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International Council for the
Exploration of the Sea

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REPORT OF THE WORKING GROUP ON THE EFFECTS OF EXTRACTION OF MARINE SEDIMENTS ON FISHERIES

St. Valery-sur-Somme, France, 12-15 May 1993

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May 1993

1. TERMS OF REFERENCE

The Terms of Reference of the Working Group on the Effects of Extraction of Marine Sediments on Fisheries as stated in ICES Cooperative Research Report 182 are given in Annex I.

The Working Group on the Effects of Extraction of Marine Sediments on Fisheries was requested to carry out the following tasks at a meeting in St. Valery-sur-Somme, France from 12-15 May 1993 by ICES Council Resolution 2:43.

a) make recommendations regarding the content of environmental impact assessments which, according to the "Code of Practice for the Commercial Exploitation of Marine Minerals" may be carried out prior to extraction of such deposits;

b) evaluate the results of environmental impact assessments carried out in France and the Netherlands related to marine aggregate extraction operations;

c) review the status of marine aggregates extraction activities in ICES Member Countries and related environmental research;

d) review the development of seabed resource mapping in ICES Member Countries;

e) review the development and implementation of electronic surveillance systems ("black boxes") for monitoring the operation of dredging vessels.

2. APPOINTMENT OF RAPPORTEUR

Mr P J Bide was appointed as rapporteur.

3. REVIEW OF NATIONAL MARINE AGGREGATE EXTRACTION ACTIVITIES

The Working Group received the following reports of marine extraction activity.

3.1. Belgium

In 1991 1,017,737 m^3 were extracted of which 407,071 m^3 was gravel in Zone 2 for private extractors.

In 1992 1,218,104 m^3 were extracted in Zone 2.

3.2. Canada

Despite the probable existence of extensive deposits of aggregates on the glaciated continental shelf, extraction continues to be actively discouraged. The potential for environmental damage and concern for interference with the fishing industry is the primary reason. Given the policy of "no net loss of habitat" under the Fisheries Act it is probable that any major proposals for extraction would be challenged under the Environmental Assessment and Review Process.

Not withstanding the above, there is one project involving beach replenishment in a tourist area of New Brunswick. The project began in 1987 and has been bringing about 8000 to 10,000 m of sand to the beach from an adjacent borrow site each year.

In the province of Prince Edward Island on an annual basis sand removal is permitted in several accretion areas along the southern coast. The material is removed from the inter-tidal zone but may extend as much as 2 km from the shore. During the past 10 years annual removal has averaged about 45,000 m. This material is used by the construction industry and accounts for approximately 50% of the provincial requirements. Sands from the North Shore of the Island are unsuitable for construction because of the fine grain size and rounded form.

For a period of three years, one estuary on Prince Edward Island has been used or the annual extraction of approximately 5,000 m of "mussel mud". There have also been a number of applications for oyster shell removal but no figures are available on quantities removed.

Most dredging in Canada is related to maintenance of navigational routes. Projects range in size from less than 1,000 m^3 to several hundred thousand m^3 and this material is dumped in the ocean unless the level of contaminants exceeds very strict limits. If contaminant levels are excessive then the material must be placed in containment cells on shore. At one site in New Brunswick where the material was of a cobble nature, it was dumped in a near shore area in attempt to improve lobster habitat. The quantities dredged and dumped over the past three years in the four Atlantic provinces are as follows:

	1990	1991	1992
Prince Edward Island	16,750	49,583	-
Nova Scotia	26,650	6,295	36,342
New Brunswick	435,842	602,810	284,115
Newfoundland	7,320	322,595	34,640
TOTALS	486,562	981,283	325,097

Reconnaissance mapping off the North Coast of Newfoundland has identified a number of sites where gold is present in the sediments. To determine the feasibility of placer mining on the deposits the University of Newfoundland proposes a small experimental extraction beginning in 1994. This will involve a strip only about 10 m wide and 200 m long in water from 2 to 30 m deep. Shallow areas will utilize a diver operated suction dredge, mid depths will utilize a clamshell dredge and in deep water a tracked vehicle mounted hydraulic dredge will be used. After extraction of gold the remaining material will be returned to the sea floor. The project will include baseline biological studies and studies will be continued in 1995 and 1996 to monitor the recovery of benthos. If successful, small scale mining operations such as this may provide alternate employment for fishermen unemployed as a result of the moratorium on fishing of northern cod.

3.3. Denmark

The extraction of marine sand and gravel represents 10-13 % of the total production of materials for construction and reclamation. The amount of materials dredged for construction has been more or less stable over the last 5 years due to very low levels of house building activity.

The dredging of sand fill for land reclamation has increased markedly over the last 10 years due to several large construction works in coastal areas.

In the last 3 years more than 9 million m^3 of sand fill and till have been dredged for the construction of the Great Belt bridge and tunnel project.

YEAR	SAND 0-2 mm	GRAVEL 0-20 mm	GRAVEL/STONES 6-300 mm	SAND FILL	MISC. (Till)
1990	1.0 M m^3	0.2 M m^3	0.6 M m^3	3.9 M m^3	0.1 M m^3
1991	1.1 M m^3	0.5 M m^3	0.9 M m^3	4.4 M m^3	1.0 M m^3
1992	0.7 M m^3	0.2 M m^3	0.9 M m^3	1.2 M m^3	0.8 M m^3

About 3 million m^3 of sand have been dredged for beach nourishment each year.

No detailed forecast for the future extraction has been prepared but it is expected that the exploitation of marine sand and gravel will increase at the expense of land materials. This is mainly based on the future termination of a number of licences on land and increasing environmental conflicts in potential excavation areas on land.

In 1994 4 million m^3 sand fill is expected to be dredged in connection with the construction of the fixed link in The Sound between Denmark and Sweden.

3.4. Finland

No new information since 1991.

3.5. France

Despite considerable demand extraction is limited. At present no extraction is taking place in the southern North Sea, eastern Channel and Mediterranean although the dredging of siliceous sand continues between Dieppe and Bordeux. However in Brittany, the area traditionally associated with marine materials, there are numerous sites dedicated to specific activities or industrial end-uses.

French production is about 2,000,000 m^3 per year of siliceous sand and 450,000 m^3 per year of calcareous material (shell sand and Maerl). The locations of current extraction sites are shown on the map in Annex III.

3.6. Ireland

No commercial extraction of sand gravel or lithothamnium has taken place. Applications for a number of licences are being considered.

3.7. Netherlands

Marine sand extraction takes place from two types of location. One is the maintenance dredging and over-dimensioning of the navigation channels to ports. The other is the rest of the Dutch Continental Shelf below 20 m water depth.

The navigation channels are the Euro-Maas channel to the Rotterdam harbour area and the IJ-channel to the IJmuiden and Amsterdam harbour area. There are also a few minor channels such as in the Western Scheldt, the Voordelta, to Den Helder and in the Wadden Sea area. Extraction in these is minor compared to the Euro-Maas and IJ-channel areas.

Marine sand extraction is carried out for landfill and beach nourishment as well as construction. On the Dutch Continental Shelf the sand extraction is carried out for the beach nourishment programme. Also some extraction for burial of oil\gas pipelines and offshore constructions takes place.

In the last three years the rates of marine sand extraction were as follows:

Euro-Maas channel
1990: $2.8 * 10^6$ m^3
1991: $2.7 * 10^6$ m^3
1992: $3.9 * 10^6$ m^3

IJ-channel
1990: $4.7 * 10^6$ m^3
1991: $3.6 * 10^6$ m^3
1992: $2.8 * 10^6$ m^3

DCS
1990: $3.6 * 10^6$ m^3
1991: $5.7 * 10^6$ m^3
1992: $5.2 * 10^6$ m^3

Total of marine sand extraction
1990: $11.1 * 10^6$ m^3
1991: $12.0 * 10^6$ m^3
1992: $11.9 * 10^6$ m^3

No gravel extraction has taken place during the last three years.

No shell extraction has taken place during the last three years.

3.8. Sweden

The extraction of marine aggregate in Sweden is very limited due to demand largely being met by the large deposits of sand and gravel on land in eskers. In 1992 only a total of 37,511 m^3 was extracted from the seabed at Västra Haken in the Sound (details at Annex III). An application for a new ten year period of sand extraction in this area has been made to the Swedish Government.

There are currently only two Swedish companies that have exploitation permits on the Swedish continental shelf, both in the Sound at Sandflyttan.

3.9. United Kingdom

Marine sand and gravel production takes place almost entirely in England and Wales. Scotland accounts for about 2% of UK production. There is no marine aggregate production in Northern Ireland.

The total quantity of marine aggregates extracted from licences issued by the Crown Estate from 1 January 1992 to 31 December 1992 amounted to 20,559,002 tonnes. 1,287,500 tonnes of which was used for Fill Contracts and Beach Nourishment. 6,317,232 tonnes of which was exported, principally to Holland, Belgium, Germany and France. A full summary of statistics are attached at Annex III.

The quantity of marine aggregates extracted for the UK construction industry has fallen steadily over the last four years from a record high in 1989 of about 21 million tonnes to about 13 million tonnes in 1992. Over the same period exports have risen steadily from about 2 million tonnes in 1989 to 6.3 million tonnes in 1992. Contract Fill and Beach Nourishment use has fallen from about 4.5 million tonnes in 1989 to about 1.3 million tonnes in 1992.

Future extraction for UK construction and export to mainland Europe is forecast to remain fairly stable in 1994. Beach Nourishment demand is expected to rise by the mid 1990's to about 5 million tonnes per year.

3.10. United States of America

As in past years, there is still only one continuing sand and gravel dredging operation along the Atlantic coast of the U.S. although other project-specific operations have been undertaken. The continuing commercial operation is mining sand from the main navigation channel into New York Harbour (the Ambrose Channel). They are removing sand at the rate of about 750,000 cubic meters per year. The sand is processed on land and stored at a shore side facility for future sale. There had been concern raised by regulatory agencies that over-deepening the channel may restrict circulation and lead to hypoxia. As a result, since July 1992 the company has been monitoring levels of dissolved oxygen and recording vertical profiles of water column density once a week. The density profiles are collected to monitor the degree of stratification in the channel. These measurements are made at the mining site and another station of similar depth elsewhere in the channel. If levels of dissolved oxygen fall below 5 mg/l, daily measurements will be required and, if they fall below 3 mg/l, additional stations will have to be examined around the dredging site and the operation may be interrupted. Levels have remained above 5 mg/l to date.

The State of New York is planning a programme to lease shoal areas outside of the channel in New York Harbour for sand mining. As part of the planned programme similar monitoring of dissolved oxygen and water density is to be done. In the same area, a large beach nourishment project is being undertaken by the U.S. Army Corps of Engineers. Sand is to be taken from an offshore borrow area within the Lower Bay of New York Harbour. The monitoring programme associated with this project includes similar conditions on dissolved oxygen concentrations.

The northern Atlantic coast of the U.S. has suffered severe beach erosion in a series of unusually intense storms in the winters of '91-92 and '92-'93. As a result, several large beach nourishment projects have occurred using offshore sand. The total amount of sand involved in these projects was in excess of 2 million m^3 including one project of about 900,000 m^3 in Delaware.

There has also recently been additional interest in mining offshore sand deposits as part of operations to manage contaminated dredged sediments. In the northeast U.S., dredged sediments are usually disposed of at open-water sites offshore. Contaminated sediments are required to be capped or covered with clean sediment, typically sand, in a 2 to 1 ratio. Large dredging projects, like the deepening of Boston Harbour or the removal of about 700,000 cubic meters of contaminated sediment from Newark Bay (Port of New York and New Jersey) will require that large sources of cap material be available.

3.11. Discussion

The Working Group noted the need to consider statistics for navigation dredging as well as mineral extraction in order to build up a complete picture of the magnitude and nature, and hence effects, of dredging activity.

The need for consistency of units and definitions in compiling statistics was noted.

Presentation of statistics over a 10 year period on a comparable basis for all member countries was deemed useful.

The Working Group also considered that more information on future requirements for material for construction uses and beach recharge was necessary.

4. OVERVIEW OF NATIONAL SEABED SEDIMENT MAPPING PROGRAMMES

4.1. Belgium

No data available within the Working Group regarding recent maps covering the Belgian sector other than mentioned in ICES Co. Res. Report 182, P.54.

The Seabed sediments 1:250.000 map covering the Ostend mapping area (51°-52° N, 2°-4°E) and compiled jointly by BGS, RGD and BGD was published in 1991, as anticipated in the ICES report.

4.2. Canada

Marine mapping is the responsibility of the Atlantic Geoscience Centre. A substantial amount of reconnaissance type mapping was completed in the 1970's and 80's but the equipment was largely limited to echo sounders and small volume samplers. Because of the growing interest in possible extraction of marine aggregates for commercial purposes more detailed mapping is currently in the planning stage. One specific project in the planning stages for Nova Scotia is as follows:

TITLE: Aggregate Assessment Offshore Nova Scotia

PROJECT COORDINATOR:

Gordon B. J. Fader. Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, B2Y 4A2, Ph 902-426-2159

PARTICIPANTS:

Field assistance from Atlantic Geoscience Centre (AGC) personnel R. Miller and C. Amos regarding sediment transport; H. Christian on geotechnical characteristics and R. Taylor and D. Forbes concerning beach erosion and nearshore processes. Student and contracted support for sample analysis and data compilation. Department of Fisheries and Oceans (DFO) scientists D. C. Gordon and T. W. Rowell for habitat assessment and fisheries.

COLLABORATORS:

John Fowler and Ralph Stea, Nova Scotian Department of Natural Resources, possible Nova Scotian based industrial aggregate supply companies.

BACKGROUND:

As a result of reconnaissance surficial mapping programmes conducted by the Geological Survey of Canada in the 1970's, large areas of the continental shelf off Nova Scotia have been identified where potential aggregates exist. These surveys were conducted only with echosounders and small volume samplers and little is known concerning the thickness, stratigraphy, or suitability of the deposits for aggregate use. Markets exist both locally and abroad for marine aggregates and many coastal states routinely extract aggregates from the seabed. With the recent development of new navigation, vibrocorer, seismic, sidescan sonar and large grab sampling devices, details of these deposits can readily be obtained , and AGC is poised to undertake such a study. The Nova Scotian aggregate industry cannot at present assess the importance or role of offshore deposits in their long range planning activities. This study will provide a description, and assessment of the aggregate potential of an area largely unknown and not developed.

OBJECTIVES AND DESCRIPTION:

To assess the aggregate resource potential of both the nearshore (less than 25 km from land) and selected offshore bank areas of the Scotian Shelf, Bay of Fundy, and Gulf of Maine surrounding the province of Nova Scotia (water depths less than 100 m). In 1993, an assessment will be made of existing data bases as background to research planning. From 1994-96, a series of marine field investigations aboard both large and small research vessels will be conducted to collect seismic reflection, sidescan sonar and bathymetric data and seabed samples and cores. The samples will be analyzed for their mineralogic and textural characteristics and suitability as aggregate; geophysical data will be interpreted and presented as maps of deposit distribution, thickness, stratigraphy, and grade. An aggregate genesis model will determine the geological history of the deposits, the role of glaciations and sea level transgression.

Baseline environmental data will be collected to facilitate the possible development of the defined resources. The biological samples will be processed under contract, with scientific direction, analysis and final interpretation by DFO. Geological samples will also be processed under contract and the interpretation of the geophysical data and synthesis reports undertaken by AGC.

OUTPUTS:

The cruises, the interpretation of the geophysical data, and synthesis reports will be undertaken by AGC. The samples will be processed by contract. Geological maps of offshore aggregate deposits delineating the distribution, thickness, grade and stratigraphic variation will be prepared.

Reports will detail the particle size, lithology and structure of the deposits. The suitability of the material for a wide variety of aggregate applications will be assessed. The geological history of the deposits will be determined including source of material, processes of formation (glaciation, marine transgressions and regressions), and the recent history of sediment movement and response to waves and currents. This information will be presented in a series of Cruise Reports, GSC Open File Reports, presentation of the results in meetings, in GSC paper series documents, and in DFO reports series and scientific journals.

PLANS FOR FISCAL YEAR:

A contracted assessment of the existing database from the Scotian Shelf will be undertaken to provide the necessary background to design survey cruises. Industrial needs will be determined and test procedures established to assess the offshore materials. Contractors reports will be released as GSC open file reports. Review of the UK experience and the United States programme in offshore aggregates will be undertaken to learn from their past experience. Cruise plans will be formulated for the 1994 field season and requests put forth for shiptime, equipment and technical support.

4.3. Denmark

A map of the surface sediments in the Danish part of the Sound at a scale of 1:100.000 was published in 1990.

An overview map of the bottom sediments around Denmark and western Sweden at a scale of 1:500.000 was published in 1992 as a result of cooperation between The National Forest and Nature Agency, The Geological Survey of Denmark and The Geological Survey of Sweden.

Detailed map of the Flensborg Fjord area will be published during 1993 by the Geological Survey of Denmark.

Some of the most important stone reefs in Danish waters have been mapped in 1991-1993 using shallow seismic equipment, side scan sonar, SCUBA-diving and sampling. The project is a cooperative venture between The National Forest and Nature Agency, The Geological Survey of Denmark and University of Copenhagen. Reports including surface sediment maps, gravel and stone concentration maps and biological results will be published in 1993.

The systematic reconnaissance resource mapping continues and is concentrated in the North Sea and the Baltic. Since 1991 mapping programmes have been carried out on Jutland Bank and Horns Reef in the North Sea and in Fehmarn Baelt, Adler Ground, Rønne Bank and Kriegers Flak in the Baltic. Maps at 1:100.000 scale of surface sediments, Quaternary geology and sand and gravel resources have been prepared. At present, between 80% and 90% of potential resource areas in the Inner Danish Waters have been mapped.

Detailed resource mapping programmes have been carried out in some regional extraction areas containing materials of high quality and in areas licensed for bridge and tunnel projects.

4.4. Finland

No new information since 1991.

4.5. France

Geological exploration on the French continental shelf to define marine aggregate deposits has been the subject of 12 years' work (fig. 1). The map for the Normandy area has recently been published. It is a digital map at 1:100,000 scale showing both distribution of sand and gravel and sea bed morphology.

Resources of siliceous sands and gravels and calcareous sands have been estimated at 33 billion m^3 of siliceous material and 5 billion m^3 of calcareous material. For several years prospecting has been carried out by French overseas departments (Antilles)

4.6. Ireland

Seabed sediment maps on a scale of 1:250,000 are available for the Irish Sea Areas, Anglesey and Cardigan Bay and the South East Coastal Area Nymphe Bank.

Work is complete and compilation under way on the Galway Bay sheet.

Work is nearing completion and compilation has commenced on the Cork-Mizen Head sheet.

Plans are being formulated for a West Coast Mapping programme.

4.7. Netherlands

Geological Survey of the Netherlands Regional mapping programmes:

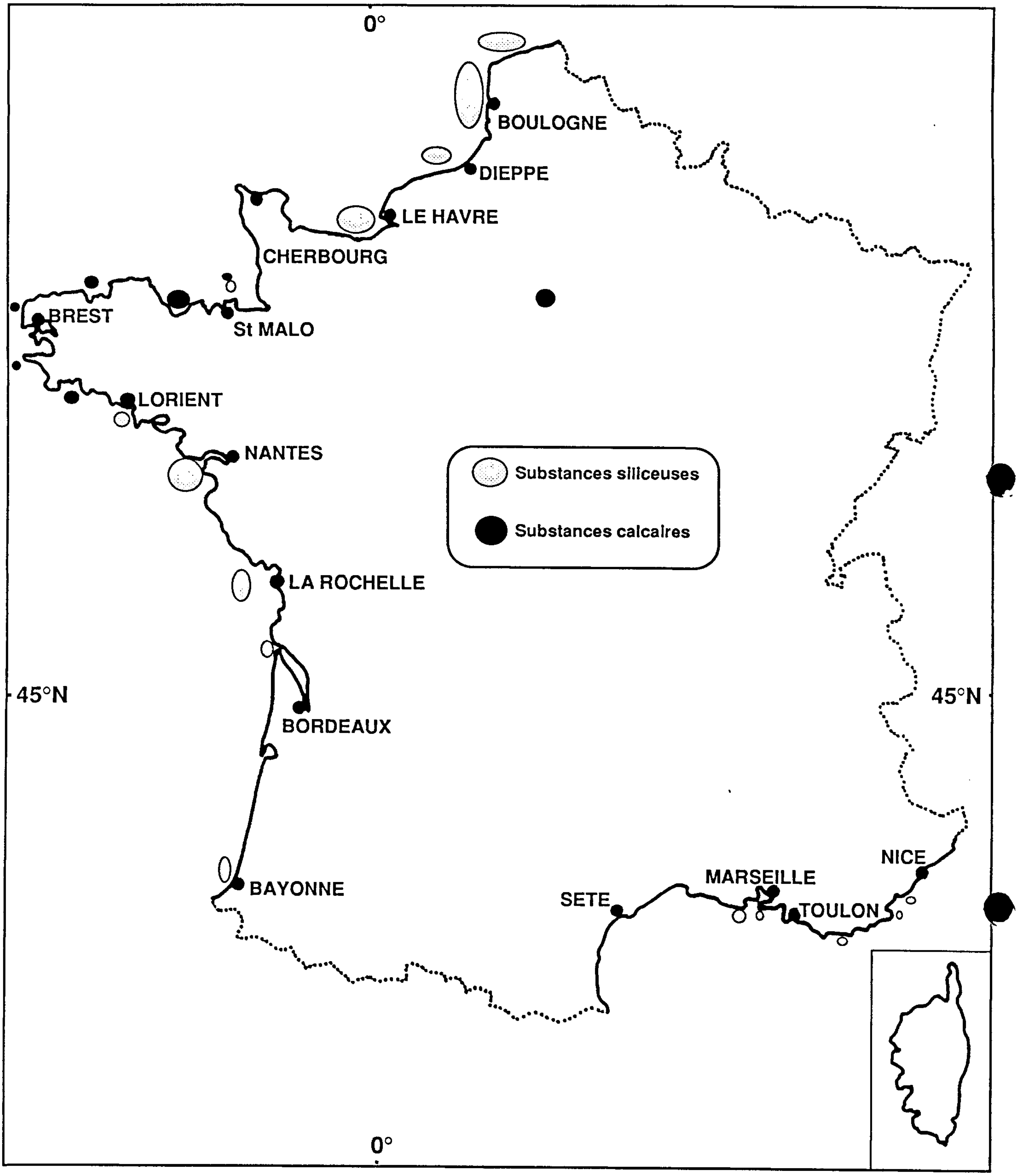
Three mapping programmes are carried out in the Dutch sector of the North Sea:

1) 1:1.000.000

The seabed sediment map of the entire Dutch sector is digitally available. On this map the mean d50 values (63-125 micron; 125-250 micron; 250-500 micron and 500-2000 micron) of the sand fraction are contoured. The 10% mud contour line can be given on this map or on a separate map.

2) 1:250.000

Since the end of 1992 all seabed sediment maps, which are made in cooperation with BGS and the Dutch Ministry of Public Works, between the 51°- 56° N and 2° - 4° E have been available. The sampling of the Oyster Ground (54°-55° N and 4°-6° E) sheet has been finished and the seabed sediment map is in preparation. Sampling is now being carried out for the Terschellingbank sheet (53°-54° N and 4°-6° E).



ZONES PROSPECTEES PAR L' IFREMER

3) 1:100.000

Detailed geological maps are made of the coastal area at a scale of 1:100.000. The maps are printed on both sides. One side shows the lithology of the first and second metres of the seabed as grain size, mud and gravel content. The other side shows the geological formations in a fence diagram and the related maps with subcrops of the top of the Pleistocene and older formations.

The first map, Rabsbank, is printed and covers the Dutch licence blocks for oil and gas S7, S8, S10 and S11. The Buitenbanken (blocks S1, 2,4 and 5) and Schouwenbank (S3, 6 and T1) sheets are in preparation. Sampling is taking place for the Indusbank sheet (P15, P18, Q 13, 14 and 16).

Applied geological research in 1992/93

In the context of the supply of material for Dutch beaches several geological studies were carried out in areas along the Dutch coast in order to determine the quality and quantity of the sediments. Extraction is allowed to take place seawards of the 20 m isobath or at least 20 kilometres from the coast.

Reports:

P.C.M. van der Klugt, 1992. Onderzoek zandwingebied noord van Terschelling, deel 1 en deel 2 aanvullend onderzoek. Report CL93377.

P.C.M. van der Klugt, 1993. Onderzoek zeezandwingebied locatie Texel. Report CL93021.

P.C. Zonneveld, 1993. Geologisch onderzoek zandwingebied, vak F (blok S5). Report CL931671.

4.8. Sweden

According to the Governmental decision taken in 1988, the Swedish Continental Shelf Area will be mapped by the Geological Survey of Sweden at a scale of 1:100 000. The work is to be completed by 2050. To achieve this an average area of 2,500 km^2 will be mapped yearly during this period. The maps within this programme show the distribution of the topmost sediments (0.5 m) of the seabed as well as the stratigraphy down to the bedrock surface. To date about 10% of the Swedish shelf area has been mapped at this scale. The Government also decided that the Survey should map simultaneously the current status of contaminants in the sediments. This part of the programme involves analyses for about 40 elements, analyses for PAH, pesticides (DDT, DDD, DDE, Chlordans), PCBs and extractable organic chlorides and bromides.

The map of the central Kattegatt will be published in 1993 followed in 1994 by the map of the northern Kattgatt. From 1993 the mapping programme will continue with the Swedish area of the south-western part of the Baltic proper. The Swedish marine geological mapping programme is based on a digital system covering data collection, processing, interpretation, presentation and final making of originals for printing.

An overview map at a scale of 1:3,000,000 covering the seabed sediments of the Bothnian Bay, the Baltic Proper, the Kattegatt and Skagerrak areas has recently (1992) been published by the Geological Survey of Sweden in the new National Atlas of Sweden, Coast and Sea volume. The book is available in an English edition. In a joint project involving the National Forest and Nature Agency of Denmark (S&N) and the Geological Surveys of Denmark and Sweden (DGU and SGU) a new map "Bottom Sediments around Denmark and Western Sweden" at 1:500,000 scale has been compiled and was published at the end of 1992.

4.9. United Kingdom

The systematic reconnaissance geological survey of the UK Continental Shelf by the British Geological Survey (BGS) which began in 1969 was completed in 1992.

The 1:250,000 scale maps (Figure 2) form a series totalling 342 sheets; each sheet covers one degree of latitude and two degrees of longitude. Separate sheets show gravity anomalies, aeromagnetic anomalies, solid (pre-Quaternary) geology, Quaternary geology and sea bed sediments. Several sheets produced at an early stage of the survey programme are currently under revision. Summary maps at the 1:1,000,000 scale showing sea bed sediments, solid geology and Quaternary geology are also available.

A series of offshore regional geological reports accompany the map series and currently three reports covering the Moray Firth, the western English Channel and the southern North Sea are published. The series, which will comprise 10 reports (Figure 3), is to be completed by 1994. A further report (BGS Research Report SB/90/1) has been produced to describe the sea bed sediments of the UK, in terms of their grain-size distribution, provenance, and associated bedforms.

The current status with publications dates of the marine aggregate resources programme (mainly funded by the Department of the Environment and the Crown Estate) is outlined below:

Desk Studies		Resource Surveys
Phase 1	Southern North Sea 1986	Great Yarmouth - Southwold 1988
Phase 2	South Coast 1988	Isle of Wight - Beach Head 1989
Phase 3	East Coast 1990	Humber 1992
Phase 4	Irish Sea 1992	

The research proposal (MARDIGRAS) submitted for EC funding under the BriteEuram Programme was not successful on its first submission. It has been revised and re-submitted under the title EUROSAND (Optmal Processing and Use of EC Marine Sand and Gravel). Partners in the submission are; MARIS, Posford Duvivier, BGS, RGD, IHC/MTI (Holland), University of Gent, Kesteleyn (Belgium), N.V. Transportbeton De Beuckelaer (Holland), G.M. Idorn Consult, Ramboll Hannemann and Hojlund A/S (Denmark), B. Steen Christensen (Denmark), Technomare (Italy).

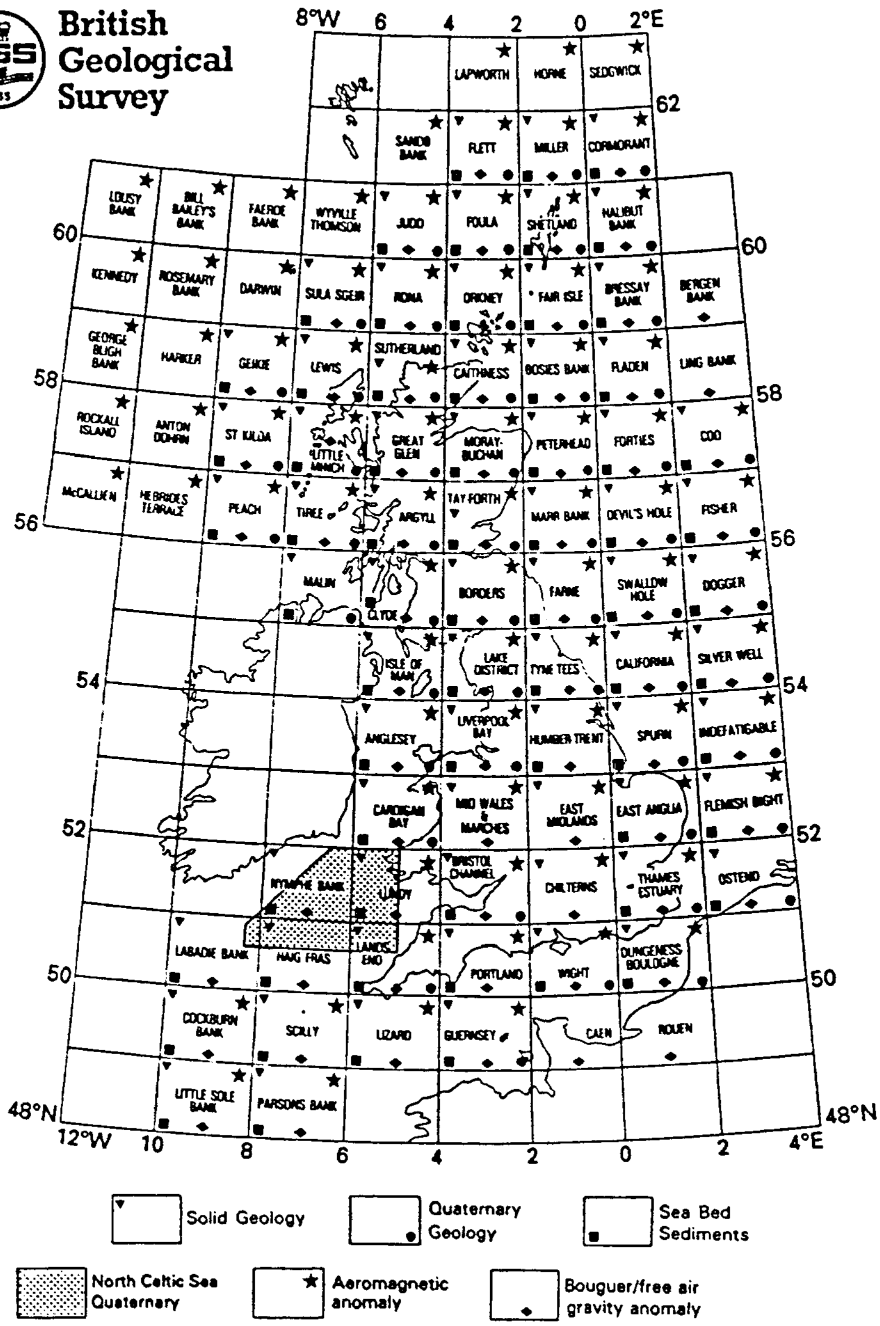
4.10. United States of America

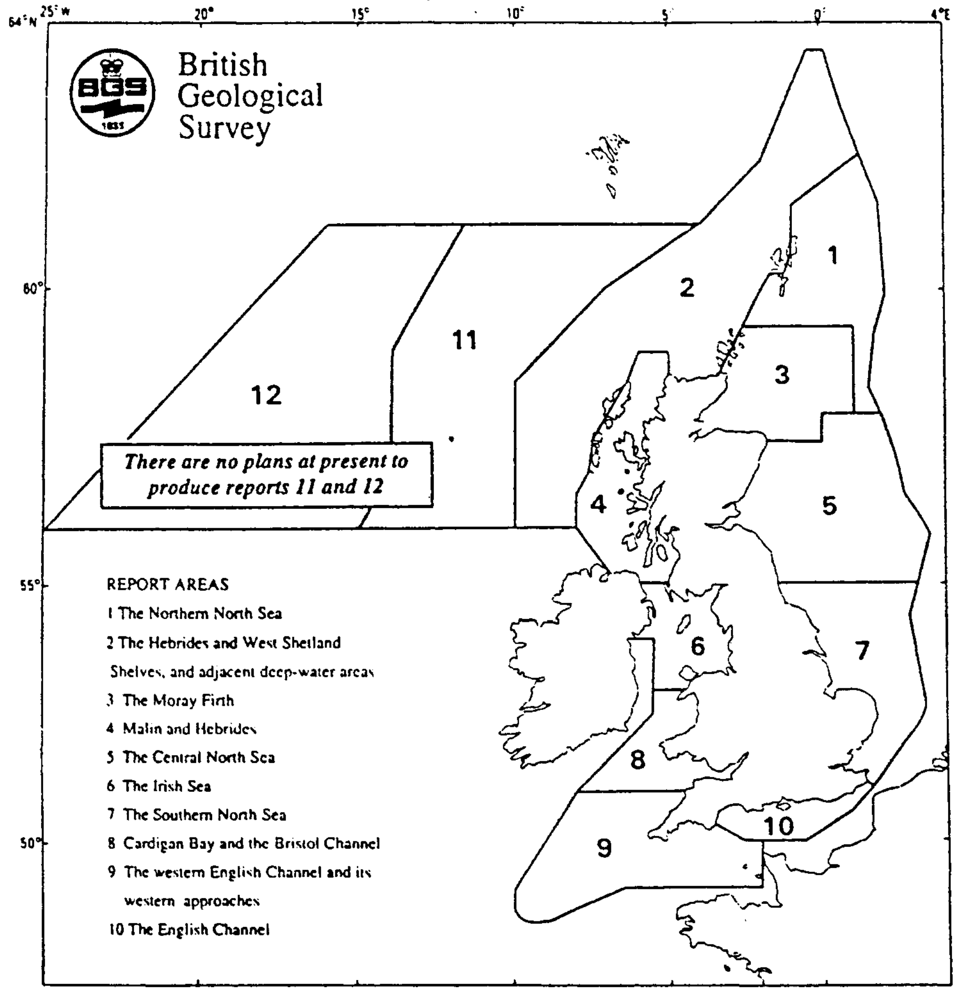
Specific mapping continues to be done by the U.S. Minerals Management Service, the U.S. Geological Survey, and the National Oceanic and Atmospheric Administration. No new maps of interest to this working group have been published since 1992 but those interested in these activities may request a newsletter (EEZ News) from

USGS-NOAA Joint Office for Mapping and Research
915 National Center
Reston, Virginia 22092
U.S.A.
Telephone: 703-648-6525
FAX: 703-648-5464
Telemail/OMNET M. LOCKWOOD

AVAILABILITY OF 1:250 000 SCALE UTM MAPS

British Geological Survey





CURRENTLY AVAILABLE

The geology of the Moray Firth - £11.50

The geology of the English Channel and its western approaches - £10.50

The geology of the southern North Sea - £15.00

UK OFFSHORE REGIONAL REPORTS

5. BLACK BOXES

Introduction

Reports on development and implementation of electronic surveillance systems ("black boxes") for monitoring of dredgers were received from Belgium, Ireland, the Netherlands, Sweden, the United Kingdom and the USA.

5.1. Belgium

In addition to the information supplied for the 1992 Working Group report, it is noted that a "black box" system is mandatory in all Belgian marine extraction vessels. installation of such a system is a condition of renewal of or application for extraction licences.

5.2 Ireland

The need for a monitoring system is recognised but no decision has been reached about the specifications of the particular "black box" system which will be required.

5.3 Netherlands

In the Netherlands a black box system will be tested in may 1993. After the test period 8 systems will be ready for operational use.

In the navigation channels a "simple" black box system is already operational, the ODIN-system. This system records where the trailing hopper dredger is at work. After a certain period, a week or month, the registration is plotted. Visual inspection of the right position, within the area which is licensed, is possible.

5.4 Sweden

As yet no system is in use or being developed. The Swedish Government will reconsider the situation in the light of future levels of dredging activity.

5.5 United Kingdom

From 1 January 1993 all dredging vessels using Crown Estate licences have been fitted with an Electronic Monitoring System (EMS).

The EMS provides the Crown Estate with information about the location of the vessel during dredging operations. The information is submitted by the licence holder to the Crown Estate monthly on a separate unique diskette for each vessel. The diskette contains a security programme which encodes the information provided by the dredging vessel. The information provided by the vessel is in a format specified by the Crown Estate. The appropriate hardware and software is provided by the licensee.

The EMS on board the vessel is switched on at all times. When it is in standby mode (dredging pumps <u>not</u> running) the EMS records date and time every 30 minutes. The EMS automatically records date, time, vessel position and dredging status indicators (if any) every thirty seconds when the vessel is dredging. The Crown Estate assumes that the vessel is dredging when the pump is running unless information is provided electronically to the contrary. For this purpose the EMS has available four channels which can be used by vessel dredging status indicators. The licensee chooses the dredging status indicators, if any, he wishes but the information must be presented to the EMS in a YES/NO/NOT USED format.

Description of basic EMS components

The basic components of the EMS on board the dredging vessel comprise the following elements:-

1. Navigation equipment and dredging status indicators (licensees responsibility).

2. Electronic outputs of navigational and dredging status indicator equipment (licensees responsibility).

3. Hardware and software for presentation of data to be recorded in specified format (licensees responsibility).

4. Software for recording data in security format on diskette provided by the Crown Estate (Crown Estate responsibility).

The diskette from each vessel is submitted to the Crown Estate at the end of each month. The information on each diskette is checked against the particular licence details and any anomalous records are automatically highlighted. Appropriate action is taken by the Crown Estate on any anomalous records.

5.6 United States of America

The U.S. Army Corps of Engineers continues to explore various electronic monitoring systems. They recently reported using a system to monitor the efficiency of overflow operations using a nuclear density gauge to determine the incoming slurry density, combining this with the flowmeter measurements to determine the loading rate. This is compared to the retention rate determined by the change in draft in order to calculate the discharge of suspended sediment into the receiving waters (S. Scott, 1992. Improving hopper dredge overflow operations with production monitoring technology, Dredging Research DRP-92-4, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi: 1-5 - Paper at Annex V).

It was noted in the meeting, from British experience, that there could be problems with the above approach if the vessel was ballasting at the same time.

6. BEACH RECHARGE

An example from the Netherlands of beach recharge and the need for marine aggregates was presented to the meeting.

In the Netherlands a new coastal defence policy was set up in 1990. It was based on the experience dealing with a sandy coast for a long period of time.

The Dutch coast consists of a sandy foreshore, beaches and a dune system for a very large part of a coastline.

Due to the struggle against the sea a monitoring system for coastal behaviour has existed since 1860. It has been upgraded and extended since that time. Now a large and sophisticated monitoring system is in place, taking measurements almost every 250 m from the first dune row for a length of about 800 m.

The long experience with coastal processes and large scale coastal behaviour made it possible to make projections of future needs for beach nourishment. On the basis of this a programme has been developed for supplying the beach projects and consequently the needs for marine aggregates, i.e. marine sands, are well established.

The basic item in the new coastal defence policy is the reference level of the coastal situation in 1990. This is a base line which represents a safe situation based on a high level of protection against damage.

Also crucial is the decision to use soft engineering, the use of sandy material, instead of building groins or dykes.

This solution is ideally suited to the situation in the Netherlands. For other coastlines an extensive study should be carried out to determine the best solution for individual coastlines. The application of cost-benefit analysis will indicate the most favourable solution.

This new approach in coastal defence policy has to be monitored and evaluated approximately every five years. In 1993 a brief evaluation will be made to check that the approach is living up to expectations. After five years a more in depth evaluation will be made. Following this it should then be clear whether the projections for sand requirements, 5-6 million m^3 every year, and the financial allocation, 60 million Dutch Florin, is enough.

This year a new kind of beach nourishment will be carried out as an experiment, a shore face nourishment between -6 to -5 m. This technique gives a lower price per m^3, but it needs a greater volume of sand. It is expected to be cheaper than traditionally beach nourishment. The beach nourishment material is deposited in shallow water on the beach slope. The natural sand transport in the surf zone will transport the sand landwards but also seawards. The net effect will be landwards. A large physical monitoring programme is being set up in cooperation with Danish and German scientists in a MAST - framework.

Two pilot studies are being carried out for hand engineering solutions, because beach nourishment is not always the best solution. A perched beach and a large dam are being considered, first in terms of engineering practicalities then in terms of cost.

7. Evaluation of results of environmental impact assessment carried out in France and the Netherlands related to marine aggregate extraction operations and UK assessments of the effects of marine extraction on benthos

The Working Group considered the results of environmental impact assessment from France and the Netherlands . In addition the preliminary results of a study being undertaken in the UK on the post-dredging recolonisation of benthos following marine gravel extraction were discussed.

Summaries of Danish environmental impact assessments in connection with the Great Belt Link project were tabled for information (Annex IX).

<u>France</u>

M. Desprez and co-workers (France) have carried out studies to compare the impact on the geomorphology and macrobenthic communities of sand and gravel extraction in two areas. The areas used for this comparison were the Klaverbank (water depth 38 m below MSL) in the North Sea and Dieppe (water depth 20 m below MSL) near the French shore in the English Channel.

Desprez and co-workers compared:

- the methodology used;
- the pre-surveys (e.g. sediment, benthos);
- amount of extracted material (laterally extensive but low intensity on the Klaverbank and intensive over a more restricted area at Dieppe);
- the extraction impact (on seabed morphology, sediment and benthos - specifically richness, densities and biomass);
- the rate of recolonisation of the extracted areas.

In both cases the impact studies used several reference stations outside the extraction area.

Klaverbank area was less diverse than the Dieppe area, 128 species compared to 228 species respectively. This may be caused in part by the method of sampling. However the Dieppe study provided a more detailed identification of species than the Klaverbank study.

The results show that the long term effects on densities and biomass were similar in both cases. The densities were reduced by 72% and by 80% for Klaverbank and Dieppe (1986-1991) respectively. For the biomass the reduction was 80% (Klaverbank) and 90% (Dieppe).

In contrast the impact on specific richness is lower on the Klaverbank (-30%) then in Dieppe (-50-70%).

Consideration of the sediment showed a difference between the two sites. In Klaverbank no change in the grain size of the sediment was evident after extraction, but in Dieppe a large increase in the proportion of fine sand was observed. At the control sites (outside the extraction area), fine sand made up 26% of the sediment. However, within the extraction site it increased to 50-70%. However, gravel patches were still present.

Recolonisation was only studied at the Klaverbank. The specific richness and densities were restored within 8 months, except for bivalves. This indicates that the biomass was not restored within the same period and that this will probably take many years. Recolonisation studies for Dieppe are proposed for 1993.

This study indicates that the benthos fauna is rapidly and intensively affected by extraction activities. These results suggest that extraction areas should not be alternated but extraction kept within a limited area.

However, further studies on recolonisation processes in areas where sand and gravel have been intensively extracted are needed before clear recommendations can be given. Prolonged extraction in a limited area may affect the morphology of the seabed. Work is required on the effects of changes in sea bed morphology or benthos fauna, fish and fishing activity.

A summary is presented in Figure 4 and a paper giving details of the study is at Annex VII.

Netherlands

In the Netherlands an extensive marine sand extraction programme is carried out each year. The main purpose is to contribute to the demands for the annual beach nourishment programme, approx. 5-6 million m^3. There is also a growing demand for the use of sea sand for landfill.

The programme for beach nourishment coastal defence works is decided on an annual basis. The aims and methods are described in a coastal defence policy plan. The yearly budget is about 6 million Dutch Florin.
In this coastal defence plan the requirement for sea sand is also set out. A conservative approach is used. Sea sand extraction is allowed seawards of the 20 m isobath or seawards of a line 20 km from the coast.

During the last three years the Regional Extraction Plan for the Dutch part of the North Sea has been produced. In April 1993 the Minister of Transport, Public Works and Water Management presented this document to the Dutch Parliament. With Parliamentary approval, this document will form the official extraction policy for the Dutch part of the North Sea.

In the extraction plan the new water management approach is taken into account. The problems of pollution and disturbance of the North Sea are presented in the North Sea Water System Management Plan. All the new Dutch policy is implemented. For the Dutch part of the North Sea a so-called "environmental zoning" system has been introduced. The aim of this zone system is to guarantee an appropriate level of protection to the ecosystem for recovery and sustainable development of a healthy, stable and divers ecosystem on the DCS. In this plan it was concluded that the sea is severely disturbed by contamination and other human activities. The plan sets objectives for the protection, recovery and development of ecosystems in the Dutch North Sea.

In the environmental zone (Figure 5) regulations controlling contamination and other human activity likely to disturb the marine environment will be implemented. In this way an appropriate level of protection is guaranteed. For example, sea sand extraction in the environmental zone is restricted to the navigation channels and seawards of the 20 m isobath.

As the boundaries of the environmental zone are broadly the 20 m isobath but also including migrating routes, the Klaverbank and the Frisian Front there is no serious conflict with sea sand extraction (Figures 6 and 7).

Within the environmental zone a special protected area is planned. In this area no activities will be permitted, hence the recovery and development of a undisturbed North Sea sea bed can be studied.

The military exclusion areas will also be studied. The aim is to study a small part of the area, where less munitions are found and military activities are less.

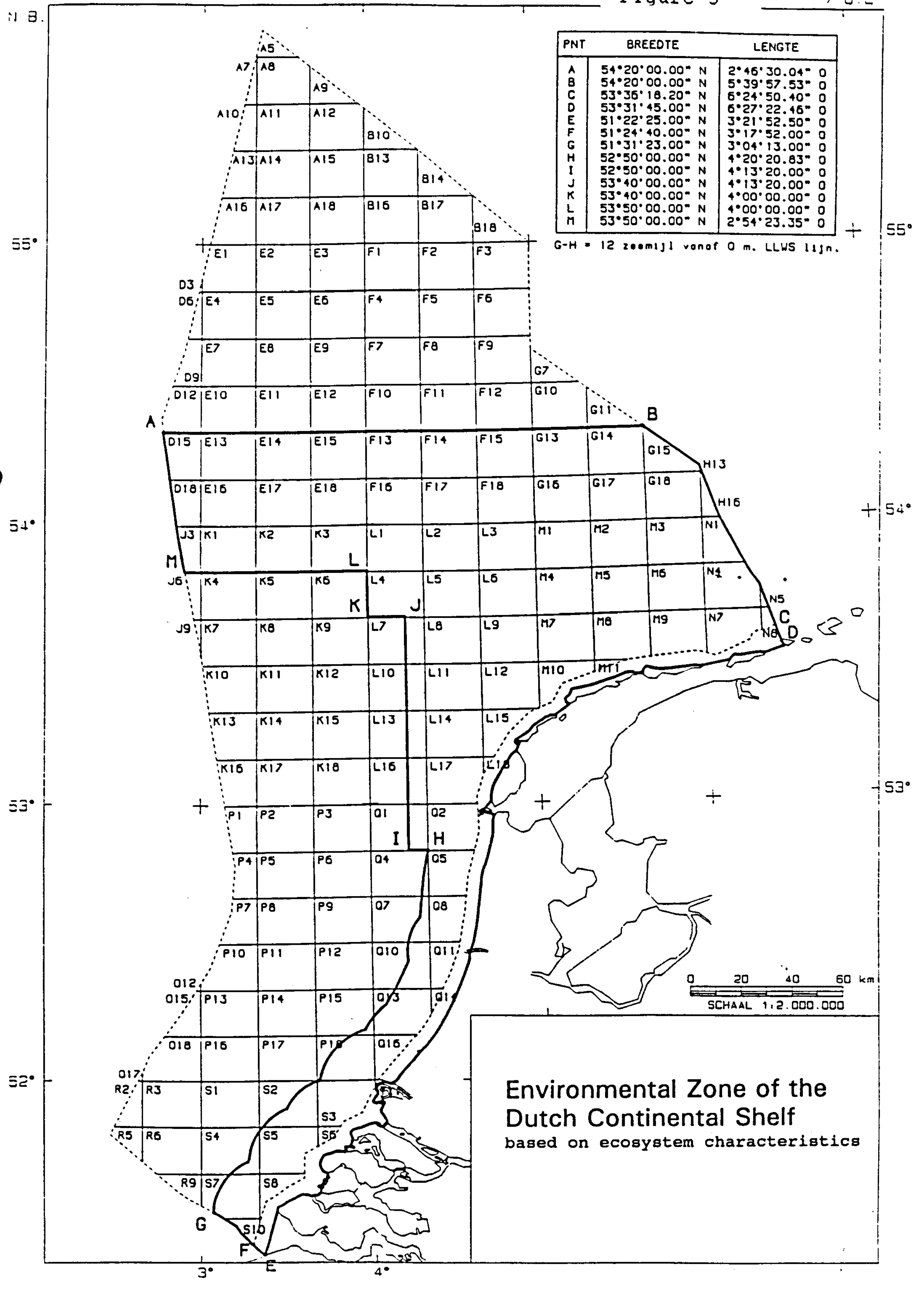
To evaluate the extraction programme and to cope with the gaps in knowledge an evaluation programme is being carried out. In 1994 a large sand extraction project will be followed by detailed studies of the environmental effects.

Gravel extraction is dealt with in another way. The amount of gravel

Figure 4

	DIEPPE			KLAVERBANK
SITE				
Location	Eastern English Channel			North Sea
Depth (below MSL)	- 20 m			- 38 m
Sediment	Gravelly sand			Gravel waves
Benthos	228 sp			128 sp (65 % common)
METHODOLOGY				
Sampling gear	Rallier dredge			Hamon grab
Sampling volume	20 l			20 l
EXTRACTION				
Dredging method	Suction hopper			Suction hopper
Duration	1980-85	1986-92		1989 (2 months)
Surface	1,5	1,5		8,5
Volume (m3)	200 000	50 000		336 000
Intensity (m3.km².month-1)	12 200	3 000		3 750
IMPACT				
Seabed morphology	Tracks 0,5 - 1,5 m			Tracks 0,3 - 0,5 m
Sediment	Refinement			No change
Benthos : specific richness	- 70 %			- 30 %
density	- 80 %			- 72 %
biomass	- 90 %			- 80 %
RECOLONISATION	1986	1988	1991	
Specific richness	-70%	-60%	-50%	in 8 months
Density	-80%	-70%	-70%	except large bivalves

Figure 5

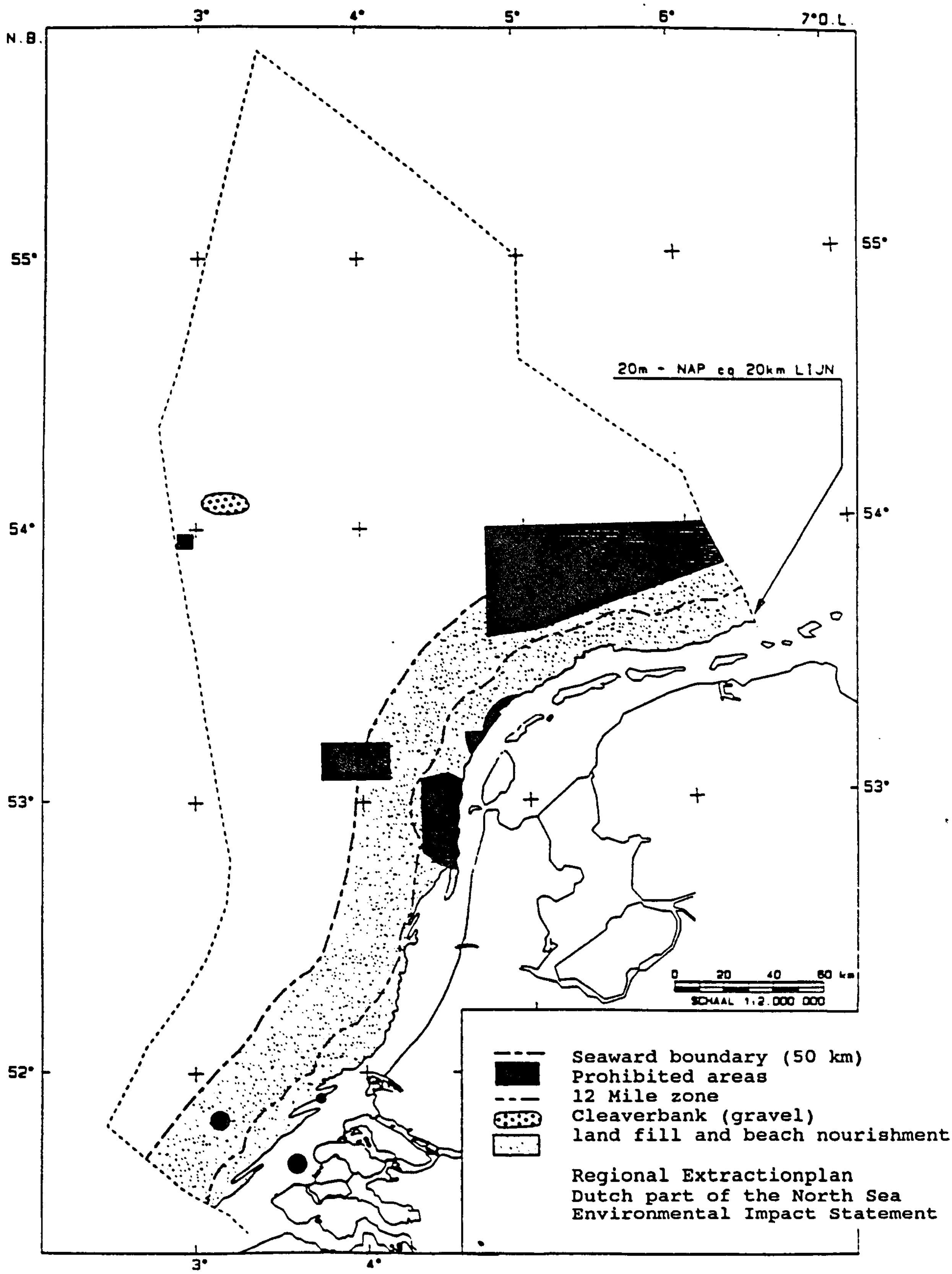


PNT	BREEDTE	LENGTE
A	54°20'00.00" N	2°46'30.04" O
B	54°20'00.00" N	5°39'57.53" O
C	53°36'18.20" N	6°24'50.40" O
D	53°31'45.00" N	6°27'22.46" O
E	51°22'25.00" N	3°21'52.50" O
F	51°24'40.00" N	3°17'52.00" O
G	51°31'23.00" N	3°04'13.00" O
H	52°50'00.00" N	4°20'20.83" O
I	52°50'00.00" N	4°13'20.00" O
J	53°40'00.00" N	4°13'20.00" O
K	53°40'00.00" N	4°00'00.00" O
L	53°50'00.00" N	4°00'00.00" O
M	53°50'00.00" N	2°54'23.35" O

G-H = 12 zeemijl vanaf 0 m. LLWS lijn.

Environmental Zone of the Dutch Continental Shelf
based on ecosystem characteristics

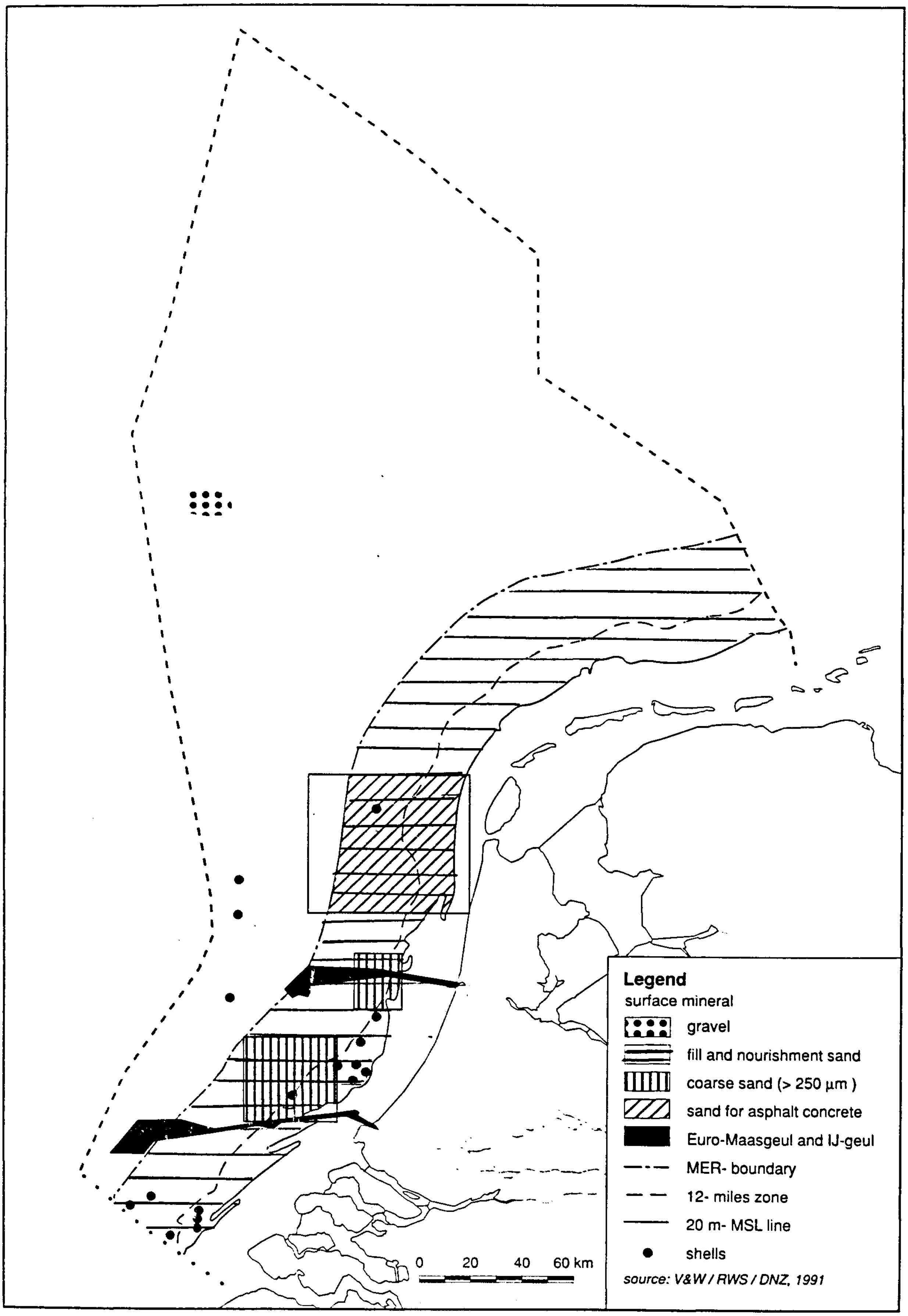
Figure 6



Extraction ares for land fill and beach suppletion sand seaward of the NAP -20 m line i.e. 20 km line, including prohibited areas.

Figure 7

Potential surface mineral extraction areas



extraction is small but cannot be discounted. Before any gravel extraction is authorised, a special Environmental Impact Statement has to be produced. The contractors wishing to carry out the extraction must make the environmental impact assessment.

Shell extraction is a small business in the Netherlands. The activity takes place in inshore waters and in the Wadden Sea. Opportunities in the Wadden Sea are decreasing so there is increased interest in the North Sea.

Strictly according to the new extraction plan shell extraction is only possible outside the 20 m isobath. However it is unlikely that commercial shell resources can be found outside this limit. A study is being carried out to establish the quantities and distribution of shells in the Dutch North Sea and the impact of shell extraction on the marine environment. In view of the concentration of shell resources in inshore waters this study is focusing on the coastal waters.

United Kingdom

During the 1980's the demand for aggregates in the UK steadily increased, primarily as a result of the boom in construction. Demand for high quality aggregates such as sand and gravel for concrete was particularly high. Marine sand and gravel deposits are an important source of these aggregates. The recent advances in marine extraction technologies, the short supply of land-based sources that can be worked in an environmentally acceptable manner and favourable market economics have paved the way for increased production of marine aggregates.

However, during the 1970's, concern was growing over the environmental impact of marine aggregate extraction, and in particular the potential threat to benthic communities and their dependent fisheries (Lart, 1991).

There are few original scientific investigations which describe the effects of marine aggregate extraction on benthos. Initial research in UK waters was undertaken by the Ministry of Agriculture, Fisheries and Food (MAFF) but the impacts on the benthos and the rates of recolonisation were not fully quantified. Accordingly, in October 1990 a three-year research programme was initiated by the Crown Estate Commission (CEC) and MAFF to determine: i. the initial impacts of dredging on the benthos and sediments; ii. the processes of recolonisation post dredging; iii. the natural faunistic differences between gravels on a wide-scale; and iv. coarse sediment quantitative sampling methods.

This research programme and its preliminary results are described in the paper at Annex VIII.

8. Content of Environmental Impact Assessments

The Working Group considered draft guidance on environmental impact assessment for marine aggregates dredging proposals. The following draft represents the Working Group's initial views on the type of guidance required for such environmental impact assessments.

The Working Group recognised that there is currently a paucity of experience of the practical application of environmental impact assessment to marine aggregates dredging proposals. Consequently the Working Group proposes that the draft guidance should be considered further at its next meeting in the light of experience over the coming year.

The Working Group considers that particular attention should be given to the degree of detail to be included in guidance on environmental impact assessment and the requirements of European Community Directives. Further attention should also be given to the structure of the document and, especially, the degree of overlap between some sub-sections.

The Working Group noted that the use of scoping documents to apply the guidance to individual proposals can reduce uncertainty and the potential for disagreement between interested parties. An example of a scoping document is given at Annex.

DRAFT GUIDANCE ON ENVIRONMENTAL ASSESSMENT FOR MARINE AGGREGATES DREDGING PROPOSALS

1. INFORMATION REQUIREMENTS

1.1 Nature of the deposit

1.1.1. The reserve should be identified by its geographical location (latitude and longitude) and described in terms of:

i. the bathymetry of the area;

ii. the distance from the nearest coastline;

iii. the geological history, including the source and type of material, isopachyte chart of the thickness of deposit, sea bed morphology over the proposed extraction site and immediate areas, the nature of underlying deposits as well as the geological stability of the deposit;

iv. the mobility of the bottom sediments under natural conditions;

v. the presence of current or proposed extraction activities nearby;

vi. potential for recharge.

1.1.2. The total quantity of material in the reserve should be estimated along with proposed extraction rates and the expected lifetime of the deposit.

1.2. Physical environment

1.2.1. To assess the physical impact of aggregate extraction activities, information should be provided on:

i. local hydrography including tidal and residual water movements;

ii. local wind and wave patterns and characteristics, average number of storm days per year;

iii. bedload sediment transport including occurrence and direction of bedforms indicating transport;

iv. natural suspended sediment loads (turbidity);

v. storm or wave-induced turbidity;

vi. transport and settlement of fine sediment suspended by the dredging activity;

vii. effects of on board-screening/grading, both in terms of turbidity and fall out to sea bed;

viii. the potential for the release of chemical contaminants during dredging should be considered;

ix. prediction for prevailing wave/current regime and local water circulation resulting from removal or creation of topographical features on the seabed including cumulative effects taking into account extraction at adjacent current or proposed extraction areas where appropriate;

x. predictions for longer term processes and bed-load movement;

xi. predictions for coastal erosion.

1.3. Biological environment

1.3.1. The principal biological impact of marine aggregate extraction is the disturbance and removal of benthic infauna and epifauna and alteration of the substrate upon which colonisation depends. To assess the biological impact of aggregate extraction, the following information will probably be required:

i. an assessment of the benthic community structure(s) (species type and abundance) within the proposed extraction area which may include temporal as well as spatial variations;

ii. information on the fishery and shellfishery resources, including spawning areas, with particular regard to benthic spawning fish (eg herring and sand eels), nursery areas, overwintering grounds for ovigerous crustaceans and known routes of migration;

iii. the predator/prey relationships between the benthos and demersal fish species (eg by stomach content investigations);

iv. the method of dredging, including the effect of different suction equipment upon the seabed and benthic fauna;

v. the estimated recolonisation time for the exposed sediments;

1.4. Interference with other legitimate uses of the sea

1.4.1. The assessment should consider the following in relation to the proposed programme for exploitation of the resource;

i. frequency, duration and period of dredging operation;

ii. economic information on the fishing resource in the immediate area;

iii. shipping lanes and navigational requirements;

iv. military exclusion zones;

v. engineering uses of the seabed (eg adjacent extraction activities, undersea cables and pipelines);

vi. adjacent areas of the sea designated as sites for the disposal of waste material;

vii. location of known wrecks (with an indiction of their historic status) and war graves;

viii. areas of conservation, cultural or historical importance which could be affected including a list of areas of special scientific or biological interest, such as adjacent Sites of Special Scientific Interest (SSSI), Marine Nature Reserves (MNR) and Marine Consultation Areas (MCA), Marine Special Protection Areas (SPA) sites designated under the Ramsar Convention, the World Heritage Convention or the UNEP "Man and the Biosphere" Programme.;

ix. recreational uses of the area (eg sport angling, diving);

x. any requirement for the disposal at sea of unwanted material produced as a result of processing the aggregate on land.

2. PREPARATION OF THE ASSESSMENT AND STATEMENT

2.1. In preparing the assessment, it will be necessary to identify and quantify any significant effects of the proposal.

2.2. These effects can be summarised as an impact hypothesis, which may draw on the results of earlier studies of environmental characteristics and their variability. The impact hypothesis will also indicate where measures need to be taken to mitigate the effects of the proposed dredging or associated operations.

2.3. It will then be necessary to consider the steps that might be taken to mitigate the effects of extraction activities. This may include: the selection of dredging equipment and timing of dredging operations to limit impact on benthic communities and spawning cycles; modification of dredging depth/area to limit changes to hydrodynamics and sediment transport and protect archaeological sites; zoning the area to be licensed or scheduling extraction campaigns to protect sensitive fisheries or to respect access to traditional commercial fisheries; limitation of on-board screening to minimise fall-out of discard material.

2.4. It may also be necessary to demonstrate the need to exploit the resource in question, through careful, comparative consideration of local, regional and national need for the material in relation to the identified impacts of the proposal and the relative environmental costs of provision from other sources, both marine and on land.

2.5. The results of the assessment should be presented as an environmental statement. The environmental statement should describe the information used as the basis of the environmental assessment and should set out the results of the assessment in the form of an impact hypothesis. It will detail all the significant effects of the proposal that have been identified and briefly explain why the proposal is unlikely to affect other interests or areas of acknowledged importance in the vicinity of the proposal.

2.6. The environmental statement should set out any measures or changes to the proposal designed to ameliorate the effects of the proposal that were identified in the impact hypothesis. Where it is not possible to ameliorate the effects of the proposal the statement should provide details of the reasons why the benefits of the proposal outweigh its environmental effects.

2.7. The environmental statement should describe the monitoring needed to ensure that the impact hypothesis is valid and any ameliorative measures are effective.

3. MONITORING

3.1. Definition

3.1.1. In the context of assessing and controlling the environmental effects of marine aggregate extraction, monitoring is the repeated measurement of a variable to identify any effect on the marine environment.

3.1.2. Monitoring of the marine environment is generally undertaken for the following reasons:

i. to establish whether licence conditions are being observed (Compliance monitoring);

ii. to establish the effect (spatial and temporal) of the dredging operation (Effects monitoring);

iv. to improve the basis on which licence applications are assessed by improving knowledge of field effects which are not readily estimated by laboratory or literature assessment (Applied research).

3.2 Guidance

3.2.1 Monitoring operations are expensive for they require considerable resources both at sea and in subsequent sample and data processing. In order to approach a monitoring programme in a resource-effective manner, it is essential that the programme should have clearly defined objectives, that measurements made can meet those objectives, and that the results be reviewed at regular intervals in relation to those objectives. The monitoring scheme may then be continued, reviewed or even terminated.

3.2.2. The impact hypothesis prepared from the environmental assessment summarises the effects of the proposal on the marine environment. It is an important element in the establishment of a monitoring programme.

3.2.3. Before any monitoring programme is drawn up and any measurements are made, the following questions should be addressed.

i. What measurements are necessary?

ii. What is the purpose of monitoring a particular variable?

iii. In what environmental compartment or at what locations can the measurements be made most effectively?

iv. For how long should be measurements continue to be made to meet the objective?

v. What should be the temporal and spatial scale of measurements made to test the hypothesis?

3.2.4 The extraction of marine aggregate has a primary impact at the seabed. Thus, although a consideration of water column effects cannot be discounted in the early stages of planning the monitoring, it is often possible to restrict subsequent monitoring to the seabed.

3.2.5. Physical monitoring may be based on remote methods such as sidescan sonar to identify changes in the character of the seabed. These measurements may require a certain amount of sediment sampling to establish ground truth.

3.2.6. Biological sampling may be based on assessment of changes in the benthic community structure.

3.2.7. In order to assess the impact, it may be necessary to compare the physical or biological status of the affected areas with reference sites located away from the extraction site. Such reference sites can be identified during the preparation of the impact hypothesis.

3.2.8. The spatial extent of sampling will need to take into account the size of the area designated for extraction, the transition between the area of exploitation and the surrounding natural sea bed and possible "far-field" effects resulting from the mobility of fine material disturbed by the dredging activity.

3.2.9. If it can be demonstrated that the effects of marine aggregate extraction can be expected to be similar over areas of similar sea bed conditions, it may be appropriate to conduct biological monitoring programmes at a few carefully chosen sites representative of these conditions.

3.2.10. A concise statement of monitoring activities should be prepared. Reports should detail the measurements made, results obtained, their interpretation and how these data relate to the monitoring objectives. The frequency of monitoring will depend on the aims and will be related to the scale of extraction activities and the anticipated period of consequential environmental changes which may extend beyond the cessation of extraction activities.

9. Resolving conflict between fishing interests and marine aggregates extraction: French experience

The following summary of recent French experience of conflicts between differing interests during the course of consideration of applications for marine aggregates extraction permissions was presented to the Working Group.

An inter-Ministerial report was published in 1992 (Ministries of Environment, Sea and Industry)

"L'exploitation des granulats marins et le cohabitation avec la fiche professionnelle"

by J.Y. Hamon, G. Leynaud & J. P. Pertus

Its conclusions are:

- present legislation is not suited to resolving marine extraction applications;
- absence of global politics;
- scientific knowledge not sufficient;
- fishermen neither informed nor involved;
- extreme risks of conflicts between dredgers and fishermen.

It proposes : 1) to improve administration:

- to provide better and more objective information;
- to increase research effort;
- to bring together consumers, dredgers, builders, fishermen etc;
- to monitor dredging activity.

2) to facilitate cooperation:

- develop dialogue between dredgers and fishermen (under Administration authority)
- develop Schemes for Sea Resources Use
- Inform the public.

3) to simplify legislation (policy)

4) to enforce dredging conditions:

- production - duration, tonnage;
- location - precise location with "black box" systems;
- sea bed morphology - bathymetry monitored with side-scan sonar before, during, after dredging;
- environmental impact - dredging activity in relation to ecology and fishing activity

In France the annual production of marine aggregates is presently about 4 millions tonnes. This production could reasonably increase up to 15 millions tonnes, in order to counterbalance the decreasing supply from land sources.

The French Government is currently considering the problems associated with permitting marine aggregates extraction following an increase in applications and increasing conflict between differing interests. As the preceding summary indicated, better dialogue, a simpler procedure for assessing applications and more robust regulation of extraction is anticipated to resolve much of the conflict.

As the paper at Annex X describes, scientists have an important role in this process by providing reliable, objective information and effective monitoring. This paper stresses the need for reference sites to determine variation in natural parameters and so determine the real as opposed to apparent effects of dredging and recolonisation. This point is also made by Desprez (Annex VII) and Kenny and Rees (Annex VIII).

10. RECOMMENDATIONS

10.1. Terms of Reference of the ICES Working Group on the effects of dredging on fisheries

The Terms of Reference of the Working Group, as set out in ICES Co Res Rep 182, require some revision to take account of work that has been completed on codes of practice for the control of dredging activity and to define more closely the present work of the Group.

The Working Group is agreed that it should consider the effects of all marine dredging operations including capital and maintenance dredging. However the Working Group is clear that its remit does not extend to the consideration of the effects of the disposal of dredge spoil or the collection of statistics on capital and maintenance dredging.

The Working Group proposes the following Terms of Reference:

a. to update knowledge of marine extraction and dredging operations and their impact on the marine environment;

b. to examine the recent results of research programmes on the effects of marine extraction and dredging operations on the marine environment, particularly the influence on fisheries;

c. to monitor and evaluate national policy and practice for the control of marine extraction and dredging;

d. to report on projections of, and significant factors affecting, future demand for marine dredged material and their possible impact on the marine environment and effects on fisheries;

e. to review national marine geological mapping programmes;

f. to collect and consider statistics and information on marine extraction and dredging;

g. to advise on major issues where an ICES policy is needed;

h. to make recommendations on management and research, as necessary;

10.2. Recommendations for future work

The Working Group proposes the recommendations listed below.

The Working Group on the Effects of Extraction of Marine Sediments on Fisheries (Chairman, Dr S J De Groot) will meet from 3-6 May, 1994 at BGS, Keyworth, Nottingham, England, to carry out the following tasks:

a. to consider further the content of Environmental Impact Assessments which, according to the "Code of Practice for the Commercial Exploitation of Marine Minerals", it may be necessary to carry out prior to extraction of such deposits, with a view to producing guidelines;

b. to review the results of Environmental Impact Assessments related to marine aggregate extraction operations;

c. to consider standards for marine geological surveying and sampling;

d. to review developments in legal and administrative frameworks and procedures in accordance with ICES Co Res Rep 182;

e. to review the status of marine aggregate extraction activities in

ICES member countries and related environmental research;

f. to compile and present marine extraction and dredging statistics for the ten year period to 1993 including comparison with published statistics for capital and maintenance dredging;

g. to review the development of seabed resource mapping in ICES member countries;

h. to examine the scope for coordination and correlation between geological and biological mapping;

In addition the Working Group will consider:

i. the scope for measures to mitigate the effects of dredging;

ii. the effects of dredging mobile sand banks;

iii. the effects of dredging in the coastal zone;

iv. the factors affecting recolonisation of dredged areas, including: minimum thickness of substrate; surface characteristics; frequency of disturbance; intensity of dredging; and proximity to undisturbed areas.

In addition the exchange of information, including working Group Reports, with the Benthic Ecology Working Group is recommended in order to provide coordination in overlapping fields of interest. To facilitate this exchange the attendance of the Chairman or a representative of the Benthic Ecology Working Group at meetings of the Working Group of the Effects of Extraction of Marine Sediments on Fisheries is recommended to continue where possible.

11. Acknowledgements

The Working Group gratefully acknowledges the assistance and sponsorship of the following organisations, without who's help the meeting would not have been possible.

GEMEL

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Conseil General de la Somme

GIE Graves de Mer, Dieppe

Societe G.S.M., Cayeux

Caisse Epargne Abbeville

Cabinet notarial M^r Lecuyer

ANNEX I

Terms of Reference

The Terms of Reference of the Working Group on the Effects of Extraction of Marine Sediments on Fisheries as stated in ICES Cooperative Research Report 182 are:

a) to update the present status of marine extraction operations and their impact on the marine environment;

b) to examine the recent results of national research programmes on the effects of marine extraction operations on the marine environment, particularly the influence on fisheries;

c) to compare the national codes of practice for the control of dredging activities and to evaluate the changes since 1979;

d) to provide information on activities in the near future and their possible impact on the marine environment and effects on fisheries;

e) to advise on major issues where an ICES policy is needed;

f) to make recommendations on management and research, as necessary.

ANNEX II

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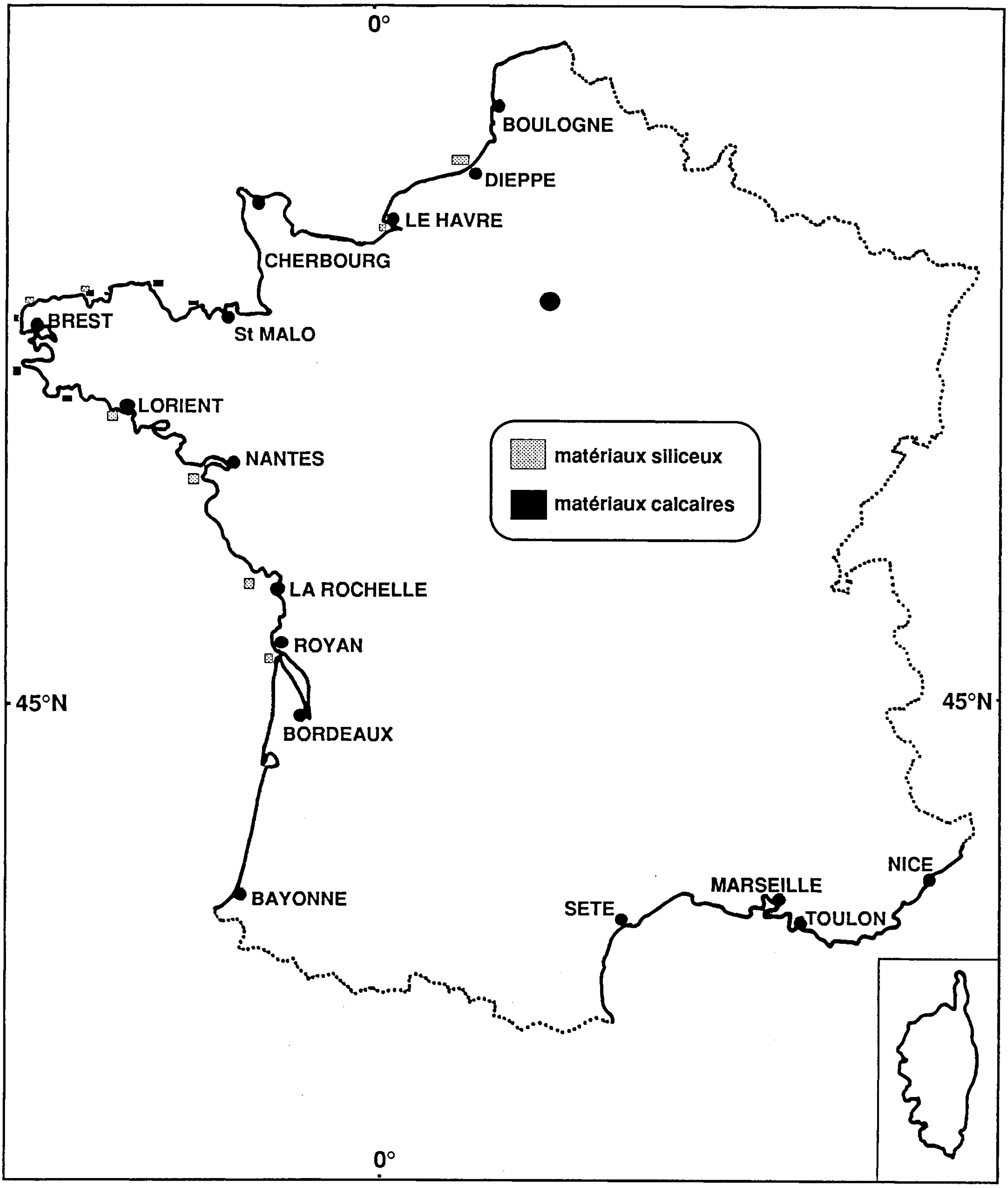

GISEMENTS EXPLOITES

SVERIGES GEOLOGISKA UNDERSÖKNING
Geological Survey of Sweden

1993-04-28

EXTRACTION OF MARINE AGGREGATE (m^3) IN SWEDEN 1980-1992

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1980-1992
Disken		525,499	104,415	2,995	38,500									671,409
Sandflyttan	111,798	18,645	28,518	3,400	11,503	5,377	6,205	8,037	4,653	1,692	1,692	423		201,943
Västra Haken	22,556	3,190	11,650	45,580	61,094	61,117	38,170	34,263	35,484	35,509	31,302	27,072	37,511	444,498
Lilla Middelgrund							785							785
Stora Middelgrund								25,380	24,534	30,768	138,776	82,534		301,982
Fårö								2,720		2,400				5,120
TOTAL	134,354	547,334	144,583	51,975	111,097	66,494	45,160	70,400	64,671	70,359	171,770	100,029	37,511	1 625,737

England and Wales

Regional Summary of Dredging Statistics
from 01/01/1992 to 31/12/1992

A. Licences to Dredge Aggregate

Dredging Area	Permitted Removal	Actual Removal
EAST COAST	16,400,000.00	10,255,813.00
THAMES ESTUARY	6,350,000.00	1,504,471.00
SOUTH COAST	13,545,400.00	4,794,290.00
SOUTH WEST	5,194,000.00	2,388,148.00
NORTH WEST	1,384,999.00	310,782.00
RIVERS AND MISCELLANEOUS	N/A	17,998.00
TOTAL	42,874,399.00	19,271,502.00

B. Licences Specifically for Fill Contracts and Beach Replenishments

England	N/A	1,287,500.00

A + B Total Dredging Amount	20,559,002.00

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year: 1992 — Reporting Period: 1 January 1992 - 31 December 1992

Country: Scotland — Region or Subarea[a]: Firth of Forth

Reporter Name: Derek Saward — Institution:

Address: SOAFD, Marine Laboratory, PO Box 101, Victoria Road, Torry, Aberdeen AB9 8DB

Type of material[b]	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m^3	million m^3	million m^3	million m^3		Specify use[c]	m^3
Silt mud clay	1.7				1,687,500 m3		
Sand	2.0	5,000 (0.005M) m3	10,000 (0.01M) m3 *		101,000 m3		
Gravely sand	2.2				204,000 m3		
Sandy gravel							
Gravel	2.4				1,000 m3		
Larger material (specify)	2.8				cobbles/boulders) rock 49,500 m3		
Calcareous materials (specify)							
Other deposits (specify)							

* Beneficial use of navigational dredgings.

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year: 1992
Reporting Period: 1 January 1992 - 31 December 1992

Country: Scotland
Region or Subarea[a]: Firth of Tay

Reporter Name: Derek Howard
Institution:

Address: SOAFD Marine Laboratory, PO Box 101, Victoria Road, Torry, Aberdeen AB9 8DB

Type of material[b]	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m³	million m³	million m³	million m³		Specify use[c]	m³
Silt mud clay	1.7				11,500 m³		
Sand	2.0	25,000 (0.025m) m³			2,500 m³		
Gravely sand							
Sandy gravel							
Gravel	2.4				500 m³		
Larger material (specify)	2.8				Boulders 500 m³		
Calcareous materials (specify)							
Other deposits (specify)							

PTO

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year: 1992
Reporting Period: 1 January 1992 - 31 December 1992

Country: Scotland
Region or Subarea[a]: East coast (excluding Firth of Tay and Firth of Forth)

Reporter Name: Derek Howard
Institution:

Address: SOAFD, Marine Laboratory, PO Box 101, Victoria Road, Torry, Aberdeen AB9 8DB

Type of material[b]	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m³	million m³	million m³	million m³		Specify use[c]	m³
Silt mud clay	1.7				416,500 m3		
Sand	2.0				223,500 m3		
Gravely sand	2.2				1,000 m3		
Sandy gravel	2.4				36,000 m3		
Gravel	2.4				20,000 m3		
Larger material (specify)	2.8				Cobbles / broken rock 40,500 m3		
Calcareous materials (specify)							
Other deposits (specify)							

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PTO

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year: 1992 — Reporting Period: 1 January 1992 - 31 December 1992

Country: Scotland — Region or Subarea[a]: Orkney and Shetland

Reporter Name: Derek Howard — Institution:

Address: SOAFD Marine Laboratory, PO Box 101, Victoria Road, Torry, Aberdeen AB9 8DB

Type of material[b]	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m^3	million m^3	million m^3	million m^3		Specify use[c]	m^3
Silt mud clay	1.7				1,000 m^3		
Sand	2.0				69,000 m^3		
Gravely sand							
Sandy gravel							
Gravel	2.4				3,500 m^3		
Larger material (specify)	2.8				Boulders / rock etc 5,000 m^3		
Calcareous materials (specify)							
Other deposits (specify)							

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PTO

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year ......1997...... Reporting Period ......1 JANUARY 1997 - 31 DECEMBER 1997......

Country ......SCOTLAND...... Region or Subarea[a] ......FIRTH OF CLYDE......

Reporter Name ......DEREK [illegible]...... Institution ....

Address ......SOAFD, MARINE LABORATORY, PO BOX 101, VICTORIA RD, TORRY, ABERDEEN AB9 8DB......

Type of material[b]	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m^3	million m^3	million m^3	million m^3		Specify use[c]	m^3
Silt mud clay	1.7				14,000 m^3		
Sand	2.0	20,000 (0.02M) m^3	256,000 (0.256M) m^3 *		136,000 m^3		
Gravely sand	2.2				207,000 m^3		
Sandy gravel							
Gravel	2.4				3,000 m^3		
Larger material (specify)							
Calcareous materials (specify)							
Other deposits (specify)							

* BENEFICIAL USE OF NAVIGATIONAL DREDGINGS

D463

PTO

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year: 1992
Reporting Period: 1 January 1992 –
Country: Scotland
Region or Subarea[a]: West Coast (Excluding Firth of Clyde)
Reporter Name: Derek Saward
Institution:
Address: SOAFD, Marine Laboratory, PO Box 101, Victoria Road, Torry, Aberdeen AB9 8DB

Type of material[b]	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m^3	million m^3	million m^3	million m^3		Specify use[c]	m^3
Silt mud clay	1.7				65,000 m^3		
Sand	2.0				4,500 m^3		
Gravely sand							
Sandy gravel	2.4				5,500 m^3		
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other deposits (specify)							

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PTO

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

Report on extraction of marine sediments and excavations

Year: 1992
Reporting Period: 1 JANUARY 1992 - 31 DECEMBER 1992

Country: SCOTLAND
Region or Subarea(a): SCOTLAND (TOTAL)

Reporter Name: DEREK SAWARD
Institution:

Address: SOAFD, MARINE LABORATORY, PO BOX 101, VICTORIA ROAD, TORRY, ABERDEEN AB9 8DB

Type of material(b)	Conversion factor	Removed for use on land (eg construction materials, roads etc)	Artificial land or island construction	Beach replenishment, coast protection	Dredge spoils which are disposed of at sea	Other	
	tonnes/m³	million m³	million m³	million m³		Specify use(c)	m³
Silt mud clay	1.7				2,195,000 m3		
Sand	2.0	50,000 (0.05M) m3	266,000 (0.266M) m3 *		536,000 m3		
Gravely sand	2.2				412,000 m3		
Sandy gravel	2.4				41,000 m3		
Gravel	2.4				28,000 m3		
Larger material (specify)	2.8				COBBLES / BOULDERS / ROCK 95,000 m3		
Calcareous materials (specify)							
Other deposits (specify)							

* BENEFICIAL USE OF NAVIGATIONAL DREDGINGS

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Annex IV

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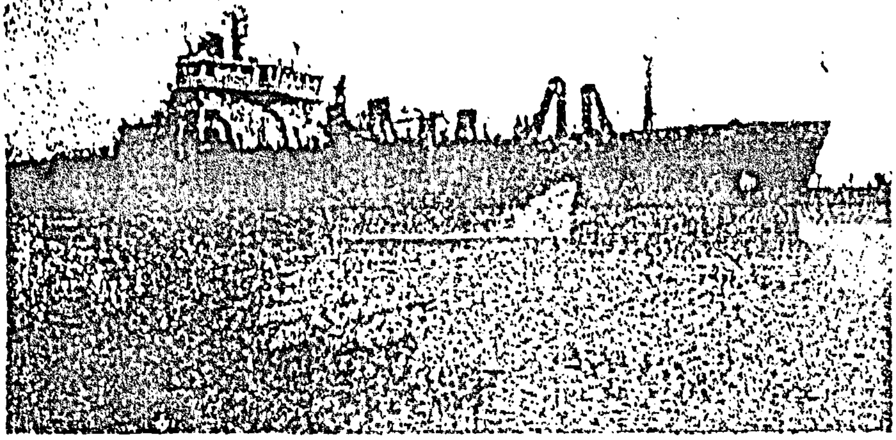
US Army Corps
of Engineers
Waterways Experiment
Station

Dredging Research

Vol DRP-92-4 November 1992

Improving hopper dredge overflow operations with production monitoring technology

by
Stephen H. Scott



The *Wheeler* operating in the Mississippi River

This article describes the use of currently available production monitoring technology for determining the efficiency of overflow operations based on operating characteristics of each individual dredge. This technology will provide data for defining how efficiently the dredge can retain solids during overflow operations in a given sediment and how various operational procedures can affect this efficiency.

Overflowing dredge hoppers to achieve economic load gain is generally justified when dredging coarse sediments. The degree of load gain will vary depending on the operating characteristics of the dredge plant as well as the dredged slurry composition.

Each hopper dredge plant has operating characteristics that influence settling of sediments in the hopper. Dredging variables, such as slurry input location, inflow rate, and solids concentration, will affect the efficiency and economic load gain of the dredge.

Economic loading, that is, the pumping time required for maximum production of the hopper dredge, is generally determined for each project area by evaluating not only the time required to *fill the hopper to maximum load*, but also the time and cost of completing a full dredging cycle (filling, overflowing, traveling, and placing the load at a designated disposal site).

Production monitoring techniques

The dredging community uses two primary types of production monitoring systems to determine the optimum dredging parameters (maximum flow rate and solids concentration) and calculate the total load in dredge hoppers.

The production meter system consists of a flowmeter used in conjunction with a nuclear density gauge. The flowmeter measures the slurry velocity in the dredge pipe, while the density meter measures the density of the material. Typically, the outputs from the flowmeter and density gauge operate a cross-point display located in the pilot house of the dredge. This display shows the dredge operator when optimum dredging conditions exist, that is, the highest flow rate of solids in the pipe. Currently, production meter data are displayed primarily in this manner and not recorded or used to calculate actual dredge production.

The vessel displacement load meter is used on hopper dredges to determine the hopper load as a function of displacement of the dredge during dredging. This system typically uses a bubbler system with ports on the hull of the vessel (bow and stern) to measure the change in hydrostatic pressure as the vessel drafts under the load. The hydrostatic pressure change is converted to units of distance (feet) and related to the vessel deadweight scale, which tabulates draft of the vessel in feet as a function of load (tons). The load data displayed as a function of time are recorded on a load chart in the pilot house. If the project area water density, sediment in-situ density, and hopper volume are known, the production in in-situ cubic yards can be calculated for each load.

Frequently, both of the these systems are installed on a hopper dredge. The production meter system is used to provide operational guidance to the dredge operator, and the displacement load meter is used to determine tonnage in the hopper. Both systems can be used to monitor overflow operations and provide data on the efficiency of overflow and how dredging parameters affect load gain during overflow.

Overflow data acquisition and analysis

During a typical overflow load cycle, the hopper is first filled to capacity with dredged material and then overflowed for a period of time until the predetermined economic load is achieved. Up to the point of overflow, load gain in the hopper is due to the dredged slurry, consisting of both water and sediment. After the point of overflow is reached, load gain in the hopper is due only to retention of solids in the hopper.

Acoustic sensor installation over the dredge *Wheeler* hopper

The production meter provides data on the flow rate of solids into the hopper over the load cycle, both up to and after overflow. The displacement load metor records the hopper load during the entire dredging cycle, with the load recorded during overflow due to solids retention in the hopper. The calculation of overflow efficiency can be defined as

$$Overflow\ efficiency = \frac{SOL_h}{SOL_t}$$

where SOL_h is the solids retained in the hopper during overflow and SOL_t is the total solids available to the hopper during overflow.

These data can be obtained by recording the production meter data — slurry velocity and density — and the displacement load chart data. Records of slurry velocity and density as a function of time can be logged for each load cycle to correspond to the load chart data. Water density, sediment particle density, and pipe diameter are variables used to calculate the solids flow rate into the hopper in tons per hour for each velocity and density data point recorded.

Total tonnage of solids available to the hopper during overflow can then be calculated by multiplying the solids flow rate by the data sampling interval and summing the values which represents the total solids available to the hopper during the overflow cycle only.

Correspondingly, the displacement load chart data represents the tons of solids retained in the hopper during overflow. These data are taken directly from the load chart for the overflow portion of the load cycle only.

The overflow efficiency is then calculated by dividing the overflow hopper load by the solids load available to the hopper during overflow. The dredge operator can use this overflow efficiency data to determine the optimum dredge operation to achieve the most economical load.

Software and hardware requirements

The displacement load chart is standard equipment on most hopper dredges, and the load data recorded during overflow can be taken directly from the load chart. To record the production meter data, an RS-232 data acquisition package interfaced to a personal computer will provide not only data storage capacity, but also analysis capability. Personal computers with hard disk storage capacities up to 600 megabytes of data will allow continuous monitoring of the density and velocity data for months at a time. Custom software can perform the solids load calculations for each load cycle with display and printing capability. Commercial software can be used for analyzing the data.

Dredge *Wheeler* overflow efficiency calculations

Tests of production monitoring systems were conducted on the U.S. Army Corps of Engineers hopper dredge *Wheeler* in July 1991. These tests were conducted under Dredging Research Program work units Technology for Monitoring and Increasing Dredge Payloads for Fine-Grained Sediments and Production Meter Technology. The tests consisted of draft measurement and production measurement.

Acoustic sensors were mounted over the bow and stern of the *Wheeler* to determine the draft as a function of vessel weight. These sensors perform the same function as the bubbler system mentioned earlier, but determine vessel draft by measuring the distance to the water surface by the transmission and reception of sound waves. Sensors were mounted both port and starboard on the bow and stern to account for vessel motion. Data from the four sensors were averaged for the final draft calculation. The data were logged on a personal computer as a function of time at an averaged sampling rate of once every 10 seconds.

Production meter data — slurry density and velocity — were also recorded on another personal computer as a function of time, with averaged data taken every 10 seconds.

The *Wheeler* production tests were conducted in the Mississippi River just below Baton Rouge, Louisiana, at the Bayou Goula and Belmont crossings. The Bayou Goula crossing is located at River Mile 196, and Belmont crossing is located at River Mile 155. Sieve analysis of sediment samples taken at Red Eye crossing at Baton Rouge (River Mile 224) indicated a fine sand composition, with 95 percent of the sediments being retained on a No. 100 sieve (0.150-millimeter mesh) and having a D_{50} of 0.250 millimeter.

The *Wheeler* has two 28-inch-diameter dragarms and a 42-inch-diameter center dragarm. Only the center dragarm was operational during the overflow study.

For the *Wheeler* overflow efficiency study, 43 hopper loads were analyzed from the Bayou Goula and Belmont locations. The weight of solids retained in the hopper was obtained from the ultrasonic data records relating the draft of the *Wheeler* to the load in the hopper. An example of the ultrasonic data for the first five loads from Bayou Goula crossing is shown in Figure 1. The overflow portion of the data record is shown as a significant change in slope of the data (see insert on figure). At this point only solids are being retained in the hopper. To obtain the number of tons of solids from the overflow data, the overflow draft is measured and compared to data from the hydrostatic deadweight chart for the dredge *Wheeler*, which relates the displacement of the dredge to the weight of material in the hopper.

Production meter data logged as a function of time for the same five loads at Bayou Goula crossing are displayed in Figures 2 and 3. Each data point, representing a 10-second average of velocity and density, was used to calculate the solids flow rate. By multiplying the solids flow rate by the sampling time for each data point and summing all of the data, the total solids available to the hopper during overflow can be calculated. To determine the overflow efficiency, the

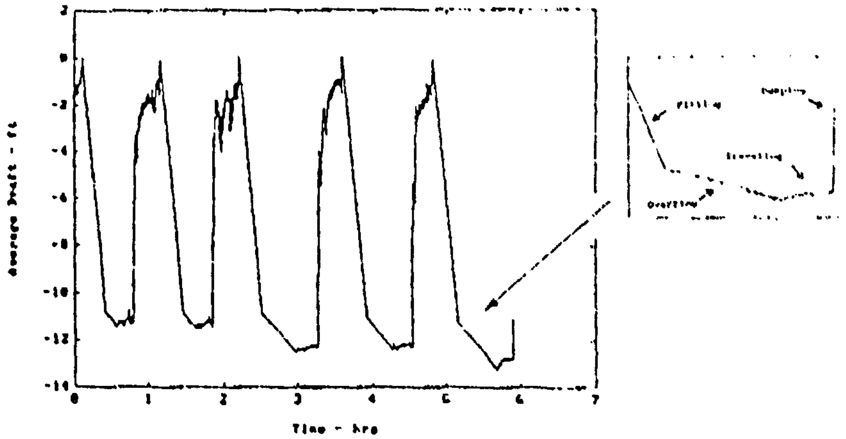


Figure 1. Acoustic sensor draft data for the *Wheeler* at Bayou Goula crossing

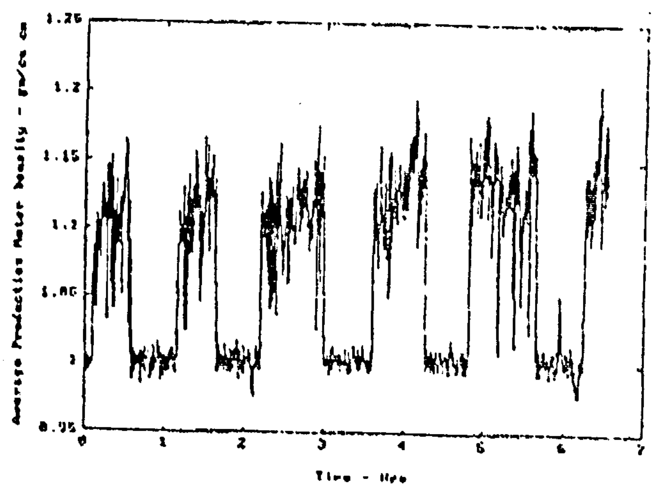


Figure 2. Density meter data for the *Wheeler* at Bayou Goula crossing

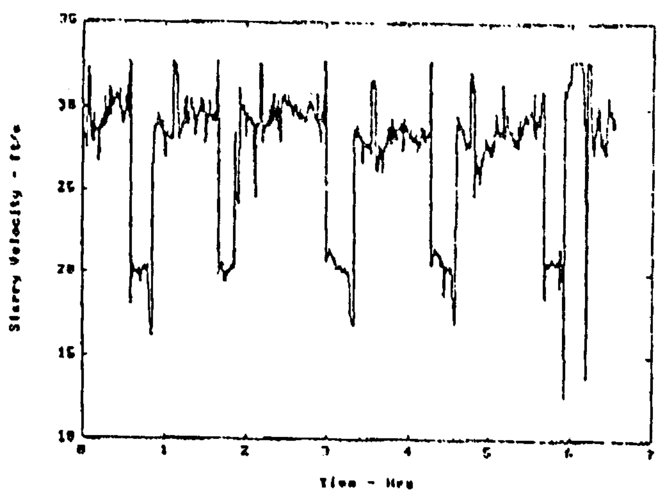


Figure 3. Flowmeter data for the *Wheeler* at Bayou Goula crossing

ratio of the solids retained in the hopper to the solids available to the hopper during overflow was calculated for each of the 43 loads.

The study results show the average percent solids retained in the *Wheeler* hopper during overflow operations in a fine sand environment was 51 percent, with a standard deviation of 5.3 percent. The maximum percent solids retained in the study was 65 percent, with a minimum of 42 percent.

Other possible uses of production measurement

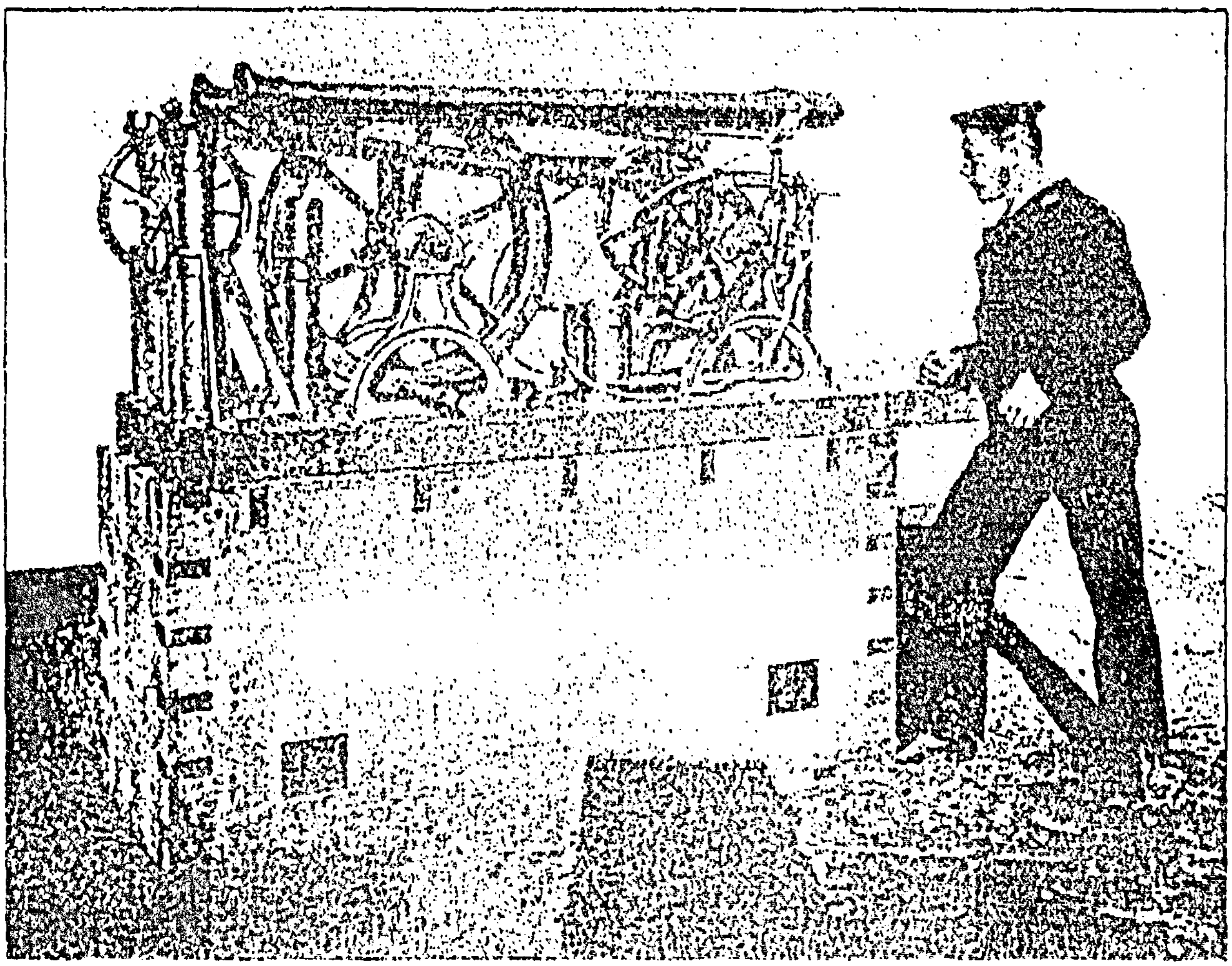
The *Wheeler* overflow efficiency study demonstrates only one of the many possible applications of production monitoring technology for improving dredging operations. Parametric studies of the effects of the inflow slurry density and flow rate on solids retention in the hopper can provide guidance on optimizing overflow dredge operations. Higher flow rates into the hopper may result in excessive turbulence in the hopper which could significantly reduce the efficiency of solids retained. High-density slurries may be optimal for nonoverflow operation, but may reduce settling velocities in the hopper during overflow due to particle interaction, reducing overflow efficiency.

Conclusions

Dredge production monitoring systems are available on most Corps dredges in the form of production meter systems for monitoring slurry density and velocity in the dredge pipe, or as displacement load meters for monitoring the tonnage of material in the dredge hopper. These systems are used to provide guidance to the dredge operator on the optimum solids load in the dredge pipe and to calculate the load in the hopper. These instruments can be further used to better define the operating characteristics of the dredge in various dredging environments. Data acquisition hardware and commercial menu-driven software packages are available for acquiring and analyzing the data. These systems can become valuable tools for providing guidance on dredge operations and applications in various environments.

For further information, contact Steve Scott at (601) 634-4286.

Steve Scott is a research hydraulic engineer in the Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station. His article, "Laboratory Investigations of Techniques for Increasing Hopper Dredge Payload," appeared in the March 1992 **Dredging Research**. *Steve's responsibilities include conducting engineering studies in the areas of dredge plant equipment and system processes. He has been principally involved in research pertaining to the monitoring and enhancement of dredge production. Steve received a Bachelor of Science degree in mechanical engineering from the University of Mississippi and a Master of Mechanical Engineering degree from Mississippi State University. He is a registered Professional Engineer in the State of Mississippi.*



Deep-sea sounding and dredging; the Sigsbee Sounding Machine folded for transportation; circa 1880 (Source: *Deep Sea Sounding and Dredging* by Charles D. Sigsbee, U.S. Coast and Geodetic Survey.
Submitted by Norm Scheffner, Coastal Engineering Research Center)

ANNEX VI

EXAMPLE OF A SCOPING DOCUMENT FOR ENVIRONMENTAL ASSESSMENT FOR A MARINE AGGREGATES DREDGING PROPOSAL

SCOPE

The form and content of the Environmental Statement are anticipated to be as follows:

1. Project Details

- Location and Size of Licence Area;
- Volume of Material to be Extracted;
- Type of Material to be Extracted;
- Proposed Method of Dredging;
- Vessel Numbers and Movements;
- Dredging Programme, including Phasing, Period of Working and Frequency;
- Discharge of Fines - quantity and composition;
- Onshore Proposals - Landings and Onward Transportation;
- Project-related Employment.

2. The Site and Its Environment

a) Physical Aspects

- Bathymetry of Licence Area and Surroundings;
- Geological History - type of material, mean thickness and evenness across the area, nature of underlying deposits;
- Local Hydrography - currents, tides and residual water movements, wave patterns, meteorological influences such as storm frequency;
- Stability, mobility and turbidity of bottom sediments and natural suspended sediment loads;
- Water quality and existing pollution levels.

b) Biological Aspects

- The benthic community structure - species type and abundance, temporal and spatial variations;
- The fishery and shellfishery resource - including sole areas, nursery areas, over-wintering grounds for ovigerous crustaceans and known routes of migration;
- predator/prey relationships between the benthos and demersal fish species;
- context of the biotic resource in relationship to the surrounding area - ie its relative importance.

c) Human Environment

- Economic importance of the fishery and shellfishery resource - catch and landing statistics, value and employment levels;
- Other dredging activity in adjacent areas - existing and/or proposed;
- Waste disposal, including sewage sludge;
- Offshore Oil and Gas Industry - adjacent exploration and/or production activity, pipelines;
- Other seabed features - cables, wrecks, war graves;
- Shipping lanes/navigation requirements;
- MoD Exclusion Areas and Uses.
- Leisure activities in the area.

d) The Policy Framework

- Statutory designations;
- Relevant EC directives, conventions and agreements;
- UK Government Policy - Mineral Planning Guidance Notes and aggregates policy.

3. <u>Assessment of Effects</u>

An analysis of the likely significant effects, including a description of the forecasting methods used.

a) <u>Physical Effects</u>

- Effects of dredging directly on the seabed - including condition of the substrate after dredging;
- Effects of removal of material on the natural sediment movement regime and topographical features on the seabed, including potential effects on coastal erosion and deposition processes;
- Implications of changes in topographical features on prevailing wave/current regime and local water circulation;
- Information on predicted transport and settlement of fines suspended by the dredging activity, from an outwash plume or from on-board screening/grading.

b) <u>Biological Effects</u>

- Effects of dredging activity directly on the benthic infauna and epifauna including any transboundary effects;
- Estimated recolonisation time for the denuded sediments;
- Effects of the settlement of fines on the benthic community over the predicted affected area;
- Further analysis of the effects on the fishery and shellfishery resources, including spawning areas, with particular regard to sole fisheries, crustaceans, and the predator/prey relationship between the benthos and demersal fish species.

c) <u>Effects on Human Environment</u>

- Analysis of the consequences of any predicted changes in fishing patterns, including landings, value and employment;
- Effects on, or conflicts with, other existing or proposed sea uses - adjacent dredging areas, oil and gas industries, dumping, navigation, MoD activities, cables and pipelines, wrecks, etc.;
- Employment in dredging activities.

d) <u>Other Indirect and Secondary Effects</u>

- Indirect employment implications at receiving ports;
- Onward transportation from receiving ports.

4. <u>Mitigation of Effects</u>

- The steps proposed to mitigate the effects of extraction activities.

  These may include:

  - measures to limit impact on benthic communities and spawning cycles through the selection of dredging equipment and timing of dredging operations;

  - measures to protect fisheries interests through zoning the licence area and/or scheduling extraction to avoid the most sensitive seasons;

  - modification of dredging depths to limit changes to hydrodynamics and sediment transport.

5. <u>Accident, Risks and Hazards</u>

- Measures to safeguard against identified risks - primarily shipping risks.

6. <u>Monitoring</u>

- Setting of objectives for a monitoring programme;
- Proposals for monitoring arrangements before, during and after dredging operations, in order to meet the specified objectives.

7. <u>Non-technical Summary</u>

- A non-technical summary of the information provided in the ES.

COMPARISON OF IMPACT OF GRAVEL EXTRACTION ON GEORMORPHOLOGY, SEDIMENT & MACROFAUNA IN TWO AREAS : KLAVERBANK (NL) & DIEPPE (F)

SITE PRESENTATION

. The Klaverbank (Fig. 1) is a relatively small area (18 km²) of the North Sea which is a potential source of gravel (about 40 to 50 millions tons suitable for the concrete industry) and its interest has grown since the gradual running down of gravel extraction on the mainland. It was doubtful, however, whether the Klaverbank would offer a suitable alternative, because of its high ecological value; this bank is the only area in the Dutch part of the continental shelf with gravel deposits and consequently an unique benthic fauna. Moreover, these deposits have been found to provide attractive spawning grounds for herring. It was decided to asses the environmental effects of an experimental extraction to determine whether gravel can be extracted on the Klaverbank. Monitoring studies have been conducted since 1988 (pre-survey).

. The extraction site of Dieppe (eastern English Channel) is a very small area (< 3 km²) located 3 milles offshore (Fig. 2), at a depth of 20 m below MSL (instead of 38 m for the Klaverbank). After a pre-survey of sediment and macrofauna in 1979, extraction began in 1980 to provide sands and gravels for the erection of a nuclear power station. Biosedimentary monitoring was undertaken to evaluate the impact of this operation on the benthic environment and to establish the limits and the degree of physical and biological changes of the bottom, in and around the extraction site.

METHODOLOGY

. All stations of the Klaverbank area were sampled with the Hamon Grab sampler along transects, located in (control stations) and near (reference stations) the extraction area (Fig. 3).

The mean sampling surface was of 0,6 m². Fauna was collected after sieving over a 1 mm mesh size, and identified at a species level except for the smallest amphipods. To obtain biomass data, samples were dried at 60° C and burnt at 560° C for 2 hours.

. In Dieppe, 12 stations (Fig. 2) have been sampled from 1979 to 1991 with a Rallier dredge which provided semi-quantitative data, the fauna being studied over 10 liters of sediment. In 1993, the use of a Shipeck grab (0,04 m²) provided quantitative data. After collection over a 1 mm mesh size, identification was made at a species level for each infaunal group.

. Rarefaction curves (Fig. 4) have shown in both sites that a minimum of 7 samples were necessary to get a representative coverage of the macrofauna, in relation to the spatial heterogeneity of sediment.

. Impact of dredging was estimated in both sites by comparison with the natural evolution of nearby reference stations.

Methodology used to assess impact of gravel extraction on benthic macrofauna can give a correct idea of densities and specific richness only for the small infaunal or epifaunal species living in abundance at the seabed surface. But they cannot give a correct estimation of the abundance of bigger, less abundant, species, mobile (Decapods) or not (clams...), neither for species living deeper in the sediment.

Thus, representative sampling needs the use of several complementary techniques (grabs, dredges...).

INITIAL SURVEY

1) Sediment and seabed morphology

. The gravel deposits of the Klaverbank have a thickness of 0.5 - 1 meter and are arranged in large waves alternating with more or less flat sand areas of equal width (Fig. 4).

This morphology explains the large spatial heterogeneity in gravel content (> 2 mm) of the seabed with a mean content of 50 % for the whole area but marked differences in presence of large cobbles.

. In Dieppe, substrate is composed of shingle banks (Fig. 5) thinly covered with a sandy gravel layer constituted of 37 % gravels (> 2 mm), 37 % coarse sands (0,5 - 2 mm) and 26% fine sands (0,2 - 0,5 mm). Locally, sand waves can cover the seabed, with a big proportion of shells.

2) Macrofauna

. On the Klaverbank a maximal number of 128 species were identified in 1991. About 50 % of the species are Polychaetes but biomass is dominated by molluscs (70 %).

. In Dieppe, a total of 228 species were identified in the 12 stations studied over 4 years. This difference results of :

- a difference in sampling methodology
- a greater diversity of the Dieppe area,
- a more detailed identification of species in Dieppe than in the Klaverbank study,

. Over the 128 species identified in the last area, 82 (65 %) are common with the former site, the most conspicuous species of both areas being the Echinoderms *Echinocyamus pusillus* and *Ophiura albida* and the Polychaetes *Glycera capitata, Notomastus latericeus, Aonides paucibranchiata* and *Pista sp.*

. On both sites, animals characteristics for both gravelly and sandy bottoms are found, in relation with the large spatial heterogeneity of the sediment:

- sand with the Polychaete *Nephtys sp*, the Gasteropod *Natica alderi* and the Echinoderm *Echinocardium cordatum*;
- sandy gravel with the lancelet *Branchiostoma lanceolatum* and the Bivalves *Ensis arcuatus*, *Dosinia exoleta*;
- gravel with the Echinoderms *Echinocyamus pusillus* and *Ophiura albida*, the Polychaetes *Pomatoceros triqueter*, *Notomastus latericeus*, *Lumbriconereis sp* and *Glycera sp* and the Sipunculid *Phascolion strombi*.

EXTRACTION

. In the Klaverbank area, gravel extraction took place during 2 months only (June to August 1989). During this period, 336 000 m^3 were extracted in about 100 tracks of 1 500 m length, 3 m width and an approximate depth of 0,5 m.

. In Dieppe (Fig 6), extraction was intensive from 1980 to 1985 with an annual average of 200 000 $m^3.year^{-1}$; intensity declined till 1988 to stabilize at a level of 50 000 $m^3.year^{-1}$ until 1992.

The differences in the duration of extraction but also in the surfaces concerned (8,5 km^2 for the Klaverbank and 1,5 km^2 for Dieppe) involved a big difference in the intensity of dredging between the 2 sites :

Klaverbank : 3 750 $m^3/km^2/month$
Dieppe : 12 200 $m^3/km^2/month$

IMPACT OF EXTRACTION

1) Seabed morphology and sediment quality

. On the Klaverbank, tracks of 3 m width and a depth of approximately 0.5 m were scanned by side-scan sonar in autumn 1989.

In 1990, seabed morphology had changed markedly with complete disappearance of extraction tracks probably due to winter storms which caused aggregate rearrangement of the seabed as shown by the change of direction of gravel waves.

No infilling of extraction tracks by shifting sandribbons was observed and no change in sediment when comparing the average gravel content (53,5 % in 1989; 54,4 % in 1990).

. In Dieppe, bottom topography was changed after several years by creation of extraction tracks which were only partly refilled despite the presence of strong currents and mobile sand-ribbons in the area.

Extraction has progressively eliminated the original sandy gravel which was replaced by fine sand derived from mobile sand-ripples and from overflow within the outwash.

Nevertheless, some shingles are still present at the bottom surface as we could observe in 1988 and again 1993.

Station N	1986	1988	1991
% fine sands	70	12	50
% Gravels	12	50	22

. The importance of seabed rearrangement observed at depths down to -40m on the Klaverbank, in relation with severe storms, suggests to conduct exploitation preferably during or just before these periods of maximal natural perturbations (winter).

2) Benthos

. On the Klaverbank, extraction led to an impoverishment of benthic fauna with a reduction of 30 % for the species number, 72 % for density and 80 % for biomass due to the high number of large bivalves removed.

. In Dieppe (Fig. 7), reduction of benthos within the extraction site is comparable for densities (80 % in 1986) but greater for species number (70 %). This study pointed out the amplitude of natural fluctuations of densities in the control stations; this situation is the consequence of the intensity of local hydrodynamism leading to a strong instability of surface sediments (shifting sand ribbons).

Moreover, benthic community has changed from one of coarse sands with the lancelet *Branchiostoma lanceolatum* to one of fine sands with the Polychaete *Ophelia*. Structure of the community was thus fundamentally changed after six years of intensive extraction, with a decrease in Crustaceans, Echinoderms and Bivalves, leading to an almost complete dominance by errant Annelids.

Recent observations in 1993 show the same dominance of Polychaetes (*Ophelia, Nephtys and Spiophanes*) plus the Echinoderm *Echinocardium cordatum*.

In 1991, reduction of biomass was estimated to 90 % but density and species number were slightly restored (- 70 % and - 50 % respectively) in the extraction area; this amelioration is probably linked to the less intensive dredging activity after 1986.

RECOLONISATION

. On the Klaverbank, total density appeared to be restored within 8 months after extraction. This rapid evolution can be explained:

- by the low intensity of dredging which led to the alternance of extraction areas with undisturbed ones;
- by the dominance of most small-sized species adapted to the dynamic circumstances of gravel bottoms by fast reproduction to compensate for high mortality rates; hence, a reduction in densities of such species due to partial extraction may be an ephemeral phenomenon.

However, biomass remained low because large bivalves had not yet recovered after 2 years. These larger organisms seem to be better indicators for the effect of gravel extraction and the recovery process.

. In Dieppe, reduction of intensity of extraction after 1986 enabled a slight recovering of benthos:

YEARS	1986	1988	1991
Specific richness	- 70%	- 60%	- 50%
Density	- 80%	- 70%	- 70%
Dredged tonnage (year^{-1})	420 000	125 000	80 000

These results show that recolonisation can begin in a few months between two distinct periods of dredging when its intensity is limited; they are in accordance with the recolonisation rate described on the Klaverbank.

We could see in Dieppe that structure of the new community is closely linked to the quality of the substrate (Fig. 8). Replacement of the original sandy gravel by fine sand led to the dominance of new species which are characteristic of the new sediment:
- the Polychaetes *Ophelia acuminata, Nephtys sp* and *Spiophanes bombyx,*
- the Echinoderm *Echinocardium cordatum.*
All these species are also observed in sandy sediments of the Klaverbank.

In less intensively dredged areas of the extraction site, we observed in 1993 the presence of shingles colonized by sessile fauna (Coelenterates and Bryozoans) and by surface dwelling species such as Echinoderms (*Ophiura albida*) and mainly Crustaceans (Amphipods, Decapods).

Perturbations of benthic communities suggest an impact of dredging activity on the upper trophic level: fish. Intensity of this impact will decrease in accordance with the feeding behaviour of species from benthic to pelagic ones. For the former category, it is necessary to study the impact of the modification of available preys.

It is essential to know the trophic value of these new species in order to quantify the exact impact of dredging activity on fisheries.

CONCLUSION

Comparison of impact of gravel extraction on the Klaverbank and off Dieppe was possible despite important differences:
- in the site location
- in the sediment characteristics,
- in the methodologies used,
- and to a lesser extent in the infaunal composition.

However, differences in the amounts of extracted material and in the duration and surfaces of dredging, constituted a major advantage:

- extensive dredging (short period, large area) on the Klaverbank led to:
  + a minimal impact on seabed morphology,
  + no change in the grain-size of the sediment,
  + a moderate reduction of specific richness (-30%),
  + a rapid recolonisation by benthic fauna (8 months),
  + but a severe reduction of densities (-70%) and biomass (-80%) comparable to the evolution observed in Dieppe (-80% and -90% respectively).

- intensive dredging (pluri-annual, small area) in Dieppe led to:
  + a stronger impact on seabed morphology,
  + a big change in granulometry of sediment with a large increase in the proportion of fine sands (from 25% to 70%),
  + a bigger reduction of specific richness (-50% to -70%),
  + a severe reduction of densities and biomass,
  + a change in benthic community linked to the evolution of sediment.

This comparison showed that benthos is rapidly and intensively affected by extraction activities and suggest that it would be preferable to concentrate dredging in small areas. But prolonged extraction in limited sites affects seabed morphology and sediment quality and, consequently, benthic communities whose trophic value needs to be ascertained.

Further studies on recolonisation processes are still needed in Dieppe before clear recommendations can be given for the best way to dredge to minimize biological impact.

An experimental extraction was proposed in the Baie de Seine in 1989; different intensities of dredging on distinct areas (fallow) should have been tested during one or several years to assess the respective recolonisation rates. This experimentation is still waiting in 1993 the agreement of local authorities and support of concerned Ministries (Sea, Environment, Industry).

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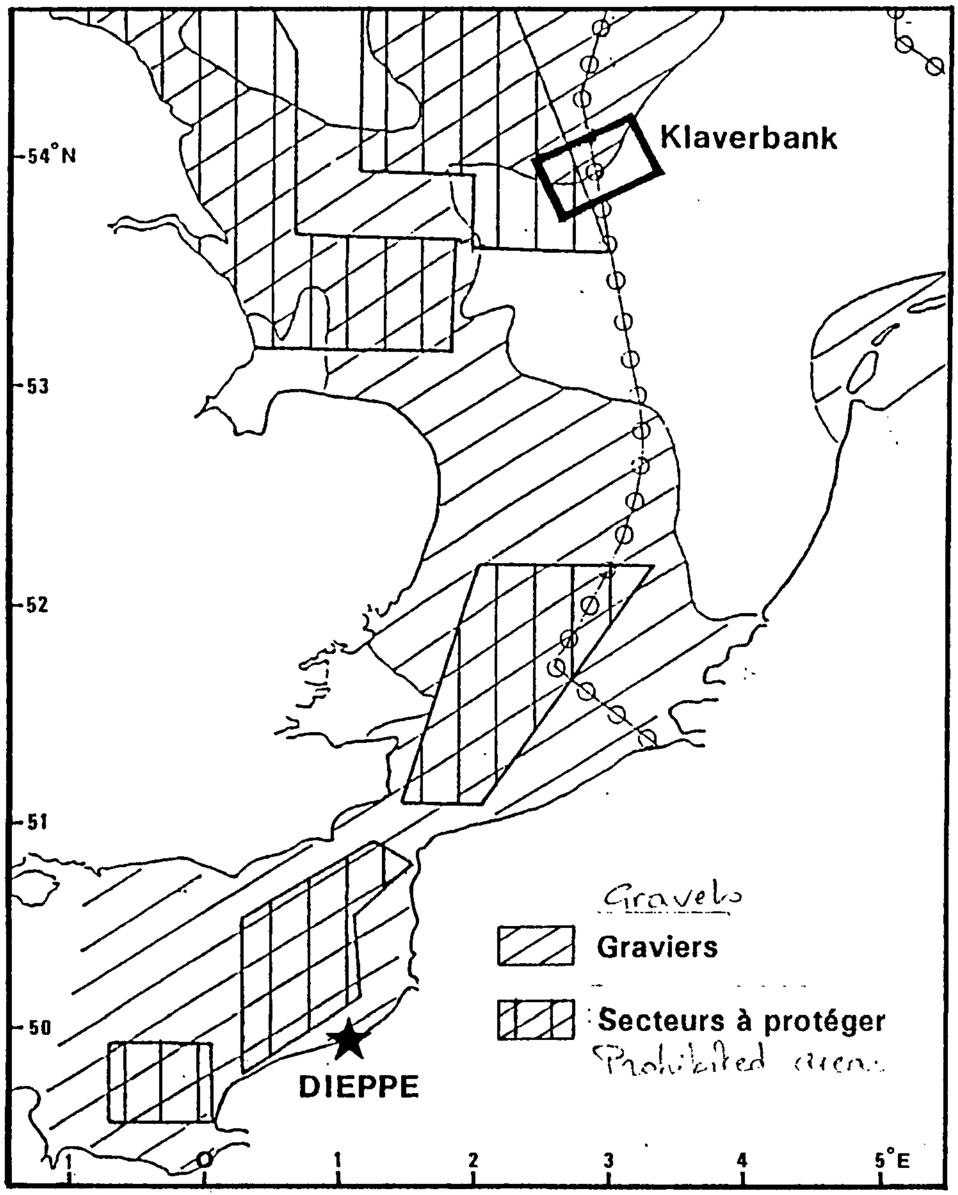
LIST OF FIGURES


Klaverbank
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53
52
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DIEPPE
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0
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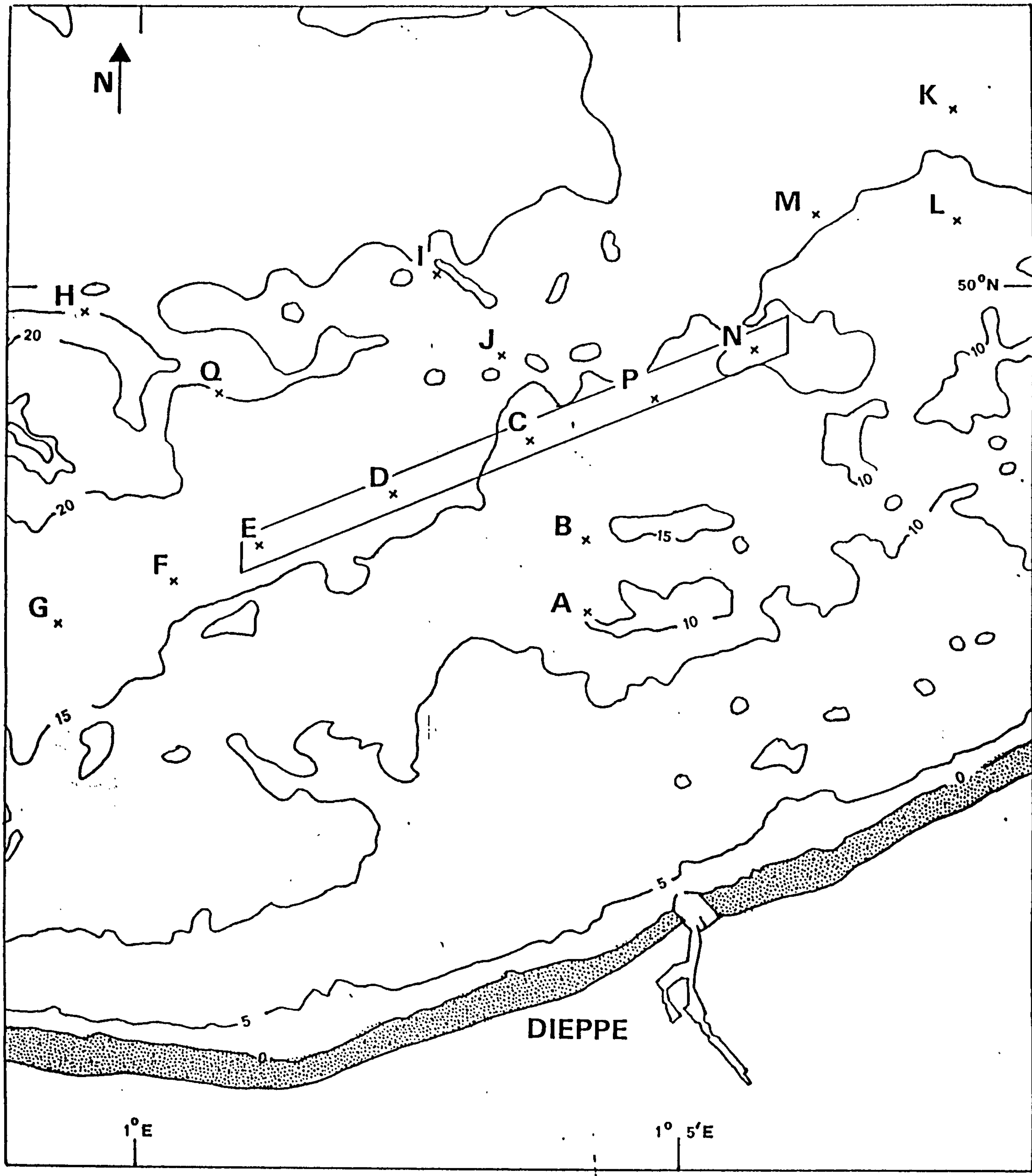
4
5°E
Gravels
Graviers
Secteurs à protéger
Prohibited areas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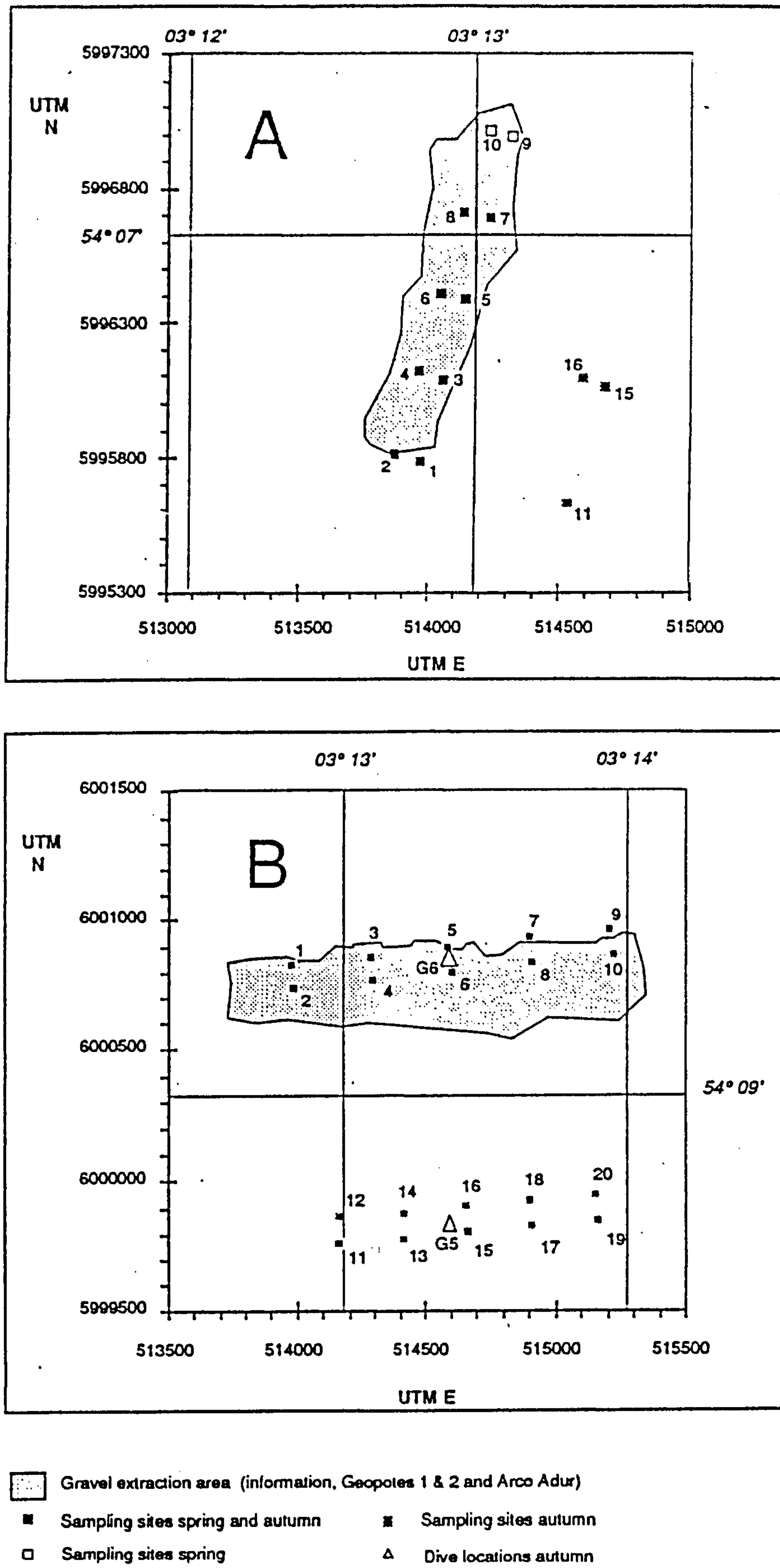

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03° 13'
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5996800
5996300
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514500
515000
UTM E
B
03° 13'
03° 14'
54° 09'
6001500
6001000
6000500
6000000
5999500
513500
514000
514500
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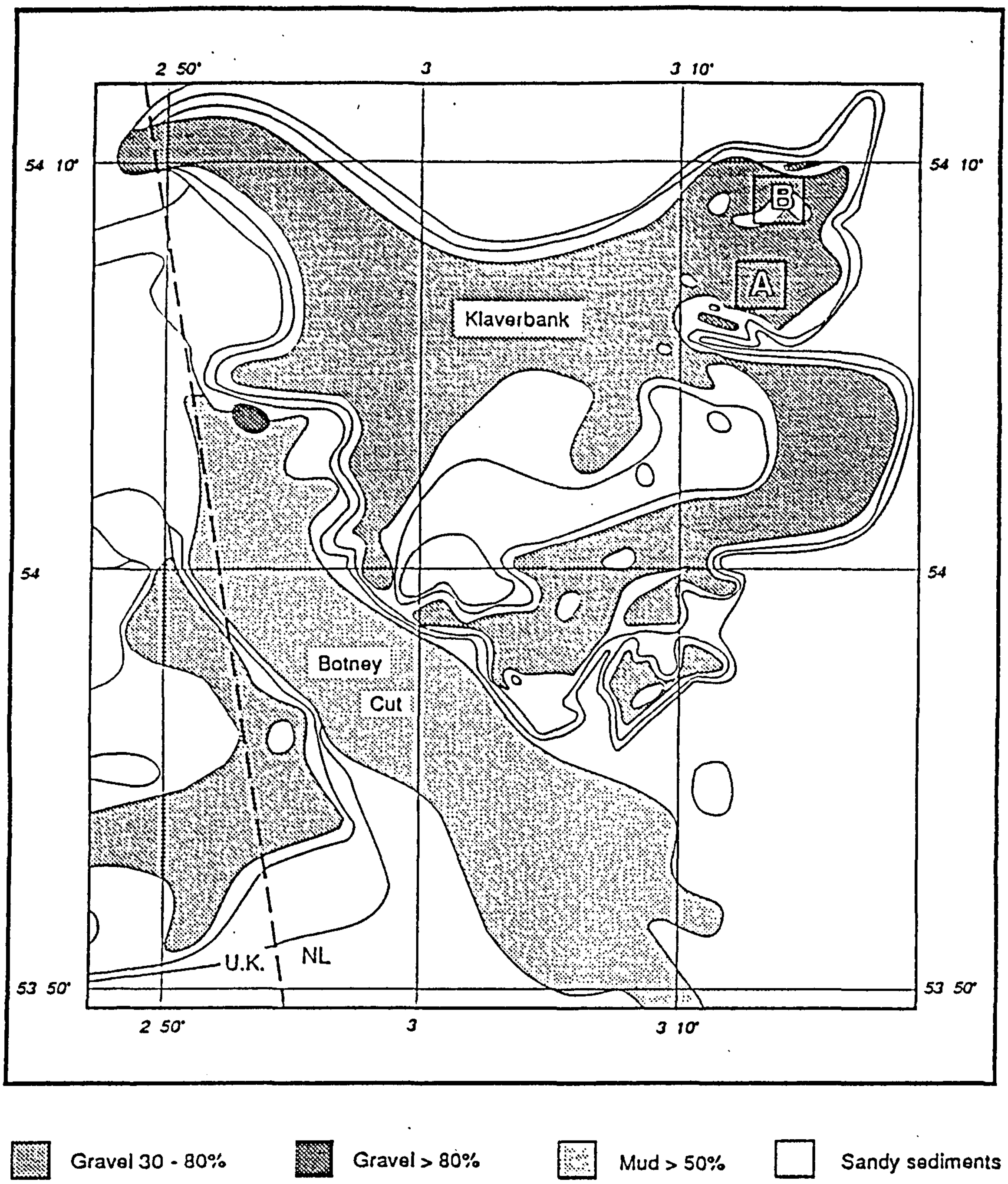
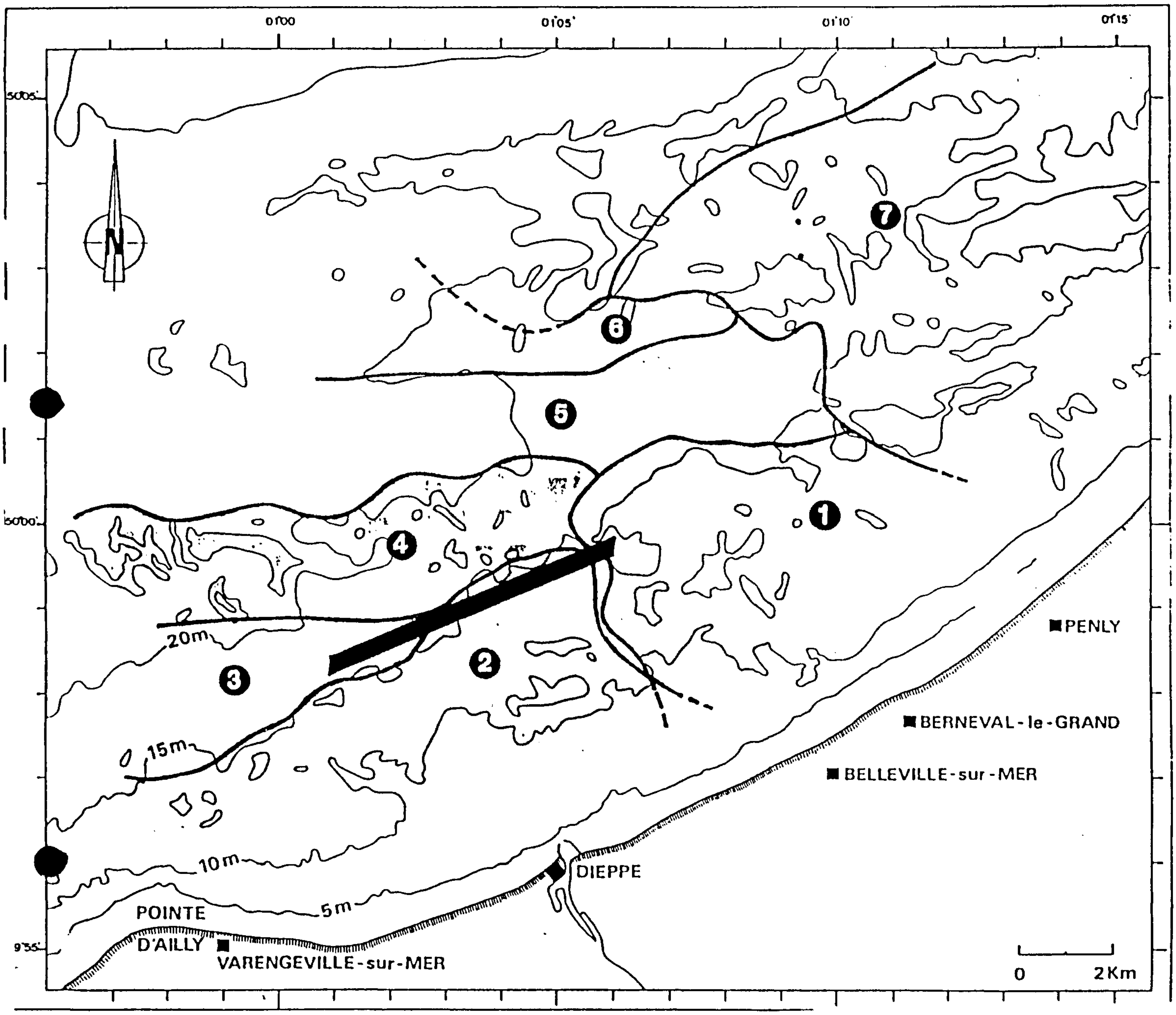
G6
G5
Gravel extraction area (information, Geopotes 1 & 2 and Arco Adur)
Sampling sites spring and autumn
Sampling sites autumn
Sampling sites spring
Dive locations autumn


2 50'
3
3 10'
54 10'
54 10'
Klaverbank
B
A
54
54
Botney
Cut
U.K.
NL
53 50'
53 50'
2 50'
3
3 10'
Gravel 30 - 80%
Gravel > 80%
Mud > 50%
Sandy sediments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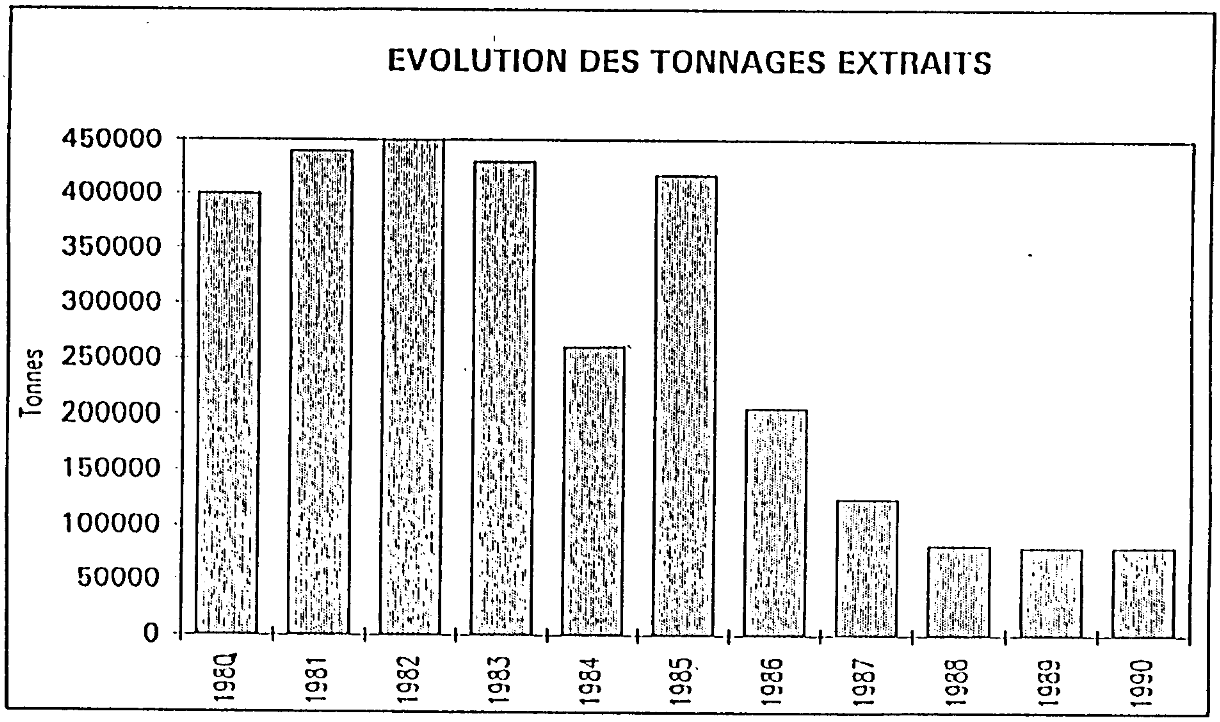
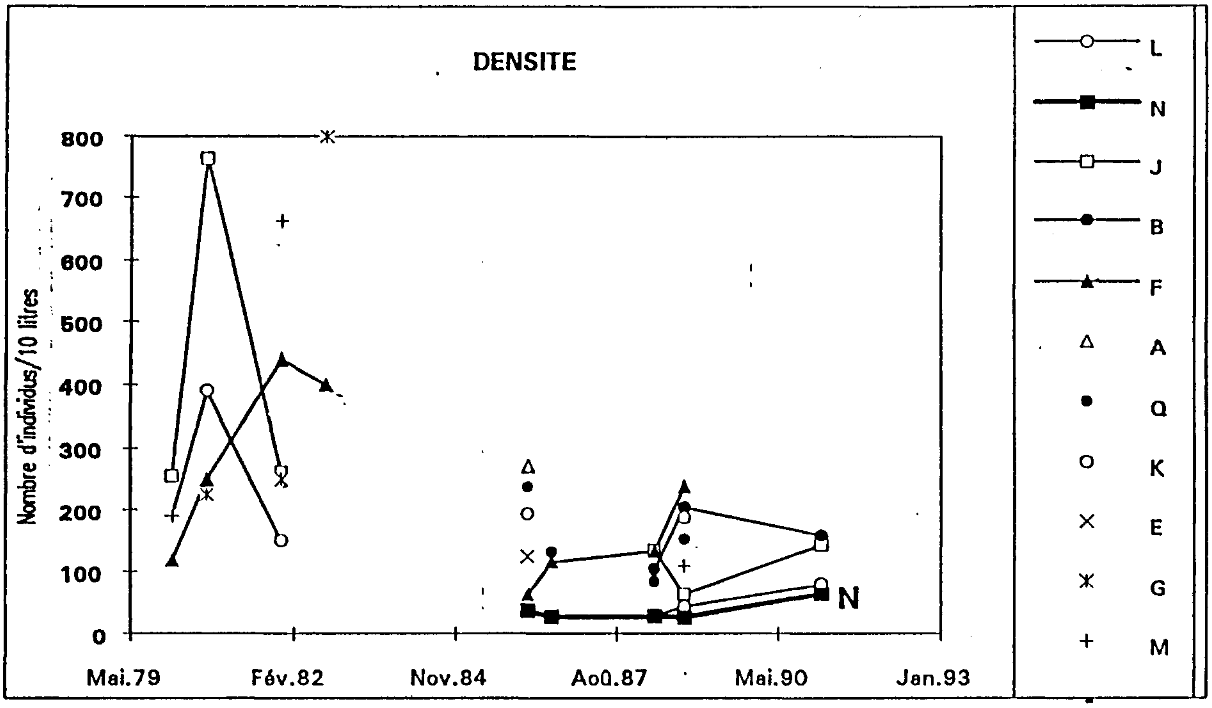


Figure 6 :

Evolution des tonnages annuels de granulats extraits de 1980 à 1990 sur le site de Dieppe.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Nombre d'individus/10 litres
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600
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200
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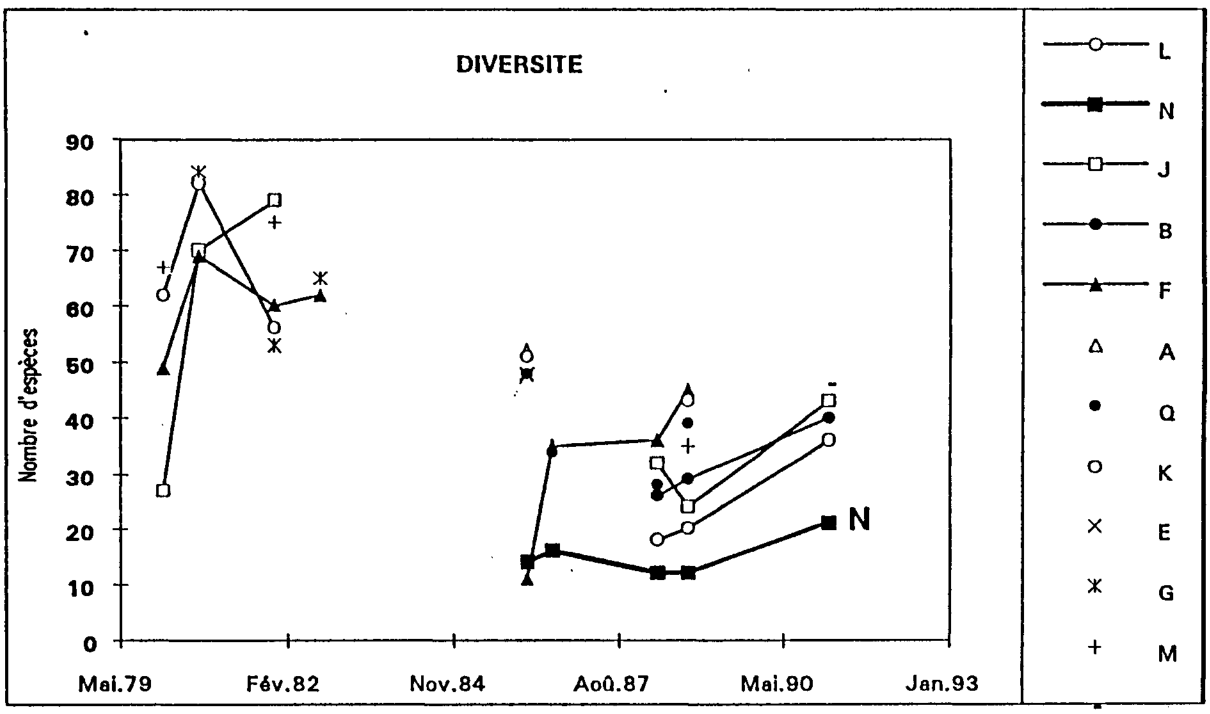
DIVERSITE
Nombre d'espèces
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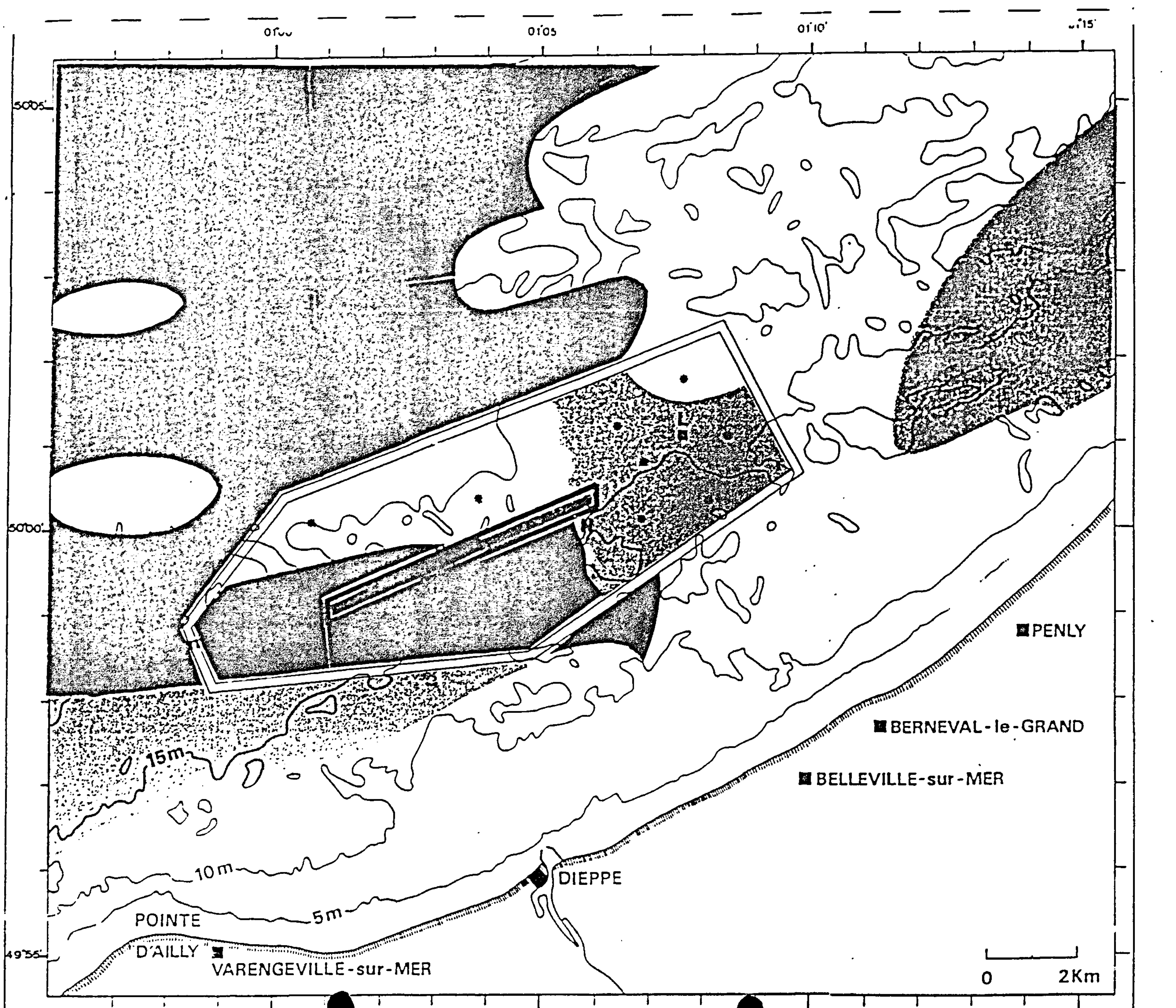
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DIEPPE
POINTE
D'AILLY
VARENGEVILLE-sur-MER
0
2Km

APRIL 1993

PRELIMINARY RESULTS ON THE EFFECTS OF MARINE GRAVEL EXTRACTION ON BENTHOS: POST-DREDGING RECOLONISATION

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INTRODUCTION

Background

During the 1980's the demand for aggregates in the UK steadily increased, primarily as a result of the boom in the construction industries which required the basic raw materials for "ballast" and concrete. In addition, there was a need for high quality aggregates which could be supplied from the marine environment. The recent advances in marine mining technologies, the short supply of land-based sources and favourable market economics have paved the way for increased production of aggregates from marine resources. However, during the 1970's, concern was growing over the environmental impact of marine aggregate extraction, and in particular the potential threat to benthic communities and their dependent fisheries (Lart, 1991). Initial research was undertaken by the Ministry of Agriculture, Fisheries and Food (MAFF) but the impacts on the benthos and the rates of recolonisation were not fully quantified. Accordingly, in October 1990 a three-year research programme was initiated by the Crown Estate Commission (CEC) and MAFF to determine: i. the initial impacts of dredging on the benthos and sediments; ii. the processes of recolonisation post dredging; iii. the natural faunistic differences between gravels on a wide-scale; and iv. coarse sediment quantitative sampling methods.

Previous Studies

There are few original scientific investigations which describe the effects of marine aggregate extraction on benthos. Some of the early observations in the UK were made during the 1970's by Shelton and Rolfe (1972) and Dickson and Lee (1973) who examined the impacts of suction-anchor dredging on a shingle bank in the English Channel. Millner and Dickson (1977) examined the impacts of suction-trailer dredging off Southwold in the Southern North Sea. More recently, investigations have been undertaken off the Isle of Wight (Lees *et al,* 1990) and off Dieppe (Desprez *et al,* 1992) in the English Channel. In addition, a comprehensive study of the effects of suction-trailer dredging on the benthic communities and seabed topography has been made at an experimental site on the Klaverbank in the Dutch sector of the central Southern North Sea (Sips and Waardenburg, 1989; Von Moorsel and Waardenburg, 1990, 1991).

METHODS

Selection of an Experimental Dredging Site

A wide-scale survey of gravel communities off the English Eastern and Southern coasts (Kenny *et al,* 1991) indicated potential sites for an offshore field experiment. These were located off North Norfolk, England (Figure 1). The gravel deposits off North Norfolk were found to support a relatively rich and stable epifaunal community, with the presence of long-lived sessile organisms such as the bryozoan *Flustra foliacea* ('horn wrack') and the hydroid *Nemertesia antennina*. This site was therefore considered to be well suited for experimental dredging. However, in order to determine the exact location of the 'treatment' and 'reference' sites, further sampling using a 3m vibrocore was undertaken to assess the thickness of the gravel deposits and to ensure that dredging would not expose an underlying stratum which was different in nature from the superficial substrate. The treatment site for the offshore dredging experiment was finally selected 17 miles North of Cromer, North Norfolk in September 1991 (Figure 1).

Experimental Dredging

During 5 days in April 1992, the MV "Sand Harrier", an "H" class commercial suction-trailer dredger, removed a total of 52,000 tonnes of mixed aggregate representing 11 hopper loads from an area measuring 500 by 270 metres.

The position and speed of the "Sand Harrier" was monitored using a Sea Information Systems "Microplot v3.1" installed on Compaq PC linked to a "RoxAnn" seabed sediment discriminator. Together they displayed a constant real-time image of the dredging operations. High navigational accuracy was achieved using a Sercel "NR53" differential Global Positioning System (GPS) which had been previously calibrated against a "range-range" differential GPS operated by BritSurvey. This gave an almost constant accuracy of $\pm$10m. Figure 2 shows the track output generated by "Microplot" for the entire operation, which represents a total of 200 tracks covering approximately 70% of the experimental area.

Pre- and Post- Dredging Surveys

An array of benthic sampling equipment was used to survey the treatment and reference sites pre- and post-dredging. Remote sampling of benthos was achieved using a Hamon grab (Figure 3). The Hamon grab was found to be ideally suited for quantitative sampling of coarse (or compacted) sediments. It operates by taking a scoop out of the sediment, and the sample bucket is then forced against a metal plate which prevents the sample from being washed away during retrieval.

In order to obtain an instant view of the seabed and provide detailed information on the occurrence, distribution and behaviour of benthic organisms, an underwater camera sledge was used. The sledge was towed for ~1 hour along a transect through the treatment and reference sites. In addition, an acoustic map of the dredged site was generated using a EG+G dual frequency (100kHz, 500kHz) side-scan sonar.

Field Procedures

Hamon grab stations were randomly located within the defined boundaries of the treatment and reference sites. Samples were washed over 5mm and 1mm square mesh sieves so as to remove excess sediment and obtain all the colonial and solitary benthos. The benthos was fixed in a 4-6% buffered formaldehyde solution (diluted with sea water) with "Rose Bengal" (a vital stain) and stored for laboratory identification and enumeration. In addition a 1 litre sub-sample was taken for particle size analysis.

The underwater camera sledge was fitted with a television camera linked via an umbilical to a TV monitor and U-matic video recorder present on the RV. A single lens Reflex (SLR) camera loaded with a 200 exposure colour 35mm film pre-set to take one exposure every 20 seconds was also attached.

Laboratory Procedures

Hamon grab samples were first washed with fresh water over a 1mm mesh sieve in a fume cupboard to remove excess formaldehyde solution. Samples were then sorted on plastic trays and specimens were placed into jars or petri dishes containing a preservative mixture of 70% methanol (GPR) , 10% glycerol and 20% tap-water. For each species a representative specimen was recorded, preserved and stored separately in a glass vial to establish a reference collection and provide a means for the verification of species identifications. Whenever possible specimens were identified to species level using the standard taxonomic keys.

Partial wet-weights for each species were determined by placing specimens on a plastic tray covered with white blotting paper for 12 hours before measuring their weights on a Sartorius 2004 MP five figure balance. Biomass estimates were then calculated from partial-wet weights using conversion factors given in Eleftheriou and Basford (1989).

Sediment sub-samples were analysed for their particle size distributions according to the Udden-Wentworth Phi Classification where Phi(0) = $-\log_2 d$ and d is the particle diameter in millimetres. Each sample was first wet sieved on a 63 micron mesh sieve to provide an estimate of the fines fraction (<63 microns). The remaining sample was then oven dried for approximately 12 hours at 100° C and allowed to cool to room temperature before being sieved through a stack of geological test-sieves ranging from -6 phi (64mm) to +4 phi (0.0063mm). A weight for each size fraction was measured using a Sartorius top-pan balance to an accuracy of $\pm$0.01g.

RESULTS

Physical Observations

Particle size data for 6 samples taken from the treatment site (Cruise COR 4/92) in March 1992, 4 weeks before dredging, were compared to 6 samples taken 2 weeks after dredging (Cruise COR 6/92) in May 1992. Results showed that the gravel content (>2mm) of the sediment increased from 36% to 56% (Figure 4).

Upon examination of the seabed using side-scan sonar and UW TV it was apparent that the dredge tracks have become infilled with sand, suggesting a redistribution of sediment has occurred. The action of the draghead on the seabed has agitated and vibrated the sediment to such an extent that gravel (>2mm) has consolidated to form ridges between furrows of sand. Inspection, by SCUBA divers, of the sand accumulations within the tracks showed that the deposits are superficial sand-ripple features, 1-2cm deep. In addition, the apparent increase in the gravel content at the treatment site may be caused by the preferential removal of sand by the suction action of the draghead.

Biological Observations

The total number of species recorded from 5 Hamon grab samples taken at the treatment and reference sites pre- and post-dredging are shown by major phyla in Figure 5. The total numbers of species 4 weeks before dredging (Cruise COR 4/92) at the treatment and reference sites were broadly similar at 70 and 62 species, respectively. However, 2 weeks after dredging (Cruise COR 6/92) the number of species at the treatment site had fallen to 30 (the polychaetes showed the most noticeable reduction from 35 to 16 species). At the reference site, the number of species has remained generally constant, having only increased slightly from May (64 species) to December (68 species). However, at the treatment site the number of species has increased from May (30 species) to December (53 species), which suggests that some readjustment or recolonisation has occurred.

The impact of dredging is more apparent when the abundance data are compared from each site, pre- and post-dredging. (Figure 6). The total abundance of animals recorded at the treatment and reference sites 4 weeks before dredging (Cruise COR 4/92) are broadly similar at $230/0.2m^2$. However, a dramatic reduction in the abundance has occurred at the treatment site post-dredging ($30/0.2m^2$), compared to the reference site ($209/0.2m^2$). The crustaceans and "others" phyla were numerically dominated by the barnacle *Balanus crenatus* and the sea-squirt *Dendrodoa grossularia*. Both showed an increase in abundance from May to December as a result of Summer recruitment. However, the increase at the reference site was greater than that at the treatment site (possible explanations are given below).

Biomass data for each site pre- and post-dredging (Figure 7) support the observations made on the abundance data (Figure 6). A large reduction in the biomass has occurred at the treatment site post-dredging: from $182g(AFDW)/m^2$ in March (Cruise COR 4/92) to $0.4g(AFDW)/m^2$ in May (Cruise COR 6/92). However, at the reference site the biomass figures remain high at

80g(AFDW)/m^2. At the treatment site in December, *B. crenatus* and *D. grossularia* contribute very little to the biomass, although they are present in relatively large numbers (Figure 6), suggesting they are new recruits. However, at the reference site the biomass figures for December are relatively large, reflecting the mixed populations of adults and juveniles of *B. crenatus* and *D. grossularia* present.

DISCUSSION

Dredging at the experimental site in April 1992 preceded the natural Summer recruitment of benthos. The 'opportunists' *D. grossularia* and *B. crenatus*, which were numerically dominant before dredging, showed the greatest increase in abundance post-dredging. However, the increase was greatest at the reference site. This may be explained by a combination of the following: i. The treatment site is physically stressed compared to the reference site, due to deposits of mobile sand being present within the dredge tracks, thereby reducing the recruitment success of sessile epibenthos such as *Sabellaria spinulosa*, *D. grossularia* and *B. crenatus*; ii. there may be spatial differences in recruitment success between the reference and treatment sites such that a larger settlement has occurred at the reference site; iii. the loss of adult sessile epibenthic populations at the treatment site has reduced the recruitment potential of juveniles, since the "cues" to settle are no longer present. For example, *B. crenatus* may require the presence of adult populations in order to stimulate settlement, as has been observed for *B. balanoides* (Stubbings, 1975). In addition, as many adults have been removed by dredging the source of juveniles which recruit locally (within 100m) is reduced; for example, *D. grossularia* larvae are not transported in the plankton but settle within a few metres of their parents (Svane and Young, 1989).

The effects of seasonality should be borne in mind. The data cover a period of seven months post-dredging and mortalities will have occurred during the winter of 1992, thereby reducing the observed gains in abundance at the treatment site.

It remains to be seen whether the populations at the treatment site adjust to the newly-created physical regime by shifting from a relatively stable community to one characteristic of a more mobile sediment.

The results from future surveys, planned for 1993 and 1994, will help to further clarify the processes of recolonisation, and the resultant community structure, post-dredging.

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SURVEY AREA

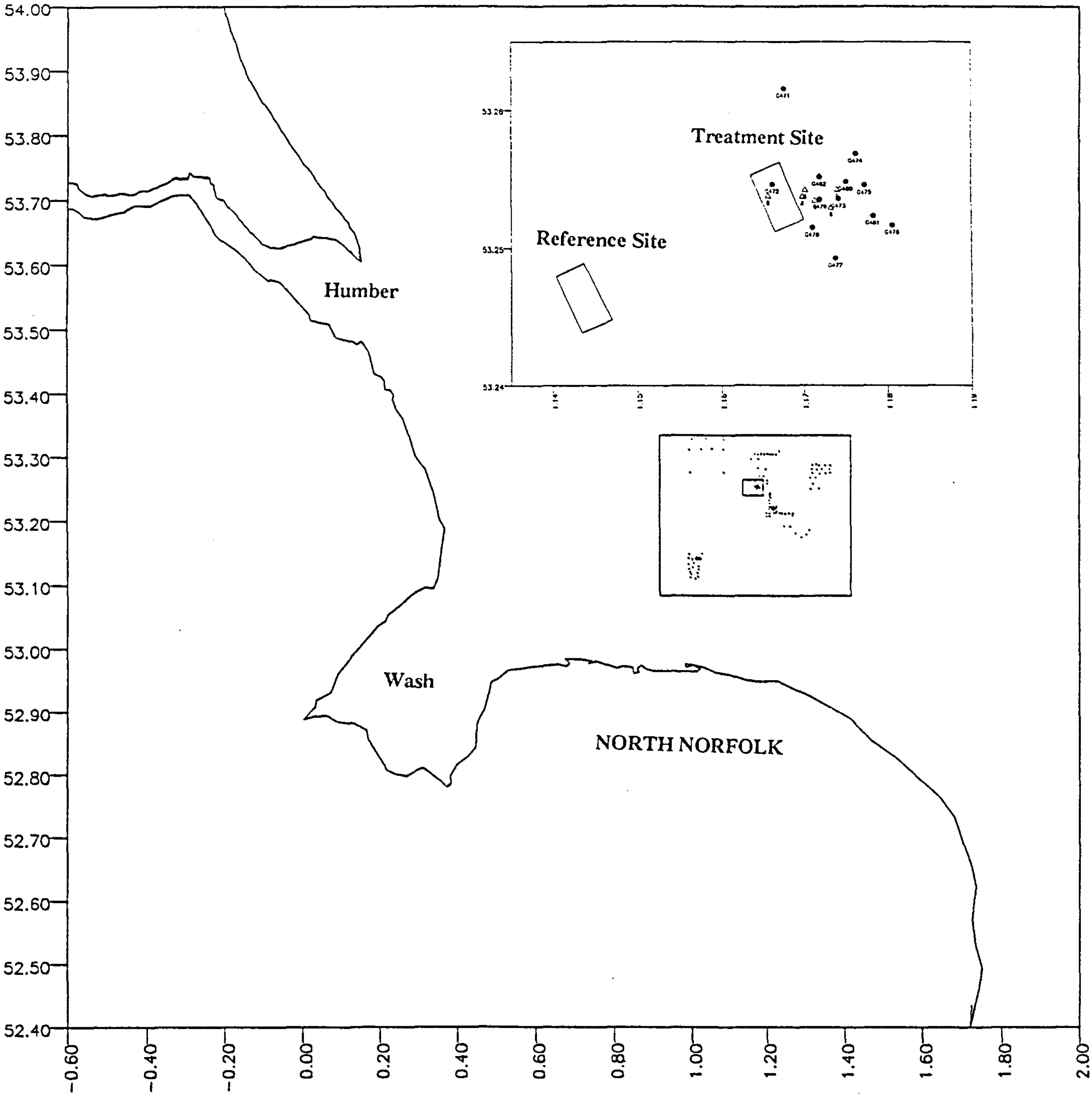


Figure 1: Benthic survey off North Norfolk (small box) in order to locate the experimental dredging and reference sites (large box).

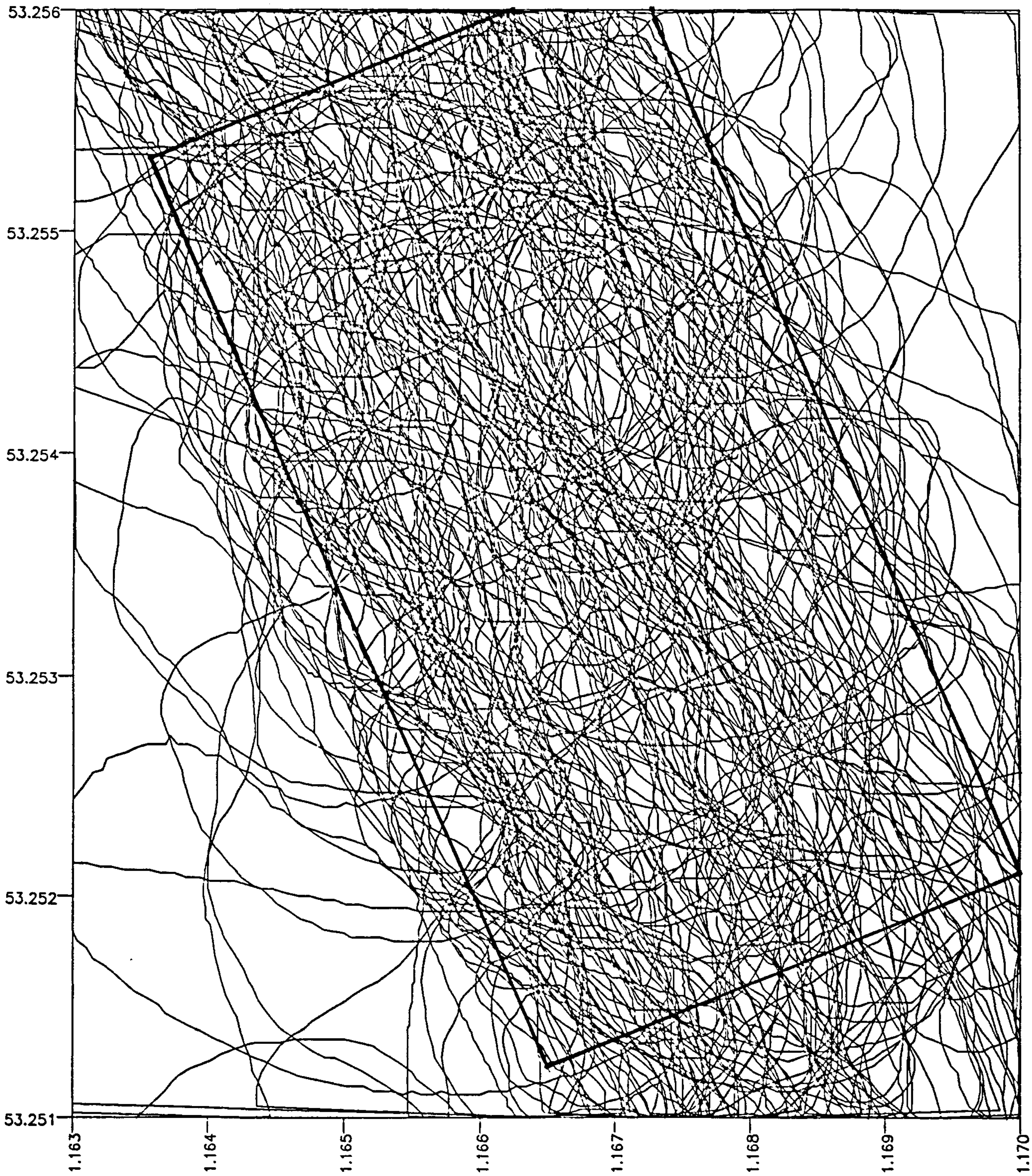


Figure 2: Tracks generated by the suction trailer dredger MV "Sand Harrier" at the experimental dredging site showing ~70% of the seabed area has been dredged.

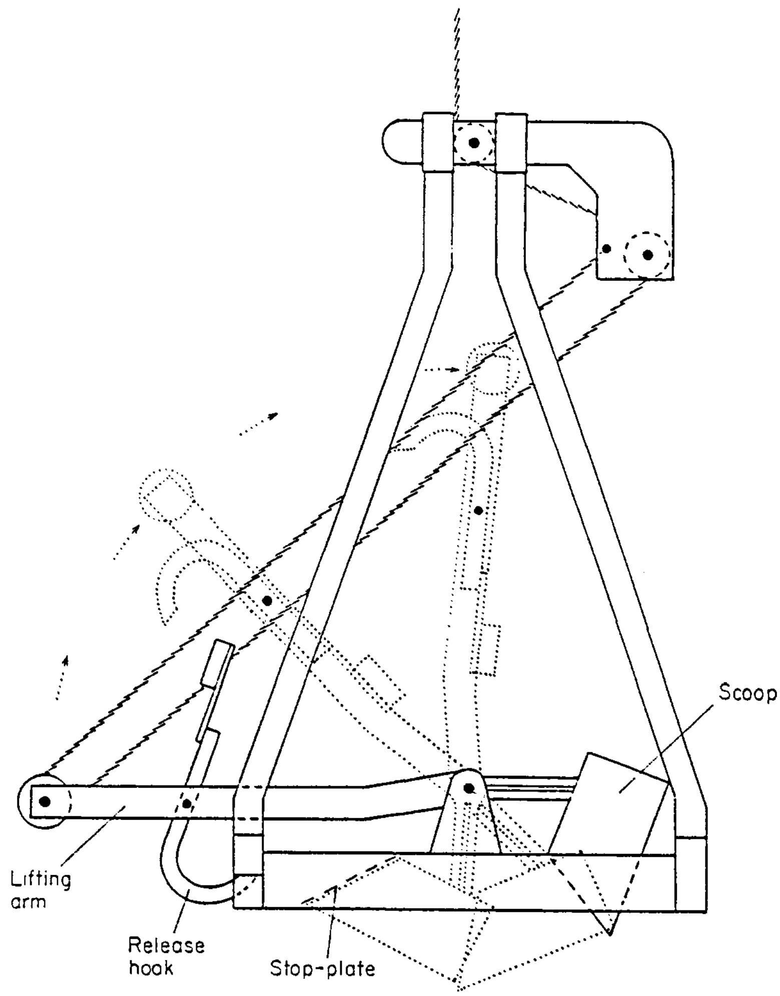


Figure 3: Schematic diagram of the Hamon grab (taken from Holme and McIntyre, 1984, after Oele, 1978).

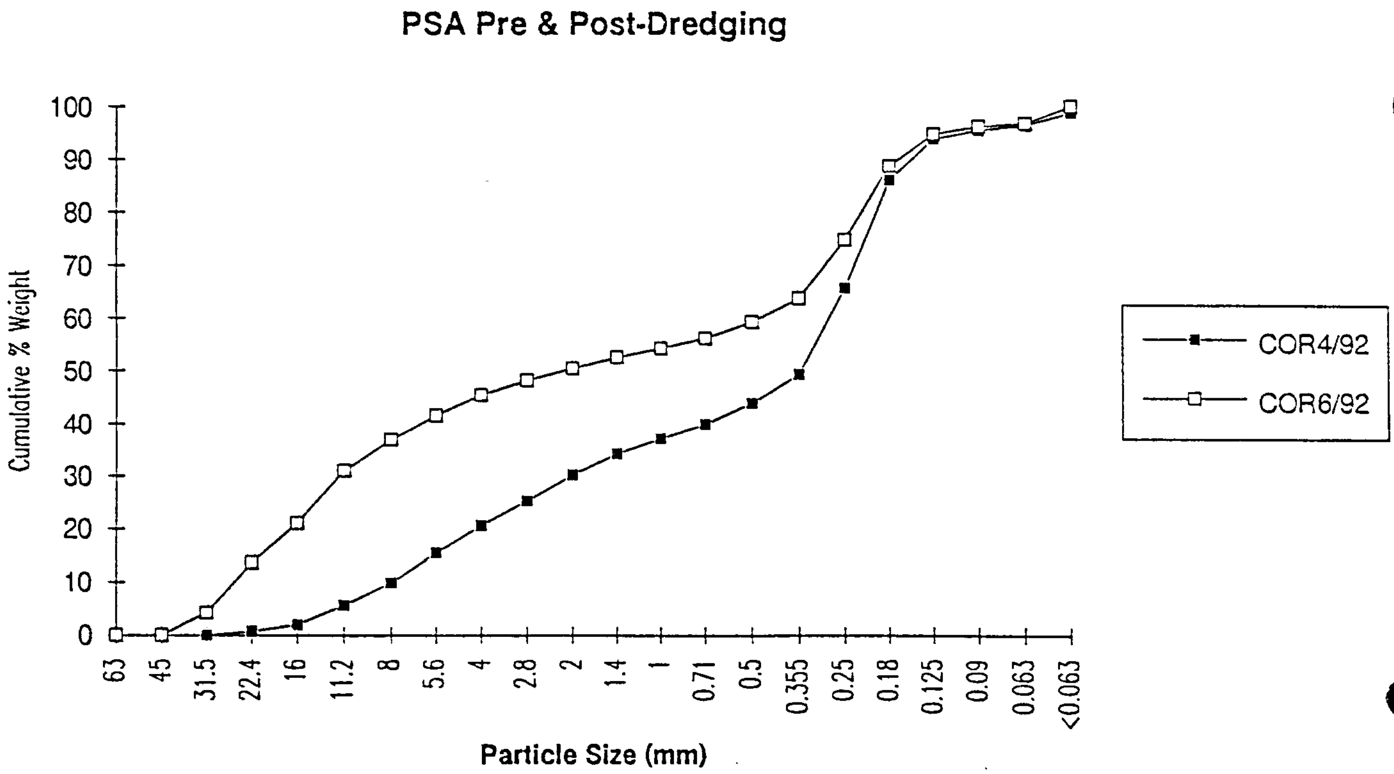
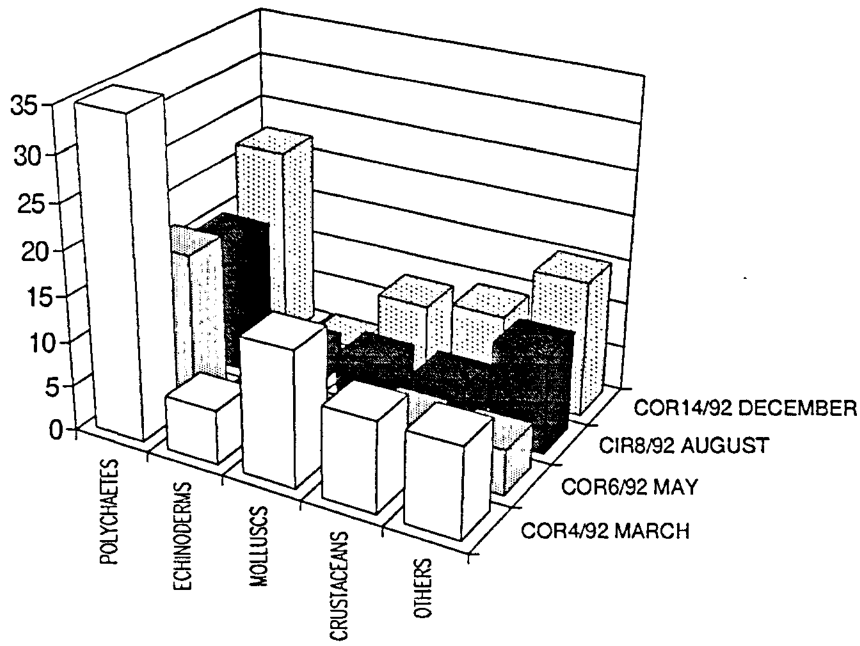


Figure 4: Average cumulative particle size distribution curves for samples taken before dredging (Cruise COR 4/92) and post-dredging (Cruise COR 6/92).

TREATMENT SITE SPECIES NUMBERS/1.05m



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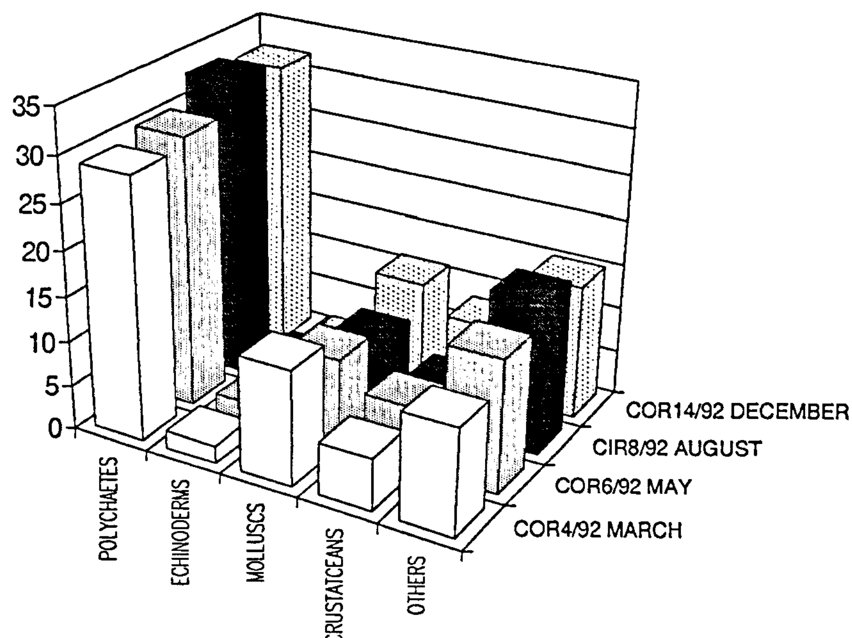
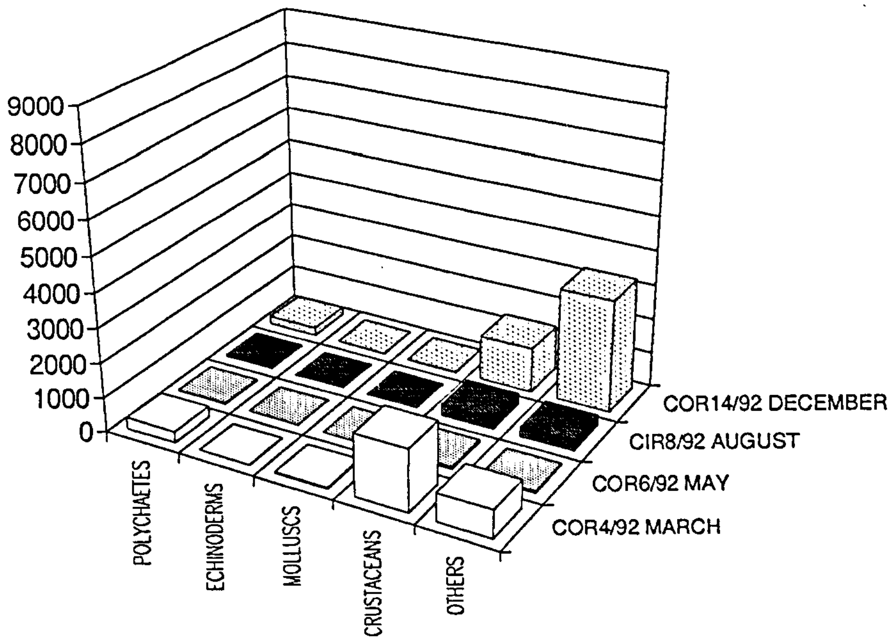


Figure 5: Number of species by major phyla for samples taken before dredging (Cruise COR 4/92) and post-dredging (Cruises COR 6/92, CIR 8/92 and COR 14/92) from the treatment and reference sites.

TREATMENT SITE ABUNDANCE 1.05/m



REFERENCE SITE ABUNDANCE/1.05m

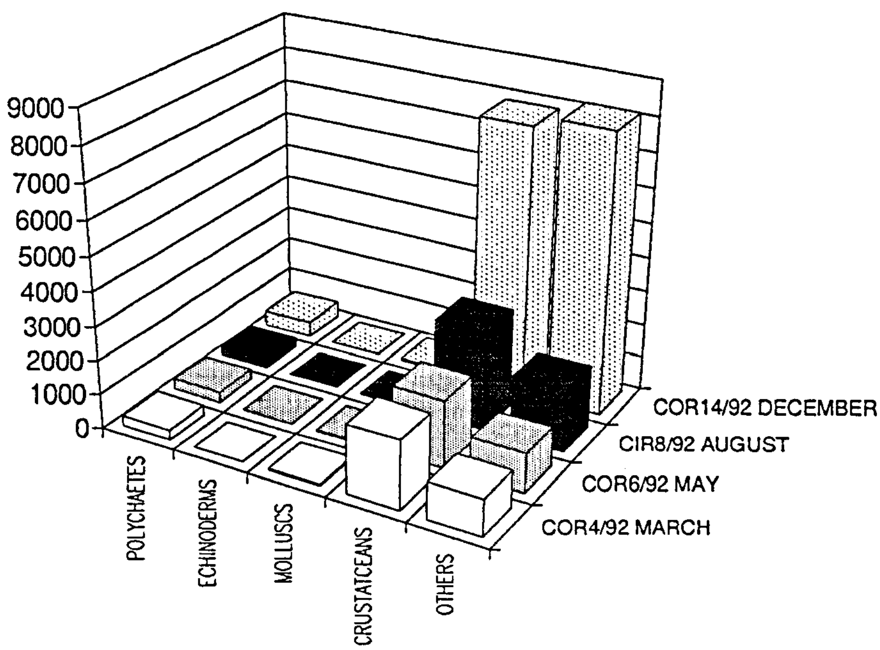
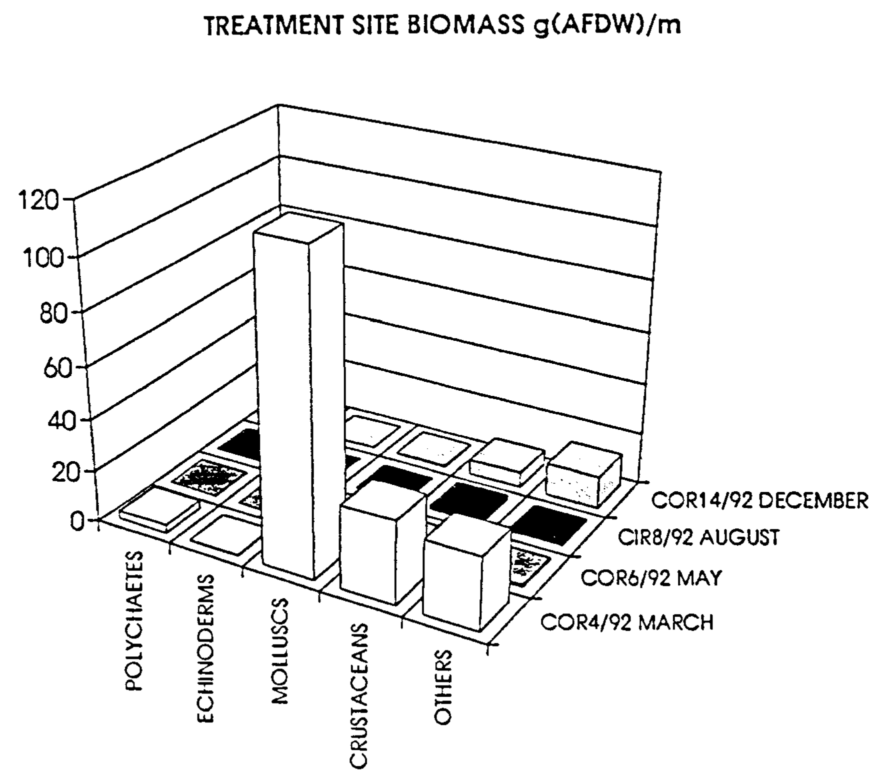


Figure 6: Abundance by major phyla for samples taken before dredging (Cruise COR 4/92) and post-dredging (Cruises COR 6/92, CIR 8/92 and COR 14/92) from the treatment and reference sites.



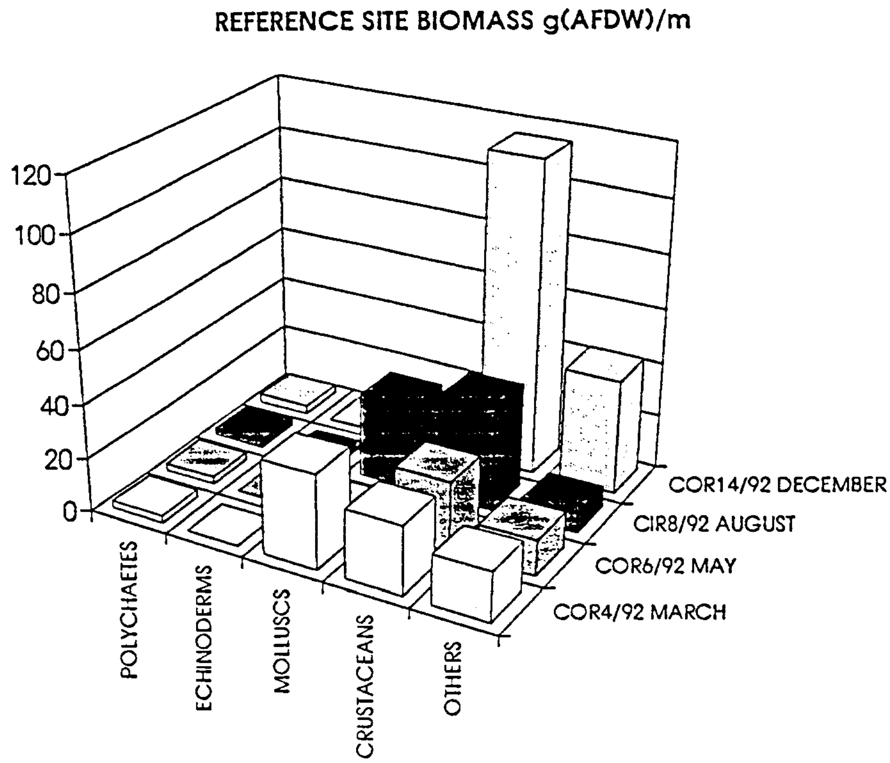


Figure 7: Biomass by major phyla for samples taken before dredging (Cruise COR 4/92) and post-dredging (Cruises COR 6/92, CIR 8/92 and COR 14/92) from the treatment and reference sites.

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Environmental Programme

Environmental Impact Status of the Great Belt Link - Supplementary Analyses of Causes and Effects

COWI/VKI Joint Venture

Note DHI/LIC Joint Venture

Document No. 93/002

Note

February 1993

COWI/VKI
Joint Venture

2. SUMMARY AND CONCLUSIONS

This note has to be considered as a first phase of an analysis of the relation between simulations by the PARTICLE model and the results from the biological monitoring programme.

Sediment trap measurements have been compared to the primary sedimentation calculated by the PARTICLE model. From this it is concluded that the resuspension may play an important role.

<u>Mussels</u>

In relation to mussel spat the effect levels found in the experiment are not directly comparable with the PARTICLE model simulations of sedimentation. In the experiment the measured sedimentation rates are the gross sedimentation, i.e. primary sedimentation of material from construction operations, sedimentation of resuspended material and the background sedimentation. The PARTICLE model only simulates the primary sedimentation. Sedimentation of resuspended material seems to have been of considerable magnitude around Sprogø. A direct comparison of effect levels from the experiment and the model simulations will therefore underestimate the area, where mussel settling has been hampered. However, in areas where the simulation shows primary sedimentation rates above the observed effect levels, the settling must have been hampered. On the two stations in the experiment, which were most affected, the sedimentation rates were measured to 3.3 and 6.1 kg/m^2/-month (cf. Figure 2.2). In the simulation the primary sedimentation at these stations has been estimated to 0.15 and 0.3 kg/m^2/month. These values are probably applicable as indications for areas where the settling of mussel spat has been hampered markedly during the settling period of May - August.

Vegetation

Direct calculation of the mean shading and growth inhibition effect on eelgrass growth from the PARTICLE model may result in an underestimation of the effects. The reason for this may be the above mentioned fact that the PARTICLE model underestimates the concentration of the very fine fraction of the sediment. This has a significant effect on shading conditions. The evaluation indicates that the effect on eelgrass growth may be at least twice that calculated from the PARTICLE model simulations.

From the biotope monitoring programme and the model simulations, it is concluded that after one growth season without significant shading, the eelgrass biotope can expand into an area which earlier had been exposed to a potential eelgrass growth reduction of minimum 20%. The weakness of this conclusion is due to lack of monitoring data from 1990.

In an area with accumulated primary sedimentation of above 100 kg/m^2 (- > 5 cm) in January 1991, disappearance of the vegetation was observed. In areas with accumulated sedimentation between 20 and 100 kg/m^2 (- 1-5 cm) for January 1991 a significant decrease of vegetation coverage was observed later.

The temporal stimulation of red algae vegetation north of Sprogø is in accordance with the calculated spreading of nutrients from the dredging activities.

At Halsskov Reef a disappearance of vegetation and a reduction in coverage has been observed within the area with an accumulated primary sedimentation of > 0.5 mm and a shading between 20-50%, as an average in the main construction period of the assess channel has been calculated (March 1992), has been calculated.

At the Anchor Block Island at Halsskov Reef disappearance and reduction in coverage was observed within the area with a calculated accumulated primary sedimentation of more than 0.5 mm. These areas were also periodically exposed to significant shading.

It is evaluated that it is meaningless to quantify critical mean sedimentation and shading levels for the growth season in relation to the observed effects. This is due to the very time varying intensity of the activities that have occurred in the area.

Herring

Herring was spawning around Sprogø throughout the construction period in spite of a total sediment spill of approx. 1.5 millonss tons through a three years period. This does not acquit the construction activities of affecting the spawning conditions. Unconsolidated fine sediment originating from construction operations have affected approx. 17% of the potential spawning area.

As the resuspension is not included in the PARTICLE model, the simulations cannot be used for predicting effects on herring spawning grounds.

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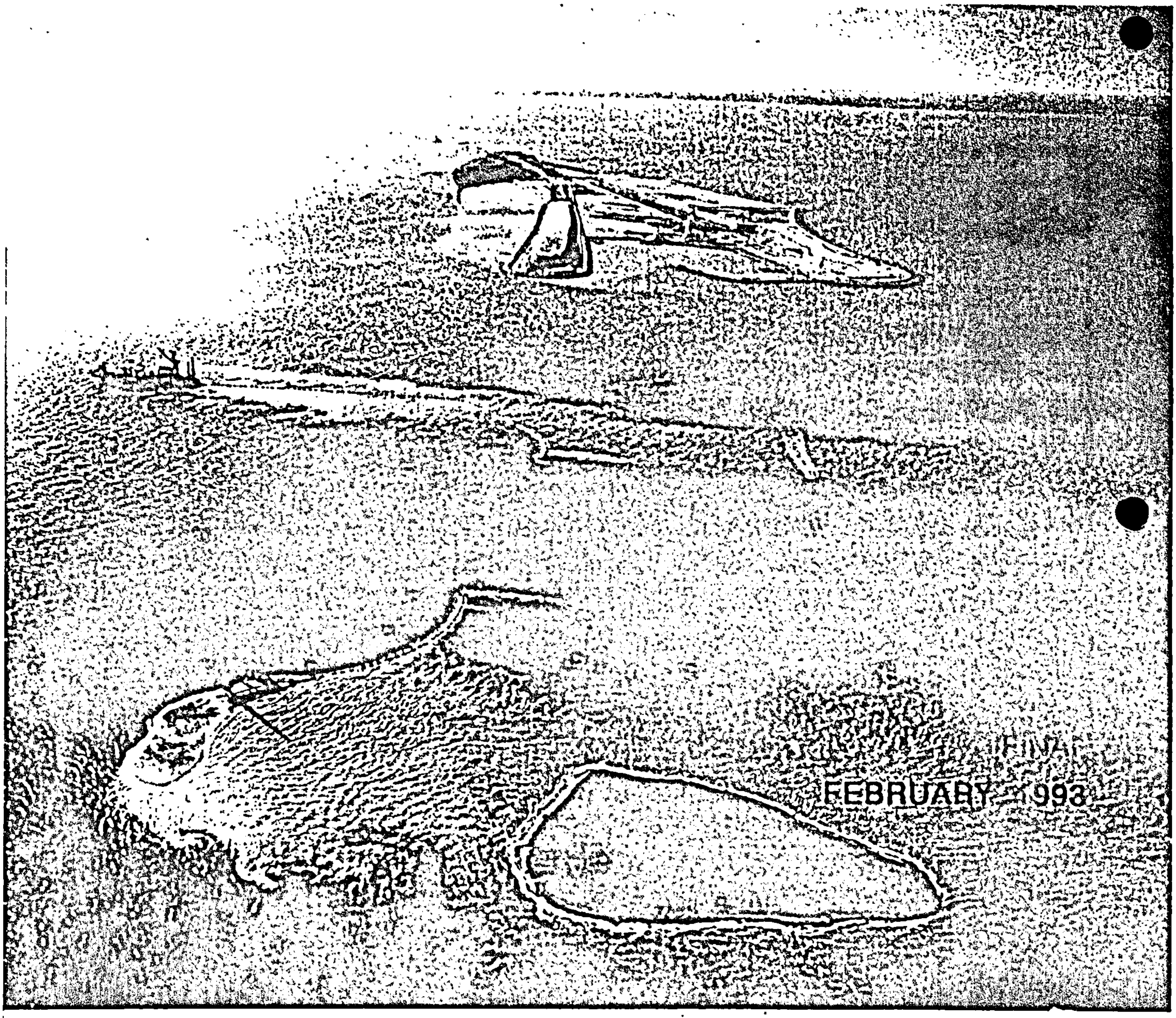
Environmental Programme

ENVIRONMENTAL IMPACT STATUS OF THE GREAT BELT LINK



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2. SUMMARY AND CONCLUSION

2.1 Summary and Conclusion

All notes, memos and reports issued under the Environmental Master Plan until October 1992 has served as the basis of the present environmental impact status. Below is given a short description of each chapter stating author, content and main findings.

Organisation and **Expert Panel** (SBF) describes the organisational setup behind the Environmental Master Plan.

Progress of Construction and **Marine Earth Works** (SBF & DHI/LIC) gives a status of the construction works and the remaining activities.

By October 1992 32.5 million tons of sediment has been handled by marine earth work operations. This has given rise to a sediment spillage to the marine environment of about 4.5 million tons. By now the total earth work operations are forecasted at 35.5 million tons of sediment, involving a total sediment spillage of about 4.65 million tons. This corresponds to an average spillage percentage of 13%. The amount of spillage depends on the sediment composition, the hydrographic conditions and the dredging equipment and the method undertaken. Sedimentation basins have proved useful to reduce the spillage to the marine environment.

The total release of nutrients is forecasted at 294 tons of Nitrogen and 21.3 tons of Phosphorus. The largest release occurred during 1989 with an average daily release of 420 kg N/day.

Progress of Environmental Programme (SBF) reviews the hydraulic and the biological monitoring programmes.

Far Field - Zero Solution (DHI/LIC) describes improvements to the design tool for calculating the Zero Solution and the present state of the of the Zero Solution requirement.

The status of the Zero Solution requirement has been investigated using the MIKE22 Great Belt CD Model, a specific design period and the compensation dredgings conducted until ultimo 1992. Relative to the total blocking imposed by the Great Belt Link on the upper layer flow the present compensation dredgings undercompensate by 15%. Thus an 85% compensation of the upper layer flow has been achieved. The sensitivity of the Zero Solution model versus choice of design period and bottom friction conditions has been investigated, also. A calculation based on an alternative design period indicated an undercompensation of approximately 27% corresponding to approximately 73% compensation of the upper layer flow.

Near Field - Physical and Chemical Impacts (DHI/LIC & COWI/VKI) reviews and comments on measurements and simulations of sediment plumes, shading, sedimentation, nutrients, oxygen and current conditions around Sprogø.

Suspended sediment has been detected 35 km away from a specific dredging operation. Simulations with the Particle model showed that 6 km off the Link alignment the monthly average surplus suspended sediment concentrations caused by some of the most intensive dredging operations were at the same level as the background concentration (2 mg/l).

Sediment plumes of moderate concentrations have been found to block the daylight. Large areas have periodically been affected by reduced daylight intensities or shading due to the extent of suspended sediment plumes.

Sediment deposits arising from sediment being spilled to the environment have been observed. NW of Sprogø a deposit of about 100,000 tons of fine sediment has been observed. In the compensation dredging area south of the western anchor block island and in the area SE of Sprogø about 600,000 tons of fine sediments have accumulated. In the area NW of the eastern anchor block island another deposit has been observed. However most of the 4.5 million tons of total sediment spillage is no longer detectable, as it has been spread over a large area.

Measurements and simulations of surplus Nitrogen concentrations indicate that release of nutrients causes local and temporary impacts only.

During situations of regional oxygen deficiency no detectable worsening could be related to the marine earth works performed so far.

The current conditions around Sprogø have been markedly affected by the ramps and the compensation dredging. System22 simulations revealed changes in the average current velocities above 5% in an area within 6 km of Sprogø.

Near Field - Biological Impacts (COWI/VKI) reviews and comments on monitoring of mussel beds, eider ducks, vegetation, soft bottom fauna, herring, phytoplankton and green toads on Sprogø.

The mussel beds around Sprogø had disappeared by November 1990. Incipient recolonization has been observed in November 1992, though the observed biomass was far from its original level.

The disappearance of the mussel beds around Sprogø has markedly affected the population of eider ducks in the Great Belt. A reduction of the population and a redistribution between the different feeding grounds have been observed.

No difference has been observed in the occurrence of spawning herring around Sprogø compared to the reference area around Vresen.

The extent of different plant communities around Sprogø is generally the same during the baseline survey in 1987/88 and in 1991, though some redistribution has taken place. The vegetation has vanished or decreased in a zone NW, W and SW of Sprogø and in the compensation dredging area. In most of the affected areas deposited sediment was observed. The coverage of vegetation has increased in an area N of Sprogø.

The soft bottom fauna monitoring has shown that the abundance, the biomass and the number of species has increased markedly from November 1987 to December 1990 within an area extending from approximately 15 km SE to approximately 15 km north of Sprogø.

The population of green toads on Sprogø has been estimated at 2000 individuals in 1990 and 1700 individuals in 1991. The apparant decrease is not statistically significant.

Discussion of Cause and Effect (COWI/VKI) seeks relationships between the physico-chemical impacts and the biological impacts.

In-situ experiments to investigate the disappearance of the mussel beds indicated that settling of musselspat was significantly hampered by increased sedimentation from the dredging operations.

Depression of the growth rate of transplanted eelgrass and in-situ tagged kelp due to shading from sediment plumes has been demonstrated by experiments.

Assessment of Future Impacts (COWI/VKI & DHI/LIC) forecasts physical, chemical and biological impacts to the environment.

The most profound future impacts to be expected in the Great Belt are connected with the protective works around the outer five bridge piers of the East Bridge.Depending on the construction method undertaken environmental impacts at Sprogø and Halsskov may be expected. A sediment spillage of 100,000 tons is expected during the winter of 1995/96. At Sprogø the impact is mainly an extension of the recovery period of areas previously affected. A preliminary estimate indicates that approximately 40% of the vegetation at Halsskov Reef has been affected by the activities. Further effects are expected from the construction of protective works around five bridge piers. During the natural armouring of the anchor block islands and the protective works an erosion of about 170,000 tons of sediment is expected.

The change of current conditions around Sprogø and the extension of the eelgrass beds around Sprogø are the significant permanent impacts to be expected due to the Great Belt Link.

Rôle et champs d'action des biologistes dans les dossiers d'extraction de granulats marins; réflexions inspirées d'expériences françaises en Manche-Est

(Place and responsibility of biologists within marine granulates extraction files; reflections from French observations over Eastern Channel)

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Résumé

Une réflexion administrative sur les dossiers d'extraction de granulats marins est actuellement en cours en France, prenant en compte à la fois la multiplication des demandes et le caractère conflictuel croissant des oppositions qu'elles créent. Recommandant meilleure concertation, allègement des procédures et meilleure garantie de respect des conditions d'exploitation, cette réflexion insiste sur le souhait de "dédramatiser" l'instruction de ces dossiers.

Dans cette dédramatisation, les scientifiques ont un rôle fort à jouer, mais peut-être différent et plus rigoureux qu'actuellement où l'on peut constater de l'inconfort et de l'ambiguïté. Rôle et responsabilités de la recherche doivent donc être réprécisés en affichant à la fois l'incertitude du biologiste mais aussi ses capacités à contribuer utilement aux dossiers.

Cette révision passe aussi par une meilleure identification des besoins en connaissances scientifiques, l'exigence d'un "point zéro" rigoureux et d'une clôture irréversible des sites après exploitation étant prioritaires pour progresser désormais dans l'étude de reconstitution des sites.

Abstract

An administrative reflection about marine granulates extraction is undertaken in France, taking into account both files multiplication and increasing conflictual level of the debates. Advising a better dialogue, a more simple proceeding and a stronger guarantee about extraction regulation, this reflection insists on a wish of "dedramatisation" of the conflicts.

In this "dedramatisation", scientists have a consistent place to hold, but perhaps different and more rigorous than now, present place being not so confortable and clear. Place and responsabilities of research have to be specified again by showing both incertainty of biologist but also capacity in efficient contribution within such files.

This reform is also proposed through a better identity of the scientific needs for such questions, requirement of a rigorous "Zero Point" of reference and a non-reversible closing of the totally exploited areas being stressed as priorities to progress from now on in the study of reconstitution of the seabed.

Préambule

Lors d'une réflexion nationale sur la gestion administrative des dossiers d'extraction, trois constatations ont été faites, en particulier pour la Manche orientale :

- les réserves terrestres de granulats devenant rares, la nécessité d'avoir recours aux ressources marines devient croissante et inéluctable à court terme,
- les difficultés de cohabitation entre les pêcheurs et les extracteurs ont tendance à s'accroître avec la multiplication des demandes de titres miniers,
- les contraintes techniques et économiques cantonnant étroitement le choix des sites à la bande côtière (rarement au-delà de 12-15 milles) et conduisant à des conflits d'utilisation de la mer, et les contraintes juridiques contribuant à exacerber les conflits potentiels, il est nécessaire de progresser dans le sens de la "dédramatisation" des oppositions.

Dans le cadre de l'instruction et du suivi administratif des dossiers, les propositions d'amélioration s'articulent selon trois volets :

- mieux organiser la concertation,
- alléger les procédures,
- garantir le respect des conditions d'extraction.

En complément, d'autres propositions sont favorables à une meilleure insertion des biologistes dans le processus par :

- un souci de plus forte prise en compte des contraintes biologiques et écologiques,
- un souhait de gérer les sites dans des schémas d'utilisation de la mer eux-mêmes intégrés dans une politique plus générale de gestion du littoral entre tous les utilisateurs,
- allègement des procédures et donc réduction des consultations souvent trop nombreuses des scientifiques,
- une demande officielle mieux formalisée de recherche scientifique dirigée vers ces questions.

Il reste aux biologistes à tirer parti de ce souci d'amélioration et de commencer par examiner plus précisément quels devraient être leur rôle, leurs responsabilités et aussi les limites de leur intervention dans ce domaine qui a une forte connotation socio-économique et politique à ne jamais oublier.

Inconfort et ambiguité du rôle des biologistes dans la gestion des dossiers d'extraction

a/ Difficile impartialité des scientifiques

Dans les débats précédemment décrits comme de plus en plus conflictuels d'utilisation de la mer, et entre pêcheurs et extracteurs singulièrement, on peut observer que les biologistes peuvent être fréquemment détournés de ce qu'ils considèrent comme leur rôle premier de "créateurs" de connaissances, pour être impliqués plutôt :

- soit comme détenteurs et fournisseurs de données particulières au bénéfice des différents partis confrontés,
- soit comme expert (et/ou émetteur d'avis) dans l'instruction administrative du dossier, institutionellement aux côtés de l'Administration pour la recherche publique et contractuellement aux côtés des exploitants pour la recherche "non publique".

Cette ambiguité tient essentiellement au double rôle de juge et parti que peut alors avoir le scientifique dans l'évaluation des dossiers lorsqu'il a fourni de l'information pour la constitution de la demande ("étude d'impact") et doit en juger le bienfondé ensuite. Elle est à souligner et peut faire elle-même l'objet d'un débat entre scientifiques d'un point de vue réglementaire mais aussi éthique.

b/ Survalorisation de l'avis scientifique par les partenaires

Le trouble peut venir dans l'esprit des scientifiques de l'importance que leurs partenaires (Administration, pêcheurs, extracteurs,...) peuvent donner, dans ce type de dossiers, à leurs données et avis alors que :

- un benthologue est plus communément considéré comme un fondamentaliste sans grande liaison avec les débats d'intérêt économique,
- un halieute s'inscrit mieux dans une évaluation ou une régulation de stock à l'échelle d'un bassin entier de pêche plutôt que sur une surface de quelques Km^2 dont la ressource en poissons, en particulier, s'avère difficile sinon impossible à estimer.

L'inconfort du scientifique tient aussi à l'imprécision de ce que l'on attend de lui et, en retour, à son incapacité virtuelle à apporter toute l'information nécessaire à des prises de décision pleinement argumentées. Or généralement, "on" attend des biologistes toutes les données dans tous les domaines, accompagnées d'un avis simple et n'incluant de préférence aucune incertitude. On peut penser que cette situation n'est pas satisfaisante pour le biologiste, l'halieutique ou l'écologiste qui, généralement:

- ne peut afficher des certitudes identiques à celles des sciences "dures" intervenant en amont des dossiers d'extraction (géologie, sédimentologie, courantologie,...),
- ne devrait pas admettre d'être le porteur d'arguments de blocage, bien souvent illusoires mais pratiques, et de servir ainsi de "bouc émissaire" alors que arbitrages lourds et décisions officielles dépendent le plus souvent d'une toute autre gamme d'éléments.
- ne devrait pas à l'opposé prendre le risque de "décider pour les décideurs".

Il faut donc que les biologistes clarifient eux-mêmes leurs ambitions naturelles dans ce type d'intervention en cherchant à :

- préciser leurs stades d'intervention,
- mieux cerner leurs responsabilités,
- mieux hiérarchiser les besoins en connaissances.

Rôle des biologistes et responsabilités de la recherche

La recherche biologique, halieutique ou écologique contribue systématiquement désormais à l'instruction d'un dossier d'extraction au même titre que les autres sources d'information sur la ressource sédimentaire, l'hydrographie, l'environnement socio-économique, la réglementation,... Cependant, cette recherche s'est souvent retranchée derrière des délais importants d'acquisition de données fréquemment signalés comme peu compatibles avec les enjeux économiques, les biologistes passant ainsi souvent pour des empêcheurs d'avancer, même si leur rôle est de mieux en mieux perçu sous la pression écologiste de l'opinion et du moment.

Pour endiguer ces critiques, les biologistes doivent savoir d'abord signaler que leur domaine de compétence est soumis à des particularités telles que:

- les rythmes d'observation biologique généralement calés sur l'année dans les pays tempérés,
- les difficultés d'évaluation quantitative des peuplements marins,
- la multiplicité des paramètres influents sur ces peuplements,
- la variabilité des données selon les sites, les saisons, les années,...
- le caractère essentiellement aléatoire de cette variabilité liée à l'hydroclimat,aux relations interspécifiques, aux effets cumulés et interactions entre pêches et mortalité naturelle,...
- le coût et la lourdeur des moyens à mobiliser pour acquérir une connaissance éventuellement suffisante mais restant le plus souvent volatile.

Ils doivent par contre se montrer de plus en plus capables d'apporter aux débats des éléments appréciés pour leur qualité intrinsèque et leur utilisabilité par l'Administration, les professionnels, les élus et même le grand public, via les médias. Cette qualité d'intervention scientifique peut venir d'une reconnaissance des capacités de la recherche à :

- savoir entretenir en permanence et valoriser les connaissance acquises, éventuellement en développant bases de données et Systèmes d'Information Géographique (SIG),
- acquérir rapidement certaines données manquantes par une méthodologie appropriée, tout en ménageant réalisme opérationnel et rigueur scientifique,
- focaliser sur les sujets et/ou résultats significatifs,
- exposer ces résultats, souvent sous forme d'avis ou expertises, en termes strictement neutres vis-à-vis des intérêts en présence,
- afficher les incertitudes et les risques d'erreur tout en les interprétant pour les non-spécialistes,
- éviter les spéculations inutiles ou, à l'opposé, les avis trop catégoriques,
- s'imposer des limites de compétence,
- enfin, et peut-être surtout, traduire en langage accessible des connaissances ou concepts parfois complexes ou inhabituels.

Ceci étant acquis, ou à acquérir rapidement, les responsabilités de la recherche paraissent plus claires, sa mission globale étant de contribuer à faire aboutir les dossiers de demande d'extraction (positivement ou non d'ailleurs) en ayant un rôle important dans la "dédramatisation" des oppositions. Sa responsabilité consiste pour celà à :

- faire en sorte que la connaissance minimale nécessaire soit disponible et mobilisée,
- contribuer à l'objectivité des débats,
- aider l'Administration à arbitrer.

Meilleure identification des besoins en connaissances

Admettant provisoirement la confusion entre fonction du biologiste créateur de données et celle d'émetteur d'avis (cf. remarque supra), les scientifiques doivent désormais mieux évaluer la précision et l'étendue des besoins en connaissances nécessaires à l'examen des demandes d'extraction, ainsi que préciser les stades essentiels de leur intervention.

a/ Eléments de dédramatisation des oppositions entre extracteurs et pêcheurs

Ces oppositions mettent en présence :

- des priorités peu compatibles, les uns vivant dans l'urgence de voir leur projet industriel aboutir et les autres se représentant avec angoisse une nouvelle atteinte à leur activité professionnelle, ceci venant bien souvent après d'autres nombreuses dégradations de leur milieu d'activité par pollution, aménagements portuaires,...
- des intérêts de valeur totalement différente, tout chiffrage de la perte de ressources halieutiques occasionnée par une souille d'extraction semblant dérisoire par rapport aux enjeux financiers liés aux besoins de granulats (cf. Annexe 2 "Estimation of scale of effects and consequences of marine aggregate extraction" du Rapport CIEM 1990/E:35),
- des influences politiques concurrentes, favorables soit à la préservation d'une animation socio-économique de la côte par la pêche (et au maintien de la paix sociale) soit à l'aménagement du territoire et à la réalisation d'infrastructures d'intérêt régional ou national pour les extracteurs.

Dans ce contexte, les biologistes peuvent apporter :

- des éléments de relativisation de l'impact
  - en termes de rapport de surface entre zones pressenties pour l'extraction et zones maritimes environnantes (par exemple en baie de Seine, quelques Km^2 dans une baie de 12 000 Km^2), ce rapport souvent très faible constituant une garantie de faible impact relatif si le site est identifié (cf. infra) comme biologiquement "non-stratégique"
  - en rappelant que l'extraction de granulats par son action essentiellement mécanique est a priori bien moins pernicieuse, et mieux contrôlable, que la plupart des autres sources de dégradation industrielle du milieu à dominante chimique, ceci ouvrant la réflexion sur des possibilités de compensation d'un domaine dans un autre
  - en rappelant enfin que les pêcheurs eux-mêmes contribuent, par leur métiers traînants surtout (dragues, chaluts à perche et même à panneaux), à une dégradation permanente du fond et de ses peuplements dans des proportions probablement comparables aux extractions mais sur des bassins entiers de pêche.

- une forte contribution à l'élaboration de Schémas d'utilisation de la mer dans lesquels l'Etat s'engage en matière de non-prolifération des sites d'extraction, de respect des règles d'exploitation des granulats et de suivi ultérieur des souilles.

b/ Exigence d'un bon "Point zéro" de référence

Il revient aux scientifiques de rappeler l'utilité essentielle d'une bonne évaluation de l'état initial d'un site d'extraction et de son environnement proche, cette exigence se justifiant par :

- l'irréversibilité des modifications du milieu (sauf à très long terme et sans garantie) créées par l'extraction
- l'obligation ainsi créée d'argumenter la demande de site d'une façon approfondie et d'éviter ainsi des erreurs lourdes
- le fait que cet état sera la base unique de toute évaluation ultérieure de dégradation, de repeuplement et aussi d'observation scientifique.

Pour réaliser ce point zéro, les scientifiques doivent à la fois garantir une action rapide et obtenir les moyens de la mener. Dans ce sens, ils doivent :

- avoir su anticiper la demande et être en mesure de valoriser vite les connaissances déjà acquises, les moyens cartographiques et informatiques (de type SIG,...) l'autorisant désormais,
- avoir pu prévoir ces interventions lourdes, nécessitant par définition des moyens navals, dans le cadre de Schémas administratifs d'aménagement bien planifiés et d'une programmation scientifique interne,
- être performants en organisation méthodologique,
- bien cibler les domaines de connaissance utiles et significatifs,
- bien limiter leur domaine de compétence.

Il semble utile d'insister sur ces deux derniers points qui font partiellement l'objet de l'Appendix I "Guidelines for fisheries consultations" du Rapport CIEM 1990/E:35. Ce guide énonce en effet certaines priorités que l'on doit retenir :

- localisation des zones et saisons de ponte,
- identification d'éventuelles nourriceries,
- localisation de gisements de coquillages (et crustacés),
- localisation de sites alimentaires remarquables pour les ressources exploitables,
- recherche de migrations des ressources exploitables.

tout en proposant quelques compléments :

- la localisation des peuplements de coquillages semble devoir s'accompagner d'une évaluation qualitative et quantitative précise, ces espèces sédentaires représentant souvent l'essentiel de la valeur halieutique pérenne et incontestable du site, à l'opposé des ressources nageuses, ou même marcheuses, dont les industriels contestent (parfois à juste titre) la présence et donc la destruction lors de l'extraction,

- la prise en compte des sites alimentaires semble trop imprécise puisqu'on peut opposer à cette notion le fait que tout site marin y contribue potentiellement et qu'il n'y a donc aucune particularité à celà; il faut donc envisager de recommander systématiquement une description précise du benthos du site, et alentour, afin de disposer des seuls indices réels de sa valeur biotique, un éventuel rôle alimentaire particulier pouvant être signalé à l'occasion.

En ce qui concerne le descriptif des activités de pêche exigées à juste titre dans l'étude d'un site, on peut penser que l'halieute a nécessairement acquis des informations pertinentes sur les "pratiques sociales" des pêcheurs (pratiques de pêche, comportements professionnels,...) qui s'avèrent utiles à l'évaluation de l'impact des extractions sur les métiers de la pêche. Il ne semble pas cependant que les halieutes doivent contribuer trop ostensiblement à cette évaluation, et en tous cas en troisième rang seulement derrière les professionnels eux-mêmes et l'Administration maritime qui doivent (ou devraient) disposer des statistiques et documents opposables aux intérêts des extracteurs. Il serait en effet judicieux d'éviter d'ajouter à ce stade une autre ambiguïté dans le rôle du scientifique car il est probable que le biologiste perdra de sa neutralité et pourra être accusé d'empiéter dans un domaine socio-économique, voire socio-politique, qui n'est pas le sien.

c/ Exigence d'une obligation de clôture d'extraction pour suivi scientifique

Le seul moyen pour les scientifiques de progresser dans l'étude des rythmes et modes de reconstitution des sites est de travailler en vraie grandeur sur les souilles industrielles. Pour celà, et le point zéro ayant été acquis, il faut disposer de la garantie essentielle, autant pour les scientifiques que pour les pêcheurs, que l'extraction puisse être arrêtée définitivement dès que les cubages prévus ont été produits.

Dès lors, le site deviendrait protégé et réservé à l'observation scientifique pour faire l'objet de toutes sortes de plans expérimentaux exigeant temps et rigueur. Le suivi sédimentaire, topographique et biologique pourrait être en effet accompagné d'essais divers de "réhabilitation accélérée" à base, par exemple, de nivellement (pour les extractions superficielles) par des engins lourds de type dragues ou chaluts à perche, ou bien de réensemencement d'espèces originaires du site tels que des bivalves (coquille, vénus,...) ou crustacés.

Enfin pourrait-on dans ces conditions progresser dans le traitement de ce mal nécessaire industriel et quitter les spéculations régnant depuis des années dans ce domaine.