: 1 x 120 ml from each depth is saved in gas tight glass bottles (winkler) and preserved with 20  $\mu\text{l}$   $\text{HgCl}_2$  (saturated solution) for determination of DIC and TA. Fill bottles completely and store cool.

Planktonic composition:

300 ml from each sampling depth is saved in an amber glass bottles and preserved with 1% lugol.

*Algae* – Triplicate vertical hauls are taken from 50 metres to surface with a 20- $\mu\text{m}$  net and preserved with 1 % lugol in 100-ml amber glass bottles.

*Zooplankton* – Triplicate vertical hauls are taken from sea bottom to surface with a 45- $\mu\text{m}$  modified WP-2 net and preserved with borax-buffered formalin (final conc. 4 %) in 300-ml amber glass bottles.

Surface  $\text{pCO}_2$

(2) Surface water from the pump is directed through the equilibrator and out. The EGM-4 is likewise connected to the equilibrator. The flow of gas and seawater are opposite in the equilibrator. Check that drierite and sodalime are fresh. No water must enter the EGM-4! The EGM-4 is connected to a PC with "PP systems Transfer" software. Note "station X, start" as comment when the  $\text{CO}_2$  measurements are stable. Note "station X, end" when measurement is complete. See fig. 8 for set-up

## SBE19plus selection of data:

# name 0 = timeJ: Julian Days  
# name 1 = prdM: Pressure, Strain Gauge [db]  
# name 2 = tv290C: Temperature [ITS-90, deg C]  
# name 3 = c0S/m: Conductivity [S/m]  
# name 4 = flSP: Fluorescence, Seapoint  
# name 5 = par: PAR/Irradiance, Biospherical/Licor  
# name 6 = sbeox0Mm/Kg: Oxygen, SBE 43 [umol/Kg]  
# name 7 = seaTurbMtr: OBS, Seapoint Turbidity [FTU]  
# name 8 = scan: Scan Count  
# name 9 = depSM: Depth [salt water, m], lat = 64  
# name 10 = sal00: Salinity [PSU]  
# name 11 = potemp090C: Potential Temperature [ITS-90, deg C]  
# name 12 = sigma-é00: Density [sigma-theta, Kg/m<sup>3</sup>]  
# name 13 = density00: Density [density, Kg/m<sup>3</sup>]

Save all files, including \*.hex and \*.con files

*Materials:*

CTD – SBE19+

Niskin water sampler and messenger

Plankton net (20-µm & 45-µm) with cod end

Plastic bottles (5-l, screw-cap)

Lugol

Borax buffered formalin

Filtering equipment and GF/C filters

plastic test tubes (10-ml + stoppers) for nutrient and chlorophyll samples

gas tight glass bottles (Winkler type) for DIC/alkalinity

amber glass bottles (100 and 300 ml)

Equilibrator (membrane)

EGM4 CO<sub>2</sub> sensor equipped with oxygen sensor

tygon tubing

water sampler/peristaltic pump

syringe with Drierite

PC with PP systems Transfer software



### 3. Sediment

#### 3.1 Oxygen, carbon (DIC) and nutrient exchange between water column and sediment.

*Geographic position (off the Weather Station):* 74°18.58'N, 20°15.74'W – water depth 60 m.

*Sampling equipment:* Kajak sediment sampler, 22-cm<sup>2</sup> Plexiglass tubes, Niskin water sampler + weight messenger and 25-l bottle.

*Number of cores:* 10 are collected together with 25 l of bottom water.

*Temporal resolution:* once during the sampling period.

*Procedure:* Collected sediment cores are adjusted to a sediment height of about 10 cm. A 3-cm Teflon-coated magnet is placed 5 cm above the sediment surface. Cores are placed in an incubator equipped with a stirring mechanism (60 rpm.) and containing aerated *in situ* bottom water.

Cores are incubated at *in situ* temperature. Three initial samples are taken of each nutrient ( $\text{NO}_3^-$ ,  $\text{NH}_4^+$ ,  $\text{PO}_4^{3-}$  &  $\text{SiO}_4$  and an extra), the samples transferred to test tubes (10-ml) and frozen (-18°C) for later analysis. Likewise, three initial  $\text{O}_2$  and DIC samples are taken. Oxygen samples are transferred to Exetainers (10-ml) and Winkler I+II are added. DIC samples are transferred to Exetainers and 5  $\mu\text{l}$   $\text{HgCl}_2$  (saturated solution) is added. Incubation is started by lowering the water level and closing with a floating lid. Incubate until about 20% of the initial oxygen content is consumed (app. 24-48 h). Within that time interval sediment cores are processed at 10 different times to document linear concentration changes. Incubation is ended by carefully removing the floating lid from the core and taking 1 sample for oxygen measurement with a glass syringe (Winkler I+II in Exetainer) followed by 1 DIC sample (Exetainer + 5  $\mu\text{l}$   $\text{HgCl}_2$ ). Finally, water samples for nutrient analyses are taken with a plastic syringe and frozen (-18°C) in plastic test tubes for later analysis.

Samples for oxygen are titrated after the flux study is completed.

#### *Materials:*

Kajak sediment sampler	20-ml glass syringe
Niskin water sampler + weight messenger	Filter holder
1 25-l water bottle	100 GF/F filters $\varnothing$ 25 mm
10 kajak tubes + stoppers	250 plastic test tubes (10 ml)
10 teflon-coated magnets + positioners	50 Exetainers for DIC and $\text{O}_2$
Incubator + stirrer	Winkler reagents I+II
Aquatic pump	10-ml beakers for titration
Floating lids	Small stir bars for titration
Tubing	Microburette
Airstone	Phosphorous acid 85%
Tweezers	Pipettes + tips
60-ml plastic syringe	Starch

### 3.2 Vertical sediment oxygen profiles.

*Geographic position (off the Weather Station):* 74°18.58'N, 20°15.74'W – water depth 60 m.

*Sampling equipment:* Kajak sediment sampler, 22-cm<sup>2</sup> Plexiglass tubes, Niskin water sampler + weight messenger, 25-l water bottle.

*Number of cores:* 4 cores are sampled together with 25 l of bottom water.

*Temporal resolution:* once during the sampling period.

*Procedure:*

(1) A 3-cm Teflon-coated magnetic stir bar is positioned 5 cm above the sediment in each sediment core. Cores are left to stand overnight in the dark in an incubator containing aerated *in situ* bottom water with stirring (60 rpm).

(2) Clarke-type microelectrodes with internal reference and guard cathode, measuring diameter <10 µm and a 90% response time <1 s are used for measuring the distribution of oxygen in the upper sediment layers. Profiles are measured at a resolution of 500 µm in the dark.

(3) 3 profiles in 3 sediment cores are measured during stirring (air-flow over 2 cm water cover of sediment) at *in situ* temperature and oxygen conditions.

(4) One sediment core is used for determination of porosity and density at a longer temporal resolution.

*Materials:*

Kajak sediment sampler

kajak tubes + stoppers

25-l bottle

Niskin water sampler and messenger

Oxygen electrode mounting system and electrodes

### 3.3 Vertical sulphate reduction profiles in the sediment.

*Geographic position (off the Weather Station):* 74°18.58'N, 20°15.74'W – water depth 60 m.

*Sampling equipment:* Kajak sediment sampler, 22-cm<sup>2</sup> Plexiglass tubes.

*Number of cores:* 4.

*Temporal resolution:* Collected at the end of the sampling period.

#### *Procedure:*

- (1) Sample 4 cores (i.d. 26 mm, with silicone-filled holes for injection) 15-20 cm in length in the collected Kajak tubes (22-cm<sup>2</sup>). Aspirate the water overlying the sediment (except for a 1-mm water film) and store the cores at *in situ* temperature.
- (2) Sediment cores are transported to Denmark for further analysis.
- (3) Into 3 sediment cores inject approximately 5 µl <sup>35</sup>SO<sub>4</sub><sup>2-</sup> through each injection hole down the entire length of the core except the sediment nearest to the rubber stopper. Deposit the <sup>35</sup>SO<sub>4</sub><sup>2-</sup> horizontally along the center 2/3 of the core with a 50-µl Hamilton syringe by extracting the syringe during injection. Note the time of injection of the first core – this is the incubation start time. Clean the Hamilton syringe after use in 3-5 x freshwater, followed by 3-5 x ethanol. Remove the syringe piston after cleaning to allow excess ethanol to evaporate. Freeze the <sup>35</sup>SO<sub>4</sub><sup>2-</sup> solution after use.
- (4) Incubate cores in the dark at *in situ* temperature for 24 h.
- (5) End the incubation by sectioning the sediment and preserving it in 50-ml centrifuge tubes as follows:

1-cm slices from 0-6 cm (i.e. 0-1, 1-2, 2-3, 3-4, 4-5, 5-6) mix with 5 ml 20% ZnAc.

2-cm slices from 6 cm down (i.e. 6-8, 8-10, ...) mix with 10 ml 20% ZnAc.

Mix quickly and thoroughly with ZnAc to ensure immediate preservation of all the sediment. Note the incubation end time.

- (4) The preserved sediment is frozen (-18°C) until analysis.

#### *Sulphate measurement:*

- (1) Sulphate concentrations are determined in sediment slices from the following sediment depths:

0-1, 5-6, 10-11 and 15-16 cm

- (2) Transfer the sediment slice (1 cm) from the fourth core to 5.0 ml demineralized water or freshwater. Mix sediment and water well.

- (3) Sample 2-3 ml of the supernatant, GF/F filter and freeze (-18°C) for later analysis of SO<sub>4</sub><sup>2-</sup>.

#### *Materials:*

Kajak sediment sampler  
5 Kajak tubes + stoppers

### 3.4 Composition and distribution of indicator species – benthic fauna.

*Geographic positions:* Three transects (20, 30, 40, 50 and 60 m). See Figure 6. 15 images per station.

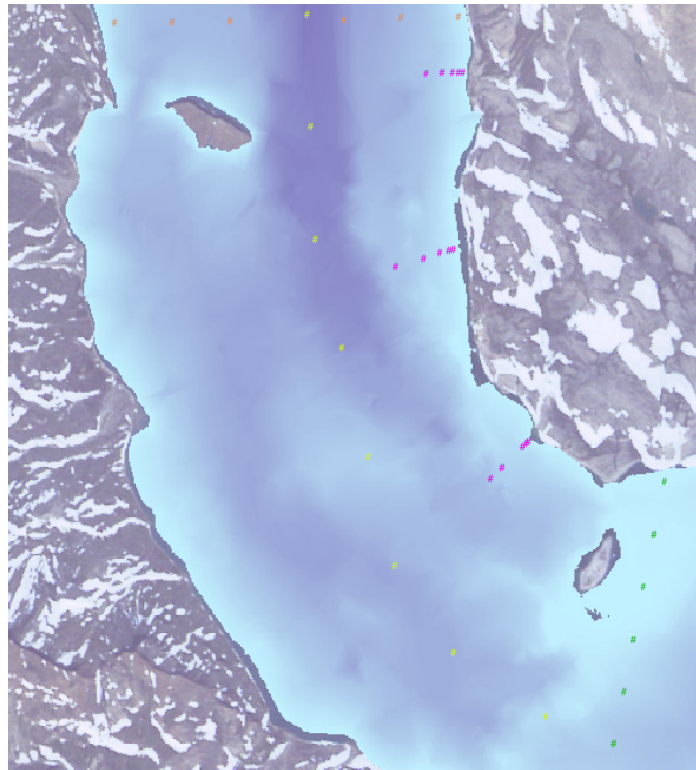


Figure 9: benthic fauna transects

#### Transect 1:

ID NO	DEPTH (m)	UTM_X	UTM_Y	LATITUDE	LONGITUDE
H1,20	-20.0	523004	8251787	74° 21.2980' N	20° 14.1450' W
H1,30	-30.1	522909	8251778	74° 21.2935' N	20° 14.3350' W
H1,40	-40.4	522844	8251736	74° 21.2715' N	20° 14.4650' W
H1,50	-50.1	522788	8251747	74° 21.2780' N	20° 14.5772' W
H1,60	-60.1	522631	8251763	74° 21.2875' N	20° 14.8890' W

#### Transect 2:

ID NO	DEPTH (m)	UTM_X	UTM_Y	LATITUDE	LONGITUDE
H2,20	-20.2	522905	8246693	74° 18.5590' N	20° 14.4730' W
H2,30	-30.9	522781	8246681	74° 18.5530' N	20° 14.7200' W
H2,40	-40.1	522458	8246488	74° 18.4520' N	20° 15.3670' W
H2,50	-49.8	522303	8246540	74° 18.4812' N	20° 15.6730' W
H2,60	-59.9	522145	8246601	74° 18.5150' N	20° 15.9850' W

Transect 3:

ID NO	DEPTH (m)	UTM_X	UTM_Y	LATITUDE	LONGITUDE
H3,20	-20.0	525299	8243111	74° 16.6160' N	20° 09.8145' W
H3,30	-30.2	525173	8243077	74° 16.5985' N	20° 10.0650' W
H3,40	-40.4	525067	8243125	74° 16.6250' N	20° 10.2735' W
H3,50	-50.2	524880	8243106	74° 16.6160' N	20° 10.6450' W
H3,60	-60.3	523984	8243074	74° 16.5990' N	20° 11.2390' W

*Sampling equipment*

Digital camera on a frame with lighting. Image area app. 0.3 m<sup>2</sup>

*Procedure: Photography*

15 images are recorded at each station and the quality of each image is checked immediately (focusing, light etc.). Back-up copies of images are made for each transect.

*Procedure: Image processing*

(1) Numbers of the following groups are counted in the images: Infaunal bivalves, brittle stars, *Strongylocentrotus sp.* *Cucumaria sp.* etc.

*Materials:*

- Digital camera + lenses
- Subal underwater housing + dome
- Nikon flash with underwater housing
- Frame
- PC with appropriate software
- Memory cards

### 3.5 Measurement of annual growth of *Laminaria saccharina*

*Geographic position (off the Weather Station):* 74°18.59'N, 20°14.24'W – 10 m curve

*Sampling equipment:* KC plant rake, tape measure, plastic bags.

*Number of plants:* 10-20 *Laminaria saccharina* plants >1.5 m in length.

*Procedure:*

(1) *Laminaria* plants (10-20) are collected with a KC plant rake or by diving along the 10 m depth curve off the Weather Station.

(2) Plant length (cf. Figure 4) is determined using a tape measure to the nearest 5 mm. “Height 1” is the length from blade base to the first marked constriction. “Height 2” is the total blade length, and “Height 3” is the length of the stipe plus the haptera.

(3) Weigh the wet weight of (a) the blade section corresponding to “Height 1” and (b) the blade section corresponding to “Height 2 minus Height 1” and (c) the stipe plus the haptera.

(4) Roll up the “Height 1” of the plants and freeze entire leaf (-18°C) in separate plastic bags until later analysis (in Denmark) of dry matter and carbon and nitrogen content.

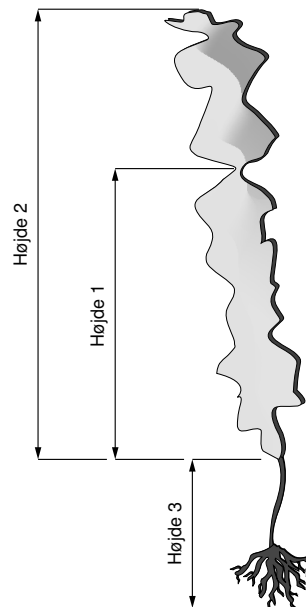


Figure 11: benthic flora – *Laminaria saccharina*

*Materials:* KC plant rake, plastic bags, tape measure, scales.

## 4 Walrus and fish

### 4.1 Monitoring of walrus at the haul-out on the island Sandøen.

*Geographic position:* 74°15.30'N, 20°18.00'W

*Procedure:*

(1) Daily visits to Sandøen are made throughout the field campaign if weather conditions allow it. The number of walrus is counted from zodiac at a distance of ca. 100 m in order not to disturb the animals.

### 4.2 Sampling of tissue from arctic char

*Geographic position:* (Off the Zackenberg hunting station) 74°27.9180'N, 20°38.3750'W

*Sampling equipment:* net, tape measure, scales, knife, data sheet.

*Procedure:*

Fish are caught with nets and 10 individuals are frozen (-18°C) until later analysis. Length and weight is noted. Each individual is frozen separately with a data sheet stating length and weight. Heads are stored for otolith analysis (age determination), and the tissue will serve as a databank of contaminants, isotopic composition etc.

*Materials*

Net

Knife