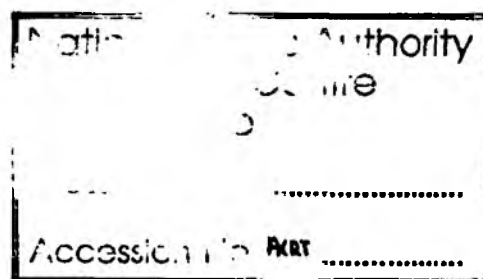


INP
Integrated North Sea Programme
1991-1992

Samen de zee op
Partnership in North Sea research



RVO



**Contributions of Research Institutes
to
Integrated North Sea Programme
1991 - 1992**

The Hague, July 1st 1991
Organizing Committee:

J. Visser	BEON/RvO
A. Bijlsma	SOZ
F. Colijn	RWS/DGW
H.J. Lindeboom	NIOZ

ENVIRONMENT AGENCY



099536

CONTENTS

1. General introduction with views on the INP by:
Prof. dr. W.G. Mook
Ir. P.H.A. Hoogweg
Ir. D. Tromp
Dr. J. van der Land
 2. INP, Contribution of the NIOZ (Netherlands Institute for Sea Research)
 3. INP, Contribution of the RWS/DGW (Rijkswaterstaat, Tidal Waters Division)
 4. INP, Contribution of the RWS/DNZ (Rijkswaterstaat, North Sea Directorate)
 5. INP, Contribution of the PML (Plymouth Marine Laboratory)
 6. INP, Contribution of the RGD (Geological Survey of the Netherlands)
 7. INP, Contribution of the KNMI (Royal Netherlands Meteorological Institute)
- Annex 1. Glossary of used abbreviation of participating institutes

GENERAL INTRODUCTION

Although the North Sea is one of the best researched sea areas in the world, many aspects of the functioning of the ecosystem are unknown. Apart from the fact that the North Sea is an extremely interesting research object, anthropogenic influences by the surrounding, highly industrialized countries, are considered to be a serious threat to its ecosystem. Therefore, all countries bordering the North Sea have been and are carrying out extensive research programmes. Notwithstanding the international co-operation in many of these programmes and despite the co-operative efforts of international organisations, many of these programmes run independently, and draw international attention only upon the appearance of the final publications. If now these programmes were better co-ordinated, the value of the results obtained from the collected data would increase strongly.

In order to promote the co-ordination and the co-operation between different national and international programmes, the BEON (Policy Linked Ecological Research of the North Sea/Wadden Sea), the NIOZ (Netherlands Institute for Sea Research), the SOZ (Netherlands Marine Research Foundation), the RVO (Council of Physical-Oceanographic Research of the North Sea) and the RWS/DGW (Rijks-waterstaat, Tidal Waters Division). took the initiative to organise an INP workshop on Texel on 6-8 June 1990. During this workshop scientists from different countries presented their future research plans which were then co-ordinated and adjusted, while new research proposals were developed. The results of the workshop were published in a workshop report. The workshop resulted in co-operation between planned national/institutional programmes in the German Bight, Frisian Front/Central North Sea and the Skagerrak/Kattegat areas in 1991 and 1992. Also the establishment of a permanent mooring site for scientific research in the stratified area of the North Sea was an important outcome of the workshop. Here permanent registrations will be made in an international co-operative way. Moreover recommendations were made concerning the insufficient international co-ordination of sea going research. To this end it was recommended the North Sea Task Force should stimulate the development of a harmonised North Sea Research Programme after 1992, and an improved communication throughout the North Sea scientific community, taking also into account other international activities within the framework of ICES and the CEC (MAST programme a.o.) The NSTF meeting of November 1990 (Berlin) endorsed the workshop recommendations. A NSTF-workshop will be held in the Netherlands in autumn 1991, co-organised by the Netherlands and ICES. The aim will be to define common international research-themes. The INP programme 1991-1992 might be considered as a pilot scheme for a future harmonised North Sea research programme on sea-going research involving all North Sea states, taking into account the relation with modelling and experimental, monitoring and laboratory activities.

This report compiles the contributions of some Dutch and UK institutes: NIOZ, RWS/DGW, RWS/DNZ, PML, RGD and KNMI. The projects described are of a multidisciplinary character with many collaborating institutes from different countries.

The INP '91-'92 is not meant to be one homogeneous programme. It brings together national and international multidisciplinary research programmes of different character. It makes these programmes more widely known throughout the European scientific and policy-making community. And it expresses the willingness of all participants to contribute to an international programme, leading to a better understanding of the North Sea system.

With the 1990-workshop and the subsequent '91 - '92 programme a process has been started which may lead to an international sea-going research programme with a broad international participation. The wish to reach this target is expressed by the slogan "Samen de Zee op/ Partnership in North Sea Research.

Several ships are involved in the programme: the new research vessel "Pelagia" (NIOZ, partly sponsored by the SOZ), the "Holland" en "Mitra" (RWS/DNZ), the "Tridens" (RIVO, State Institute for Fishery Investigation) and the "Challenger" (UK). Most cruises will visit the permanent mooring site in the Oyster Grounds. At this mooring research equipment from different countries will be installed. In close international co-operation the short-term programmes at the mooring site can be linked to the long-term observations of the moored instruments.

The following institutes are participating in the programme:

The Netherlands: NIOZ, RWS/DGW, RWS/DNZ, RWS/RIZA, DIHO, IMW-TNO, RIVO, RGD, KNMI, VUA, RUL, RUG, RUU, SBNO, DGSM, TRIPOS, Waardenburg, SODM, NOGEPA, WL, ITZ, LNV/NMF, EZ, CATO.

United Kingdom:	UW, PML, NHM, UB
France	: CNRS/lab GsY
Denmark	: DGS
Norway	: UB, UO, NI, IM
Sweden	: UG, UU
U.S.A.	: ORNL
Canada	: BIO
Belgium	: UG

Annex 1 gives a glossary of used abbreviations of participating institutes.

The following introductory notes give the views on the INP by:

Prof. dr. W.G. Mook	Director NIOZ (Netherlands Institute for Sea Research), an institute for fundamental research
Ir. P.H.A. Hoogweg	Director of RWS/DGW (Rijkswaterstaat, Tidal Waters Division), a policy related research institute
Ir. D. Tromp	Director of RWS/DNZ (Rijkswaterstaat, North Sea Directorate), an institute related to the water management of the North Sea
dr. J. van der Land	Chairman of SOZ (Netherlands Marine Research Foundation), an agency for the co-ordination and funding of Dutch sea-going research

RATIONALE OF THE INTEGRATED, MULTIDISCIPLINARY CONTRIBUTION OF NIOZ

Prof. Dr. W.G. Mook, Director Netherlands Institute for Sea Research

Central theme in the Integrated North Sea Programme is the horizontal and vertical (short-term) transport of dissolved and particulate material in the North Sea, and the effect of transport phenomena on the ecology.

Recently it has become clear that short-term transport phenomena may play an important role in the total ecology of the North Sea. Storms bring nutrient-rich water to the surface, where subsequently algal blooms may occur. Calcifying algae may transport inorganic carbon to the sediment, while flocculation may be an important mechanism in transporting organic material including microcontaminants to the sediment. Mesocosm experiments indicate that the sediment is receiving a significant amount of organic material from the water phase throughout the entire year, and subsequently these sediments may act as sinks or regenerator of organic material or nutrients.

From this it is clear that not only policy-making institutions are in need of a fully integrated research programme, with insight into various aspects and impacts of natural and anthropogenic perturbations. It is equally valid that a purely scientific approach can not be limited to merely the physics, the chemistry, the biology or the geology of the North Sea. The true approach has to be multidisciplinary and integrated.

As a multidisciplinary institute, NIOZ will incorporate, in cooperation with other institutions in the Netherlands as well as from abroad, the different aspects of "transport" in detail.

The "mooring project" on the Oyster Grounds aims at enlightening the effect of storms on the redistribution of the deeper water layers and the resulting influence on plankton dynamics. This mooring project, focussing on the short-term dynamics at once place, is closely linked to "pelagic systems of the stratified North Sea", which aims at studying the structure and functioning of the planktonic system along a North Sea transect.

"Production and sedimentation of calcifying algae" will be studied in a Norwegian fjord, where coccolithophorid blooms occur during fairly predictable periods.

"Flocculation and sedimentation" will be observed in different water masses in the North Sea and near the Norwegian coast. These projects will also give information on "silt and organic matter transport and sedimentation", focussing on the "distribution mechanisms of increasing concentrations of organic contaminants".

The "role of the sediment in recycling the sedimentated material" is closely linked to this subproject.

The results of all subprojects will be used to develop mathematical models describing (parts of) the ecological phenomena observed. In order to obtain a better understanding of the effects of short-term transport on the functioning of the ecosystem, special attention will be paid to techniques to couple physical, chemical and biological models.

INTEGRATED NORTH SEA PROGRAMME, A FUTURE LINK BETWEEN SCIENCE AND POLICY-MAKERS

Ir. P.H.A. Hoogweg, Rijkswaterstaat, Director Tidal Waters Division.

The projects mentioned in this small booklet cover several aspects of the physics, chemistry and biology of the North Sea. Still large parts of the North Sea are terra incognita, only small parts bordering the coasts are relatively well studied. The temporal resolution of processes involved in the North Sea are only known during short term studies.

Long term series of observations only exist for a few locations and are mostly limited to areas in the vicinity of marine research institutes, such as Plymouth, Texel and Helgoland. Most series on nutrients go back to the early seventies such as the Dutch water quality monitoring network. However, a few series on nutrient measurements go back as far as the 1930's. Biological information from monitoring studies is even more scarce. Therefore it proves difficult to get a well balanced impression on the water and sediment quality of the North Sea. The monitoring effort and the scientific studies dealing with processes in the North Sea gain more and more interest. An impetus to North Sea research has been given in the BEON-programme, a national programme financed by several Ministries for policy-oriented scientific studies, and research programmes defined by NSTF and the NERC-programme. This programme will facilitate the communication between scientists and policymakers using workshops and models to integrate results, and will enable us to find out which threats are most serious for the North Sea ecosystem. Only based on such studies measures can be taken to avoid future problems and to reach a sustainable system leaving space for harvesting of marine production such as fishes. The establishment of a framework for a discussion on acceptable levels of use of the system will be one of the future goals for which this programme should deliver the elements.

The interest of the Tidal Waters Division in this programme is evident; their primary task is strongly linked to most of the elements of the programme: the ecological processes in the North Sea, the effects and transport of contaminants, and the effects of eutrophication. Therefore the programme is connected to these types of problems: a ferry project to study the short term fluctuations of phytoplankton biomass along a transect running from the Belgian coast to the English coast, a project on the use of flowcytometry for the assessment of phytoplankton blooms, including toxic species, a study on the effects of contaminants and finally a contribution to the mooring study. In practice, all these studies are just small parts of the large jig-saw puzzle. A further integration of the different projects and the formulation of new proposals will be needed to establish a real integrated North Sea programme. This workshop will take place in November in collaboration with ICES and NSTF in the Hague.

By this cooperative study we aim to reach a holistic view on the North Sea ecosystem.

THE IMPORTANCE OF AN INTERNATIONAL RESEARCH PROGRAMME IN THE NORTH SEA

ir. D. Tromp; Chief Director of RWS - North Sea Directorate

In recent years, attention and concern for the ecological state and health of the North Sea have increased by the work of The OSLO- and PARIS COMMISSIONS and their Working Groups. This is not surprising, since there are clear indications of the severe impact of intensive human uses over the last sixty years on the ecological state of the North Sea. In short, the North Sea ecosystem is incomplete and unbalanced. There is a shift from long-living to short-living species. International Ecosystem Management, with emphasis on both elimination of pollution and measures to reduce disturbance by certain human uses, would be appropriate for the large, complex North Sea ecosystem. This was recognized at International Ministerial level. The three International Ministerial Conferences (IMC) on the Protection of the North Sea resulted in measures and action plans with respect to human uses of the North Sea in order to guarantee sustainable ecological development of the North Sea.

At the Third IMC, in The Hague 1990, the present problems and national action plans were evaluated. The North Sea Task Force (NSTF) was installed to prepare the North Sea Quality Status Report (QSR) for the next IMC in 1995. The QSR will form the scientific basis for the further discussions and decisions to be made by the Ministers. It is of importance that results of both current International Monitoring Programmes and Research Projects are incorporated. Questions to be answered are, among others: a) what are the environmental effects of the measures taken? b) when will these effects (improvements) take place? These questions can only be answered if one has insight in the ecological processes. This insight can be obtained through international research efforts.

One step towards this approach is the International North Sea Research Programme, and especially the establishment of a permanent mooring site in the Oystergrounds. Continuous measurements will contribute to identify and quantify the dynamic hydrographical, chemical and biological (algal) processes in a stratified area (Oystergrounds) in relation with nutrient fluxes and meteorological conditions (wind, light). The mooring is located 135 km off the coast of Terschelling (Ts 135). This location forms also part of the Dutch monitoring surveys of our research vessel "HOLLAND". Furthermore, this area is of interest for management and research, since it is located in the ENVIRONMENTAL ZONE recently established by the Dutch Government. This zone obtained special status of protection through stricter regulations for contamination and disturbance by certain human uses, as specified in the Water System Management Plan North Sea (WSP, 1991). At the mooring, the North Sea Directorate will intercalibrate the various measurements and will take samples biweekly for further analyses.

It is thus expected that results of the INP will yield insight necessary for appropriate international management and will contribute to the sustainable development and the health of our common North Sea ecosystem.

MARINE RESEARCH IN THE NORTH SEA, A NEW EUROPEAN APPROACH

Dr. J. van der Land, Chairman of the Netherlands Marine Research Foundation (SOZ)

There is an increasing acceptance of the need to protect the marine environment and of the resources this requires. Management of the marine environment presupposes insight and knowledge of physical, chemical and biological conditions of the marine environment and of the extent and deployment of resources. The North Sea has always traditionally been heavily exploited by man. The activities had a profound impact on the environment, an impact which has intensified during the last decades. Shipping, fisheries, military activities, mineral extraction and the use of the sea as an ultimate wastereceiver have all left their marks on the marine environment. The more hidden signals, dealing with the deterioration of the ecosystems, can only be detected by scientific research by means of an adequate technology. The present management policy is still lacking a firm scientific base. Therefore the problems we face today can only be solved in an international framework and by pooling intellectual and financial resources in Europe. This is underlined by the Third Conference on the Protection of the North Sea, by Eureka's EUROMAR, by CEC Marine Science and Technology (MAST) Programme and by the Integrated North Sea Programme (INP). The Stichting Onderzoek der Zee (SOZ) (The Netherlands Marine Research Foundation) has an active role in EUROMAR, MAST and in INP.

The EUROMAR objective is to enhance the development of technology by a closer cooperation between European industries and research organisations. EUROMAR aims a.o. at a better understanding of the pollution of the marine environment. SOZ together with Rijkswaterstaat organized the first EUROMAR Technology Market in 1988.

SOZ and Rijkswaterstaat act as the national delegates for MAST. The overall purpose of the MAST programme is to contribute to establishing a scientific and technological basis for the exploration, exploitation, management and protection of European coastal waters and seas surrounding EC member states as well as to introduce the necessary Community dimension to various on-going research activities.

SOZ has also actively been engaged in the development of the Integrated North Sea Programme (INP). The initiative for this programme arose in 1988 within the scientific commission on marine biology of SOZ. The objective was to start an multidisciplinary, international research campaign. Until then most research in the North Sea was carried out separately by different countries and disciplines. SOZ got a positive response from other Dutch institutes on SOZ's request to join the INP. Together with BEON, RvO, NIOZ and DGW/Rijkswaterstaat an international workshop was held in 1990, which started the international cooperation. An important part of the INP will be financed by SOZ with a budget of Dfl. 1 million. The SOZ funded research projects "Microcontaminants in the North Sea" and "Benthic links and sinks in the North Sea nutrient cycling" have been scientifically reviewed by SOZ and have been judged as "excellent" by international referees.

The international cooperation of the INP for 1993-1995 will be discussed in an international workshop in November this year. SOZ is very glad to be part of the organizing committee of it. For the solution of the scientific and management problems of the North Sea we will need new approaches, new technologies and new organizational structures, but above all a willingness to cooperate. SOZ aims to contribute to these developments.

I N P

INTEGRATED NORTH SEA PROGRAMME

INP 1991 - 1992

Contributions of the

Netherlands Institute for Sea Research

(NIOZ)



Nederlands Instituut voor Onderzoek der Zee

NETHERLANDS INSTITUTE FOR SEA RESEARCH

CONTENTS

Preface

Rationale of the integrated, multidisciplinary programme

Map of the North Sea

- 1. Pelagic systems of the stratified North Sea**
- 2. Flocculation in the North Sea and adjacent areas**
- 3. Sedimentation in the northern North Sea
(Norwegian Channel, Skagerrak and Continental Slope)**
- 4. Interactions between short-term physical dynamics and
phytoplankton dynamics in a stratified water column**
- 5. Distribution mechanisms of organic contaminants in
the water, sediment and biota of the North Sea**
- 6. Microcontaminants in the North Sea**
- 7. Benthic links and sinks in North Sea Nutrient Cycling
(BELS)**
- 8. Coccolithophorid blooms in the northern part of
the North Sea**

RATIONALE OF THE INTEGRATED, MULTIDISCIPLINARY PROGRAMME

Central theme in the Integrated North Sea Programme is the horizontal and vertical (short-term) transport of dissolved and particulate material in the North Sea, and the effect of transport phenomena on the ecology. Recently it has become clear that short-term transport phenomena may play an important role in the total ecology of the North Sea. Storms bring nutrient-rich water to the surface, where subsequently algal blooms may occur. Calcifying algae may transport inorganic carbon to the sediment, while flocculation may be an important mechanism in transporting organic material including microcontaminants to the sediment. Mesocosm experiments indicate that the sediment is receiving a significant amount of organic material from the water phase throughout the entire year, and subsequently these sediments may act as sinks or regenerators of organic material or nutrients.

During the INP the different aspects of these transport pathways will be studied in detail.

The mooring project (subproject 4) on the Oyster Grounds aims at enlightening the effect of storms on the redistribution of the deeper water layers and the resulting influence on plankton dynamics. This mooring project, focussing on the short-term dynamics at one place, is closely linked to subproject 1 (Pelagic systems of the stratified North Sea), which aims at studying the structure and functioning of the planktonic system along a North Sea transect.

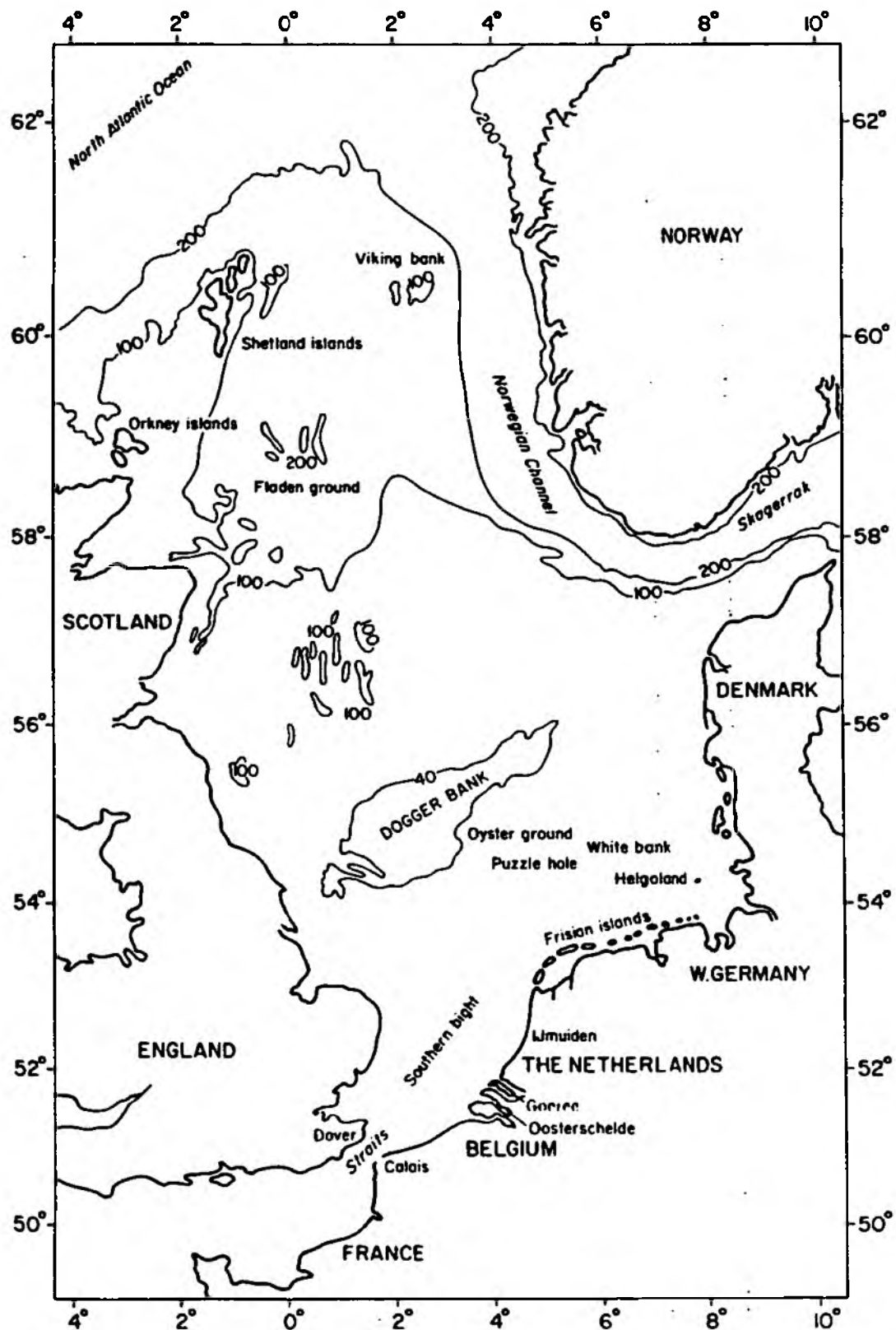
Production and sedimentation of calcifying algae will be studied in a Norwegian fjord, where coccolithophorid blooms occur during fairly predictable periods (subproject 8).

Flocculation and sedimentation will be observed in different water masses in the North Sea and near the Norwegian coast (subprojects 2 and 3).

These projects will also give information on silt and organic matter transport and sedimentation to be used in project 5, focussing on the distribution mechanisms of organic contaminants. The effects of increased concentrations of these microcontaminants on biochemical pathways in different organisms is the major research area of subproject 6.

The role of the sediment in recycling the sedimentated material is the subject of subproject 7.

The results of all subprojects will be used to develop mathematical models describing (parts of) the ecological phenomena observed. In order to obtain a better understanding of the effects of short-term transport on the functioning of the ecosystem, special attention will be paid to techniques to couple physical, chemical and biological models.



Map of the North Sea

1. Pelagic systems of the stratified North Sea

Participating institutes

NIOZ

Participants

Dr. B.R. Kuipers, Dr. R. Riegman, Dr. H.G. Fransz, 2 postdocs, 2 oio's

Project aim

In the North Sea the annual cycle in composition, productivity and vertical distribution of phytoplankton shows considerable spatial variation. Differences are explained by a combination of local differences in input of new nutrients from the Atlantic Ocean and from rivers, in temperature regime and in vertical mixing related with depth, tidal energy and wind stress. A close coupling between phytoplankton and fish exists, despite the large differences in location dependent food web structure. In limited areas of a specific nature such coupling can be short, as e.g. through the macrobenthos in shallow areas with sedimentation or through herbivorous zooplankton in areas with coastal upwelling and in the ocean front in the north.

The areal distribution of annual catch rates of the important fish species is rather even over the whole North Sea, and does not show a relative importance of any area in particular. Especially for the main part of system, the summer stratified Northern North Sea, this seems quite surprising. In this large sea area, an early and heavy spring bloom is followed by months of severe nutrient depletion of the euphotic zone, lying over a strong deep chlorophyll maximum. The situation is complicated by a gradual anti-clockwise shift of the surface water from the highly productive ocean front through the Central North Sea towards the Norwegian trench.

Though there have been several pelagic and benthic system research projects in the offshore Northern North Sea, a proper understanding of the ecosystem as a whole requires, that next to more frequent research in the vertically mixed Southern Bight and different coastal areas, a detailed study is made of the pelagic system of the stratified North Sea, with the emphasis on the fate of phytoplankton and the factors governing it, and on the nature of the heterotrophic system, its productivity and the life strategies of its members that lead to an

efficient channeling of energy to higher trophic levels notwithstanding the summer nutrient depletion.

The aim of the project is to study at four different times of year the structure and a number of selected functions of the planktonic system along a transect that runs with the main water circulation current from the ocean front in the Orkney-Shetland region to the Dogger Bank.

Watermasses moving gradually along this transect will meet light- and nutrient availability that changes gradually with latitude and time of year, and the average structure of the planktonic system is expected to change accordingly. These changes in structure will be simulated with the pelagic system model, and improving the model after comparisons with the changes observed in the field is regarded the main goal of the project. Besides, the cruises will yield autecological data on phytoplankton, microzooplankton and different species of heterotrophs that will be useful for experimental work with the mesocosms and different other projects of NIOZ pelagic research.

Work plan

Measurements are planned in the northern North Sea along a transect running from the Shetlands to the Dogger Bank. Along the transect, there is a gradient in depth and in the time and speed of development and the stability of thermal stratification. This gradient reflects a wide range of environmental conditions such as light and nutrient availability. The transect runs southward in the centre of the circulating current that brings oceanic water from the Shetland region into the Central North Sea. Our aim is to follow the transect to the north while doing a limited number of observations to determine the optimal route, and back to the south while carrying out continuous registrations and frequent measurements and sampling covering abiotic factors and the complete as possible pelagic food web over the whole water column.

Samples and measurements on each station:

On each of the 30 station the following measurements will be made:

- a. CTD cast for: - temperature- and salinity-depth profile
 - Rosette watersamples at 8 depths for chlorophyll and nutrient concentrations.
(Nutrient analyses: NO_3 , NH_4 , PO_4 , SiO_4 ,
30 stations, 8 depths per station = 250-300 samples)
 - Rosette water samples at selected depths for phytoplankton density, species composition and production study
 - Rosette water samples at selected depth for microzooplankton density and species composition
- b. Rosette sampler cast with special bottles for group de Baar
- c. Zooplankton sampling with 50 μm vertical
300 μm vertical net
250 litre water sampler
- d. Box-core sample for chlorophyll concentration profile in sediment
- e. Collection of experimental material for shipboard experiments
phytoplankton and microzooplankton
- f. Benthos Multinet haul for zooplankton when leaving station

Between the stations profiles will be made with the scientific echosounder at different frequencies.

Shipping period

Cruises of 3 weeks during

November - December 1991

April - May 1992

June 1992

September - October 1992

Apparatus

^{14}C -lab container

Climate container

clean lab container de Baar

CTD outfit

Rosette sampler with different sets of bottles

Phytoplankton research equipment Riegman

Zooplankton nets and other equipment

Microzooplankton-grazing experimental equipment
Simrad Scientific sounder
Emiliana research equipment

New investments

Flushing app. "ELISA"	f. 12,000
small fluorimeter	f. 20,000
Sonificator (CO ₂ -cooled)	f. 10,000
	<hr/>
	f. 52,000

2. Flocculation in the North Sea and adjacent areas

Participating institutes

NIOZ

Participants

Prof.dr. D. Eisma, S. Chen, Dr. M.J.W. Veldhuis, Dr. R. Riegman, Dr.
G.C. Cadée, R. Nolting, Drs. J. Beks

Project aim

A study of flocculation of suspended matter in relation to watermass,
particle composition and plankton growth.

Work plan

During four cruises distributed over the seasons suspended matter particle size will be measured in-situ with simultaneous determination of salinity and temperature and sampling of suspended matter for particle composition (mineralogy, organic matter content, elementary composition). This will be combined with determination of DOC, chlorophyl, pigments and plankton composition. At each station this is done for at least surface water and bottom water and regularly also at intermediate depths. The stations are situated in different watermasses in the North Sea. This program will be combined with other INP programs involving plankton that are planned for the PELAGIA in 1992 and following years.

Shipping period

Four cruises of 3 weeks during each season in 1992.

Apparatus

CTD + Rosette sampler

In-situ suspension camera

Automated microprobe

New investments

3 Go-flo flasks 12 litre f. 10,000

(for suspended organic matter)

**3. Sedimentation in the northern North Sea (Norwegian Channel,
Skagerrak and Continental Slope)**

Participating institutes

NIOZ

VUA

DIHO

Denmarks Geological Survey (DK)

University of Gothenburg (Swe)

Lab. CNRS Gif-sur-Yvette (F)

Participants

Dr. Tj. van Weering, Dr. S. Troelstra, Dr. A. Kuypers, Dr. B.

Dennegard, Drs. W. van der Werff, Drs. L. Moodley, Dr. G. Klaver

Project aim

The aim is to gain a quantitative insight into the accumulation of organic matter in the sediment and the influence of composition and abundance of bottom fauna. Based on sedimentation rates as determined from sediment cores and box cores, bottom fauna will be studied in relation to data on pore waters and the water column.

The sediment tripod will be tested in a region showing a bottom current as detected by 3.5 kHz profiles.

Sediment cores will be studied for a climate impact of Atlantic bottom water after the last glaciation, and for detecting changes in surface-water velocities.

Work plan

A benthic lander is to be placed in the Skagerrak after detailed shallow seismic survey. Box core and piston cores will be collected along trajectories perpendicular to isobaths. A similar programme will be carried out over the continental slope. Finally the benthic lander is to be recovered.

Shipping period

3 continuous weeks during summer 1991 and 1992.

Apparatus

CTD/Transmissometer

boxcorer

piston corer

benthic lander

3,5 kHz shallow seismic equipment (leen SO2)

sidescan sonar

New investments

boxcorer 30 kf

benthic lander (IAS 1988-1989) 450 kf

4. Interactions between short-term physical dynamics and phytoplankton dynamics in a stratified water column

Participating institutes

NIOZ

RWS (DGW, DNZ, (DGSM))

University of Wales (Menai Bridge) (UK)

Dept. of Physical Geography, Univ. Uppsala (Sweden)

Participants

Drs. C. Veth, Dr. Ir. H. Ridderinkhof, Dr. B. Wetsteyn, Dr. F. Colijn,
Dr. W. Zevenboom, Ir. H. Klein-Baltink, Dr. S. Floderus, Dr. D. Mills,
Ir. W.G. Bos

Project aim

Determination of the influence of the variability in the physical structure of a stratified water column on the plankton dynamics.

A quantitative determination of the short term variability of the phytoplankton biomass and activity.

The simultaneous measurement of physical and biological variables in order to develop and calibrate a coupled physical-biological model of plankton growth in a stratified shelf sea.

The establishment of a mooring for the continuous monitoring of the "physics-algae" dynamics over the entire year.

Modelling will be a major part of the project. An existing one-dimensional physical mixed-layer model will be extended to a coupled physical-biological model. The observations will be used to develop and to test the model. The emphasis will be on short-lasting phenomena, because the importance of these phenomena has often been underestimated. Observations can also be used to calibrate the eutrofication models used for the North Sea. Of particular importance are the experiments with vertically resolved one-dimensional models to improve the formulation of processes in coupled physical-biological modelling.

Work plan

Within the framework of the INP-project an extensive mooring will be deployed during 1991 and 1992 in the North Sea with several

instruments at a mooring site in the Oyster Grounds. This mooring project is aimed at the simultaneous observation of physical phenomena and biological consequences, in particular the occurrence of phytoplankton blooms following a deepening of the surface mixed-layer by a strong wind forcing event. This deepening causes the entrainment of nutrients from the nutrient-rich bottom layer into the nutrient-depleted surface layer. This nutrient pulse is able to cause a short lasting plankton bloom which is often missed with ordinary routine monitoring from ships, in particular immediately following the strong-wind event.

The cruise programme with R.V. Pelagia consists of:

- deployment of the mooring with instruments
- CTD-surveys in the area near the mooring to determine the local variability
- physical, biological and chemical measurements near the mooring
- regular service visits with R.V. Holland to the mooring site to change tapes and batteries, cleaning of instruments etc.

Simultaneously modelling activities will go on in which measured data already available will be implemented.

Shipping period

The main measurements will take place with the moored instruments. From ships mainly additional physical, biological and chemical measurements and service activities will be carried out. The sea area is the Oyster Grounds, south of the Dogger Bank near position 54°25' North, 4°00' East.

1991

The cruise programme consists of a series of 2 weeks with:

R.V. Pelagia:

- 1 week (beginning of July): deployment of the mooring and CTD-survey additional measurements,
- 1 week (October): recovery of the mooring (perhaps part of the mooring will stay at the site for a winter experiment).

R.V. Holland:

Two-weekly service cruises with CTD-casts and several measurements within the standard monitoring programme of Rijkswaterstaat.

1992

A comparable programme will be done in 1992, but with 5 weeks with

R.V. Pelagia. In case the winter mooring was deployed, this schedule starts in January.

Apparatus

Instruments used in the mooring and during the cruises are from several institutes. The list is preliminary:

In the mooring:

- mooring material (NIOZ and others)
- 2 thermistor chains (NIOZ)
- 3 fluorimeters (1 RWS, 2 Univ. of Wales)
- 2 transmissometers (Univ. of Wales)
- solarimeter (RWS)
- sediment traps (Sweden)
- meteo-buoy (RWS 77)

From the ships:

- CTD/Rosette (NIOZ-Pelagia)
- CTD/Rosette (RWS-Holland)
- Echosounder (NIOZ-Pelagia)
- Echosounder (RWS-Holland)
- Instruments for nutrient analysis and species composition (RWS)

Colleagues from the U.K. and Sweden also bring their instruments.

New investments (1991)

Current meters 20 kf

For 1992 a MAST-II proposal is in preparation, mainly to cover costs of the British and Swedish participants.

5. Distribution mechanisms of organic contaminants in the water, sediment and biota of the North Sea

Participating institutes

NIOZ

Participants

Dr. K. Booij, Dr. J.M. Everaarts

Project aim

Evaluation of the distribution of organic contaminants in the North Sea is essential for the long-term fate assessment of these compounds. Hexachlorocyclohexanes (HCHs), chlorinated benzenes and polychlorinated biphenyls (PCBs) are valuable model compounds, because of the low detection limits and the wide range of hydrophobicity (octanol water partition coefficients in the range 10^4 to 10^8).

Knowledge of dissolved contaminant concentrations is crucial for the application of transport models, firstly because the water phase is the intermediate for all transport between the environmental compartments: sediment, benthic/pelagic fauna, suspended matter and air, secondly because either the water phase or the air phase are used as a reference for models that describe the equilibrium distribution of organic contaminants.

The project has several aims: 1. relating the sediment-water partition coefficient to sediment characteristics; 2. comparing concentrations in the sediment phase after correction for the sediment water partition coefficient; 3. relating concentrations in benthic fauna to concentrations in the sediment phase; and 4. determining concentrations in the water phase by means of liquid-liquid extraction and extraction with XAD-2 resins.

Work plan

In 1990 a cruise was made to the southern North Sea. The aim of the 1991 cruise is to extend the data set to the northern North Sea and the Skagerrak.

Shipping period

June 1991 for 3 weeks. The cruise will be combined with the cruise of Van Weering et al., INP project 3).

Apparatus

Box corer

Piston corer

Van Veen grab

6. Microcontaminants in the North Sea

Participating institutes

NIOZ

RWS (DGW)

Institute of Marine Research, Bergen (N)

Institute of Biochemistry, Bergen (N)

Oak Ridge National Laboratory (USA)

Participants

Dr. J.P. Boon, Dr. J.M. Everaarts, Dr. K. Booij, M.T.J. Hillebrand, Ir. H. Sleiderink, Ir. M.L. Eggens, E. Evers, Dr. J. Klungsoyr, Dr. S. Wilhelmsen, Dr. A. Goksøyr, Dr. L. Shugart, P.J. den Besten, Dr. C. ten Hallers-Tjabbes

Project aim

This project tries to connect increased environmental concentrations of contaminants with the occurrence of certain changes in biochemical pathways, genetic damage and physiological responses in 4 fish species (the dab (Limanda limanda), plaice (Pleuronectes platessa) and flounder (Platichthys flesus) and a gadoid species (= cod family) that occurs most) and two invertebrate species (the seastar Asterias rubens and the whelk Buccinum undatum).

Work plan

Contaminant concentrations will be measured in sediment and the species mentioned above. Dab and cod are also chosen for monitoring programmes of the Joint Monitoring Group of the OSPARCOM and the North

Sea Task Force (NSTF) of ICES. Compounds analyzed are those which are suspected to cause deleterious effects in the North Sea: PCBs and PAHs. Whenever possible, the analysis of chlorinated dioxines and dibenzofurans is encouraged, but extra funding is a necessity for this part of the programme.

Biological effect parameters studied, are the hepatic monooxygenase biotransformation enzyme system (Phase I). An increased incidence of aberrations in the structure of DNA are taken as a precursor for the development of tumours at a later stage.

Measurements will be carried out on the Dutch part of the Continental Shelf of the North Sea.

Shipping period

3 weeks during September 1991 and 3 weeks during May 1992

Apparatus

- CTD meter
- continuous recording of salinity of bottom water
- 4-5 m beam trawl
- boxcorer
- 2 x 50 l containers voor vloeibare stikstof
- deep freezing equipment -20°C en -80°C
- 3 container laboratories; 2 of these with fume hoods

New investments

Apparatus for on board determination of the activity of the mono-oxygenase enzyme system	Total kf 116.5
--	----------------

7. Benthic links and sinks in North Sea Nutrient Cycling (BELS)

Participating institutes

NIOZ

DIHO

Participants

Dr. W. van Raaphorst, Dr. F.C. van Duyl, Prof.dr. R.P.M. Bak, Dr. H.J. Lindeboom, Dr.ir. H.W. van der Veer, G.W. Berger, A.J.J. Sandee

Project aim

In shallow systems like the North Sea, sediments may be important in nutrient cycling. From an eutrophication perspective not only the links, i.e. recycling of nutrients, but also the sinks are important, i.e. nutrient removal from the ecosystem. Key processes in recycling are mineralization of organic matter and vertical diffusive transport of constituents in interstitial waters. Nutrient sinks are denitrification, sorption and precipitation, and burial in deeper sediment layers. Several (micro)biological and (bio)geochemical processes act in concert and ultimately determine the sediments being important links or sinks. Mutual interrelationships between organisms as well as between organisms and the sediment matrix live a complex structure. Consequently, the role of groups of organisms within nutrient cycling is not always straight forward. For a better understanding in benthic nutrient recycling and removal, it is necessary to get more insight into these relationships.

The first research question of this proposal is: To what extent do sediments in the eastern North Sea (NS) act as nutrient (mainly N, P) links or sinks. The second reads: How do benthic groups of organisms (bacteria, protozoa, meio- and macrobenthos, demersal fish) affect sedimentary nutrient cycling in that area.

Work plan

Measurements will include sediment nutrient chemistry and early diagenesis, microbiology (bacteria, protozoa), and higher trophic levels (meio- and macrofauna, demersal predators), as well as their interrelations.

1) To determine sedimentary nutrient (N, P, Si) cycling in the eastern North Sea during summer and winter, respectively; 2) To identify and quantify key processes (links and sinks) within North Sea benthic nutrient cycling, and 3) to make reliable estimates of benthic nutrient recycling in the eastern North Sea, and of benthic removal of N and P brought in from the continent.

The study area is the Eastern North Sea including seaside border of main estuaries and other nutrient tributories, going from the Southern Bight via the German Bight to the Skagerrak and the Norwegian Channel.

Shipping period

3 weeks during August 1991 and during March 1992

Apparatus

- 4-5 m beam-trawl fishing gear
- CTD, Rosette with Niskin bottles
- Reineck-type boxcorer
- ca 10 container laboratories, including ^{14}C -container and climate container
- liquid scintillation counter
- autoanalyzers (N, P, Si)
- deep freezing equipment -20°C

New investments

- GC with ECD kf 80
- epifluorescence microscope kf 60

8. Coccolithophorid blooms in the northern part of the North Sea

Participating institutes

Plymouth Marine Laboratory,
National History Museum
University of Bristol
University of Bergen
University of Oslo
Nansen Institute
Vrije Universiteit Amsterdam
Rijksuniversiteit Leiden
NIOZ

Participants

J. Green, P. Holligan, J. Aiken, D. Purdie, J. Young, C. Brownlee, P. Burkill, P. LeB. Williams, B. Heimdal, E. Sakhaug, F. Thingstad, M. Heldal, P. Westbroek, P. van der Wal, J. van Bleijswijk, R. Kempers, G. Kraay, J. Knappertsbusch, G. Cadée, M. Stoll, M. Veldhuis and others.

Project aim

The objective of the programme is to develop and test a comprehensive numerical model describing the complex interactions between pelagic organic, carbonate and DMS production and the physical/chemical environment. This model will allow to assess the role played by these biological processes in the global cycles of carbon and sulphur in relation to climate regulation and global change. These processes will be investigated by interactive laboratory, field and modelling studies. Three spatial separated boxes can be conveniently distinguished: primary production (euphotic zone); transformation (intermediate and deep waters) and preservation/archive (sediment-water interface and sedimentary record). Chemical compounds produced by *E. huxleyi* are particulate organic carbon (POC), dissolved organic carbon (DOC), particulate inorganic carbon (PIC) and dimethyl sulphide (DMS). For the study of each of these boxes a different range of methodologies is required. It will be attempted to combine the resulting models in a single dynamical model of the *huxleyi* system, and to integrate this in turn in existing models of the global carbon

and sulphur cycles. Validation will be achieved by reconstructing coccolithophore distributions in the last few glacial/interglacial cycles from the sedimentary record in combination with paleoclimatological data.

Objective of the 1992 study

To investigate the (in)organic carbon fluxes of *E. huxleyi*, as a model organism of a calcifying phytoplankton species, throughout a spring bloom period, including the pre-bloom and post-bloom conditions.

The data gathered in this interdisciplinary study will be used for an overall carbon budget and assessing the fluxes of carbon, including sedimentation, over the growth season. For practical reasons the study will be conducted in a Norwegian fjord. Along the Norwegian coast coccolithophorid blooms are annual events and fairly predictable considering their blooming period. Although from a sedimentological point of view the open ocean is preferred as a study area, dense populations of *E. huxleyi* are more difficult to trace, especially when one is interested in the initiation of the growth season.

Topics concerning the physical, chemical and biological aspects of the bloom formation will be traced and used to test a theoretical model based on laboratory measurements. Next to this type of experiments the sea/air interaction with respect to down flux of atmospheric CO₂ and efflux of DMS will be studied. Measurements will be carried out using the highest possible technical standards presently available. Within the framework of the Joint Global Ocean Flux Study the study on coccolithophorids is getting much attention, yet very few field experiments, as here proposed, have been carried out. Therefore, where possible experiments will be conducted according to the JGOFS standards.

Research area and type of experiments

1. Surveys in a Norwegian fjord, most likely the Espeland fjord, located in the vicinity of the marine field station of the University of Bergen. Scientists on board of the R/V Pelagia and another, smaller vessel to be appointed, will study the temporal and spatial distribution of coccolithophorid blooms.

2. Enclosure studies. Scientists of the University of Bergen are already skilled in the use of enclosures for bloom dynamic studies. Several of them will be used, kept under different conditions, for a detailed inventory of the impact of selective additions or omissions. These will include the air/sea fluxes of CO₂, addition but also exclusion of atmospheric CO₂ influx, and selective nutrient additions.

Shipping period

3 week cruise April/May 1992, near the coast of Norway (Bergen)

Apparatus

rosette-CTD + fluorometer, O₂ sonde

autoanalyzer container

C-lab container

container flow cytometer SOZ pool no 13

CO₂ measurements 1 container

alkalinity 1 temperature controlled container

zooplankton 1 container

DMS measurements 1 container

Fytoplankton work (general wetlabs)

Light measurements dry lab

DOC, POC wet lab

New investments

Enclosures and baggs f. 5000

Light meter 4000

Sediment traps, small ones 1500

* Hardcopy unit, with processor 4000

new nets 2000

total f. 16500

I N P

INTEGRATED NORTH SEA PROGRAMME

INP 1991 - 1992

Contributions of the

Rijkswaterstaat

Tidal Waters Division

(RWS/DGW)



Ministerie van Verkeer en Waterstaat

Directoraat-Generaal Rijkswaterstaat

Dienst Getijdewateren

Contents

Introduction

1. Phytoplankton distribution and pigment composition in the southern Bight.
2. Flow cytometry in combination with biological monitoring programme of phytoplankton.
3. Sources of PAH concentrations in sediment of the Oysterground.

Introduction

This paper describes the contributions of the Tidal Waters Division (DGW) of Rijkswaterstaat to the Integrated North Sea Programme (INP). It covers three projects, the first one dealing with observations done with a ferry crossing daily the southern Bight of the North Sea from Zeebrugge to Hull, and a second one on flowcytometry in combination with biological monitoring of phytoplankton.

The third project is dealing with study on the sources of PAH in sediment of the Oysterground area.

1. Phytoplankton distribution and pigment composition in the southern Bight.

Participating institutes
DGW, RUG, DNZ

Participants
Dr. F. Colijn, Dr. J.W. Hofstraat, Dr. W.W.C. Gieskes

Project aim

The southern Bight of the North Sea is completely mixed throughout the year. Nevertheless different watermasses are found: coastal water masses along Belgium and the Netherlands, Channel water intruding from the south, and Atlantic water running south all along the coast of the UK. Despite all research the spatial and temporal resolution of phytoplankton growth never has been studied in great detail over a longer period of time. At best during cruises measurements have been performed during a few consecutive days. Therefore the effects of tidal mixing, of wind induced mixing and sudden intrusion of large, different watermasses have never been studied on a small time scale along a transect covering these different watermasses.

The aim of the project is to study the variation in plankton biomass and composition on different time and spatial scales, in combination with measurements of salinity and temperature.

The data obtained can be used as sea truth data for remote sensing purposes.

This project is linked to the one mentioned under 4 on the dynamics of phytoplankton in relation to physical factors.

The data will be available as input and calibration and validation data for models under development.

Work plan

On board the ferry sensors for salinity, temperature and fluorescence are situated. The water is taken from one of the available water inlets at about 3 m depth. Every other night the transect is sampled from Zeebrugge to Hull and vice versa. Data will be presented in 3-D plots and will also be used for GIS presentation in relation to other parameters. Data acquisition is done every minute, which means that at full speed of the ferry every 0.3 nautical miles a measurement takes place (in fact a mean value is derived from the continuous measurements).

Calibration of the equipment is performed via simultaneous cruises with the M.S. Holland on four occasions throughout 1991. In between calibration of the instruments will be performed on board in Zeebrugge. Extra calibration of the fluorimeter is planned by chlorophyll-a analysis of water samples. During at least two surveys the total pigment composition will be analysed, including the species composition of the phytoplankton in the same samples.

Shipping period

Continuous cruises with the ferry from April 1, 1991 onwards

Several calibration surveys by m.s. Holland

Total pigment composition as determined by HPLC for samples collected during several cruises with m.s. Holland

Phytoplankton analysis by light microscopy for samples collected during several cruises with m.s. Holland

Apparatus

On board ferry

Salinity / WTW LF 191

Temperature sensor

Fluorescence sensor: Turner Instruments model 10

Dedicated data acquisition program running on Tulip AT386

Laboratory instrumentation

Binocular microscope for phytoplankton analysis

HPLC set-up at RU Groningen

Instrumentation on board m.s. Holland

In-line:

Salinity/temperature sensor Guildline Instruments

Turbidity Monitek 160

Fluorescence Turner Instruments model 10

In situ(on rosette sampler):

Salinity/temperature/depth sensor Guildline Instruments

Turbidity Monitek 350

Fluorescence Chelsea Instruments Aquatracka Mk II

2. Flow cytometry in combination with biological monitoring programme of phytoplankton

Participating institutes
DCW, DNZ, Tripos

Participants
Dr J.W. Hofstraat, Dr F. Colijn, M. Rademaker

Project aim

To make available data on the phytoplankton species distribution in the Dutch part of the continental shelf of the North Sea. The data will be used for the study of phytoplankton distribution and succession, and for assessment of the effect of the reduction of the input of nutrients into the North Sea on species composition and changes therein.

Work plan

Measurements in the framework of the Dutch phytoplankton monitoring program are done throughout the year at 17 locations on the Dutch continental shelf of the North Sea. In addition, monitoring is done in the estuarine Delta region in the southwestern and in the Wadden Sea and Ems estuary in the northern part of the Netherlands. The frequency of sampling is once every 4-5 weeks in the period October-April, and once every 2 weeks in the rest of the year for most of the stations. At the reference station N10, 10 km off the coast at Noordwijk, sampling will be done every week. Samples are taken in the surface layer only (at -3 m) when the sea is well mixed, and at three depths (at -3 m, in the thermocline and between the thermocline and the sea bottom) in the water column under stratified conditions.

Samples are taken both with and without addition of a fixative. Larger phytoplankton species are analysed microscopically in samples conserved with Lugol's acidic iodine solution. Smaller phytoplankton is analysed by observation of fluorescence of living or glutaraldehyde fixed phytoplankton. The latter fixation is done in the laboratory. Living samples from a limited number of stations are also analysed by means of flow cytometry.

In addition to the analysis of the phytoplankton species composition supporting chemical determinations of chlorophyll a and nutrients are done. Furthermore a number of in-situ determinations is carried out (see below).

Shipping period

Throughout the year, once every 4-5 weeks in October-April and once every 2 weeks in the period April-October.

Apparatus

All samples (in laboratory, on board ship)

Water flow-through system

Guildline conductivity, temperature, oxygen, pH sensors

Turner model 10 fluorescence meter

Monitek 160 turbidity meter

Introduction

This paper describes the contributions of the Tidal Waters Division (DGW) of Rijkswaterstaat to the Integrated North Sea Programme (INP). It covers three projects, the first one dealing with observations done with a ferry crossing daily the southern Bight of the North Sea from Zeebrugge to Hull, and a second one on flowcytometry in combination with biological monitoring of phytoplankton.

The third project is dealing with study on the sources of PAH in sediment of the Oysterground area.

1. Phytoplankton distribution and pigment composition in the southern Bight.

Participating institutes
DGW, RUG, DNZ

Participants
Dr. F. Colijn, Dr. J.W. Hofstraat, Dr. W.W.C. Gieskes

Project aim

The southern Bight of the North Sea is completely mixed throughout the year. Nevertheless different watermasses are found: coastal water masses along Belgium and the Netherlands, Channel water intruding from the south, and Atlantic water running south all along the coast of the UK. Despite all research the spatial and temporal resolution of phytoplankton growth never has been studied in great detail over a longer period of time. At best during cruises measurements have been performed during a few consecutive days. Therefore the effects of tidal mixing, of wind induced mixing and sudden intrusion of large, different watermasses have never been studied on a small time scale along a transect covering these different watermasses.

The aim of the project is to study the variation in plankton biomass and composition on different time and spatial scales, in combination with measurements of salinity and temperature.

The data obtained can be used as sea truth data for remote sensing purposes.

This project is linked to the one mentioned under 4 on the dynamics of phytoplankton in relation to physical factors.

The data will be available as input and calibration and validation data for models under development.

Work plan

On board the ferry sensors for salinity, temperature and fluorescence are situated. The water is taken from one of the available water inlets at about 3 m depth. Every other night the transect is sampled from Zeebrugge to Hull and vice versa. Data will be presented in 3-D plots and will also be used for GIS presentation in relation to other parameters. Data acquisition is done every minute, which means that at full speed of the ferry every 0.3 nautical miles a measurement takes place (in fact a mean value is derived from the continuous measurements).

Calibration of the equipment is performed via simultaneous cruises with the M.S. Holland on four occasions throughout 1991. In between calibration of the instruments will be performed on board in Zeebrugge. Extra calibration of the fluorimeter is planned by chlorophyll-a analysis of water samples. During at least two surveys the total pigment composition will be analysed, including the species composition of the phytoplankton in the same samples.

Shipping period

Continuous cruises with the ferry from April 1, 1991 onwards

Several calibration surveys by m.s. Holland

Total pigment composition as determined by HPLC for samples collected during several cruises with m.s. Holland

Phytoplankton analysis by light microscopy for samples collected during several cruises with m.s. Holland

Apparatus

On board ferry

Salinity / WTW LF 191

Temperature sensor

Fluorescence sensor: Turner Instruments model 10

Dedicated data acquisition program running on Tulip AT386

Laboratory instrumentation

Binocular microscope for phytoplankton analysis

HPLC set-up at RU Groningen

Instrumentation on board m.s. Holland

In-line:

Salinity/temperature sensor Guildline Instruments

Turbidity Monitek 160

Fluorescence Turner Instruments model 10

In situ (on rosette sampler):

Salinity/temperature/depth sensor Guildline Instruments

Turbidity Monitek 350

Fluorescence Chelsea Instruments Aquatracka Mk II

2. Flow cytometry in combination with biological monitoring programme of phytoplankton

Participating institutes

DGW, DNZ, Tripos

Participants

Dr J.W. Hofstraat, Dr F. Colijn, M. Rademaker

Project aim

To make available data on the phytoplankton species distribution in the Dutch part of the continental shelf of the North Sea. The data will be used for the study of phytoplankton distribution and succession, and for assessment of the effect of the reduction of the input of nutrients into the North Sea on species composition and changes therein.

Work plan

Measurements in the framework of the Dutch phytoplankton monitoring program are done throughout the year at 17 locations on the Dutch continental shelf of the North Sea. In addition, monitoring is done in the estuarine Delta region in the southwestern and in the Wadden Sea and Ems estuary in the northern part of the Netherlands. The frequency of sampling is once every 4-5 weeks in the period October-April, and once every 2 weeks in the rest of the year for most of the stations. At the reference station N10, 10 km off the coast at Noordwijk, sampling will be done every week. Samples are taken in the surface layer only (at -3 m) when the sea is well mixed, and at three depths (at -3 m, in the thermocline and between the thermocline and the sea bottom) in the water column under stratified conditions.

Samples are taken both with and without addition of a fixative. Larger phytoplankton species are analysed microscopically in samples conserved with Lugol's acidic iodine solution. Smaller phytoplankton is analysed by observation of fluorescence of living or glutaraldehyde fixed phytoplankton. The latter fixation is done in the laboratory. Living samples from a limited number of stations are also analysed by means of flow cytometry.

In addition to the analysis of the phytoplankton species composition supporting chemical determinations of chlorophyll a and nutrients are done. Furthermore a number of in-situ determinations is carried out (see below).

Shipping period

Throughout the year, once every 4-5 weeks in October-April and once every 2 weeks in the period April-October.

Apparatus

All samples (in laboratory, on board ship)

Water flow-through system

Guildline conductivity, temperature, oxygen, pH sensors

Turner model 10 fluorescence meter

Monitek 160 turbidity meter

Stratified areas (in-situ equipment)

Rosette sampler

Guildline CTD and oxygen sensors

Chelsea Instruments Aquatracka fluorescence meter

Secchi depth

LiCor irradiance meter

Laboratory

Olympus IMT-2 inverted fluorescence microscope

Flow cytometer (Optical Plankton Analyser)

Spectra Physics HPLC equipment for chlorophyll analysis

Technicon autoanalyser for nutrient analysis

3. Sources of PAH concentrations in sediment of the Oysterground.

Participating institute: DGW

Participants: dr. H. Klammer, F. Smedes

A recent study on the distribution of organic and inorganic micropollutants in the sediments of the Oyster Grounds indicated that levels of Polycyclic Aromatic Hydrocarbons (PAHs) were comparable to those found in the Dutch Wadden Sea, in contrast to the levels of several heavy metals (1,2,3). For some PAH it was assumed that advective transport of riverine material was responsible for these relatively high concentrations.

However, calculations of isomer-distributions and measurements of PAHs and other compounds in different areas indicated that deposition from the atmosphere is a more likely candidate (2,3).

A study on the contribution to the sediment pollution by lateral (submersive) transport and atmospheric deposition could give better insights on the origin of the contaminants.

Therefore, the 1991 and 1992 INP sediment trap programme for monitoring in situ parameters gives an ideal opportunity: by measuring PAH concentrations in material collected from the sediment traps and the seabed, such insights could be gained relatively easily.

In practice, the 1991 Frisian Front study could be used as a pilot study, to identify the optimum of several parameters (e.g. the necessary amount of material (grams of dry weight), numbers of samples), to perform the 1992 Oyster Ground study most efficiently.

For the 1991 study, we would probably need about 10 (sub-) samples from the sediment traps, each about 500-1000 mg dry weight. Also, some sediment samples need to be collected (preferably by closed box-core or piston core).

PAH compounds analyzed will be: Fenanthrene, Fluoranthene, Pyrene, Benzo(b)- and Benzo(k) fluoranthene, Benzo(a) anthracene, Chrysene, Perylene, Benzo(a)- and Benzo(e) pyrene, benzo(g,h,i) perylene, Dibenzo(a,h) anthracene and Indeno-(1,2,3-c,d) pyrene.

I N P

INTEGRATED NORTH SEA PROGRAMME

INP 1991 - 1992

Contributions of the

**Rijkswaterstaat
North Sea Directorate**



**Ministerie van Verkeer en Waterstaat
Directoraat-Generaal Rijkswaterstaat
Directie Noordzee**

**SEAGOING AND AIRBORNE PROJECTS OF RWS-NORTH SEA DIRECTORATE:
Ecological, Toxicological and Hydrophysical aspects**

A short overview, 1991

<u>Project title</u>	: INP - MOORING
Participants	: DNZ (Zevenboom/Kamphuis/Klein Baltink), DGW, NIOZ, ITZ, and institutes from other North Sea Countries (see elsewhere). International Joint Project.
Aim	: To identify and quantify dynamic hydrographical, chemical and biological (algal) processes in a stratified area (Oystergrounds, Ts135) in relation with meteorological conditions (wind, light). DNZ will focus biweekly on intercalibration aspects (in relation with the monitoring programme, see JMG), algal species and light. The mooring site is located in the ENVIRONMENTAL ZONE (see MILZON-project).
<u>Project title</u>	: JOINT MONITORING GROUP (JMG)
Participants	: DGW, DNZ, RIZA, RIVO, NIOZ, DIHO. Joint Project of DGW and DNZ. Secretary : ir. Ida Akkerman; Chairwoman : dr. Wanda Zevenboom.
Aim	: Assessment of inputs and concentrations of contaminants (spatial and temporal) in water, sediments and biota; "biomonitoring" (trends in relative abundance of biota, such as phytoplankton, benthos). International scope: JMG, NSTF, OSPARCOM, ICES. Contributions to QSR-1993.
Survey periods	: monthly; weekly at N10; biweekly at INP-mooring station (Ts135, Oystergrounds); biweekly during May-October at algal monitoring stations; benthos monitoring during spring.
Ship	: HOLLAND (DNZ).
<u>Project title</u>	: CONTAMINATION SEDIMENTS
Participants	: DNZ (Sydow/van Zwol), DGW (Laane).
Aim	: Assessment of spatial distribution of contaminants in sediments of the Dutch Continental Shelf (DCS).
Survey period	: February - March
Ship	: HOLLAND (DNZ).
<u>Project title</u>	: ALGAL BLOOMS
Participants	: DNZ (Zevenboom/Orth/Kamphuis/Backus), DGW (Colijn), TRIPOS (Rademaker).
Aim	: Assessment of frequency, scale, spatial and

temporal trends in (surface) algal blooms, including correlations with meteorological factors (wind and light).

Survey period : April - October (algal growth period): tight linking between seagoing and airborne surveys and satellite images.

Ship, aircraft : HOLLAND (DNZ), airplane (coast guard/DNZ).

Project title : **TOXIC ALGAE**

Participants : DNZ (Zevenboom/Orth/Kamphuis), DGW (Wetsteyn), TRIPOS (Rademaker), DIHO (Speur).

Aim : Assessment of frequency, scale, trends in toxic algal species along the Dutch Waddenc coast.

Survey period : August - September

Ship : HOLLAND (DNZ).

Project title : **FLUX MANCHE**

Participants : France, UK, Belgium, DNZ/DGW.

Aim : Assessment of algal composition in Channel.

Project title : **MILZON (ENVIRONMENTAL ZONING)**

Participants : DNZ, DGW, WL, RGD, NIOZ, DIHO, NMF. Joint Project of DNZ and DGW. Projectleader: dr. Wanda Zevenboom; Co-projectleader: dr. Rob Leewis; Secretary: drs. Loes de Jong.

Aim : To distinguish different ecologically homogeneous areas of the DCS, their different ecological values and their vulnerability, on the basis of ecosystem features, in order to contribute to the designation of the ENVIRONMENTAL ZONE (zone with special protection status); To evaluate the ENVIRONMENTAL ZONE, established by the Dutch Government, with respect to development in ecological values.

Project title : **MILZON - BENTHOS**

Participants : DNZ (de Jong/Zevenboom), DGW (Leewis), SBNO, NIOZ, DIHO (Groenewold/van Scheppingen/Holtman/Duineveld/Craeymeersch).

Aim : Assessment of spatial distribution of benthos of DCS, with focus on the Environmental Zone (MILZON).

Survey period : May

Ship : HOLLAND (DNZ).

Project title : **MILZON - KLAVERBANK**

Participants : DNZ (de Jong/Zevenboom), DGW (Leewis), Waardenburg (van Moorsel), RGD (Laban), RIVO (Corten).

Aim : Assessment of vulnerability and recovery of bottom morphology and benthos of the

gravel area Klaverbank in relation with gravel extraction; potential spawning area of herring.

Survey period : September - October
Ship : MITRA (DNZ).

Project title : MONMIJ (Monitoring impact offshore mining)
Participants : DNZ (de Jong/Zevenboom/de Krieger), DGW (Everts), SODM (Henriquez), EZ (van der Ham), VROM (Meyer), NOGEPA (Marquenie), NIOZ (Daan et al), MT-TNO (van het Groenewoud).

Aim : Assessment of recovery of sediment quality and benthos around offshore drilling locations, dose-effect relationships and ecotoxicological aspects of muds (boxcosms).

Survey period : August - September
Ship : MITRA (DNZ).

Project title : BENTHOS - BEAMTRAWLING
Participants : DNZ (Sydow), NIOZ (Bergman/Lindeboom), RIVO (de Groot), RGD (Laban).

Aim : Assessment of recovery of sediment morphology and benthos, and further impact of beamtrawling.

Survey period : May, August
Ships : TRIDANS (RIVO), MITRA (DNZ).

I N P

INTEGRATED NORTH SEA PROGRAMME

INP 1991 - 1992

Contributions of the

Plymouth Marine Laboratory (U.K.)

P.M.L.



Plymouth Marine Laboratory

CRUISE PROGRAMME : RRS CHALLENGER. 83/91

PML FILE : VES 11.1

DATES : AUGUST 4th - SEPTEMBER 2nd 1991.

PML NORTH SEA CRUISE AND INTEGRATED NORTH SEA PROGRAMME

PERSONNEL

1. N.J.P. OWENS (Principal Scientist)
2. E.M.S. WOODWARD
3. A.P. REES
4. D.H. PLUMMER
5. I.E. BELLAN
6. J.A. STEPHENS
7. R. BELLERBY
8. J.L. DIXON
9. S-J BURY (Scottish University Reactor Centre / PML)
10. INEZ FLAMELING (NIOZ., NETHERLANDS)
11. H. de WILDE (NIOZ., NETHERLANDS)
12. RVS Personnel (Mechanical)
13. RVS Personnel (Computing)

LEG 1

13. S. OOSTERHUIS (NIOZ)

LEG 2

AR. ROWDEN. (PML).

ITINERARY

TUESDAY 30th JULY: Equipment loaded at Plymouth for transport to Great Yarmouth.

WEDNESDAY 31st JULY: Equipment departs Plymouth , with 2 drivers.

THURSDAY 1st AUGUST Remaining scientists depart Plymouth early morning
The *Challenger* will be unloaded from Paul Dando's previous cruise, and the new cruise equipment will be loaded

FRIDAY 2nd AUGUST: Commission and calibrate equipment.

SATURDAY 3rd AUGUST: Commission and calibrate equipment.

SUNDAY 4th AUGUST: Sail from Great Yarmouth, (am). on track of leg 1

MONDAY 5th AUGUST

-MONDAY 19th AUGUST: Complete track of Leg 1. Dock into Den Helder (The Netherlands), for port-call, and change personnel and equipment.

TUESDAY 20th AUGUST: Sail from Den Helder on Leg 2. (pm).

WEDNESDAY 21st AUGUST

-MONDAY 2nd SEPTEMBER: Complete Leg 2 programme.

MONDAY 2nd SEPTEMBER: Dock into Dundee, unload PML equipment (transport by Pickfords or similar), and personnel return to Plymouth.

OBJECTIVES

1. To study the contribution of the major nutrient species to the formation of phytoplankton blooms, and to establish the relationships between these nutrients and the phytoplankton species present. Particular attention will be focused on the contribution from ammonia, urea, and phosphate.
2. To investigate the spatial distributions of the major nutrients across the whole area of the North Sea. The nutrients to be analysed will be; Nitrate, Nitrite, Phosphate, Silicate, Ammonia and Urea. Techniques employed will be autoanalytical and chemiluminescent methodologies. Particular emphasis will be paid to the inputs of these nutrients from the major European estuaries flowing into the North Sea.
3. To study the primary production and nitrogen assimilation rates of the phytoplankton using ^{32}P , ^{14}C , and ^{15}N isotope ratio studies. Also using these techniques to carry out in-situ incubations throughout the water column, in selected regions of the North Sea.
4. To investigate the distributions of chlorophyll and the particulate carbon and nitrogen loadings of the water, across the cruise area.
5. To deploy an Undulating Oceanographic Recorder to study the vertical and physical properties of the water column.
6. To study the influence of bioturbation upon the physical and chemical parameters of the sediment, and infaunal identification and classification.
7. NIOZ studies
 - a) N_2O fluxes of the water/atmosphere interphase, and sediment denitrification studies
 - b) Vertical zooplankton net hauls.

INTEGRATED NORTH SEA PROGRAMME OBJECTIVES.

During this cruise we will occupy the mooring site as defined by the mooring group of the Integrated North Sea programme. We will also pass through, or be close to many of the positions tentatively suggested by the North Sea task force as monitoring stations.

As part of the pilot programme of the proposed integrated North Sea programme this cruise will be carrying out collaborative research with the NIOZ (Texel, Holland) cruise on the RV Pelagia. The dates for this cruise are 5th - 22nd August, and the principal scientist will be Dr. Wim van Raaphorst.

A series of stations have been agreed and the two cruise programmes will attempt to occupy and carry out a minimum of one profile using a CTD/Rosette system. Data is to be obtained for the usual suite of CTD parameters, and also for the dissolved nutrients, chlorophyll, and any other determinands that the scientific teams normally measure. The positions agreed as INP stations are in Table 2. It is proposed that 2 or 3 NIOZ scientists will be sailing on the Challenger as part of the co-operative programme. Also when possible it is intended to rendezvous for an intercalibration exercise.

METHODS AND TECHNIQUES.

1. Continuous underway monitoring techniques will be employed along the cruise track as shown on the attached sheet.
2. Water will be supplied on-board from an overside submersible pump. This will allow for the continuous monitoring of the major nutrients chlorophyll, and the determination of the hydrographic variables, eg. temperature, salinity, etc.
3. Discrete water samples will be taken from the underway pumping system at regular intervals, to give good spatial coverage of samples for primary productivity and nitrogen assimilation rate studies, and for POC/PON, ^{15}N , Chlorophyll, and gas analysis samples.
4. The Undulating Oceanographic Recorder will be towed during the monitoring programme, where conditions are suitable.
5. Samples will be taken from the Rosette/CTD system for water column analysis at regular intervals during the cruise.
6. Stations at A,B,C,D,E will be occupied from dawn to dusk and an in-situ incubation rig will be deployed, free floating, during the hours of daylight. During occupation of these stations box-coring will take place for studies of the sediment processes and bionurbation experiments. Also zooplankton net hauls will take place during the day.
7. Analysis will be carried out for N_2O gas in collaboration with the NIOZ laboratory. Surface and vertical profile samples will be taken.
8. Zooplankton distribution and analysis will be carried out by the NIOZ scientists.

EQUIPMENT**Supplied by PML**

Nutrient autoanalyser.
Sub-surface pumps
UOR plus computing system
Fridges and freezer
Incubators
In-situ incubation rig
Vacuum pumps
Filtration systems
Gas Chromatograph
Shaker Incubator
Liquid Scintillation Counter
Mass Spectrometer, and associated equipment

Supplied by NIOZ

Gas Chromatograph , and ancillary equipment.
Box Corer.
Zooplankton nets.

Supplied by RVS

CTD and Rosette system, and spares.
Salinometer
Thermosalinograph
Fluorimeter, transmissometer, and oxygen sensor for CTD
Dahn buoys (2), plus lights and reflectors
Clean Chemistry container

41
POSITIONS FOR CRUISE TRACK
LEG 1

1. 52.42' N 02.30' E	2. 54.00' N 02 20' E
3. 53 00' N 01.26' E	4. 53.08' N 00.52' E
5. 53.15' N 01.18' E	6. 53.38' N 01.32' E
7. 53.34' N 00.10' E	8. 53.50' N 01.06' E
9. 54.04' N 00.06' W	10. 54.38' N 01.10' E
11. 54.34' N 00.40' W	12. 54.38' N 01.08' W
13. 55.08' N 01.27' W	14. 55.28' N 01.01' W
15. 55.15' N 00.50' W	16. 54.38' N 01.08' W
17. 55.03' N 01.38' E	18. 54.25' N 04.00' E
19. 55.17' N 06.00' E	20. 55.30' N 07.20' E
21. 55.02' N 08.10' E	22. 54.40' N 07.10' E
23. 54.14' N 07.20' E	24. 53.51' N 07.47' E
25. 54.06' N 08.15' E	26. 54.12' N 07.51' E
27. 54.28' N 07.50' E	28. 54.14' N 07.20' E
29. 54.04' N 04.40' E	30. 53.40' N 04.38' E
31. 54.00' N 06.00' E	32. 53.51' N 07.47' E
33. 53.24' N 04.50' E	34. 53.42' N 04.30' E
35. 53.30' N 03.01' E	36. 52.50' N 02.47' E
37. 52.00' N 02.54' E	38. 52.00' N 04.03' E
39. 52.08' N 03.56' E	40. 52.30' N 03.28' E
41. 52.44' N 04.00' E	42. 52.37' N 04.18' E
43. 52.00' N 04.03' E	44. 51.21' N 02.30' E
45. 51.48' N 02.40' E	46. 50.57' N 01.20' E
47. 51.25' N 01.20' E	48. 51.46' N 02.02' E
49. 51.51' N 01.30' E	50. 52.00' N 02.06' E
51. 52.04' N 01.36' E	52. 53.00' N 03.55' E
53. 53.20' N 04.24' E	

INTO DEN HELDER. (REST AND REPLENISHMENT).

POSITIONS FOR CRUISE TRACK
LEG 2.

1. 61.30' N 01.12' E	2. 60.12' N 05.34' W
3. 59.22' N 00.30' E	4. 59.55' N 01.04' W
5. 58.26' N 03.00' W	6. 57.43' N 01.42' W
7. 60.20' N 04.00' E	8. 59.20' N 04.44' E
9. 58.30' N 03.43' E	10. 58.13' N 05.10' E
11. 57.47' N 07.00' E	12. 57.26' N 07.37' E
13. 56.40' N 06.40' E	14. 56.06' N 07.50' E
15. 56.00' N 06.28' E	16. 56.30' N 05.16' E
17. 56.00' N 04.38' E	18. 55.25' N 03.50' E
19. 55.45' N 01.52' E	20. 57.26' N 01.28' E
21. 55.44' N 01.29' W	22. 56.08' N 02.42' W
23. 56.42' N 01.00' W	

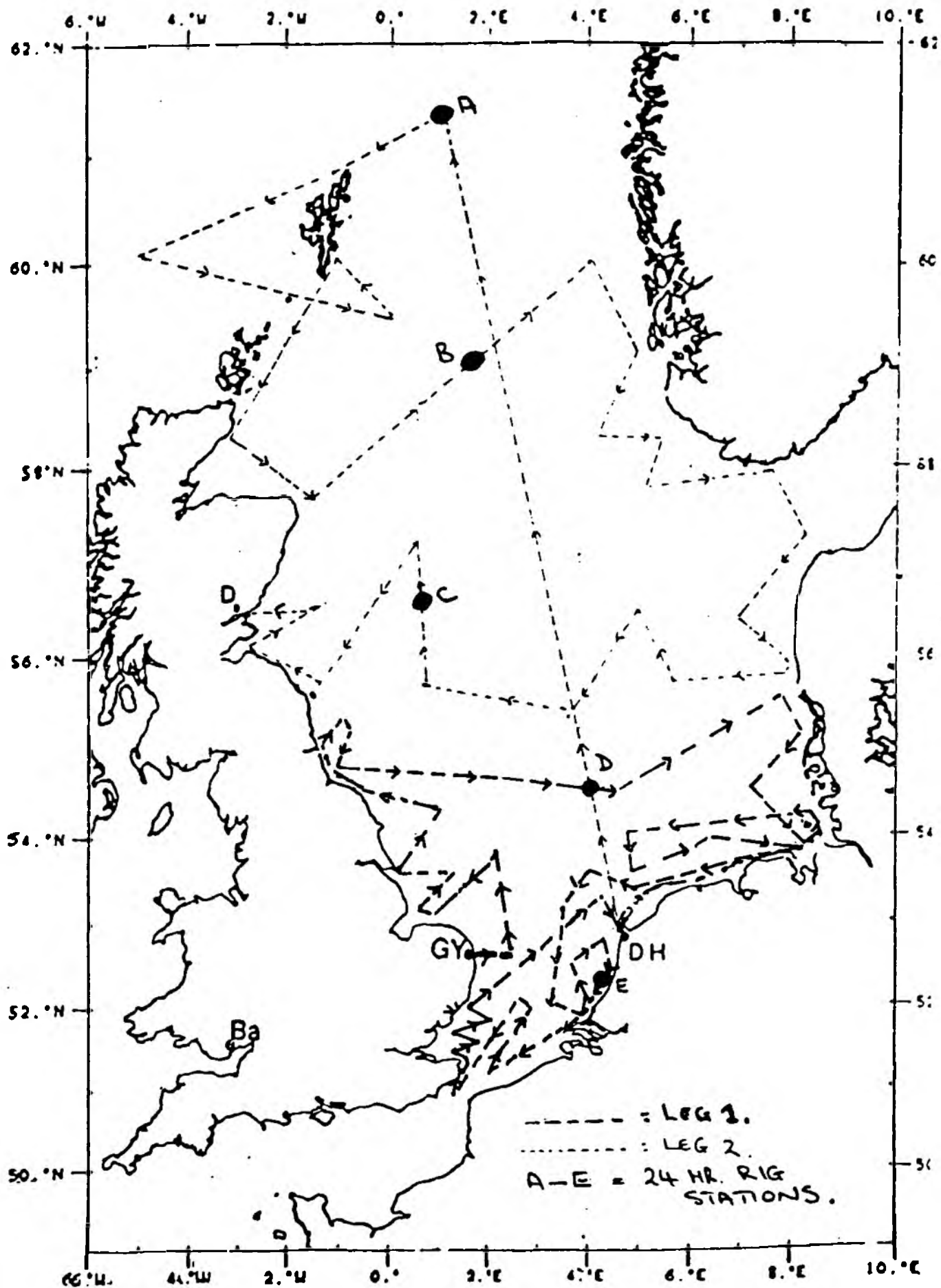
CRUISE END:- DUNDEE

INP-BELS

	A	B	C	D	E	F	G
1	INTEGRATED NORTH SEA PROGRAMME:						
2							
3	Benthic Links and Sinks in Nutrient Cycling						
4	Location and coordinates of benthic sampling stations						
5							
6							
7							
8	LOCATION	DEPTH	COORDINATES			Cont. plat	Prioriteit
9							
10	Hoek van Holland	20m	52.08 N	03.56 E	Station 1	NL	1
11	Ijmuiden	20m	52.37 N	04.18 E	Station 2	NL	3
12	Breeveertien	29m	53.00 N	03.55 E	Station 3	NL	2
13	Wash	15m	53.28 N	00.53 E	Station 4	UK	1
14	Neth Coast Boundary S	30m	53.30 N	03.01 E	Station 5	UK/NL	1
15	Friese Front	32m	53.42 N	04.30 E	Station 6	NL	1
16	Borkum	32m	54.00 N	06.00 E	Station 7	NL	1
17	Helgoland/Weser	32m	54.14 N	07.20 E	Station 8	FRG	1
18	Deutsche Bucht	15m	54.06 N	08.15 E	Station 9	FRG	2
19	NW Doggerbank	29m	55.03 N	01.38 E	Station 10	UK	3
20	Oystergrounds (monitor)	44m	54.25 N	04.00 E	Station 11	NL	1
21	Tail End (Centr. N S)	43m	56.00 N	04.38 E	Station 12	DK	1
22	Jutland West	41m	56.00 N	06.28 E	Station 13	DK	2
23	Esbjerg	22m	56.12 N	07.38 E	Station 14	DK	3
24	Skagerrak W	100m	57.26 N	07.37 E	Station 15	N	1
25	Weiss Bank	45m	55.17 N	06.00 E	Station 16	FRG	3
26	Skagerrak N	335m	58.16.70 N	10.27.00 E	Station 17	DK/S	1
27	Skagerrak S	60m	57.47.98 N	10.01.66 E	Station 18	DK	2

CRUISE TRACK R.R.S. CHALLENGER

CRUISE 83 1991.



I N P

INTEGRATED NORTH SEA PROGRAMME

INP 1991 - 1992

Contributions of the

Geological Survey of the Netherlands

(RGD)



Rijks Geologische Dienst

RGD

Geological Survey of the Netherlands (RGD), Marine Geology Division

Subject: fieldwork 1991/92

Project

MAST 1

Project management: Prof. dr. G. de Moor (University of Ghent)

Proniciple investigator of the Netherlands: drs. A. Stolk (University of Utrecht) Technical assistance P.C.M. van der Klugt (RGD).

Aim of reseach:

To study the relationship between sea floor currents and sediment mobility in the southern North Sea.

Period:

1991: week 17, 20, 36 and 37

Project

Coastal development

Project manager: prof. dr. J.H.J. Terwindt (UNiversity of Utrecht)

Principal investigator: drs. J. van der Meene (University of Utrecht)

Technical assistance P.C.M. van der Klugt (RGD)

Aim of research:

Modelling the morfology and geologic setting of the shore face connected ridges offshore the Dutch coast.

Period:

1991: week 18 and 19

Project

Coastal development

Project manager: dr. R.T.E. Schüttenhelm (RGD)

Project leader: C. Laban (RGD)

Main investigator: dr. Sha Li Ping (RGD)

Aim of research:

To study the geologic setting and development of the outer tidal delta's and channels of the Friese Zeegat (between the

Dutch Wadden Island Ameland and Schiermonnikoog).

Period:

1991: week 6, 21, 24, 27, 32, 34, 35, 43 and 44.

1992: pm

Project

Coastal development

Project manager: dr. R.T.E. Schüttenhelm (RGD)

Project leader: C. Laban (RGD)

Aim of research:

Erodeability shore face Dutch coast.

Period:

1991: week 45 and 46

1992: pm

Project

BEON (Biological and Ecological Research in North sea and Wadden Sea)

Project manager: dr. S.J. de Groot (RIVO) (Netherlands Institute for Fisheries Investigations)

Project leader: C. Laban (RGD)

Aim of research:

To study the penetration depth of beamtrawl gears in the seabed.

Period: week 22

Project

Mapping North Sea scale 1:250.000

Project leader: C. Laban (RGD)

In cooperation with directorate North Sea Ministry of Public Works and Transport.

Aim of research:

The production of geological maps of the Dutch sector of the North Sea at a scale of 1:250.000. Each map covers an area of 1° N and 2° E and consists of three sheet: a) Sea bed sediments, b) Quaternary geology and c) Solid geology

(preQuaternary)

Period:

1991: weeks 28, 29, 40, 41 and 42.

1992: pm

Project

Mapping North Sea scale 1:100.000

Project leaders: drs. P.T.J. Kok (RGD) and drs. J.H.J. Ebbing (RGD).

In cooperation with directorate North Sea Ministry of Public Works and Transport

Aim of research:

Geological mapping of the Dutch coastal area at a scale of 1:100.000. Each map extends from the shore line to about 30 kilometre off shore and about 20 nautical miles North. Each map consists of three sheets: a) applied geology and b) geologic setting.

Period:

1991: weeks 47, 48, 49, 50 , 51 and 52.

I N P

INTEGRATED NORTH SEA PROGRAMME

INP 1991 - 1992

Contributions of the

Royal Netherlands Meteorological Institute

(KNMI)

koninklijk nederlands meteorologisch instituut



Experiment: ASGASEX (Air-Sea Gas Exchange experiment).

Participating institutes:

KNMI

NIOZ

Bedford Institute of Oceanography (BIO), Canada

Plymouth Institute of Marine Science, UK

Project leader:

Dr.W.A. Oost. KNMI

The experiment:

The experiment will take place at Meetpost Noordwijk (MPN) of Rijkswaterstaat in the fall of 1991 (pilot experiment) and the spring of 1992.

The vertical fluxes of CO₂ will be measured with several methods to compare the results and to contribute to the worldwide parameterization of the transport of CO₂ between the sea and the atmosphere.

One of the techniques used is the eddy correlation method, which is the most direct way of measuring this type of fluxes. So far this method has not been used to measure CO₂ fluxes at sea, because it requires a very sensitive and fast responding sensor; adequate sensors have only recently been developed. NIOZ is primarily responsible for concentration measurements, KNMI and BIO for the eddy correlation measurements and data on other fluxes (momentum, heat, water vapor).

The results fit in with the objectives of JGOFS, the Joint Global Ocean Flux Study and of the JSC/CCCO working group on air-sea fluxes, formed by the Joint Scientific Committee (JSC) of the World Climate Research Programme (WCRP) and the Committee of Climate Changes and the Ocean (CCCO).

Time schedule:

Organization and technical development: until Oct. 1991

Pilot experiment: Nov 11 - Nov 22, 1991 (provisionally)

Analysis pilot experiment: Nov 22, 1991 - Jan 31, 1992

Main experiment: March 9 - April 4, 1992 (provisionally)

Analysis, report and publication: April 4, 1992 - Dec 31, 1992.

Netherlands:

CATO	C.A.T.O. Marine Ecosystems R&M Studies.
DGSM	Directorate General of Shipping and Maritime affairs
DIHO	Delta Institute for Hydrobiological Research
EZ	Ministry of Economic-affairs, Energy Policy Directorate
IMW-TNO	Netherlands Organization for Applied Scientific Research, Institute Environmental Sciences
ITZ	Institute for Toxonomy Zoology
KNMI	Royal Netherlands Meteorological Institute
LNv/NMF	Ministry of Agriculture, Nature Conservation, Environmental Protection and Wildlife Management Department
NIOZ	Netherlands Institute for Sea Research
NOGEPA	Netherlands Oil and Gas Exploration and Production Association
RGD	Geological Survey of the Netherlands, Marine Geology Division
RIVO	State Institute for Fishery Investigation
RUG	State University of Groningen, Department of Marine Biology
RUL	State University of Leiden, Department of Chemistry
RUU	State University of Utrecht, Institute for Marine and Atmospheric sciences and department of Geography.
RWS/RIZA	Rijkswaterstaat, Institute for Inland Water Management and Wastewater Treatment.
RWS/DNZ	Rijkswaterstaat, North Sea Directorate
RWS/DGW	Rijkswaterstaat, Tidal Waters Division
SBNO	Foundation for the advancement of Oceanography
SOZ	Netherlands Marine Research Foundation
SODM	State Supervision of Mines
TRIPOS	Institute for applied Marine Biological Research
VUA	Free University of Amsterdam, Department of Earthsciences
Waardenburg	Consultants for Environment and Ecology
WL	Delft Hydraulics

United Kingdom:

NHM	National History Museum
PML	Plymouth Marine Laboratory
UB	University of Bristol, Department of Botany
UW	University of Wales, Bangor, School of Ocean Sciences

France:

CNRS/GsY	CNRS/Lab. Gif-sur-Yvette
----------	--------------------------

Denmark:

DGS	Denmarks Geological Survey
-----	----------------------------

Norway:

IM	Institute for Marine Research, Bergen
NI	Nansen Institute
UO	University of Oslo, Department of Marine Research
UB	University of Bergen, Department of Marine Biology and Biochemistry

Sweden:

UG	University of Gothenburg, Department of Marine Sciences
----	---

U.S.A.:

ORNL Oak Ridge National Laboratry

Canada:

BIO Bedford Institute of Oceanography

Belgium:

UG University of Ghent, Department of Earth Sciences