Ödsmål, Kville sn, Bohuslän

Hällristning Rock carving
Fiskare från Bronze age
bronsåldern fishermen

THE BALTIC ENTRANCE PROJECT:

Methods and Equipment. Quality of Measurements.

by

Staffan Lööf and Bodil Thorstensson

February 1980

5	6	7 MI projektnr

8 Projekt			9 MI rapportnr
☐ 1 Uppläggning	☐ 2 Komplettering	☐ 3 Avslutat	

10 Inrapportör	11 Kontraktnr	12 Startår	13 Slutår	14 MI projektnr (i förek fall) 1258

15 Finansierande organ

SNV FO-nämnd, kontrakt 7-182/74-78

16 Projektets/Rapportens titel och undertitel

THE BALTIC ENTRANCE PROJECT:
Methods and Equipment. Quality of Measurements.

17 Projektledare/Rapportförfattare

Lööf, Staffan   (författare)

Thorstensson, Bodil (författare)

18 Sammanfattning av projektet/rapporten (ange gärna målsättning, metod, teknik resultat m m)

The hydrographic conditions in northern Kattegat were investigated in a project "The Baltic Entrance Project: the GF-section". In this paper information about all methods used for the analyses together with a short description of the equipment are presented. There is an attempt to verify the quality of measurements. In this discussion some statistical features are used and connected with this "the weak points" and source of errors within the analyses are mentioned.

De hydrografiska förhållandena i norra Kattegatt har undersökts i ett projekt betitlat "The Baltic Entrance Project: the GF-Section". I detta papper ges information om alla metoder som använts för analyserna tillsammans med en kort beskrivning av utrustningen. Det görs ett försök att verifiera mätkvaliteten. I denna diskussion används några statistiska begrepp i relation till svaga punkter och felkällor inom analyserna.

19 Sammanfattningen skriven av
B. Thorstensson

20 Förslag till nyckelord
Y, hydrografi, Kattegatt, kem. analysmetoder, mätkvalitet

21 Klassifikationssystem och klass

22 Indexterm

23 Bibliografiska uppgifter	24 ISSN
Meddelande från Havsfiskelaboratoriet nr 257 IHR Göteborg Series No 3	25 ISBN

26 Hemligt	paragraf	27 Språk	28 Antal sidor	29 Pris
☒ Nej ☐ Ja, jämlikt §sekretesslagen		eng	15+7 tab	3 fig

30 Rapporten beställs hos

Se ovan 1

THE BALTIC ENTRANCE PROJECT : Methods and

Equipment. Quality of Measurements.

by

Staffan Lööf and Bodil Thorstensson
National Board of Fisheries, Sweden
Institute of Hydrographic Research
P.O. Box 2566
S-403 17 Göteborg, Sweden

Abstract.
The hydrographical conditions in northern Kattegat were
investigated in a project "The Baltic Entrance Project:
the GF-section". In this paper information about all
methods used for the analyses together with a short
description of the equipment are presented. There is
an attempt to verify the quality of measurements. In
this discussion some statistical features are used
and connected with this "the weak points" and source
of errors within the analyses are mentioned.

CONTENTS

1. Introduction

The project started in July 1974. The aim was to calcu-
late the balance of water and material in northern
Kattegat.

Ten stations were chosen between Göteborg and Frederiks-
havn (see table 1 and the map for positions). They were
designated GF 1 - 10. The two stations GF-4 and GF-9
are the traditional stations SW Vinga and E Frederikshavn
respectively.

The first expedition was carried out in August 1974.
Until December 1977 75 cruises were made, i.e. roughly
20 a year. The vessel used was the "Ulla Rinman" (l.o.a.
24 m) belonging to the Swedish Sea Rescue Institution.
Some expeditions were performed with research vessels
belonging to the National Board of Fisheries - Sweden.
The rescue vessel was equipped with some special arran-
gements for water sampling. The scientific staff con-
sisted of three persons.

Mostly the stations were visited in the direction from
Göteborg   to Frederikshavn without abruption. When
arriving at a station the first measure to be taken was
laying out the Haamer current meters. Then water was
sampled by means of reversing Knudsen bottles at the
standard hydrographical depths. An isolated Knudsen
sampler was used   . to collect the water just
above the sediment. Thereafter the bathythermograph
was lowered and a continuous temperature recording was
obtained. If the station was included in the biology
sampling program phyto- and zoo- plankton hauls were
performed.

Before leaving the station the current meters were reco-
vered and the capsules were read.

During the cruise from one station to the next the
reversing thermometers were read and the water sampled
was divided into different test tubes and bottles. In
some cases reagents were added immediately. All analyses
were performed at the laboratory ashore the subsequent
day. The NO_2- and NO_3-samples were conserved with H_gCl_2,
and TOC-samples with H_2SO_4.
The quality of data is dependent on both sampling and on
the analytical methods used. When choosing methods spe-
cificity, accuracy, precision and sensitivity have to be
considered.

The methods used by the GF-project have generally been
those described in the New Baltic Manual (hereafter
referenced as NBM). They are almost identical with the
methods used for standard hydrographical work at the
laboratory (minor modifications have sometimes been
introduced). However, the accuracy of each method, de-
fined as the degree of agreement between the measured
value and the true value, has so far not been established
for this particular laboratory. Since it is very diffi-
cult to determine the true value of hydrographical para-
meters under field conditions, discussions on the relia-
bility of chemical analyses are sometimes restricted to
e.g. precision. Hence it was considered too great a task
to establish the accuracy of the chemical analyses in
the GF-project. Instead, our effort was concentrated on
a study of the precision of the methods.

The standard deviation (SD) is frequently used as a
measure of the precision of a method. Relative standard
deviation, also called coefficient of variation (CV),
is the standard deviation put in relation to the mean

value (MV) of a set of N independent measurements. The
tables in this chapter will beside SD, CV, MV and N
also display the maximum value (MAX), the minimum value
(MIN) and their difference (DIFF) for each set of mea-
surements.

Wet chemical methods have been used for the analyses
of nutrients. When evaluating the precision of these
methods certain limits for CV are sometimes used: up
to 10 % is considered good, 10 - 20 % acceptable,
20 - 50 % doubtful and 50 % or more is unacceptable.
The figures should, of course, be used only as a guide.
Fonselius (1974) vindicates that Baltic surface phos-
phate values "should be reported with an accuracy of
not more than around ± 20 % standard deviation". However,
these data were computed from a time series at an anchor
station. - When dealing with samples with concentrations
close to the detection limit the standard deviation and
the coefficient of variation increase rapidly. The above
mentioned limits are then, of course, no longer applicable.

The results presented in this chapter derive from a
group of data obtained at regular hydrographic expe-
ditions. From each serial water sampler a large sample
(nutrients only) was taken at the same occasion as the
ordinary samples for the hydrographic series. Because of
the large amount of water needed for 10 - 20 subsamples
for salinity and oxygen determinations a special sampler
(Hydro Bios 5 1) dedicated for this purpose only was
employed.

2. Temperature T.

Methods and Equipment.

A thermometer is fixed to each sampler. The kind of
thermometer used is a protected reversing thermometer. The
temperature was determined to one hundred of a centigrade.

Quality.

The thermometers used were delivered (various years
before the GF-project started) by the manufacturer
with a certificate of precision. Right before the
measurements started the thermometers were recalibra-
ted. There were rather great changes, max. 0.1 °C,
from the last calibration for reasons which are not
clear. Most important is the aging factor. Let us
assume this error to be 0.04 °C at its most. The
reading adds approximately 0.01 °C, and so does the
correction procedure. We then arrive at a maximum
error of ± 0.06 degrees Celsius.

3. Salinity S.

Methods and Equipment.

The conductivity of the samples was measured by means
of a laboratory salinometer manufactured by Plessey
Environmental System, U.S., model 6230 N.

Quality.

For the salinity samples a bottle containing approxi-
mately 170 ml was used. To decrease the carry over
effect between samples of markedly different salinities.
The routine samples are analysed in the order sur-
face to bottom, bottom to surface and so on. This is
very important, especially when using bottles of this
size since the amount of water is generally not suf-
ficient to rinse the measuring cell completely twice.
Due to the carry over effect sometimes two sets of data
exist in the tables describing the results of precision
investigations with N and N-1 samples respectively.

In these cases it was observed that the first sample
in the series was contaminated by the preceding one.
Therefore, a second statistical calculation has been
performed where the first value has been excluded
(table 2).

Most manufacturers of the type of salinometer used in
this project claim a reproducibility of ± 0.002 - 0.003 ‰
S. As revealed by table 2 this instrument precision
can be obtained when the measurements are carefully
performed with sufficient rinsing between samples of
different salinities. However, intercalibrations have
shown that the comparability of salinity measurements
performed with different instruments, even of the same
type, is much worse than the reproducibility of one and
the same instrument. A standard deviation of ± 0.01 ‰ S
is therefore claimed as a more realistic value (Grass-
hoff 1976).

Due to the influence of the carbonate system, the accura-
cy of salinity measurements cannot be better than
± 0.02 ‰ S. This should be kept in mind when evaluating
data from conductivity measurements. Within the period
of the project the old laboratory salinometer had to be
replaced by a new one. So two different instruments,
but of the same type, have been used for the salinity
determinations in this project. However, all values in
table 2 were recorded with one and the same instrument.
Therefore, ± 0.01 ‰ S is stated as the precision of the
GF-project salinity determinations.

4. Oxygen O_2

Methods and Equipment.
This analysis was made according to the common Winkler
method, (modified by Carritt and Carpenter, see NBM).

Quality.
In order to examine the quality of the oxygen determina-

tions 10 (in some cases 20) subsamples were drawn
from a 5 l water-sampler. Titration was then carried
out according to the standard procedure. Several tests
with water containing different amounts of oxygen were
performed. One would perhaps suspect that due to
oxygenation during the subsampling procedure the samp-
les at the end of a series could yield somewhat higher
oxygen values. However, this was not observed.

Intercalibration exercises with 5 participating labora-
tories gave a precision expressed as standard deviation
of ±0.03 ml/l (Fonselius 1966, 1968). In literature,
the reproducibility is often stated to be as good as
±0.02 ml/l for oxygen contents of less than 2 ml/l and
±0.04 ml/l for oxygen contents above 2 ml/l.

Table 3   suggest that a skilled analyst sometimes
can obtain a standard deviation of ±0.02 ml/l for samp-
les richer in oxygen than 2 ml/l (column 4 and 7). As
in all titration analyses, the personal experience and
fitness is of great importance to the precision. Inabi-
lity to detect the correct endpoint of the titration
will e.g. give values with great scattering.

The major contribution to the systematic error is to
be found in the sampling procedure. This seems to be
worth special attention especially when working with
samples of low oxygen contents (Grasshoff 1976).

5.   Phosphorus.

a) Phosphate phosphorus PO$_4$-P
   Methods and Equipment.
   The samples were determined by a method which is a
   modification of the method by Murphy and Riley. The
   reagents are the same as for total phosphorus (see
   paragraph b).0.7 ml of each reagent is added, molyb-
   date reagent before the ascorbic acid.

   Quality.
   Table 4 ·   shows 17 sets of phosphate measurements in
   the range 0 - 1 µgat/l. Even if SD is low throughout
   the series (generally ± 0.04 µgat/l), concentrations
   below 0.10- 0.12 µgat/l will occasionally give rather
   dispersed values. It has been proved that an insufficient
   cleaning of the test tubes might cause a considerable
   scattering in a set of replicate samples (Dahlin, pers.
   com.). The general trend is that most samples in a set
   is fairly well gathered in a cluster around a central
   value but sometimes the material is biased by one or
   two strongly deviating measurements. But SD remains
   mostly at a low level because these values are rela-
   tively scarce.

   Hydrographers consider the phosphate analysis to be
   trouble-free, simple and accurate. Koroleff and Palmork
   (1972) give a relative error of accuracy of ± 15 % at
   the 0.2 µgat/l-level and ± 5 % at the 0.9 µgat/l-level.
   This corresponds to ± 0.03 and ± 0.05 µgat/l respectively.
   The limit of detection is 0.02 µgat/l.

b) Total phosphorus TOT-P
   Methods and Equipment.
   A modification of the method described in NBM has been
   used. The following parts differ: sample volume is 25 ml;
   the ascorbic acid reagent contains only 70 g ascorbic
   acid per litre together with 0.3 g EDTA and 6 ml formic

acid; 0.7 ml of each reagent is added, ascorbic acid
before the molybdate reagent. The oxidation has been
made in closed bottles at overpressure in a kitchen
pressure cooker.

Quality.

From the sets of measurements displayed in table 5
the conclusion might be drawn that the precision, expres-
sed as standard deviation, is almost as good as for
PO_4-P. However, by experience analysts know that this
method may occasionally give rather peculiar results.
Hence special attention has been paid to the checking
of total phosphorus data. Despite this some of the data
might still be questionable.

The range of a set of data is usually not recommended
as a measure of precision. However, if a set consists of
only a few measurements the range might be of some use.
In table 5 some extremely great differences is en-
counted (e.g. columns 2 and 7). NBM says that " the
precision is very good and the reproducibility is in
most cases better than 0.7 µg/l (0.02 µgat/l)". However,
the analysing procedure contains a rather subjective
step: adding of the oxidizing agent by means of a spa-
tula. The spatula, made of perspex contains a cavity.
This cavity is filled with $K_2S_2O_8$ and the amount is
adjusted by drawing a steel spatula along the perspex
surface. In this way the excess of the oxidizing agent
is removed. It is important that the amount of peroxydi-
sulphate is kept constant from time to time since this
influences pH and in this way the colour development.

Summing up the precision of the total phosphorus measu-
rements is not as good as it is for phosphate phosphorus.
Taking into consideration the variations found at inter-
calibration excercises and tests at the laboratory
an average precision expressed as standard deviation of
approximately ± 0.06 µgat/l is probably a realistic
choice.

6.   Nitrogen.

a) Ammonia _NH$_4$-N.

Methods and Equipment.
The method used has been the one described by Folke
Koroleff (see NBM), where blue indophenol is formed in
the presence of ammonia. The reagent called B has been
exchanged to a modified variant, described under "Remarks"
in NBM. Further on in this manual there is a description
of the buffer used for the samples to avoid precipitate.

Quality.
When performing ammonia analyses cleanliness and pro-
tection of the samples from sources liable to cause
contamination is of utmost importance.

As was the case with total phosphorus measurements
ammonia analyses will sometimes give some deviating
values in a set of replicate samples. Table 6 gives
an example of this. Generally SD is in the order of
± 0.02 - 0.03 µgat/l. In a couple of sets some extreme
values increase the range (DIFF) and therefore SD
and CV as well.

NBM states a reproducibility better than ± 5 % in routine
work. Dahl (1973) presents results from an intercalibra-
tion exercise which gave CV = ± 4.8 %. These figures
seem to be a bit low according to experience at the
Institute of Hydrographic Research. A representative
value of CV is rather found in the range ± 5 - 10 %.
The limit of detection is 0.02 µgat/l.

b) Nitrite _NO$_2$-N.

Methods and Equipment.
This analysis was performed according to NBM with
sulphanilamide and diamine dihydrochloride giving a
red azo-product that was measured photometrically.

Quality.

The method for the determination of nitrite seems to
be the most accurate one among those dealing with
nutrients containing nitrogen. As can be seen from the
few examples in table 7   the reproducibility is
extremely good. Seldom does the difference between the
highest and the lowest value in a set of ten exceed
±0.02 µgat/l which in fact is the inaccuracy in the
instrument display. Grasshoff (1976) claims a reprodu-
cibility of ±0.02 µgat/l. The limit of detection is
0.02 µgat/l.

However, field comparisons suggest that the good repro-
ducibility often is of little help when working practi-
cally. Due to the inaccuracy in the depth determination
when using conventional sampling methods it is very
difficult to collect water from the narrow layers where
nitrite compounds often accumulate. Figure 1 and 2
show the results of a field comparison between two
research vessels with separate samplings (Fonselius, 1979).
                        - Another problem is the very low
concentrations close to the detection limit that are re-
latively frequent.

c) Nitrate _NO$_3$-N
   Methods and Equipment.
   The treatment of these samples followed NBM. In those cases
   where there are alternative ways of performance the
   following alternative was chosen: the reductors used
   were filled with amalgamated cadmium granules; ammonium
   chloride-ammonia solution was used to buffer the samples,
   called buffer B in the manual.

Quality.

A critical factor in nitrate determinations is the
condition of the reductors. A reductor in good shape
should give a deviation between duplicate samples of
not more than ±0.1 µgat/l in the range 0 - 5 µgat/l
and ±0.2 µgat/l in the range 5 - 10 µgat/l (Grasshoff
1976). In non-automated systems the U-shaped type has

proved to be the most suitable one when using amalgamated cadmium. The reason for this is the need for a reproducible flow speed.

The ten samples in each set displayed in table 8. have all been run on different reductors. CV is generally ± 3 % or better. Grasshoff (1976) claims that " if no systematic sampling errors are involved, the relative accuracy of the nitrate determinations can be assumed to be ± 3 % in the range between 0 to 3 µgat $NO_3-N \cdot 1^{-1}$ ".

Nitrate data from the GF-project have been reported to the first decimal place. If the reductors are freshly calibrated and found to give a high yield the second decimal place could be relevant. Due to the project design calibrations could not be performed before every single expedition. Therefore the relevancy of the second decimal was considered questionable. The lowest detectable amount of nitrate is 0.1 µgat/l.

d) Total nitrogen_ TOT-N
Methods and Equipment.
In NBM there are some alternative treatments; the samples of 10 ml were boiled in closed bottles at overpressure together with 15 ml of the oxidation mixture. The bottles used were 50 ml "Sovirel" bottles closed by stoppers of polypropylen. After boiling 1.5 ml 0.3 N hydrochloric acid was added (see under "Comments" in NBM).   After cooling, the samples were buffered with 2 ml borate buffer. The following treatment on reductors and addition of reagents was the same as for nitrate.

Quality.
No tests have been performed in order to establish the precision of this total nitrogen analysis. The method employed is known to be of a rather low precision.

The oxidation of phosphorus compounds in sea-water to
phosphate is supposed to be almost quantitative when
using peroxydisulphate as the oxidizing agent and
boiling at overpressure. This seems not to be the case
with nitrogen compounds. Furthermore, when adding the
alkaline solution containing the oxidant, ammonia is
formed and liberated. An additional loss might be
caused by the formation of gaseous nitrogen during the
oxidation process. Hence, total nitrogen data from the
GF-project are reported as whole numbers only. The new
method by Koroleff, where both total nitrogen and total
phosphorus are analysed, has been tested by Valderrama
(to be published).

7. Total Organic Carbon   TOC

Methods and Equipment.
The analyses were made according to Menzel and Vac-
caro at the Institution of Marine Botany at University
of Lund.

Quality.
Data of total amount of organic carbon from the GF-
project have been reported to the first decimal place.
Within a series of 5 samples the differences range to
0.10 - 0.12 mg/l. This will give a reliability of the
chemical analysis of ± 0.06 mg/l. Most samples lie
in the range of 2 - 3 mg C/l. Extreme values like
0.6 and 9.3 mg C/l are seldomly found.

References:

Carlberg, S.R. (ed), 1970: New Baltic Manual (=NBM).
                      ICES Cooperative Research Report,
                      Series A(29).

Dahl, I., 1973: Vatten, Årg. 29, nr. 4:336-340.

Dahlin, H., personal communication.

Fonselius, S.H., 1966: Unesco techn.pap. in mar.sci. 3,
                                                  3-5.

Fonselius, S.H., 1968: Unesco techn. pap. in mar. sci. 9,
                                                53-62.

Fonselius, S.H., 1974: in Proceedings of the IX Con-
                      ference of Baltic Oceanographers,
                      p. 363 ff (mimeo), Kiel 1974.

Fonselius, S.H., 1979: ICES C.M. 1979/C:20, Intercom-
                      parison of Hydrographical measure-
                      ments during BOSEX-77.

Grasshoff, K. (ed), 1976: Methods of Seawater Analysis.
                      Verlag Chemie, New York/Weinheim.

Koroleff, F. and K. Palmork, 1972: ICES C.M. Hydr. Com.
                      paper no. C 21.

Menzel, D.W. and Vaccaro, R.F.,: The Measurement of
                      dissolved Organic and Particulate
                      Carbon in Seawater. Limnol.
                      Oceanogr., 9:138-142.

Valderrama, J.,: On the simultaneous analysis of total
                      nitrogen and total phosphorus in
                      natural waters (to be published).

Table 1.

Positions of
the section Göteborg - Frederikshavn.

GF	1	N 57°34.7′	E 11°51.5′
	2	34.45′	48.5′
	3	33.7′	40.0′
	4	33.0′	31.5′
	5	32.3′	26.0′
	6	32.0′	19.5′
	7	30.3′	8.5′
	8	27.9′	10°54.0′
	9	26.0′	42.5′
	10	25.0′	35.7′

Table 2.

SALINITY ‰ S

	1 a	1 b	2 a	2 b	3	4 a	4 b	5	6	7
MAX	19.759	19.745	19.877	19.862	20.445	30.152	30.152	31.779	32.559	33.954
MIN	19.740	19.740	19.859	19.859	20.443	30.122	30.135	31.773	32.553	33.948
DIFF	0.019	0.005	0.018	0.003	0.002	0.030	0.017	0.006	0.006	0.006
MV	19.744	19.742	19.863	19.860	20.444	30.140	30.142	31.776	32.555	33.951
SD	0.006	0.002	0.008	0.001	0.001	0.008	0.005	0.002	0.002	0.002
CV %	0.030	0.010	0.040	0.005	0.005	0.027	0.017	0.006	0.006	0.006
N	10	9	5	4	8	10	9	10	10	10
	-- same set --		-- same set --			-- same set --				

" -- same set -- " indicates a set of samples where it has been obvious that the first sample was contaminated by the preceding one by the carry over effect in the measuring cell. This value has been excluded and a second calculation performed.

Table 3.

OXYGEN - O_2 ml/l

	I	II	III
	N=10	9	20
MAX	0.28	0.32	4.56
MIN	0.18	0.18	4.48
DIFF	0.10	0.14	0.08
M	0.23	0.22	4.51
SD	0.03	0.04	0.03
CV %	14	18	0.66

	IV	V	VI
	N=10	9	10
MAX	4.76	5.02	5.04
MIN	4.69	4.93	4.98
DIFF	0.07	0.09	0.06
M	4.71	4.97	5.02
SD	0.02	0.03	0.02
CV %	0.42	0.65	0.35

	VII	VIII	IX	X
	N=10	10	20	10
MAX	5.07	5.93	5.96	6.68
MIN	5.01	5.81	5.81	6.57
DIFF	0.06	0.12	0.15	0.11
M	5.05	5.87	5.89	6.61
SD	0.02	0.04	0.03	0.03
CV %	0.40	0.68	0.57	0.45

Table 4.

PHOSPHATE PHOSPHORUS   µgat/l   N=10

	1	2	3	4	5	6
MAX	0.04	0.05	0.07	0.07	0.12	0.13
MIN	0.01	0.02	0.02	0.04	0.05	0.11
DIFF	0.03	0.03	0.05	0.03	0.07	0.02
MV	0.03	0.04	0.05	0.03	0.07	0.12
SD	0.01	0.01	0.02	0.01	0.02	0.01
CV %	40	34	31	18	29	8

	7	8	9	10	11	12
MAX	0.14	0.25	0.29	0.31	0.38	0.46
MIN	0.12	0.18	0.22	0.22	0.32	0.37
DIFF	0.02	0.07	0.07	0.09	0.06	0.09
MV	0.13	0.21	0.25	0.27	0.34	0.42
SD	0.01	0.02	0.02	0.04	0.02	0.02
CV %	6	11	9	15	5	7

	13	14	15	16	17
MAX	0.53	0.58	0.65	0.98	1.02
MIN	0.49	0.51	0.56	0.81	0.98
DIFF	0.04	0.07	0.09	0.17	0.04
MV	0.51	0.55	0.58	0.90	1.00
SD	0.01	0.02	0.03	0.06	0.01
CV %	3	4	5	7	2

Table 5.

TOTAL PHOSPHORUS µgat/l N=10

	1	2	3	4	5
MAX	0.38	0.57	0.64	0.79	0.83
MIN	0.28	0.31	0.58	0.67	0.74
DIFF	0.10	0.26	0.06	0.12	0.09
MV	0.34	0.42	0.61	0.72	0.80
SD	0.03	0.07	0.02	0.04	0.03
CV %	9	17	3	5	4

	6	7	8	9
MAX	0.89	0.90	1.16	1.24
MIN	0.75	0.63	1.10	1.10
DIFF	0.14	0.27	0.06	0.14
MV	0.77	0.72	1.14	1.15
SD	0.04	0.07	0.02	0.04
CV %	5	10	2	4

Table 6.

AMMONIA NITROGEN µgat/l

	1	2	3	4	5
MAX	0.40	0.42	0.43	0.44	0.62
MIN	0.26	0.35	0.34	0.34	0.26
DIFF	0.14	0.07	0.09	0.10	0.36
MV	0.28	0.39	0.38	0.33	0.33
SD	0.05	0.02	0.03	0.03	0.07
CV %	16	5	7	9	23
N	10	10	20	20	20

Table 7.

NITRITE NITROGEN µgat/l   N=10

	1	2	3	4	5
MAX	0.13	0.14	0.16	0.36	0.57
MIN	0.09	0.13	0.16	0.35	0.55
DIFF	0.04	0.01	0	0.01	0.02
MV	0.11	0.13	0.16	0.36	0.56
SD	0.02	0.003		0.004	0.006
CV %	14	3		1	1

Table 8.

NITRATE NITROGEN µgat/l N=10

	1	2	3	4	5
MAX	1.9	1.9	2.2	2.2	3.5
MIN	1.8	1.8	2.0	2.0	3.3
DIFF	0.1	0.1	0.2	0.2	0.2
MV	1.8	1.9	2.1	2.1	3.4
SD	0.05	0.05	0.06	0.07	0.06
CV %	3	3	3	3	2

	6	7	8	9
MAX	3.7	3.8	6.6	11.4
MIN	3.3	3.6	6.0	11.1
DIFF	0.4	0.2	0.6	0.3
MV	3.4	3.7	6.2	11.3
SD	0.10	0.06	0.18	0.15
CV %	4	2	3	1

Hydrographic stations

● Hydrographic stations

Göteborg

Vrångö

Läsö Trindel

Läsö N

Läsö

Läsö Rende

Frederikshavn

70m
40m
20m

1
2
3
4
5
6
7
8
9
10

FIG.1
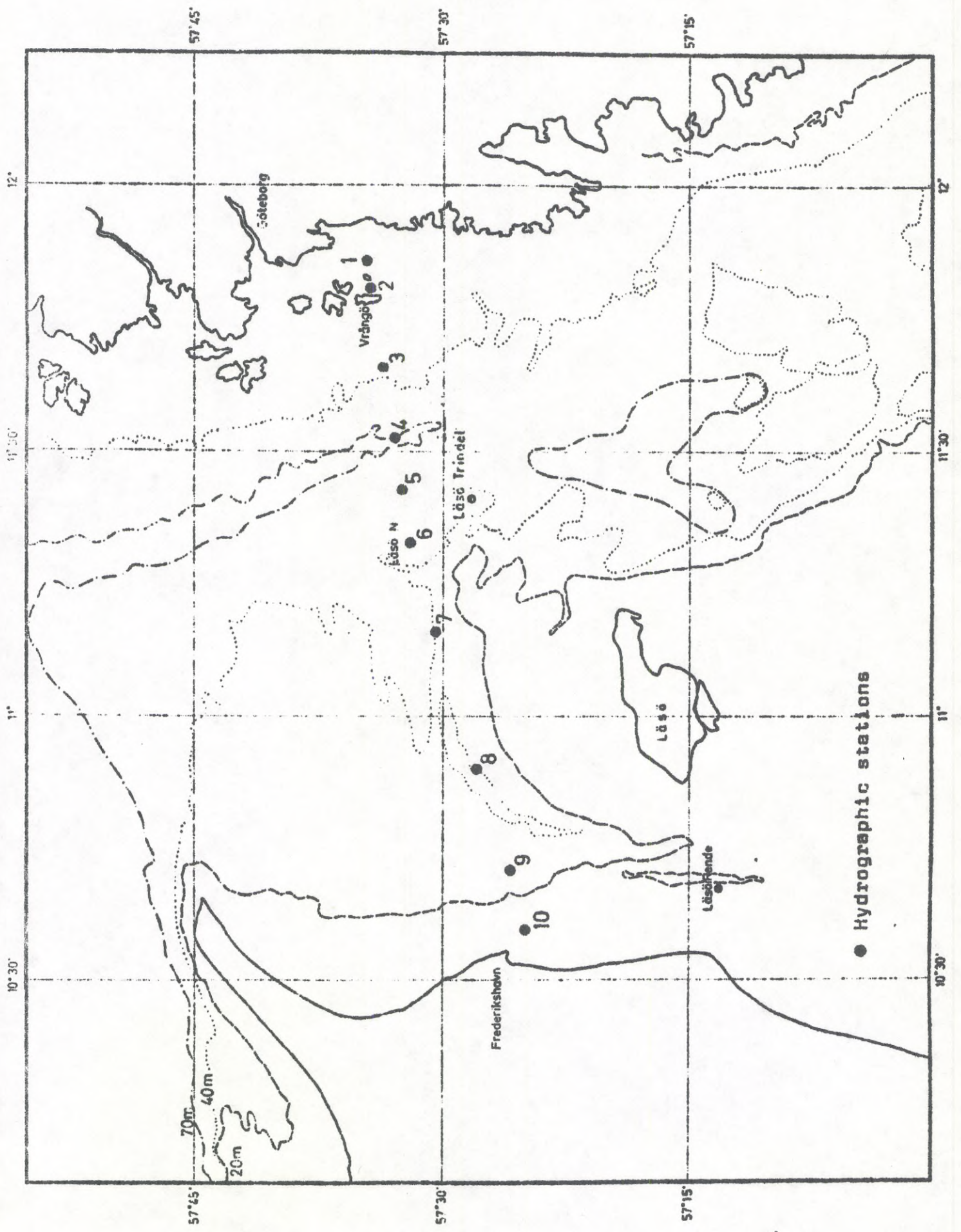
Penck – Argos NO$_2$ µgat/l

<u>Linear regression</u>

Number of points 35
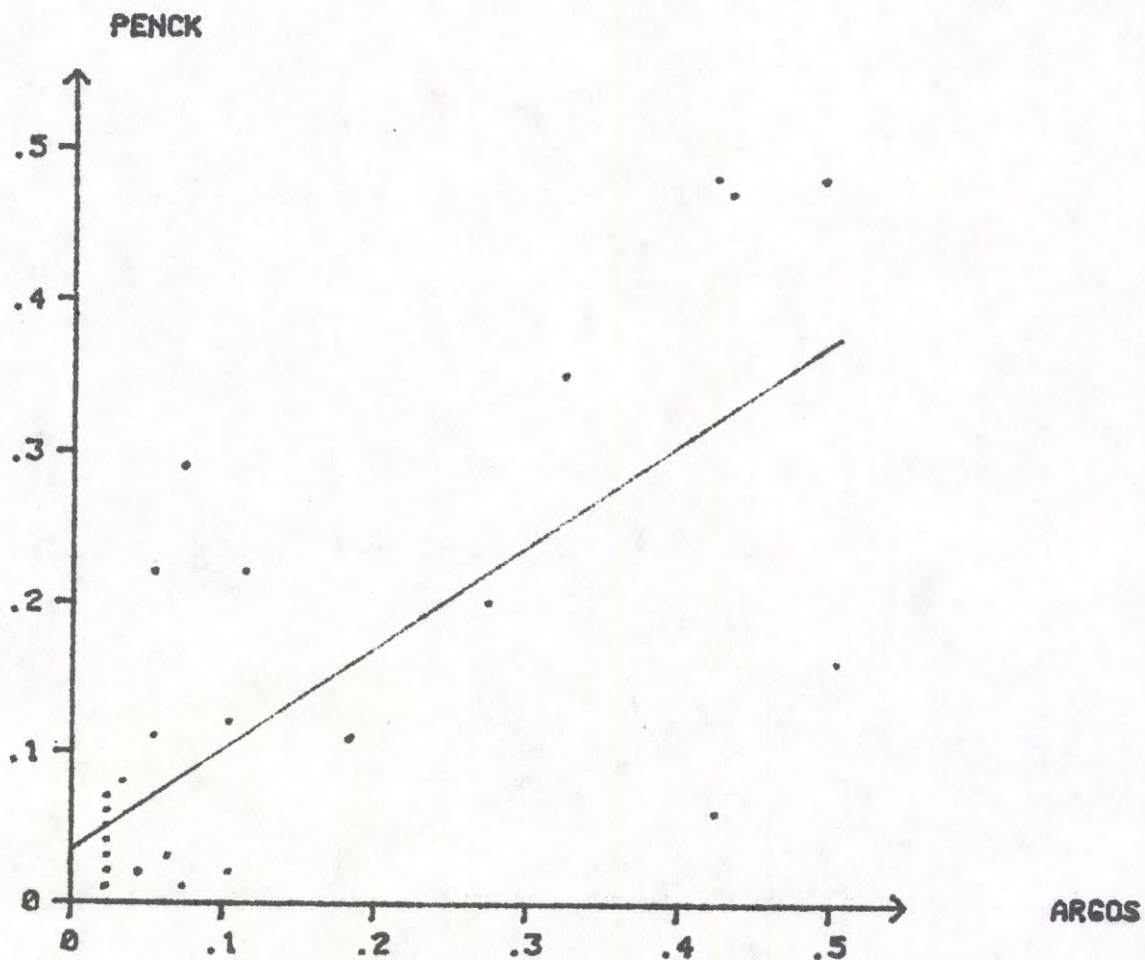x-values assumed to be independent and y-values dependent
The equation of the line: Y=A+B×X
Interception of the line with y-axis = A = 0.04 ± 0.10
(with 95% probability)
Inclination of the line   = B = 0.67 ± 0.20
(with 95% probability)
Corr. coeff. 0.751304

INTERCOMPARISON NITRITE (UGAT/L) BOSEX

FIG.2

Poseidon - Argos NO_2 ugat/l

<u>Linear regression</u>
Number of points 88
x-values assumed to be independent and y-values dependent
The equation of the line: $Y=A+B^\times X$
Interception of the line with y-axis = A = 0.03 ± 0.07
(with 95% probability)
Inclination of the line   = B = 0.69 ± 0.17
(with 95% probability)
Corr. coeff. 0.648386

INTERCOMPARISON NITRITE (UGAT/L) BOSEX

HYDRO-PLOT 1970-10-19 KL.1249