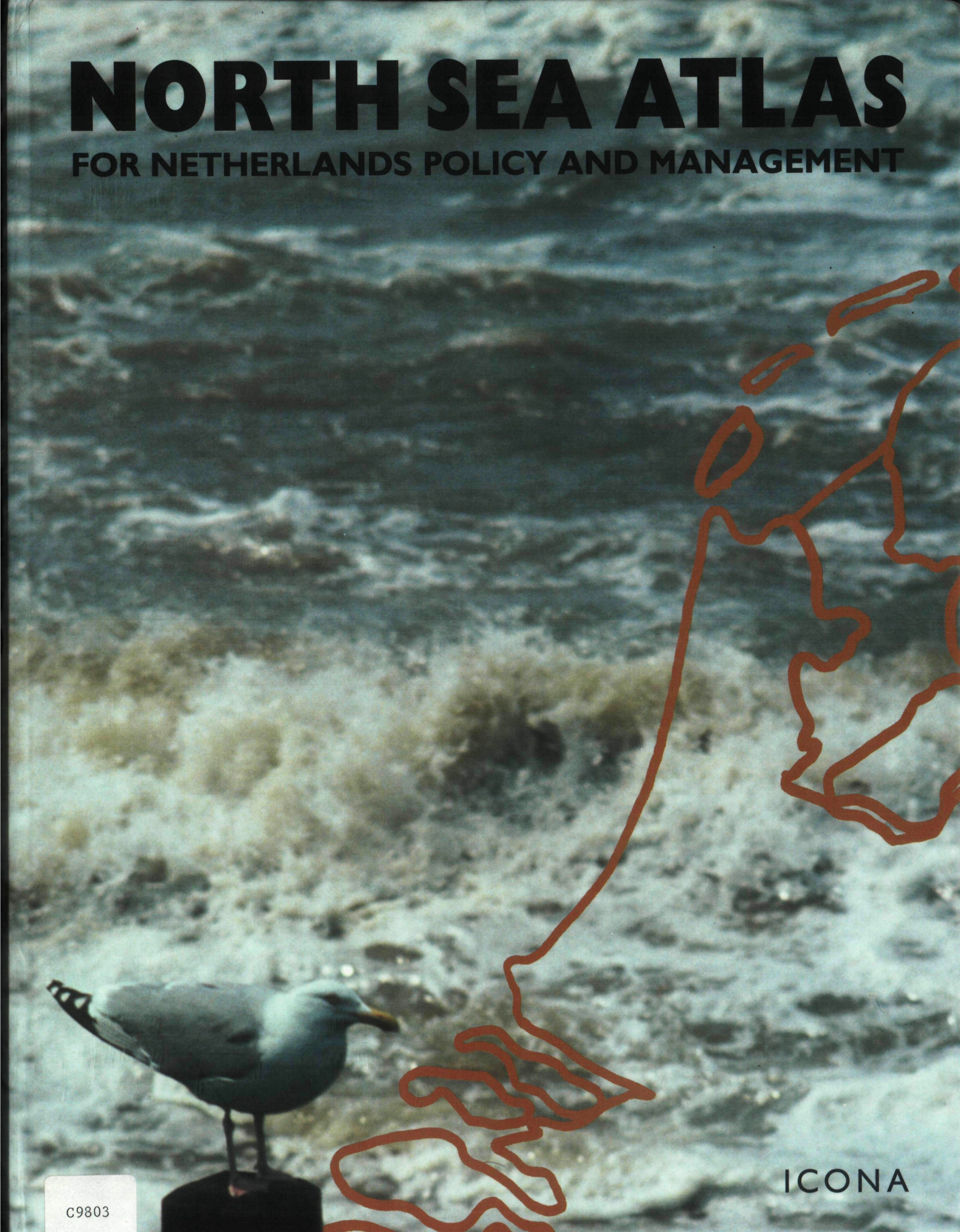
NORTH SEA ATLAS

FOR NETHERLANDS POLICY AND MANAGEMENT



ICONA

NORTH SEA ATLAS

for Netherlands Policy and Management

ICONA

(Interdepartmental Co-ordinating Committee for North Sea Affairs)

Stadsuitgeverij Amsterdam

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Foreword

When you open this atlas you will not smell the salty air of the North Sea. Nor will you hear the murmur of the waves or feel the loose North Sea sand under your feet. Nevertheless this atlas is about the North Sea. The atlas forms part of a triptych. The other two parts of the triptych consist of the report "The North Sea ... new possibilities" and the "Discussion Memorandum on North Sea Spatial Policy". These three documents mark the conclusion of a policy exploration of North Sea spatial policy. This policy exploration began by investigating what developments may be expected in the future. We then set down on paper the policies we propose to adopt to control the present and future spatial use of the North Sea. Lastly, the latter were given visual form in the present North Sea Atlas.

We cannot of course claim that, when we have the North Sea Atlas on our bookshelves and have studied the various reports, we will indeed know the vast space of the North Sea: the North Sea cannot be known. It presents itself to us in so many different guises that not even the North Sea Atlas can show them all. Sometimes the North Sea is grey and recalcitrant, threatening those who sail on it or fish it or even live on it. At other times it is green and withdrawn, wholly at the user's command. This North Sea, which is a home to so many animal and plant species, is a valuable heritage that cannot be sufficiently cherished.

The triptych shows how important the North Sea is for us. We would like its treasures to be actively preserved for our children and the following generations. We are doing all we can to make that possible. The North Sea Atlas shows the treasures that we wish to protect and how we protect them. It is an excellent medium for the purpose.

J.R.H. Maij-Weggen
The Netherlands Minister of Transport, Public Works and Water Management
Co-ordinating Minister for North Sea Affairs

Acknowledgements

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The content and arrangement of the atlas are based on the spatial approach of North Sea policy, supplemented with physical, chemical and biological information about the North Sea. The arrangement of the North Sea Atlas is as follows:
- general information about the North Sea, partly as a support to the other maps
- description of the spatial diversity of the North Sea environment, insofar as it is relevant to its spatial use
- spatial use
- environmental effects of spatial use, insofar as these can be depicted spatially
- spatial effect of measures taken to harmonise the uses of the North Sea and to protect the marine environment.

All the maps have been based on the most recent information which could be presented in map form. This information is shown in maps of the North Sea, the Netherlands sector of the Continental Shelf or of the Netherlands coast, depending on the nature of the subject or the information supplied. Each map is accompanied by an explanatory text and a reference to the relevant sources. Maps can be compared among themselves with the loose enclosed overlays. The cartographic material and the commentaries have been supplied by a large number of officials from various departments and members of research institutes (see colophon). The editors have processed this material into the present form and content. The Translation Branch of the Ministry of Foreign Affairs has looked after the translation of the Netherlands version 'Noordzee-atlas voor het Nederlands beleid en beheer' into English. The contributors have checked their texts on a correct translation of technical terms.

Contents

Loose enclosed overlays of the North Sea, the Netherlands sector of the Continental Shelf and the Netherlands coast

General

Topography (map 1 to 3)
Management (map 4 to 7)
Research (map 8 to 11)

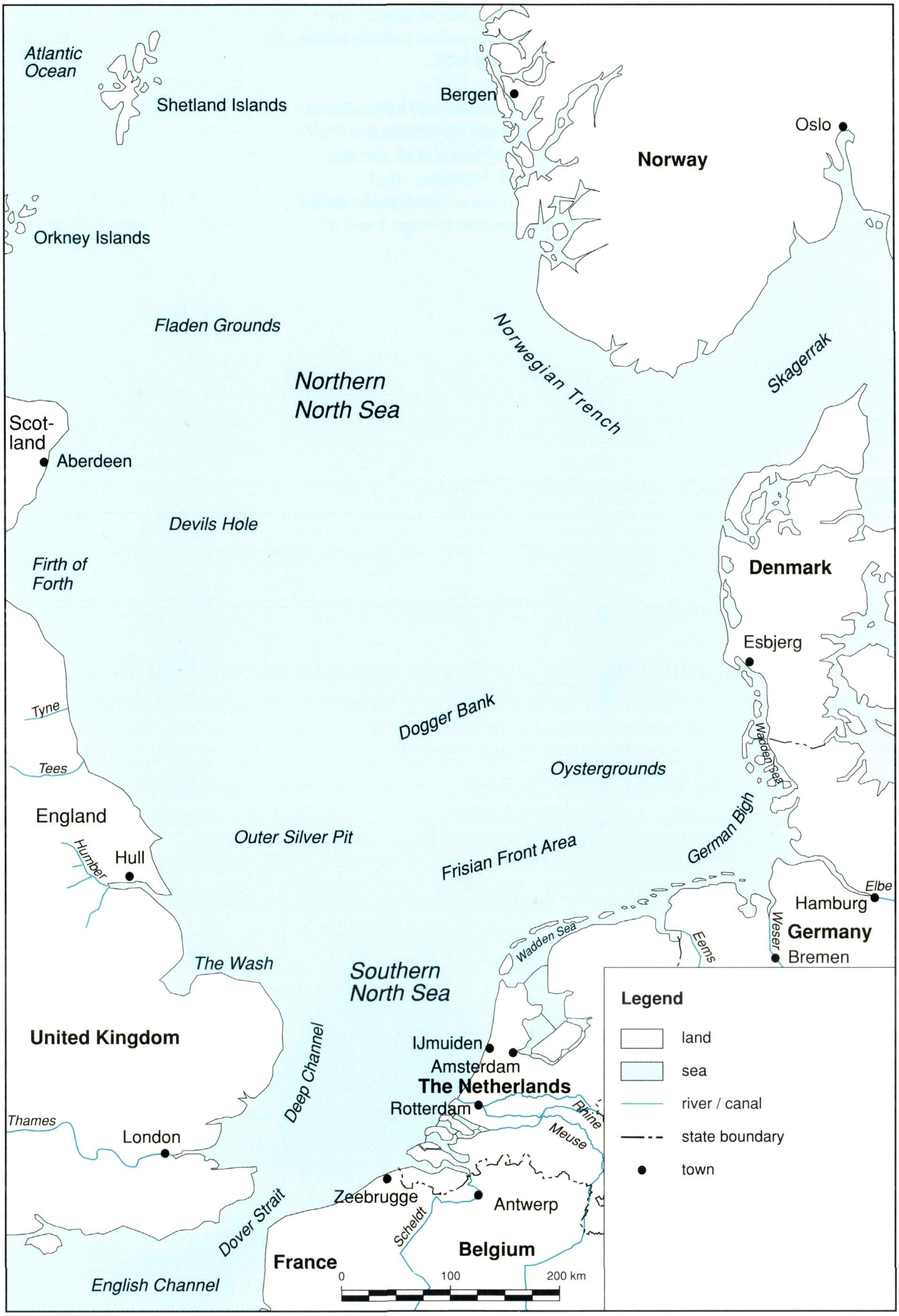
The North Sea

The information contained in the North Sea Atlas is plotted on maps of the North Sea [1], the Netherlands Continental Shelf [2] or the Netherlands coast [3], depending on the nature of the subject. In order to facilitate comparisons between maps, the basic topography is also shown on overlays. The North Sea overlay shows latitudes and longitudes and the ICES quadrants (ICES stands for: International Council for the Exploration of the Sea). ICES quadrants are of particular relevance to the fisheries maps [64 to 67].

The solid land is shown in yellow on the basic topography of the maps. The sea, inland waters and rivers are shown in blue. White is used on the maps to indicate that data about the area in question were lacking or not available. Maps 1 to 3 contain all the topographical names included in the atlas.

The North Sea, in fact, occupies the area between 4° west and 12° east longitude, and between about 49° and 62° north latitude. The whole North Sea, taken from the Strait of Dover to a line from the Shetland Isles to Bergen, has an area of about 572,000 km^2.

The North Sea

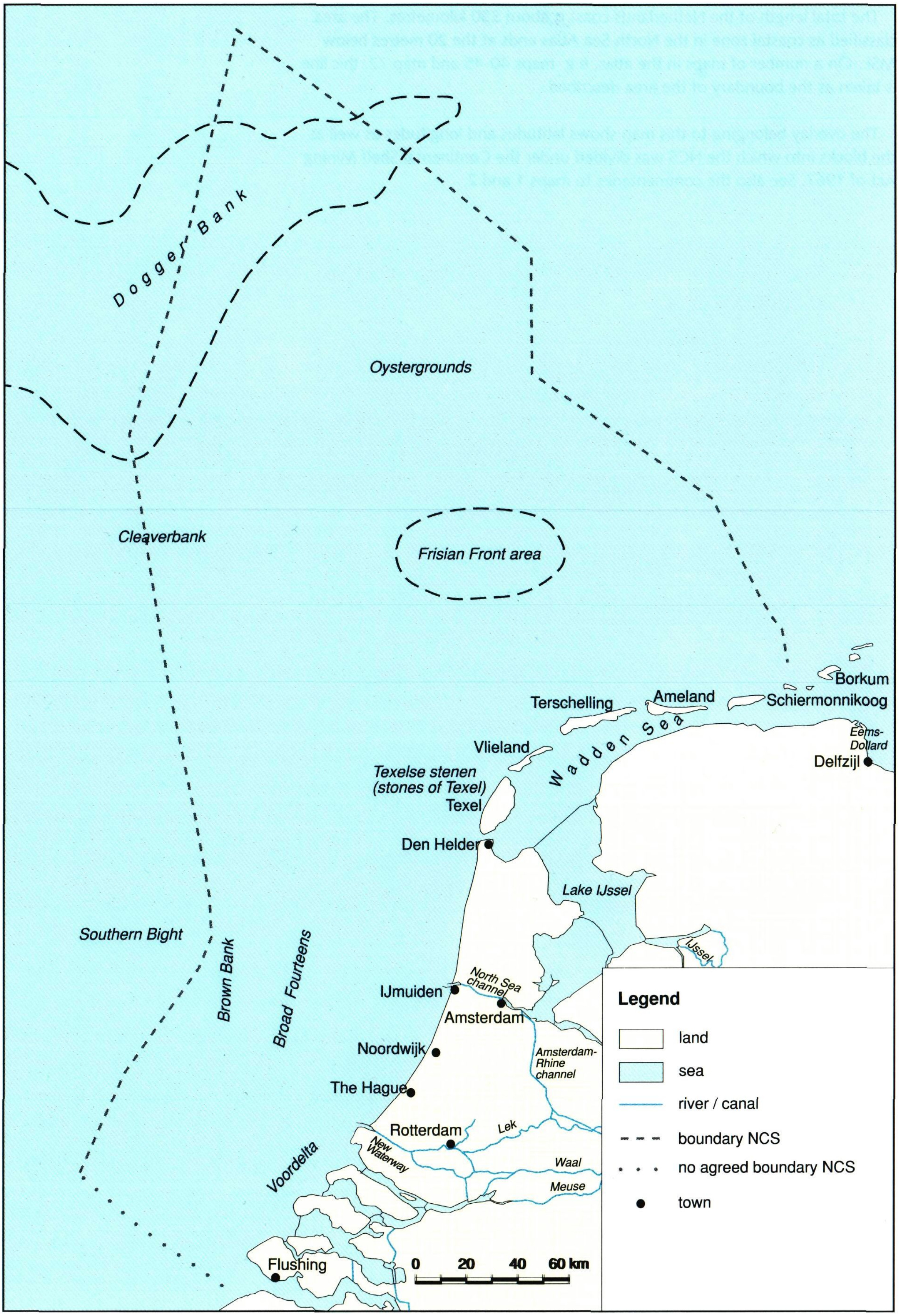


The Netherlands Continental Shelf (NCS)

The Netherlands sector of the Continental Shelf (NCS) has an area of about 57,065 km². By Continental Shelf is generally meant the seabed and the subsoil. Many of the maps, however, show only the limits of the NCS.

The overlay of the topography of the NCS shows latitudes and longitudes as well as the blocks into which the NCS was divided under the Continental Shelf Mining Act of 1967. These blocks are used in the assignment of oil and gas activities and in relation to the extraction of sea sand. Moreover, much information about the geology and use of the North Sea is classified and stored on the basis of this subdivision. See also the commentaries to maps 1 and 3.

The Netherlands Continental Shelf (NCS)



The Netherlands coast

The total length of the Netherlands coast is about 390 kilometres. The area classified as coastal zone in the North Sea Atlas ends at the 20 metres below MSL. On a number of maps in the atlas, e.g. maps 40-45 and map 72, this line is taken as the boundary of the area described.

The overlay belonging to this map shows latitudes and longitudes as well as the blocks into which the NCS was divided under the Continental Shelf Mining Act of 1967. See also the commentaries to maps 1 and 2.

The Netherlands coast

Delimitation of the Continental Shelf

By Continental Shelf is generally meant the seabed and the subsoil, beyond the territorial sea, up to a distance of 200 nautical miles measured from the coast (baseline). International legal rules have been established for the delimitation of the Continental Shelf by the bordering coastal states. They have been mainly laid down in the Convention of Geneva on the Continental Shelf (1958). The UN Convention on the Law of the Sea (1982) also contains rules relating to the Continental Shelf, but this Convention has not yet come into force.

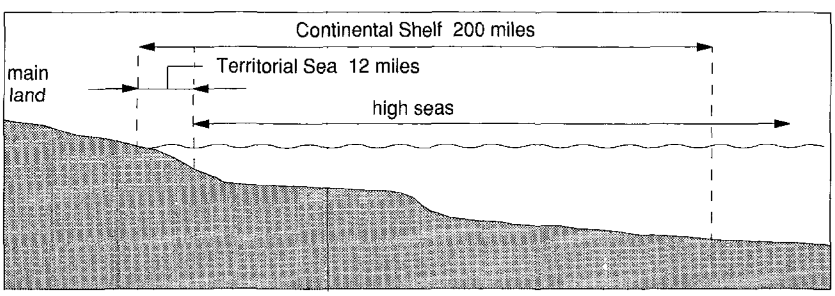
Article 6 of the Continental Shelf Convention states that the delimitation must be effected through an agreement between the states whose Continental Shelf borders on that of the other. If the states concerned cannot reach an agreement, the equidistance line shall be taken as the boundary. This is a line each point of which is equidistant from the coasts of the states concerned. A different formulation has been chosen in the UN Convention on the Law of the Sea (which will supersede the Continental Shelf Convention when it comes into force). It emphasises that the result of the delimitation shall be equitable.

A coastal state enjoys sovereign rights on its Continental Shelf in relation to the exploitation of its natural resources (oil, gas, sand, gravel, sedentary animal species).

Many bilateral delimitation agreements were concluded between the North Sea states in the 1960s and the first half of the 1970s after the conclusion of the Convention of Geneva. The resultant boundaries have been drawn in on the map. The oldest agreement is that between the Netherlands and Germany (1964). The boundary was then only partially defined (over a segment of 26 nautical miles). Further agreement was not possible because of a dispute about the correct delimitation criteria. The Netherlands and Denmark considered that the equidistance line should be applied. Germany pointed out that, because of the convex form of the coast, application of the equidistance rule would result in the German Continental Shelf being completely enclosed by the Netherlands and Danish areas, which would be unequitable. In anticipation of the solution of this dispute the Netherlands and Denmark concluded a delimitation agreement in 1966. The dispute between the three countries was submitted to the International Court of Justice which decided in favour of Germany in 1969. The agreement between the Netherlands and Denmark was withdrawn in 1971 when Germany concluded agreements with the Netherlands and Denmark fixing the boundaries of the Continental Shelf.

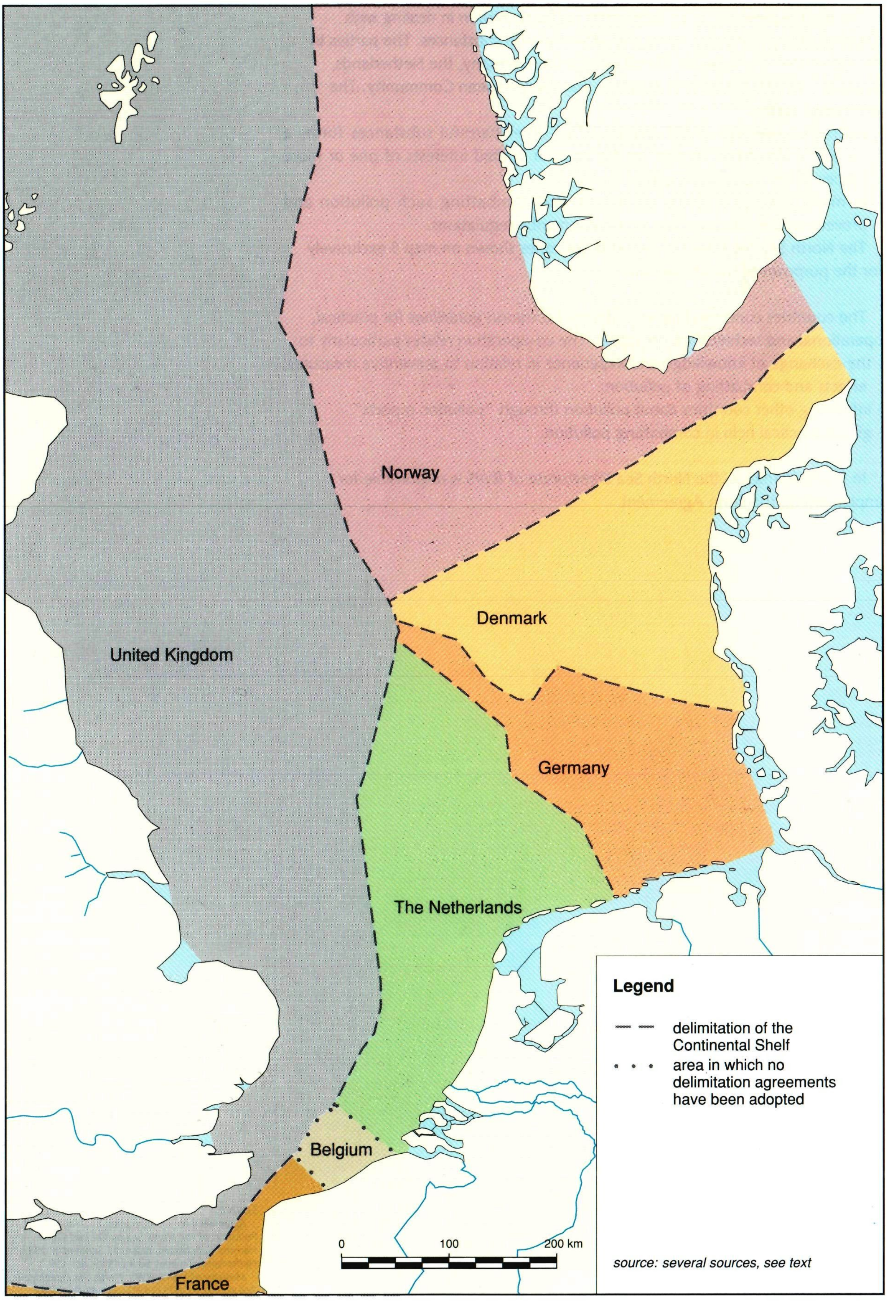
Seventeen delimitation agreements have now been concluded for the partition of the Continental Shelf in the North Sea. The most recent agreements are those between the United Kingdom and Belgium (1991) and between Belgium and France. No agreement has yet been concluded for one Continental Shelf boundary, that between Belgium and the Netherlands.

Maritime zones



Source:
Freestone, D., IJlstra, T. (eds.) (1991). The North Sea: Basic Legal Documents on Regional Environmental Co-operation. p. 215-227 and p. 383-418. Graham and Trotman/Martinus Nijhoff. ISBN 0-7923-0919-7.
Convention on the Continental Shelf, Geneva, 29 April 1958, Netherlands Threaties Series 1959, no. 126.
United Nations Convention on the Law of the Sea, Montego Bay, 10 December 1982.

Delimitation of the Continental Shelf



Zones of responsibility under the Bonn Agreement (1983)

The Bonn Agreement is an agreement for co-operation in dealing with pollution of the North Sea by oil and other harmful substances. The parties to the agreement are: Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, the United Kingdom and the European Community. The agreement applies:

- whenever pollution of the sea by oil or other harmful substances forms a serious or immediate danger to the coast or related interests of one or more parties to the agreement; and
- to monitoring as a means of tracing and combatting such pollution and preventing the contravention of environmental regulations.

The North Sea has been divided into the zones shown on map 5 exclusively for the purposes of the agreement.

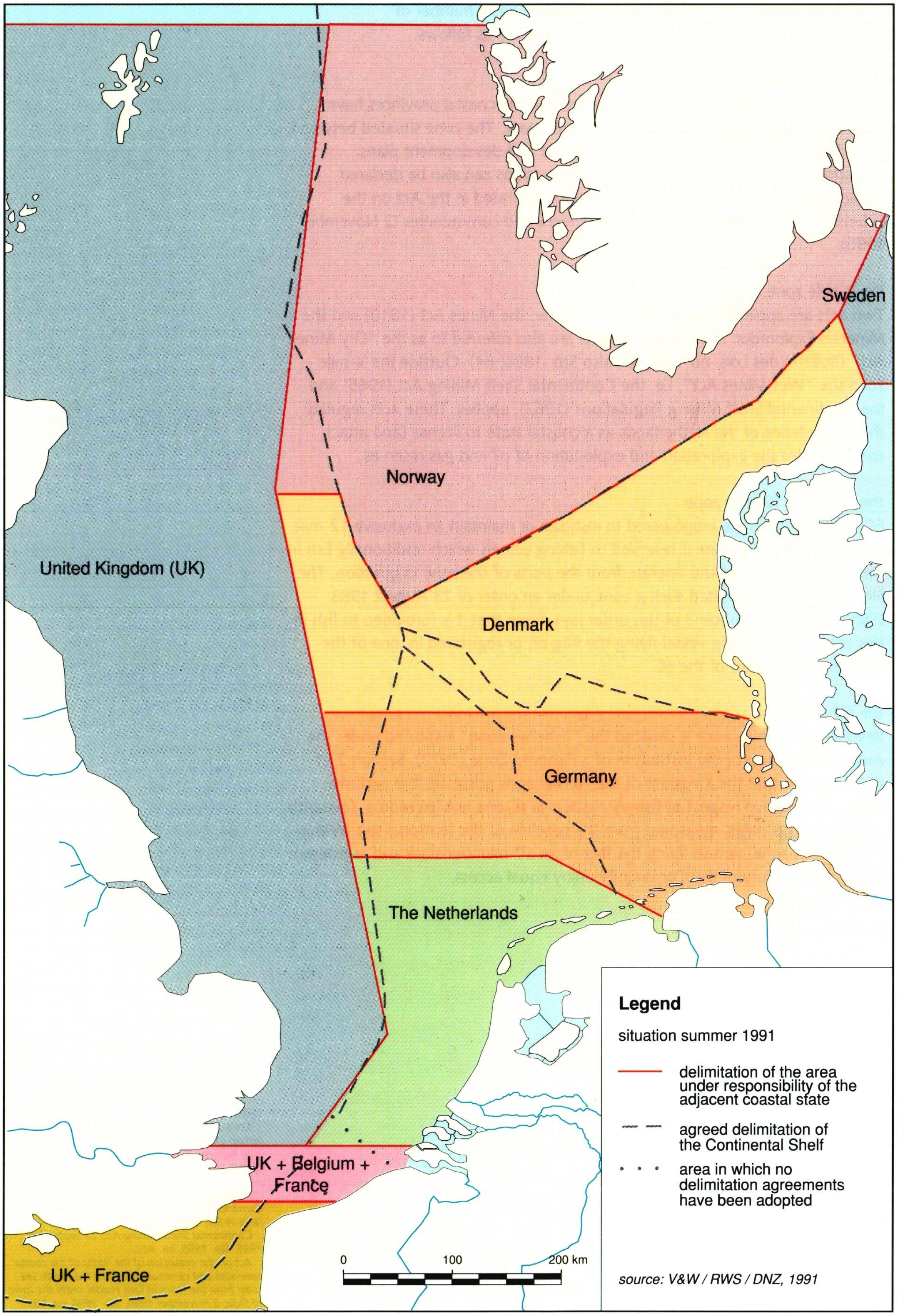
The countries concerned have established common guidelines for practical, operational and technical co-operation. The co-operation relates particularly to:

- the exchange of knowledge and experience in relation to preventive measures, effects and combatting of pollution;
- informing other countries about pollution through "pollution reports";
- giving practical help in combatting pollution.

In the Netherlands, the North Sea Directorate of RWS is responsible for implementing the Bonn Agreement.

Source:
Agreement for Co-operation in Dealing with Pollution of the North Sea by Oil and Other Harmful Substances, Bonn, 13 September 1983, Netherlands Treaties Series 1983, no. 159.
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991): unpublished data.

Zones of responsibility under the Bonn Agreement (1983)



Administrative zones on the NCS

The Netherlands sector of the Continental Shelf has a number of administrative zones. Viewed from the land these are as follows:

- the 1-kilometre limit

The boundaries of the coastal communities and the coastal provinces have been fixed at 1 kilometre from the low water mark. The zone situated between these boundaries must be included in regional and development plans. Municipal and provincial land use control provisions can also be declared applicable to this zone. These matters are incorporated in the Act on the extension of the limits of the coastal provinces and communities (2 November 1990).

- the 3-mile zone

Two acts are applicable within the 3-mile zone: the Mines Act (1810) and the Minerals Exploration Act. These two acts are also referred to as the "Dry Mines Act" (Bulletin des Lois, no. 285, see also Stb. 1886, 64). Outside the 3-mile zone the "Wet Mines Act", i.e. the Continental Shelf Mining Act (1965) and the Continental Shelf Mining Regulations (1967), applies. These acts regulate the competence of the Netherlands as a coastal state to license (and attach conditions to) the exploration and exploitation of oil and gas reserves.

- the exclusive 12-mile zone

EC member states are empowered to institute or maintain an exclusive 12-mile zone. Fishing in this zone is reserved to fishing vessels which traditionally fish in the waters concerned and operate from the ports of the zone in question. The Netherlands has instituted such a zone under an order of 23 August 1983 (Stct. 1983, 165). Article 3 of this order lays down that it is forbidden to fish in this zone with a fishing vessel flying the flag of, or registered in, one of the other member states of the EC.

- the fisheries zone

Beyond the 12-mile zone is situated the "fisheries zone" instituted under the Authorisation Act for the Institution of a Fisheries Zone (1977). Section 2 of this act states that the Kingdom of the Netherlands possesses the exclusive legal jurisdiction in respect of fishery matters in a zone not exceeding a breadth of 200 nautical miles, measured from the baseline of the territorial sea. Within the fisheries zone, vessels flying the flag of an EC member state and registered within the territory of the Community enjoy equal access.

Source:

Decision on the establishment of a 12-mile exclusive fisheries zone, 23 August 1983, Stct. 1983, no. 165.

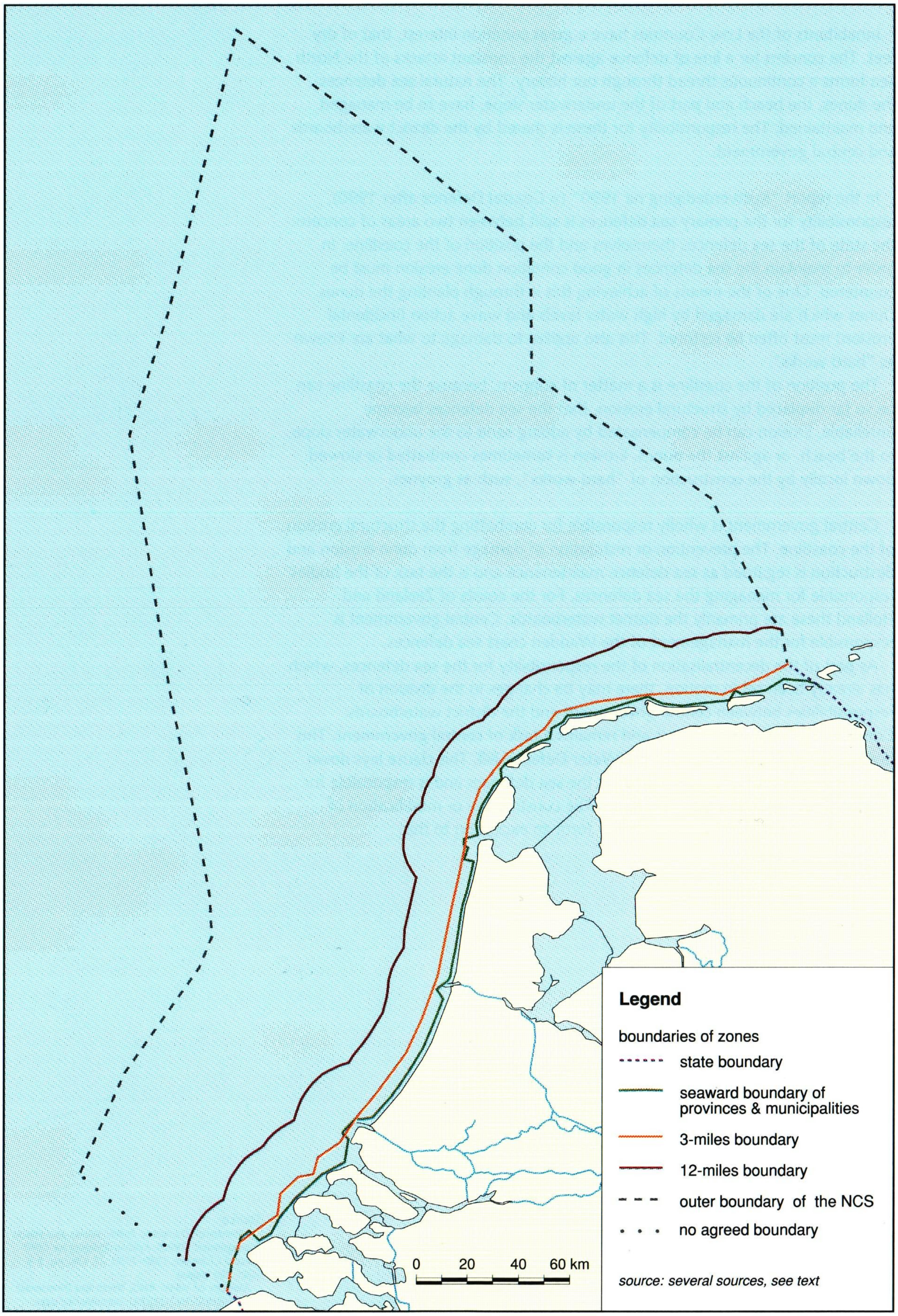
Council Resolution of 3 November 1976 on certain External Aspects of the Creation of a 200-mile Fisheries Zone in the Community with Effect from 1 January 1977, OJEC No C 105, 7.5.1981, p. 1.

Loi concernant les Mines, les Minières et les Carrières, 21 April 1810, Bulletin des Lois no. 285 (also in Stb. 1886, no. 64).

Continental Shelf Mining Act, 23 September 1965, Stb. 1965, no. 428.

Act on the extension of the limits of the coastal provinces and communities along the North Sea coast from the town of Den Helder untill the town of Sluis, 2 November 1990, Stb. 1990, no. 553.

Administrative zones on the NCS



Sea defence management

Inhabitants of the Low Countries have a great common interest, that of dry feet. The concern for a line of defence against the constant attacks of the North Sea forms a continuous thread through our history. The natural sea defences, the dunes, the beach and part of the underwater slope, have to be managed and maintained. The responsibility for these is shared by the district waterboards and central government.

In the report "Kustverdediging na 1990" (= Coastal Defence after 1990), responsibility for the primary sea defences is split between two areas of concern: the state of the sea defences themselves and the position of the coastline. In order to maintain the sea defences in good condition dune erosion must be countered. One of the means of achieving this is through planting the dunes. Dunes which are damaged by high water levels and wave action (incidental erosion) must often be restored. This also applies to damage to what are known as "hard works".

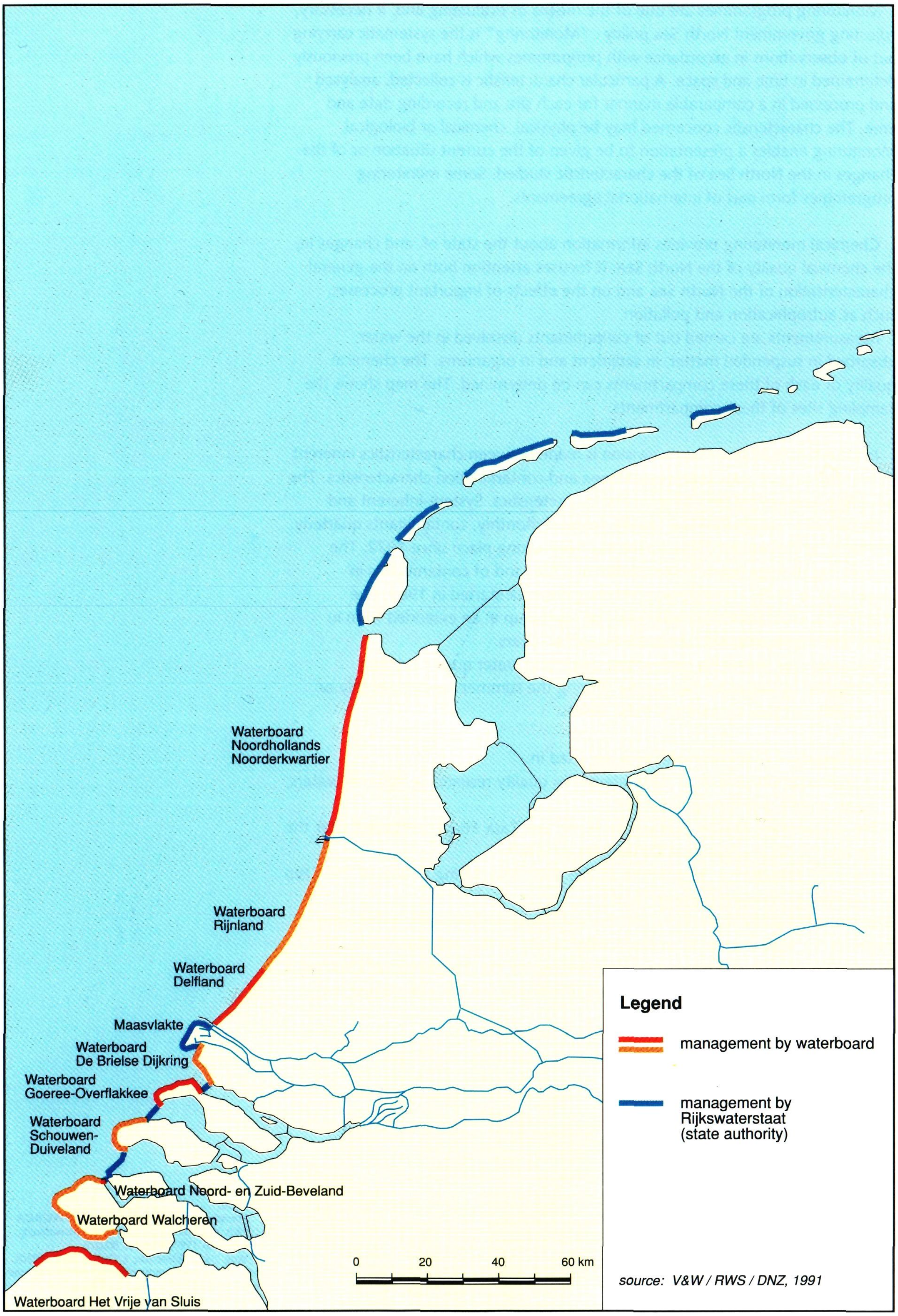
The position of the coastline is a matter of concern, because the coastline can be so far displaced by structural erosion, that the sea defences become unreliable. Erosion can be compensated by adding sand to the underwater slope, to the beach, or against the dunes. Erosion is sometimes combatted or slowed down locally by the construction of "hard works", such as groynes.

Central government is wholly responsible for combatting the structural erosion of the coastline. The prevention or restoration of damage from dune erosion and destruction is regarded as sea defence maintenance and is the task of the bodies responsible for managing the sea defences. For the coasts of Zeeland and Holland these are primarily the district waterboards. Central government is responsible for the management of the Wadden coast sea defences.

As part of the decentralisation of the responsibility for the sea defences, which has already been set in motion, there may be changes in the division of responsibilities between central government and the district waterboards. Combatting structural erosion is and remains a task of central government. This division derives from clause 8 of the Water Defence Bill. This clause lays down that the sea defence manager manages the sea defences and is responsible for all the works needed to maintain them. The construction or modification of works for combatting structural erosion form an exception to this.

Source:
Ministry of Transport, Public Works and Water Management (1990). Kustverdediging na 1990. Second Chamber, 1989-1990, 21 136, no. 5-6. SDU, The Hague.
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991): unpublished data.

Sea defence management



Chemical monitoring

Monitoring programmes are one of the means of evaluating and, if necessary, adjusting government North Sea policy . "Monitoring" is the systematic carrying out of observations in accordance with programmes which have been previously determined in time and space. A particular characteristic is collected, analysed and processed in a comparable manner for each site and recording date and time. The characteristic concerned may be physical, chemical or biological. Monitoring enables a presentation to be given of the current situation or of the changes in the North Sea of the characteristic studied. Some monitoring programmes form part of international agreements.

Chemical monitoring provides information about the state of, and changes in, the chemical quality of the North Sea. It focuses attention both on the general characterisation of the North Sea and on the effects of important processes, such as eutrophication and pollution.

Measurements are carried out of contaminants dissolved in the water, absorbed in suspended matter, in sediment and in organisms. The chemical quality of each of these compartments can be determined. The map shows the sampling sites of these compartments.

In monitoring programmes a division is made between characteristics inherent in the system, eutrophication phenomena and contamination characteristics. The sampling frequency differs by group of characteristics. System-inherent and eutrophication parameters are usually sampled monthly, contaminants quarterly. Monsters of the water compartment has been taking place since 1972. The monitoring of suspended matter started in 1988, and of contaminants in organisms in 1979. The mussel monitoring network started in 1989. The monitoring programme for sediment was started up in an extended form in 1990 and monitoring will take place every two years.

The map also shows the sites where swimming water quality is being investigated by means of monitoring. During the summer season monthly or fortnightly samples are taken at these points.

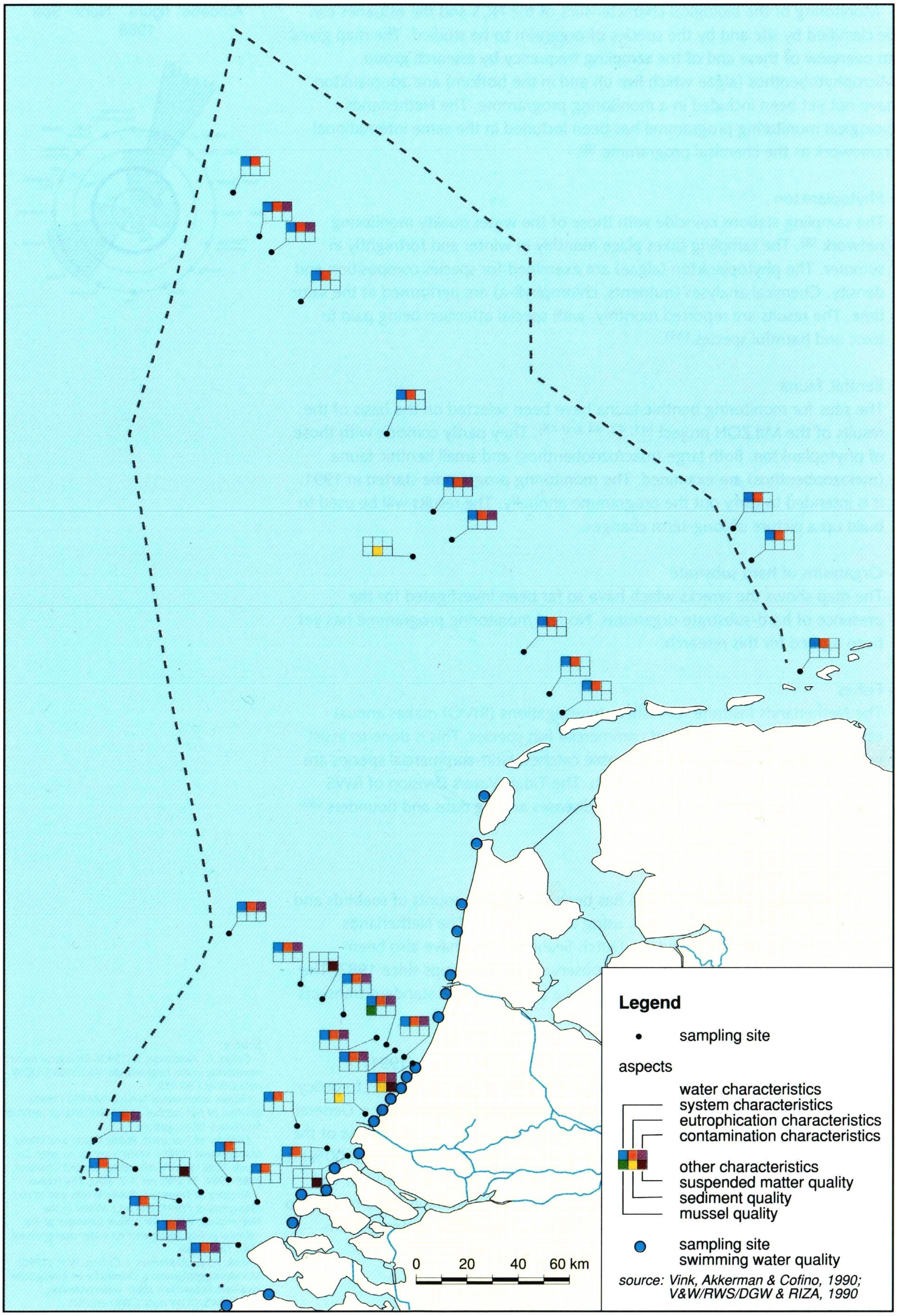
The results of chemical monitoring are used in:

- "Kwaliteitsonderzoek in de rijkswateren"(= quality research in national waters; water quality monitoring network)
- the Monitoring Master Plan of the North Sea Task Force (instituted after the Second North Sea Ministers Conference in 1987)
- the Joint Monitoring Programme of the Joint Monitoring Group of the Oslo and Paris Commissions (since 1979).

The mussel monitoring network and the swimming water quality monitoring network are used only in the water quality survey of the national waters. The monitoring programme concerned is carried out by the directorates of Zeeland, Noord-Holland, Friesland and Groningen, the North Sea Directorate and the Tidal Waters Division of RWS.

Source:
Ministry of V&W, RWS/DGW and RWS/RIZA (1990). Kwaliteitsonderzoek in de rijkswateren; programma 1991. Nota no. 90.079.
Vink, J.S.L., Akkerman, I, Cofino, W.P. (1990). Monitoringsprogramma chemische en biologische kwaliteitskenmerken zoute watersystemen. V&W/RWS/DGW nota GWIO-90.050.

Chemical monitoring



Biological monitoring

Monitoring of the biological characteristics of the NCS and the estuaries can be classified by site and by the species of organism to be studied. The map gives an overview of these and of the sampling frequency by research group. Microphytobenthos (algae which live on and in the bottom) and zooplankton have not yet been included in a monitoring programme. The Netherlands biological monitoring programme has been included in the same international framework as the chemical programme [8].

- Phytoplankton
  The sampling stations coincide with those of the water quality monitoring network [8]. The sampling takes place monthly in winter and fortnightly in summer. The phytoplankton (algae) are examined for species composition and density. Chemical analyses (nutrients, chlorophyll-a) are performed at the same time. The results are reported monthly, with special attention being paid to toxic and harmful species [84].

- Benthic fauna
  The sites for monitoring benthic fauna have been selected on the basis of the results of the MILZON project [41, 43, 44 and 45]. They partly coincide with those of phytoplankton. Both large (macrozoobenthos) and small benthic fauna (meiozoobenthos) are examined. The monitoring programme started in 1991. It is intended to carry out the programme annually. The results will be used to build up a picture of long-term changes.

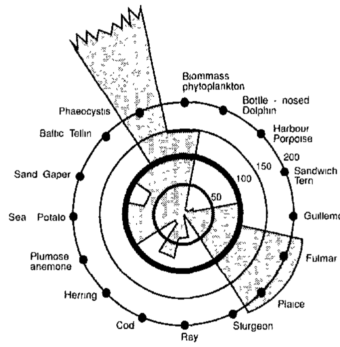
- Organisms of hard substrate
  The map shows the wrecks which have so far been investigated for the presence of hard-substrate organisms. No real monitoring programme has yet been agreed for this research.

- Fishes
  The Netherlands Institute for Fishery Investigations (RIVO) makes annual estimates of the populations of commercial fish species. This is done to assist with the determination of the allowable catches. Non-commercial species are not covered by the systematic research. The Tidal Waters Division of RWS collects data at certain sites about fish diseases among dabs and flounders [89-91].

- Seabirds and mammals
  The Tidal Waters Division of RWS has been conducting counts of seabirds and mammals on the NCS since 1985, using aircraft [49-51]. The Netherlands Institute for Sea Research and the Dutch Seabird Group have also been conducting bird counts and mammal observations from ships since 1987. The aerial counts are now carried out six times a year along the standard transects on the NCS.

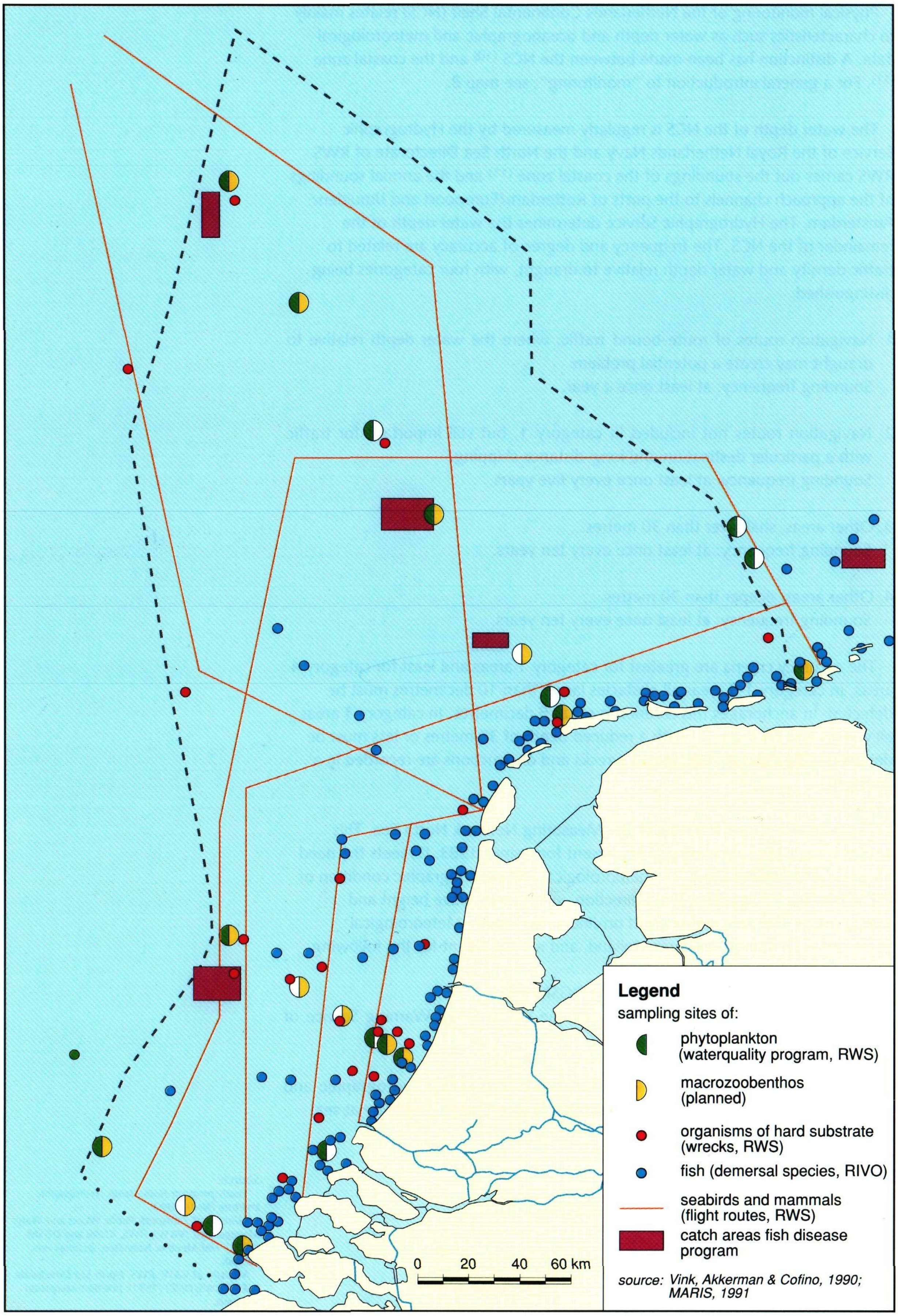
The document "Water in the Netherlands: a time for action" (1991) introduces a method of relating the results of monitoring programmes to policy: the "AMOEBE" (Algemene Methode voor Oecologische Beschrijving = General Ecological Description Method). The "AMOEBE" figure for the North Sea of the situation in 1988 is included here as an illustration. The reference level (100%) is equivalent to a virtually untouched salt-water system (situation in 1930). The relative numbers of various characteristic species are indicated in 1988 relative to 1930. The results show clearly the present disturbance of the water systems.

'Amoebe' figure North Sea 1988



Source:
Colijn, F., Akkerman, I. (1990). Biological trend monitoring in the Netherlands. V&W/RWS/DGW nota GWAO-90.018.
Marine Information Service (MARIS) (1991): position of fish catches of the Netherlands Institute for Fishery Investigations.
Ministry of Transport, Public Works and Water Management (1989). Water voor nu en later, De Derde Nota Waterhuishouding. Second Chamber, 1988-1989, 21 250, no. 1-2. SDU, The Hague. .
Ministry of Transport, Public Works and Water Management (1991, 2nd ed.). Water in the Netherlands: a time for action: summary of the national policy documents on water managemant. SDU, The Hague.
Vink, J.S.L., Akkerman, I, Cofino, W.P. (1990). Monitoringsprogramma chemische en biologische kwaliteitskenmerken zoute watersystemen. V&W/RWS/DGW nota GWIO-90.050.

Biological monitoring



Physical monitoring of the NCS

Physical monitoring of the Netherlands Continental Shelf (NCS) relates mainly to characteristics such as water depth and oceanographic and meteorological data. A distinction has been made between the NCS [(10)] and the coastal zone [(11)]. For a general introduction to "monitoring", see map 8.

The water depth of the NCS is regularly measured by the Hydrographic Service of the Royal Netherlands Navy and the North Sea Directorate of RWS. RWS carries out the soundings of the coastal zone [(11)] and the annual soundings of the approach channels to the ports of Rotterdam/Europoort and IJmuiden/Amsterdam. The Hydrographic Service determines the water depth of the remainder of the NCS. The frequency and degree of accuracy are related to traffic density and water depth relative to draught, with four categories being distinguished:

1. Navigation routes of route-bound traffic, where the water depth relative to draught may create a potential problem.
   Sounding frequency: at least once a year.

2. Navigation routes not included in category 1, but still important for traffic with a particular destination and long-distance shipping.
   Sounding frequency: at least once every five years.

3. Other areas, shallower than 30 metres.
   Sounding frequency: at least once every ten years.

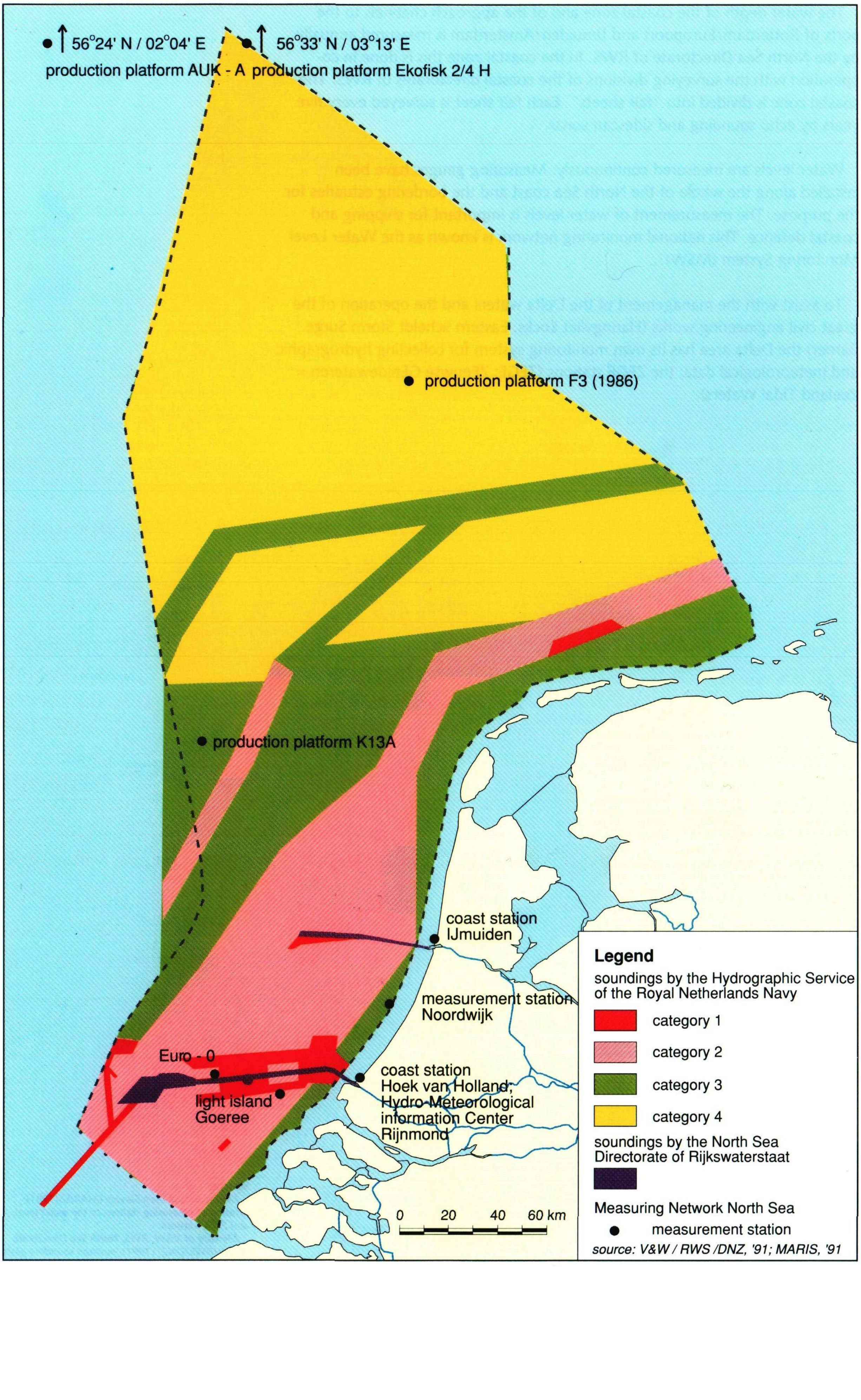
4. Other areas, deeper than 30 metres.
   Sounding frequency: at least once every ten years.

The accuracy criteria are greatest for category 1 areas and least for category 4 areas. In category 1-3 areas all obstacles larger than 10 decimetres must be detected. In anchorages this criterion is set at 5 decimetres. In category 4 areas all wrecks and obstructions with a reduced depth of 30 metres or less must be detected. The data of investigated wrecks and obstructions are recorded in a wreck file.

The map also shows the sites of the Measuring Network North Sea. This network has been functioning in its present form since 1983. It meets the need for basic information about the meteorological and oceanographic condition of the North Sea: wind speed, wind direction, water level, wave height and temperature. The data are received on-line at the Hydro-Meteorological Information Centre at Hoek van Holland, and are important for the following tasks and services:
- assistance to route-bound shipping by DGSM [(59)];
- storm surge warning by the KNMI and the Storm Surge Warning Service of RWS;
- KNMI weather forecasts;
- management of the NCS by RWS: predicted and actual hydrographic and meteorological data are important constraints on all kinds of activity at sea;
- climatological research.

Source:
Yearly program Netherlands Hydrographic Institute (NHI), 1990.
Ministry of Transport, Public Works and Water Management (V&W), RWS, KNMI and DGSM (1983). Het Meetnet Noordzee; techniek en gebruik.
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991): position navigation channels.

Physical monitoring of the NCS



Physical monitoring of the coastal zone

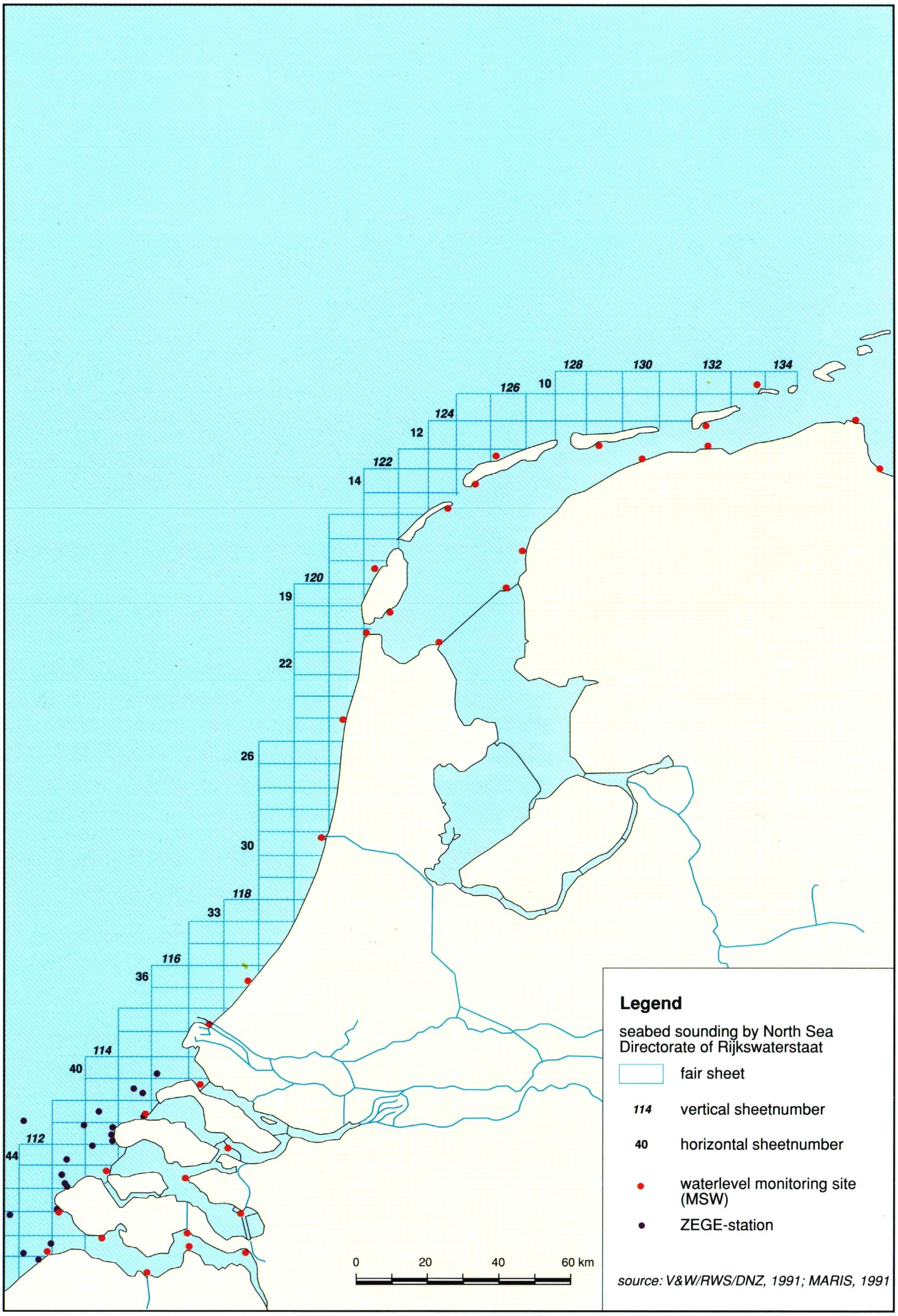
The water depth of the coastal zone and of the approach channels to the ports of Rotterdam/Europoort and IJmuiden/Amsterdam is measured annually by the North Sea Directorate of RWS. In the coastal zone this is done in co-operation with the surveying divisions of the coastal directorates of RWS. The coastal zone is divided into "fair sheets". Each fair sheet is surveyed every five years by echo sounding and sidescan sonar.

Water levels are measured continuously. Measuring gauges have been installed along the whole of the North Sea coast and the bordering estuaries for the purpose. The measurement of water levels is important for shipping and coastal defence. This national monitoring network is known as the Water Level Monitoring System (MSW).

To assist with the management of the Delta waters and the operation of the great civil engineering works (Haringvliet Locks, Eastern Scheldt Storm Surge Barrier) the Delta area has its own monitoring system for collecting hydrographic and meteorological data: the ZEGE stations (ZEGE: ZEeuwse GEtijdewateren = Zeeland Tidal Waters).

Source:
Marine Information Service (MARIS) (1991): position of measuring stations of the water level and ZEGE-stations.
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991): position sounding plots.

Physical monitoring of the coastal zone



Water

Bathymetry

The North Sea is as a result of the subsidence of the earth's crust in the whole of the area concerned. In the south the sedimentation of sand and mud from the land has kept pace with the subsidence; in the north the supply of erosion material was insufficient. This explains why the depth of the North Sea increases from a few tens of metres in the south to over 500 metres in the north. The relief of the North Sea floor is a relic of the ice ages, during which the land ice pushed up, scoured or displaced the sediments.

In the shallow southern part of the North Sea the sandy sediments have been much exposed to more recent forces such as the tides and wave action. In this part of the North Sea the bottom therefore consists mainly of undulating sands and elongated sandbanks like the Norfolk and Flemish Banks [30]. An exception to this is the Deep Channel, which is about 50 metres deep and extends in a north-south direction off the English coast. During the ice ages this area acted as the meltwater discharge of the ice masses to the north.

North of around 53° 30' N the water becomes deeper than 30 metres. This transition coincides with lower current velocities, different water masses and a sediment richer in silt.

Still farther north, at about 55° N, lies the Dogger Bank, a shallow zone with an area about half as large as the Netherlands. There are only about 18 metres of water at the shallowest point. During severe storms the waves from the northern North Sea break here.

The Dogger Bank was probably pushed up by land ice. The same ice has elsewhere scoured out deep channels and troughs. The latter include the Silver Pit, a 90-metre deep trough south of the Dogger Bank, and the great trench along the Norwegian coast which is some 700 metres deep in some places. Other depressions are the Fladen Grounds (300 metres) and Devils Hole (260 metres). There are long tunnel valleys in the neighbourhood of these depths. They are 1 to 3 kilometres wide and 100 metres deep. It is assumed that they were formed by meltwater which flowed under high pressure under the land ice.

Source:

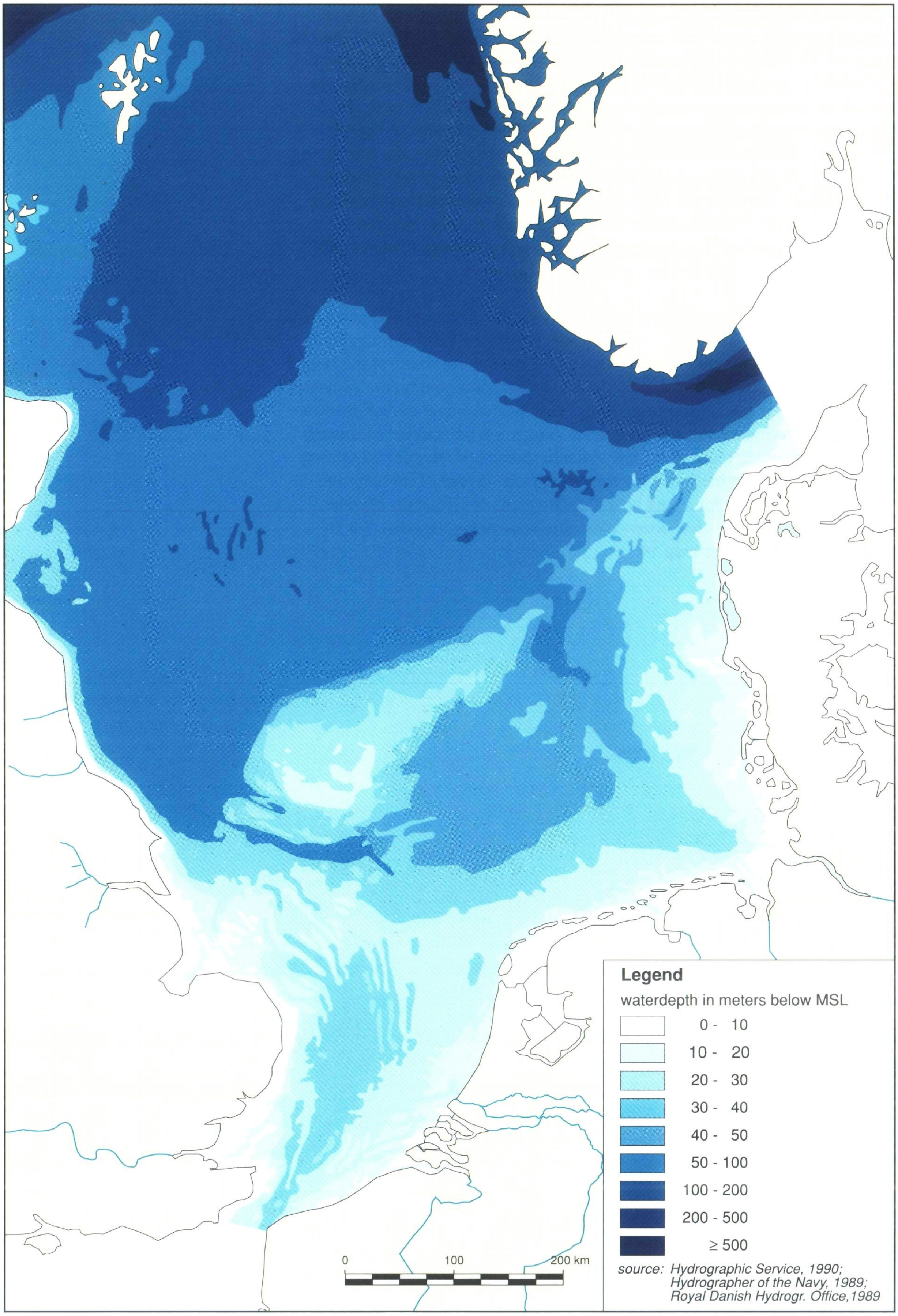
Hydrographic Service of the Royal Netherlands Navy (1990). North Sea Southern Sheet, international chart series, 1 750,000, sheet 1014.

Eisma, D., Jansen, J.H F , van Weering, Tj C.E. (1979). Seafloor morphology and recent sediment movement in the North Sea. In· Oele, E., Schüttenhelm, R T E., Wiggers, A.J. (eds.). The Quarternary history of the North Sea, 217-231 Acta Univ. Uppsala, Uppsala.

Hydrographer of the Navy (1989). North Sea Central Sheet, international chart series, 1:750,000, sheet int 1042

Royal Danish Hydrographic Office (1989) North Sea Northern Sheet, international chart series, 1 750,000, sheet int. 1041

Bathymetry



Legend
waterdepth in meters below MSL
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 100
100 - 200
200 - 500
≥ 500
0
100
200 km
source: Hydrographic Service, 1990; Hydrographer of the Navy, 1989; Royal Danish Hydrogr. Office, 1989

Residual currents, water masses and fronts in winter

The water in the North Sea circulates according to a fixed pattern: Atlantic water enters via the English Channel in the south and along the Scottish coast in the north. Outflowing water leaves the North Sea along the Norwegian coast.

The inflow is caused by the predominantly westerly wind, which pushes the Atlantic water towards the North Sea, and by the tidal wave. The ebb tides do not completely neutralise the water movement of the flood tides. A counter-clockwise residual current remains in the North Sea basin. When the wind blows for a long time, not from a westerly, but from a northerly or easterly direction, the circulation pattern may be temporarily reversed. Averaged over the whole year, the residual current along the Netherlands coast amounts to a few centimetres per second. The North Sea water travels a distance of about 1500 kilometres per year. It is refreshed every one to two years.

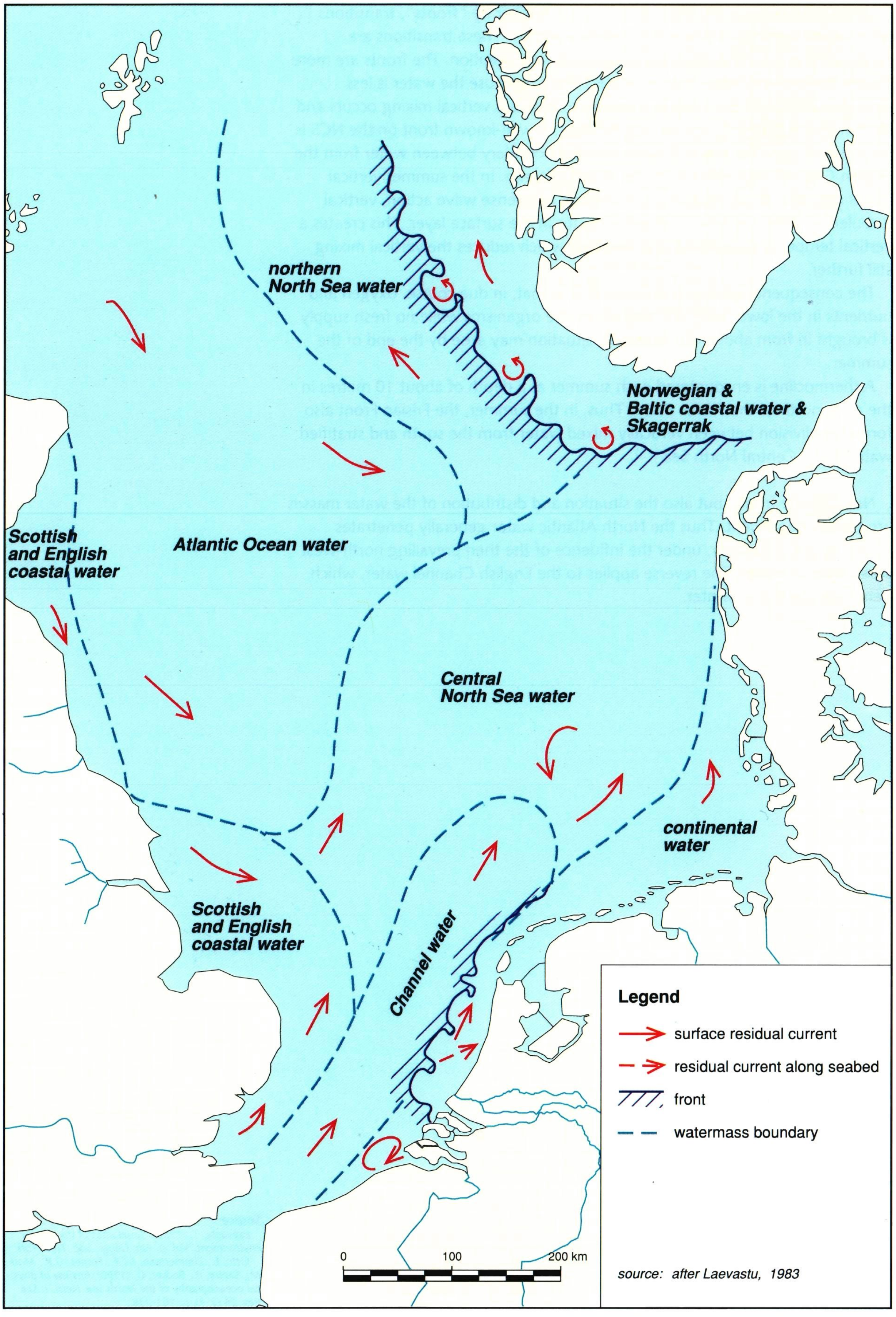
North Sea water consists of different water masses which meet and partly mix. Besides the Atlantic water just referred to, water from the Baltic Sea also flows into the North Sea, entering via the Skagerrak. Closer to the coasts of the United Kingdom and the continent the seawater has a high concentration of river water which is relatively light and spreads slowly from the rivers over the salt seawater. As a reaction to this movement more saline seawater is transported coastwards along the bottom. Because of its slow seaward spread and the generally strong residual current along the coast, the river water with its load of contaminants lingers along the coast for a long time. Contaminants consequently become concentrated in a zone a few dozen kilometres wide along the coast. For an explanation of fronts, see map 14.

Source:

Laevastu, T (1983). Serial atlas of the marine environment. Vol 4. Am Geogr Soc., New York.

Otto, L., Zimmerman, J T F , Furnes, G.K., Mork, M., Saetre, R., Becker, G. (1990). Review of physical oceanography of the North Sea Neth J. Sea Res. 26 (2-4), p. 161-238.

Residual currents, water masses and fronts in winter



Residual currents, water masses and fronts in summer

Water masses are often separated from each other by "fronts", transitions within a relatively short distance (a few kilometres). These transitions are measurable in salinity, temperature, nutrients and pollution. The fronts are more clearly marked in summer than in winter. This is because the water is less strongly agitated by the wind in summer, so that less vertical mixing occurs and the horizontal gradients remain longer intact. A well-known front on the NCS is the Frisian Front. The Frisian Front forms the boundary between water from the English Channel and water from the Atlantic Ocean. In the summer vertical fronts may also occur. As a result of the lack of intense wave action, vertical turbulence is low and solar heat accumulates in the surface layer. This creates a vertical temperature gradient (thermocline) which reduces the vertical mixing still further.

The consequence of this stratification (15) is that, in due course, oxygen and nutrients in the lower layer are used up by the organisms while no fresh supply is brought in from above. An anaerobic situation may arise by the end of the summer.

A thermocline is encountered each summer at a depth of about 10 metres in the area, north of the Frisian Front. Thus, in the summer, the Frisian Front also forms the division between vertically mixed water from the south and stratified water in the Central North Sea (15).

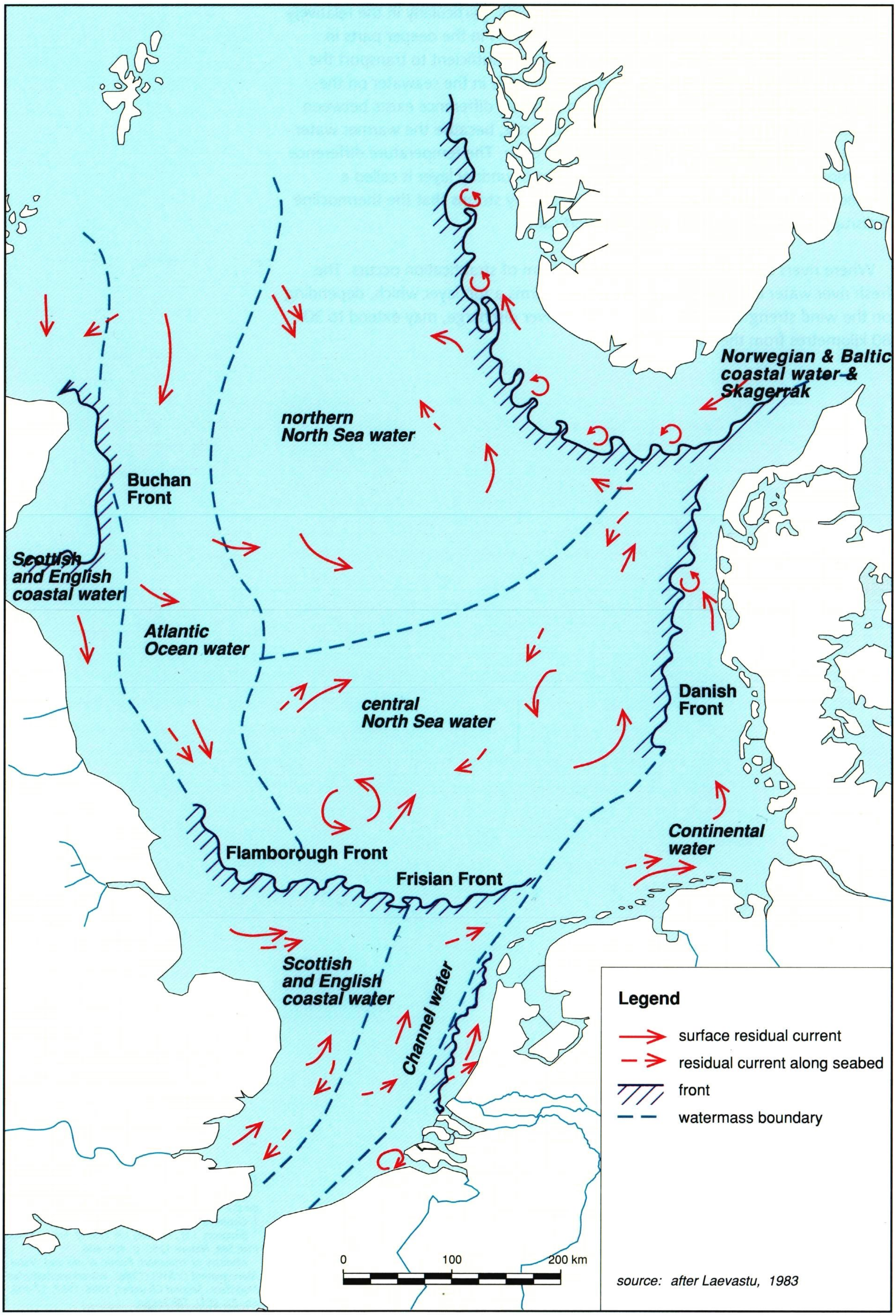
Not only the fronts, but also the situation and distribution of the water masses are season-dependent. Thus the North Atlantic water generally penetrates farther south in summer, under the influence of the then prevailing north-west wind, than in winter. The reverse applies to the English Channel water, which penetrates farther in winter.

Source

Laevastu, T (1983) Serial atlas of the marine environment Vol 4 Am Geogr Soc, New York

Otto, L, Zimmerman, J T F, Furnes, G K, Mork, M, Saetre, R, Becker, G. (1990) Review of physical oceanography of the North Sea. Neth J Sea Res 26 (2-4), p 161-238

Residual currents, water masses and fronts in summer



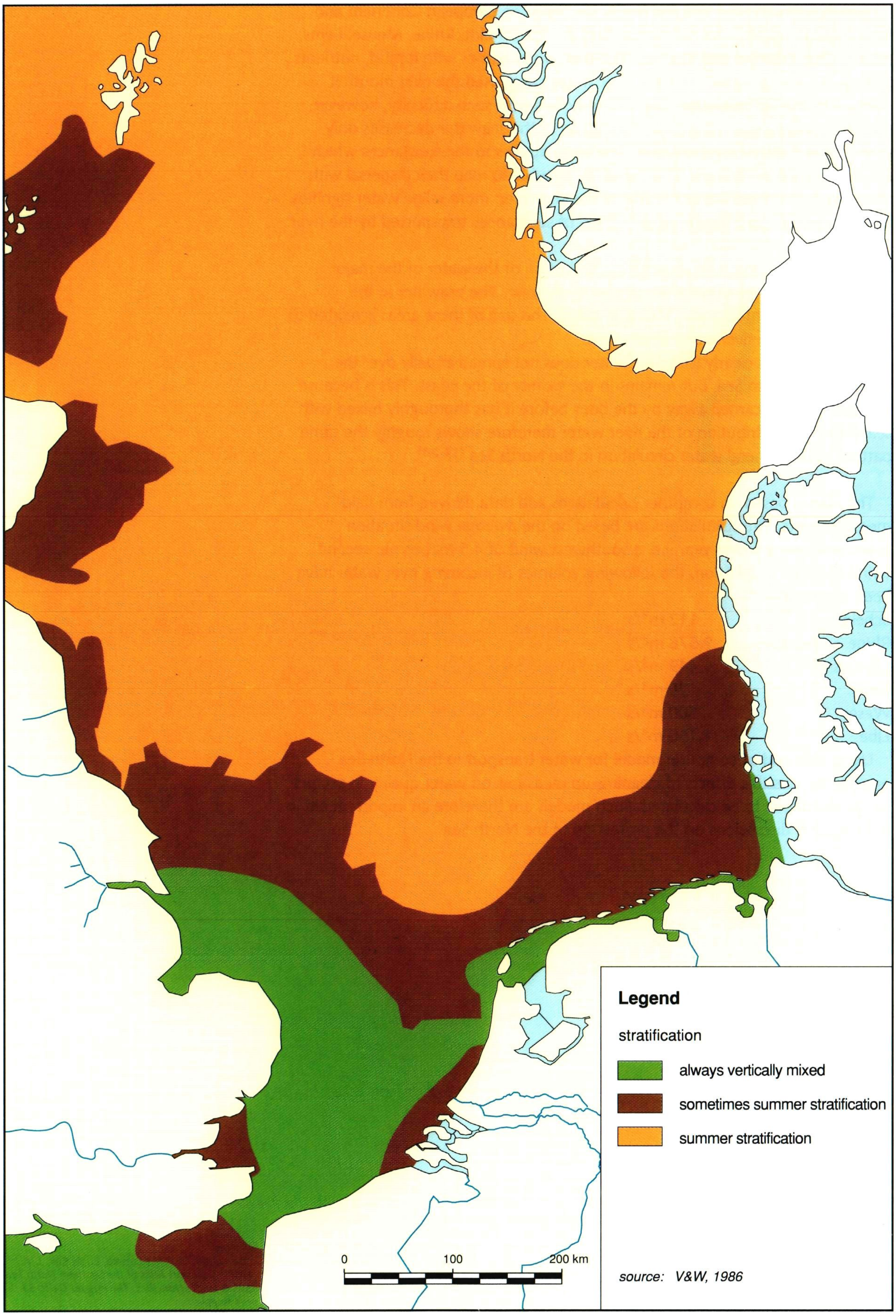
Stratification

The water in the North Sea is generally well mixed, particularly in the relatively shallow areas with strong tides. A stratification occurs in the deeper parts in summer. The action of waves and currents is then insufficient to transport the solar heat, which causes a small temperature increase in the seawater on the surface, to greater depths. As soon as a temperature difference exists between different water layers, mixing is made more difficult, because the warmer water continues to float on top of the colder bottom layer. The temperature difference can amount to a couple of degrees Celsius. The boundary layer is called a thermocline. In autumn the sea is so churned up by storms that the thermocline is disrupted, and the water mixes again vertically.

Where rivers enter the North Sea another form of stratification occurs. The fresh river water is lighter than seawater and forms a top layer which, depending on the wind strength and the volume of the river discharge, may extend to 30-80 kilometres from the river mouth.

Source:
Pingree, R.D., Griffiths, D.K (1978). Tidal fronts on the shelf seas around the British Isles J. Geophys. Res , 83, p. 4615-4622.
Simpson, J H., Hunter, J.R. (1974). Fronts in the Irish Sea. Nature 1250, p. 404-406
Ministry of Transport, Public Works and Water Management (V&W) (1986). Waterkwaliteitsplan Noordzee Second Chamber, 1986-1987, 17 408, no. 22. SDU, The Hague.

Stratification



Dispersal of river water in the North Sea

Numerous rivers flow into the North Sea from the European Continent and the United Kingdom. The most important are the Scheldt, Rhine, Meuse, Eems, Weser, Elbe, Humber and Thames. The river water carries with it mud, nutrients and contaminants. Once the fresh river water has passed the river mouth it mixes with the salt seawater. The mixing occurs with such difficulty, however, that the concentration of original river water in the seawater decreases only gradually and over a long distance. The same applies to the substances which are transported by the river. It is therefore possible to map their dispersal with reference to the fresh water fraction of the seawater: more saline water signifies less river water and a lower concentration of substances transported by the river.

The accompanying map shows the distribution of the water of the major continental rivers on a time scale of about one year. The seawater in the coloured areas contains over 1 % river water. The size of these areas is related to the volume of the river water discharged.

The map shows clearly that river water does not spread equally over the whole of the North Sea, but remains in the vicinity of the coast. This is because the river water is carried away by the tides before it has thoroughly mixed with seawater. The distribution of the river water therefore shows roughly the same pattern as the general water circulation in the North Sea [13, 14].

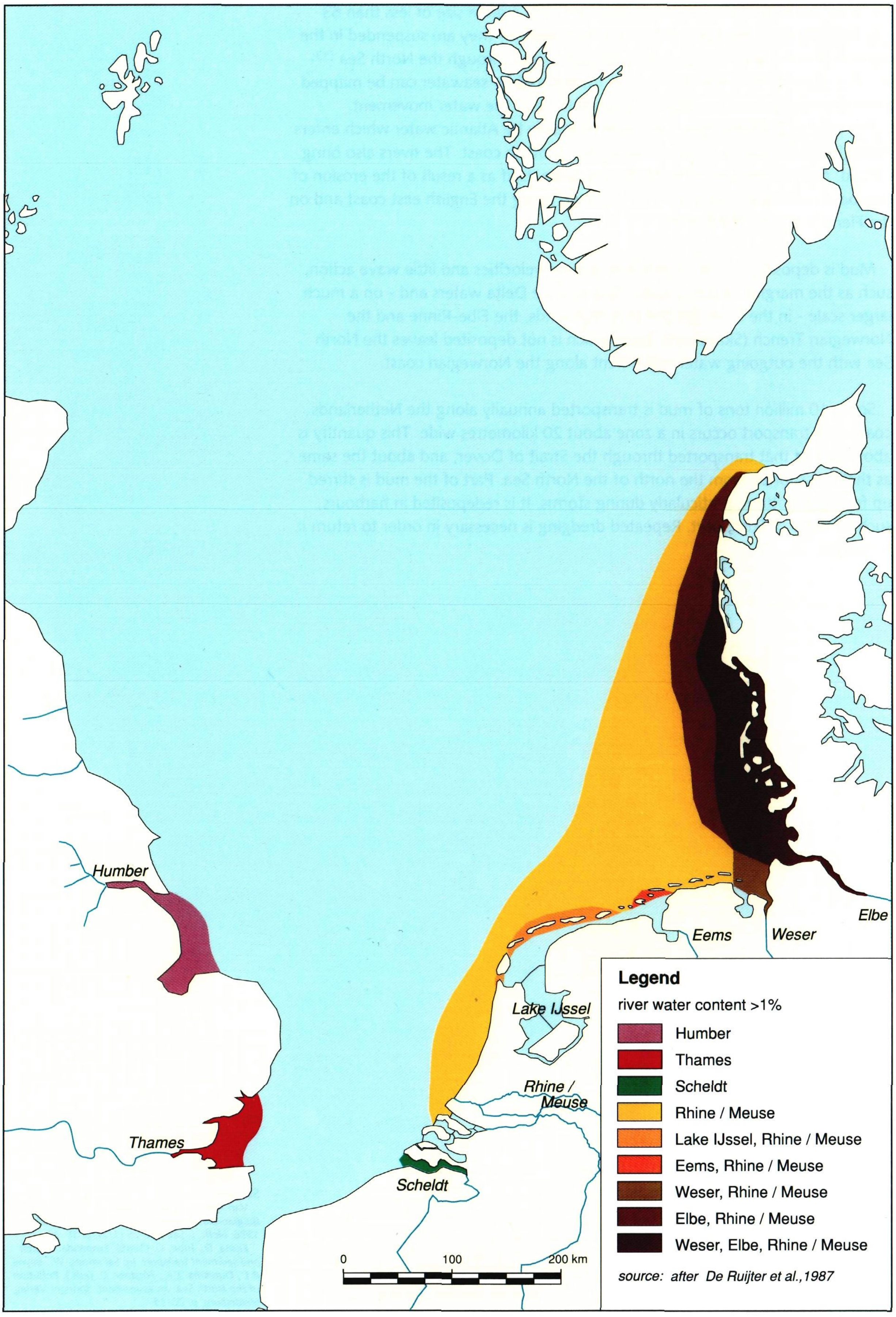
The map is based on computer calculations and data derived from field measurements. The calculations are based on the average wind situation measured over a whole year; i.e. a southwest wind of 4.5 metres per second (wind force 3). In addition, the following volumes of incoming river water have been assumed:

Scheldt:	112 m^3/s
Rhine + Meuse:	2,578 m^3/s
Lake IJssel:	449 m^3/s
Eems:	120 m^3/s
Weser:	500 m^3/s
Elbe:	1,150 m^3/s

Using this kind of computer model for water transport in the North Sea enables the possible effects of cleaning-up measures on water quality in sectors of the North Sea to be calculated. Such models are therefore an important aid in international discussions on the protection of the North Sea.

Source:
De Ruijter, W.P.M., Postma, L., de Kok, J.M. (1987). Transport Atlas of the Southern North Sea. RWS & Delft Hydraulics, The Hague/ Delft, 33 pp.+ floppy.

Dispersal of river water in the North Sea



Mud transport and deposition

"Mud" is the collective name for particles with a grain size of less than 63 micrometres (µm). Because of their small dimensions they are suspended in the water and move with the general water circulation through the North Sea [13, 14]. The quantity of suspended matter transported by seawater can be mapped by multiplying the concentration by the volume of the water movement.

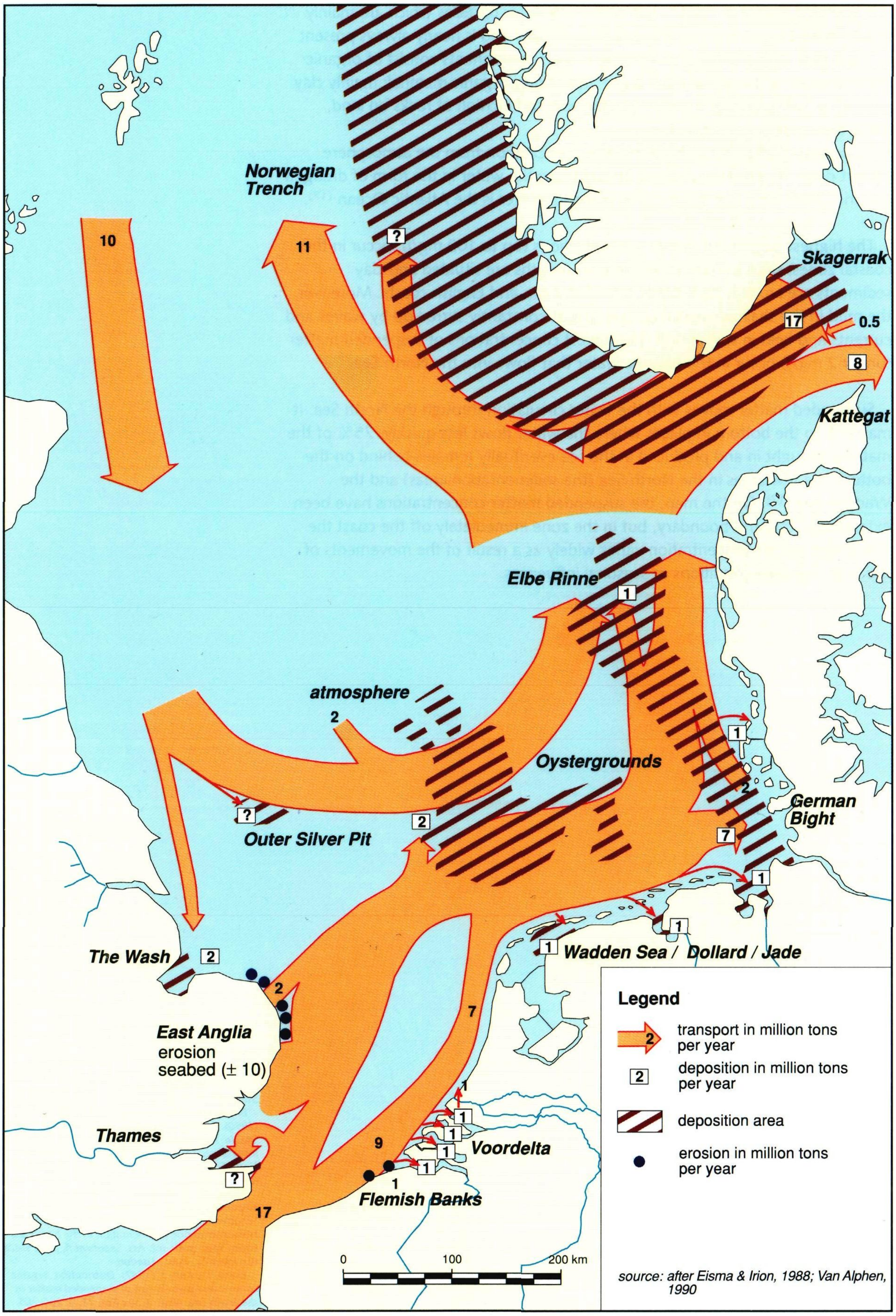
The mud in the North Sea is brought in mainly by Atlantic water which enters through the English Channel and along the Scottish coast. The rivers also bring in mud. Mud is released in the North Sea basin itself as a result of the erosion of clay banks or coasts. Examples can be found along the English east coast and on the Flemish Banks off Belgium.

Mud is deposited at places with low current velocities and little wave action, such as the margins of the Wadden Sea and the Delta waters and - on a much larger scale - in the Silver Pit, the Oystergrounds, the Elbe-Rinne and the Norwegian Trench (Skagerrak). Mud which is not deposited leaves the North Sea with the outgoing water movement along the Norwegian coast.

Some 10 million tons of mud is transported annually along the Netherlands coast. The transport occurs in a zone about 20 kilometres wide. This quantity is about half of that transported through the Strait of Dover, and about the same as that transported from the north of the North Sea. Part of the mud is stirred up from the bottom, particularly during storms. It is redeposited in harbours, such as those of Europoort. Repeated dredging is necessary in order to return it to the sea.

Source:
Van Alphen, J.S.L.J. (1990). A mud balance for Belgian-Dutch coastal waters between 1969 and 1986. Neth. J. Sea Res. 25 (1/2), p. 19-30.
Eisma, D., Irion, G. (1988). Suspended matter and sediment transport. In: Salomons, W., Bayne, B.L., Duursma, E.K., Förstner, U. (eds.). Pollution of the North Sea, an assessment. Springer Verlag, Heidelberg, p. 20-35.

Mud transport and deposition



Suspended matter

Suspended matter or mud is a collective name for particles which are mainly smaller than 63 µm. The material sinks very slowly and is nearly always present in suspension in the water column. The various components consist of organic material, such as living and dead algae and of non-organic material: mainly clay particles which originate from the breakdown and erosion of rocks on land, along the coast or on the seabed.

Suspended matter is also brought in as precipitation from the atmosphere (desert dust). A certain quantity is brought into the water in the form of dredged material. Another major source of suspended matter is the Atlantic Ocean (17).

The highest suspended matter concentrations (up to 100 mg/l), occur in the coastal zones, since that is where the river mouths are situated and clay sediments are eroded, particularly off the Belgian and English coasts. Moreover, the mud in the shallow coastal zone is almost constantly stirred up by waves and currents and held in suspension. The lowest concentrations of suspended matter (under 2 mg/l) occur in the Atlantic water that flows into the North Sea.

Suspended matter moves with the water circulation through the North Sea. It may sink to the bottom in places where the water flows less quickly. 75% of the material brought in and produced in the sea eventually remains behind on the bottom in a few areas in the North Sea (the sedimentation areas) and the Wadden Sea (17). On the map, the suspended matter concentrations have been extended to the land boundary, but in the zone immediately off the coast the suspended matter concentration varies widely as a result of the movements of the tides, weather conditions or seasonal influences.

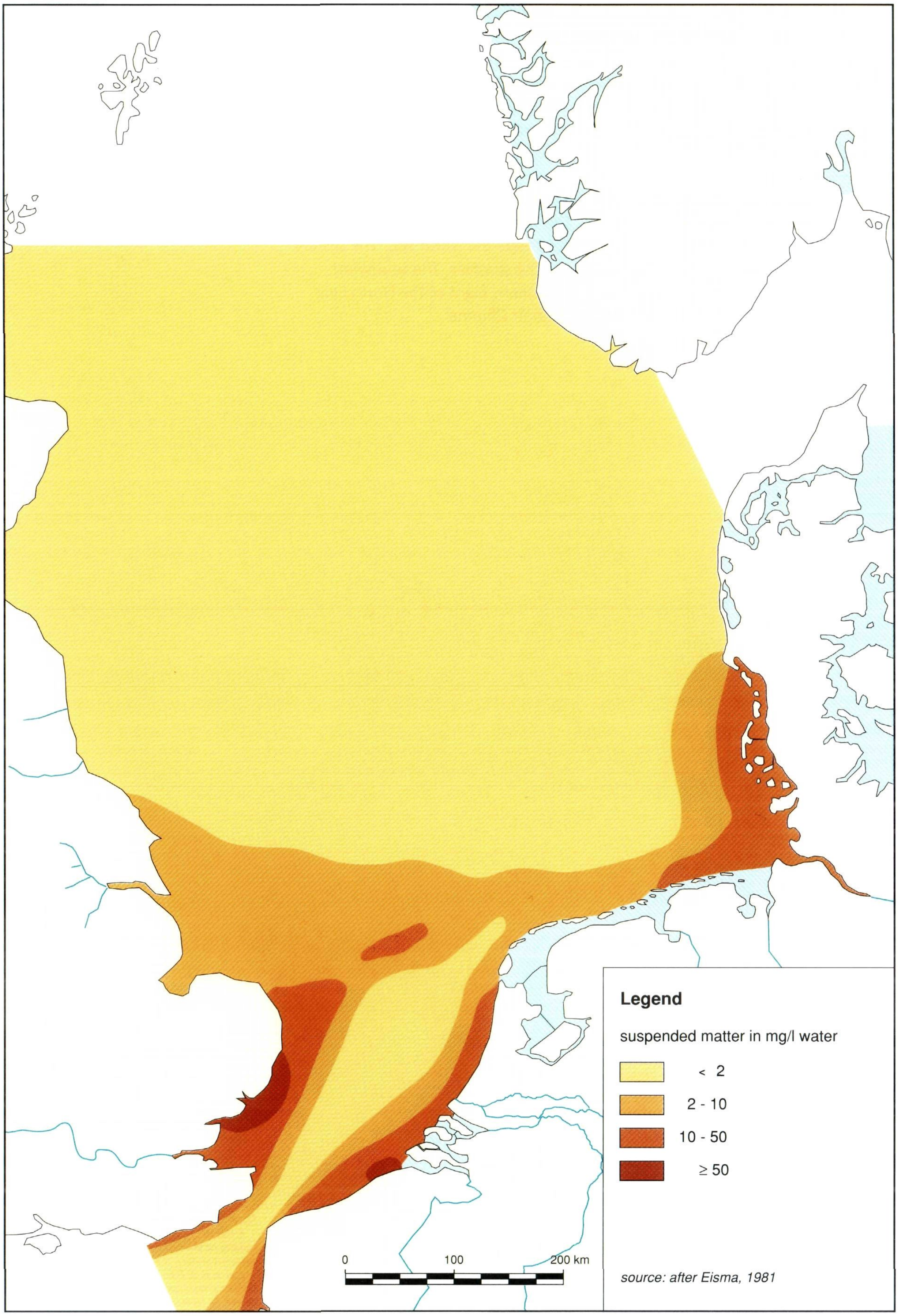
Source:

Brockmann, U.H , Laane, R.W P M , Postma, H (1990) Cycling of nutrient elements in the North Sea In Part 2 of the Proceedings of the International Symposium on the Ecology of the North Sea 18-22, May 1988. Neth J Sea Res 26 (2-4), p 239-264.

Eisma, D (1981) Supply and deposition of suspended matter in the North Sea In Nio, S D , Schuttenhelm, R T E , van Weering, Tj C.E (eds) Holocene marine sedimentation in the North Sea basin Spec publ int Ass Sediment 5, p. 415-428. Blackwell Sc Publ , London

Eisma, D , Kalf, J (1987). Distribution, organic content and particle size of suspended matter in the North Sea Neth J Sea Res. 21, p 265-285.

Suspended matter



Salinity in winter

The water of the North Sea is not everywhere equally saline. In the Atlantic water, which enters the North Sea through the English Channel and along the Scottish coast in the north, one litre of seawater contains on average about 35 g of salt. Along the coasts of the Netherlands, Germany, Denmark and Norway, as a result of the outflow of fresh river water, the salinity is lower, sometimes only 25 g/l. The map gives a picture of the average winter salinity of the North Sea during the period 1905-1953.

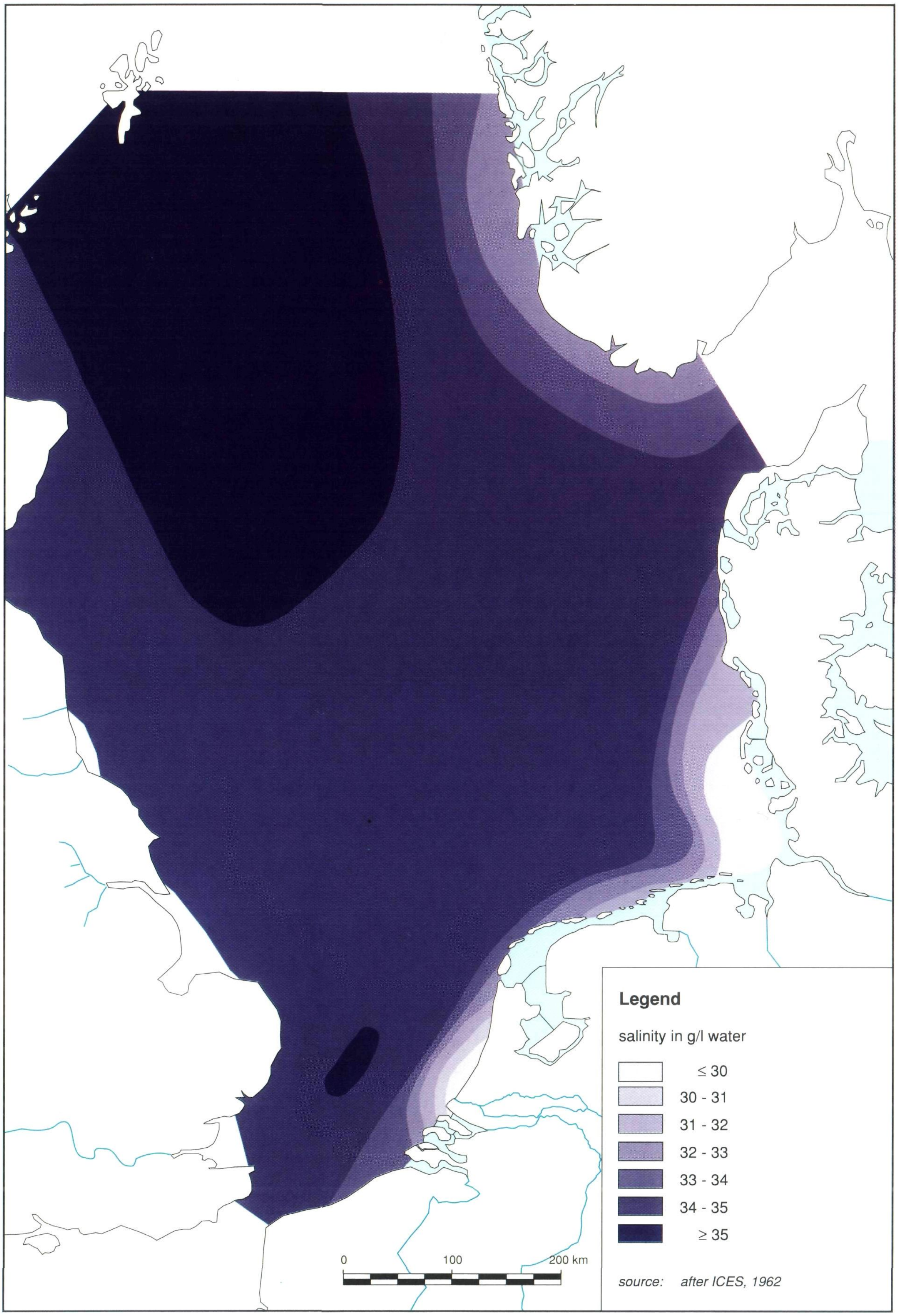
The net water movement in the North Sea is greatly affected by the climatic conditions in the different seasons [13, 14]. This is also reflected in the pattern of salinities. In winter more North Atlantic water enters the North Sea. The salinity of the central North Sea is then higher than in the summer. The southwest winds in winter have a similar effect on the Southern Bight of the North Sea, where more Atlantic water flows in via the English Channel.

Source:

ICES (1962). Mean monthly temperature and salinity of the surface layer of the North Sea and adjacent waters. ICES, Charlottelund.

Laane, R.W.P.M., Leewis, R.J., Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Salinity in winter

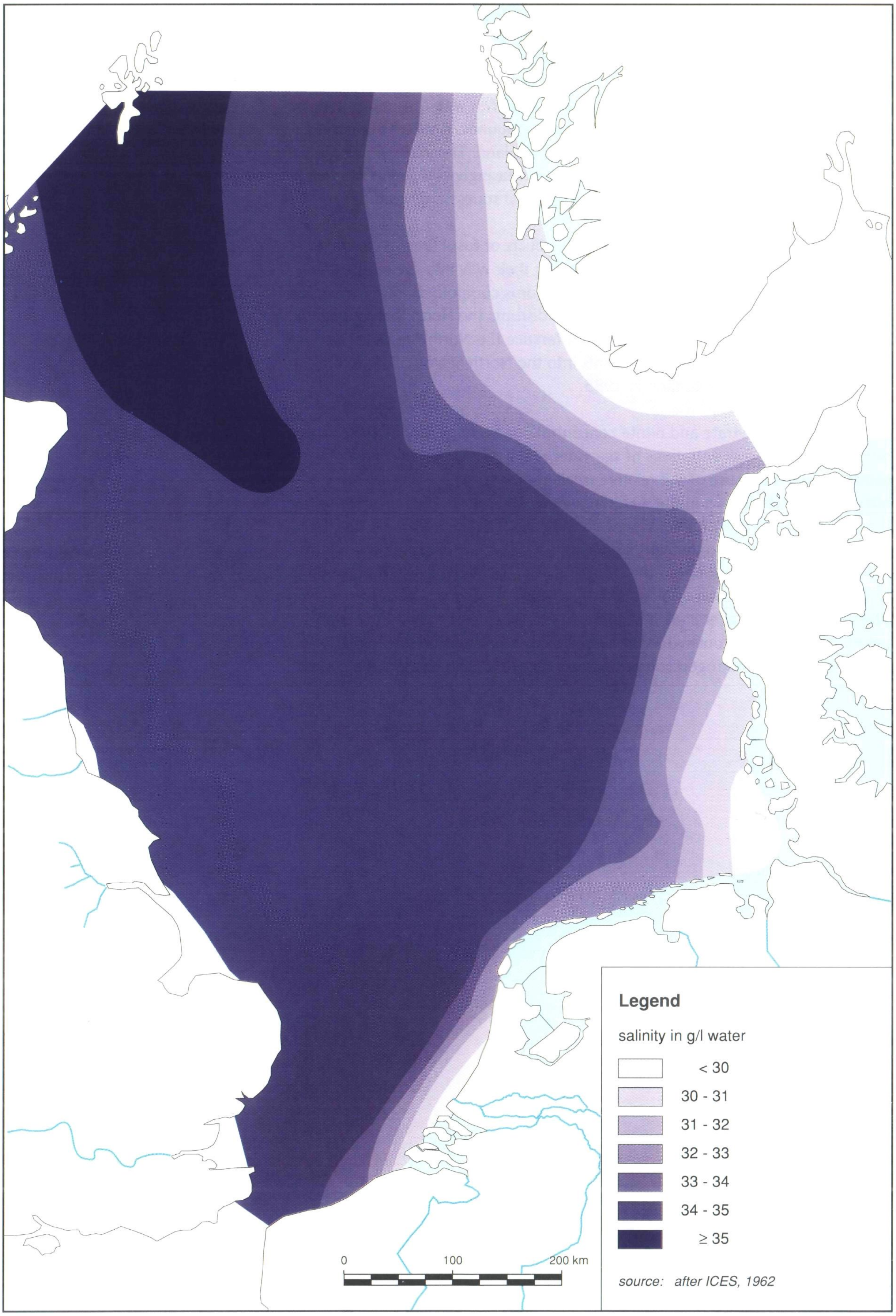


Salinity in summer

The average salinity in the North Sea is affected by the seasons. The summer values on the map are averages of measurements over the period 1905-1953. The seasonal difference in the Skagerrak is striking [19]. It arises because most of the inland waters in the countries around the Skagerrak freeze in winter, so that little fresh water enters the sea.

Source:
ICES (1962). Mean monthly temperature and salinity of the surface layer of the North Sea and adjecent waters. ICES. Charlottelund
Laane, R.W.P.M., Leewis, R.J., Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Salinity in summer



Nitrate and nitrite concentration in winter

Nitrate and nitrite are chemical compounds of nitrogen (N) with oxygen (O). Together with compounds of phosphorus (P), they are important nutrients for the phytoplankton (algae) in the water, so that they form the basis of all marine life.

Nitrogen compounds occur naturally in seawater. The water from the Atlantic Ocean, in particular, brings in many nitrogen compounds. Another permanent and natural source is the water discharge from the land. The water flowing into the sea from the rivers, however, has become increasingly charged in the course of time with nitrogen compounds from non-natural sources: agricultural fertilisers and sewage discharges.

Nitrogen compounds in the combustion products of fossil fuels in cars and industrial processes are also increasingly finding their way into the sea via the atmosphere. An excess of nitrogen and phosphorus compounds in the seawater causes eutrophication (overmanuring), which disrupts the North Sea ecosystem. During the Second North Sea Ministers Conference the North Sea states decided to aim at reducing the inflow of nutrients into the North Sea by 50% before 1995, starting from the situation in 1985.

The map shows nitrate and nitrite concentrations in the winter of 1987. The nitrate and nitrite concentrations of seawater are higher in winter than in summer. This is because of the relative small number of algae, so that more nitrate and nitrite remain in the water in winter. The transport of river water to the sea causes relatively higher values on the coasts. In the north, nitrate-rich Atlantic water flows into the North Sea.

The nitrate concentration on the Dogger Bank is relatively low. This is related to the primary production of biomass (27), which is relatively high here in winter. The sea over the Dogger Bank is shallow and clear, so that the sunlight even penetrates to the phytoplankton in the bottom water layer. The biological processes, in which nitrogen compounds are absorbed, can continue here even in winter.

Source:

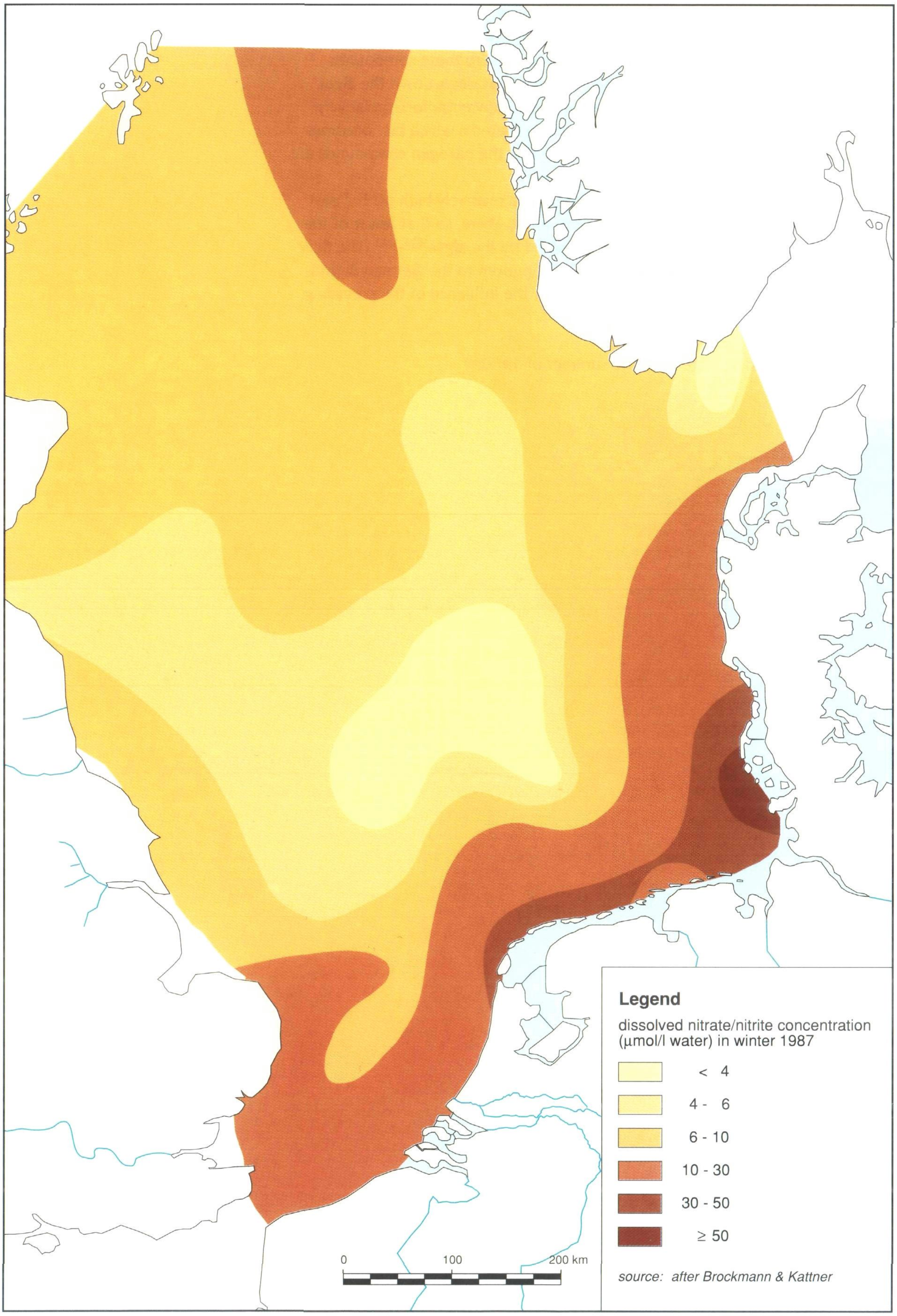
Brockmann, U.H., Laane, R.W.P.M., Postma, H. (1990). Cycling of nutrient elements in the North Sea. Neth. J of Sea Res, 26 (2-4), p. 239-264.

Brockmann & Kattner (in press). In: Estuarine Coastal Shelf Science.

Laane, R.W.P.M., Leewis, R.J., Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Peeters, J.C.H. (V&W/RWS/DGW) (1991): oral information.

Nitrate and nitrite concentration in winter



Nitrate and nitrite concentration in summer

In summer the nitrate and nitrite concentrations of the seawater are much lower than in winter [21]. This is because more sunlight penetrates into the water, so that algae are more numerous and they absorb these compounds much more actively. A scarcity of nitrogen compounds slows down the algal growth. In the German Bight the nitrate and nitrite concentration is relatively high. It is assumed that phosphate is the building material which first becomes limited during algal growth in that area [24], so that the nitrogen compounds are no longer fully absorbed.

The concentration of nitrogen compounds is also relatively high off the east coast of the United Kingdom. The sea is very turbid there, so that fewer of the nutrients brought in by the Thames are absorbed by the algae [27, 28]. The flow of nutrients from the east coast of the United Kingdom to the German Bight is caused by the eastward water movement under the influence of the prevailing southwest winds.

The map is based on data from the summer of 1986.

Source:

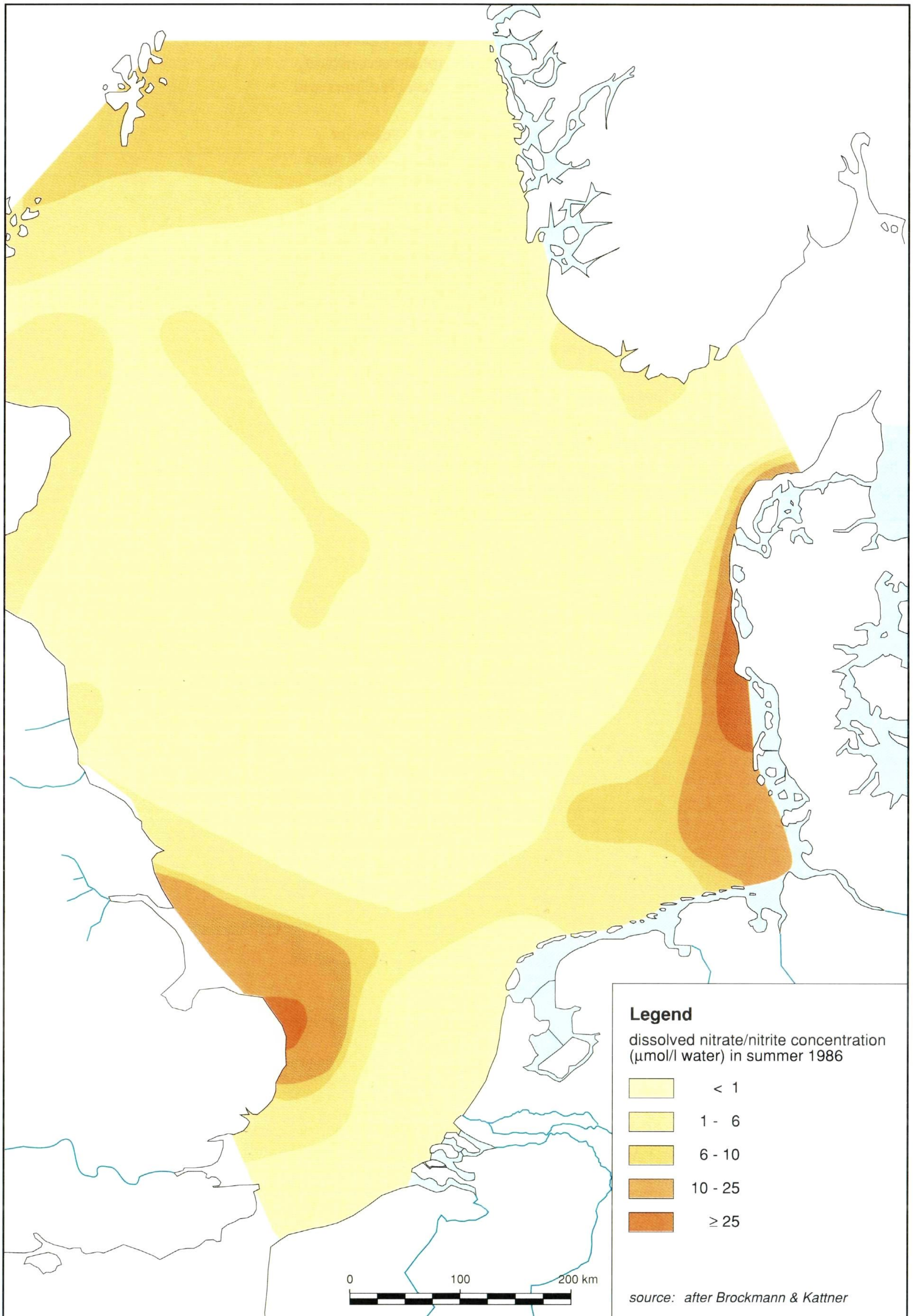
Brockmann, U.H., Laane, R.W.P M., Postma, H. (1990). Cycling of nutrient elements in the North Sea. Neth. J. of Sea Res., 26 (2-4), p. 239-264.

Brockmann & Kattner (in press). In: Estuarine Coastal Shelf Science.

Laane, R.W.P.M., Leewis, R.J , Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Peeters, J.C.H. (V&W/RWS/DGW) (1991): oral information.

Nitrate and nitrite concentration in summer



Phosphate concentration in winter

Phosphorus (P) occurs most commonly as a chemical compound with oxygen (O) in the form of phosphate. Like the nitrogen compounds, it is a "macro-nutrient", an indispensable foodstuff for phytoplankton. Phosphate is constantly added to seawater, mainly via the rivers. It comes from agricultural fertilisers and sewage discharge.

The supply of too many nutrients results in overmanuring of the seawater, which disrupts the North Sea ecosystem (eutrophication). Algae generally need sixteen times more nitrogen molecules than phosphates molecules. When the supply of nutrients departs widely from this ratio, the possibility exists that algal species will predominate which causes a nuisance or are poisonous to man.

In order to combat eutrophication, the North Sea states decided at the Second North Sea Ministers Conference to aim at a reduction of the discharge of nutrients into the sea by 50% before 1995, on the basis of the situation in 1985.

The map shows the phosphate concentrations in the winter of 1987. The phosphate concentrations of the seawater are higher in winter than in summer. This is because of the relatively low absorption of phosphate by algae, so that more phosphate remains in the water in winter. The higher values on the coasts are the result of the slow mixing of phosphate-rich river water with seawater. The phosphate concentration on the Dogger Bank is relatively low. The sea is shallow and clear there, so that a relatively large amount of light can deeply penetrate to the bottom. This means that algae, even in winter [21,27], can absorb phosphate.

Source:

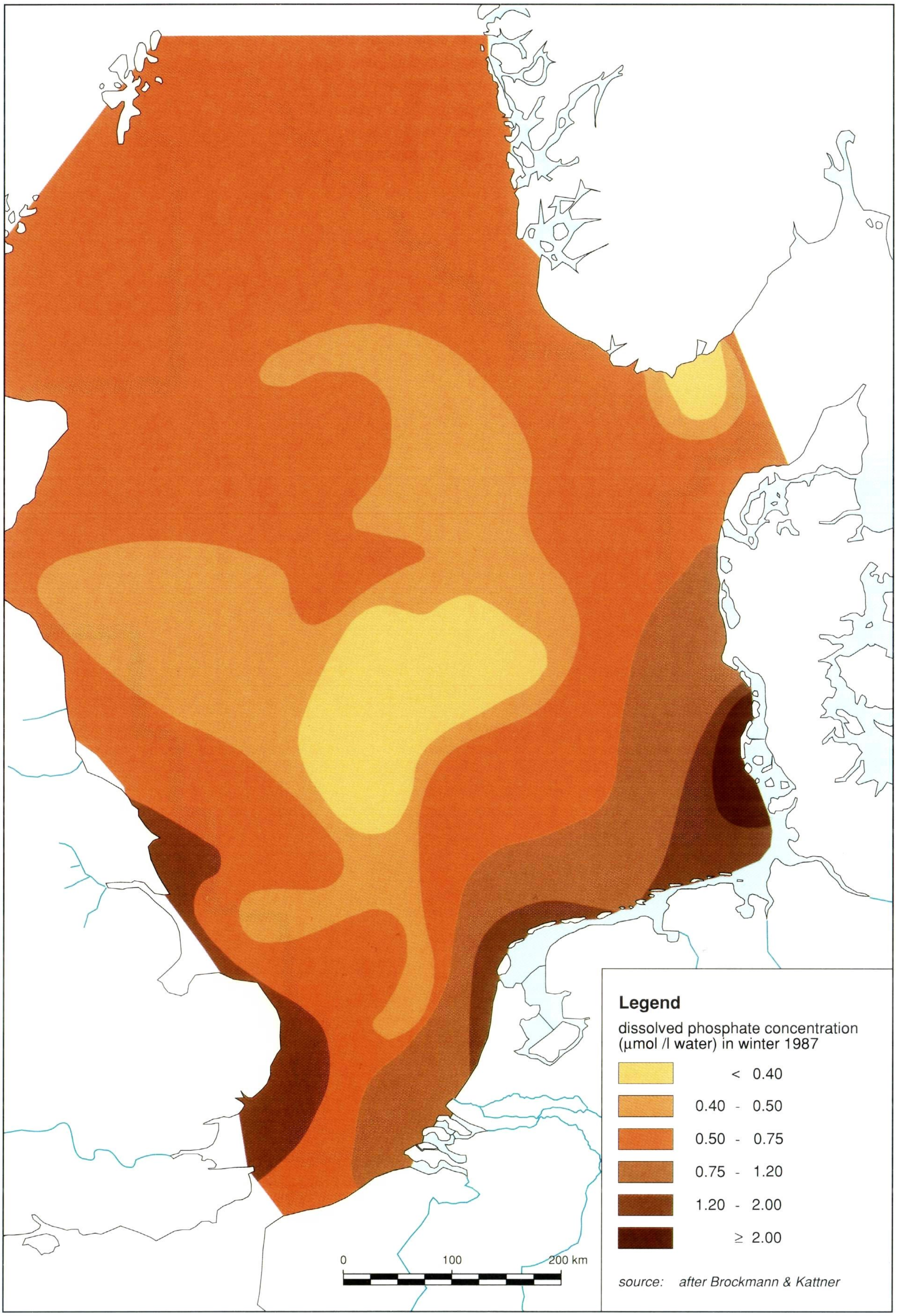
Brockmann, U.H., Laane, R W P M , Postma, H (1990). Cycling of nutrient elements in the North Sea. Neth. J. of Sea Res , 26 (2-4), p. 239-264.

Brockmann & Kattner (in press) In· Estuarine Coastal Shelf Science

Laane, R.W.P.M , Leewis, R.J., Colijn, F , van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Peeters, J.C.H. (V&W/RWS/DGW) (1991)· oral information.

Phosphate concentration in winter



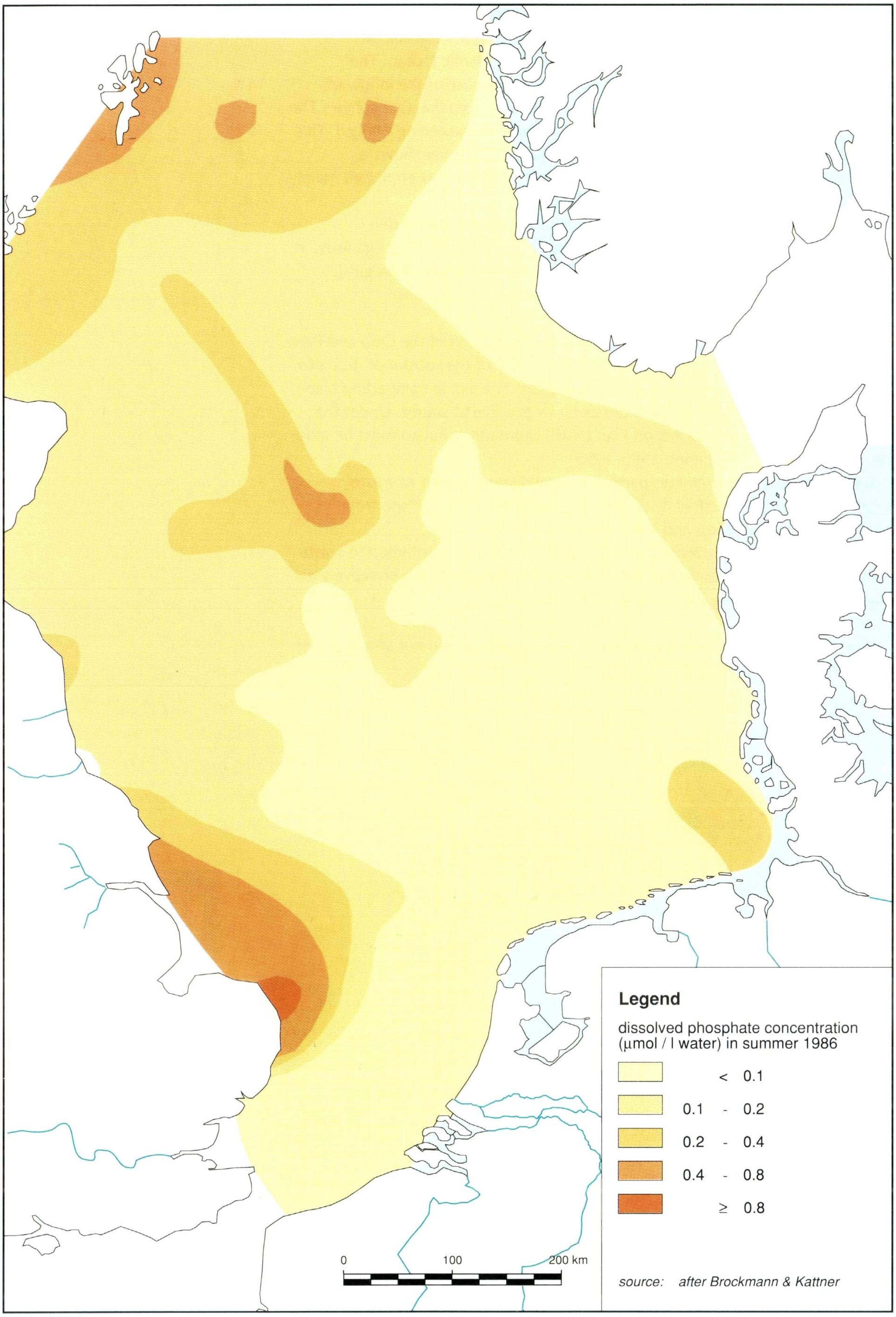
Phosphate concentration in summer

The phosphate concentrations in the North Sea are lower in summer than in winter [23]. This is related to the increase in the quantity of sunlight which penetrates into the water. More light and higher temperatures stimulate algal growth and thus the absorption of phosphate. The higher phosphate concentration in the Elbe and Thames estuaries is probably partly the result of the low algal activity caused by the turbidity of the water. The increase in phosphate northwards is related to the presence of phosphate-rich Atlantic water.

The map is based on data for the summer of 1986.

Source:
Brockmann, U.H., Laane, R.W.P.M., Postma, H. (1990). Cycling of nutrient elements in the North Sea. Neth. J. of Sea Res., 26 (2-4), p. 239-264.
Brockmann & Kattner (in press). In: Estuarine Coastal Shelf Science.
Laane, R.W.P.M., Leewis, R.J., Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.
Peeters, J.C.H. (V&W/RWS/DGW) (1991): oral information.

Phosphate concentration in summer



Cadmium concentration

Cadmium (Cd) occurs naturally in seawater in concentrations of under 10 nanogrammes per litre (ng/l). In the North Sea these values can still be measured only in the water which flows in from the Atlantic Ocean. The concentration has increased in the remaining areas because of the inflow of polluted river water and the precipitation of cadmium from the atmosphere. The concentration is highest in the coastal areas, sometimes exceeding 40 ng/l. This is because river water mixes poorly with seawater. The seabed shows a comparable pattern, with cadmium-polluted river mud being precipitated mainly in the catchment area of the river water [32].

Little is known about the specific effects of cadmium on the marine environment, although the element is certainly poisonous to living organisms. It has a chemical structure which is very similar to that of calcium. Biological processes in which calcium plays a part are disrupted by cadmium.

Cadmium has been placed on the blacklist of the EC and of the Oslo and Paris Commissions. This is not only because of the toxicity of the substance, but also because of its tendency towards bioaccumulation. The aim in combatting blacklisted substances is to deal with them as far as possible at source. Under the guidelines of the North Sea Action Plan (NAP) cadmium pollution must be reduced by 90% during the period 1985-1995.

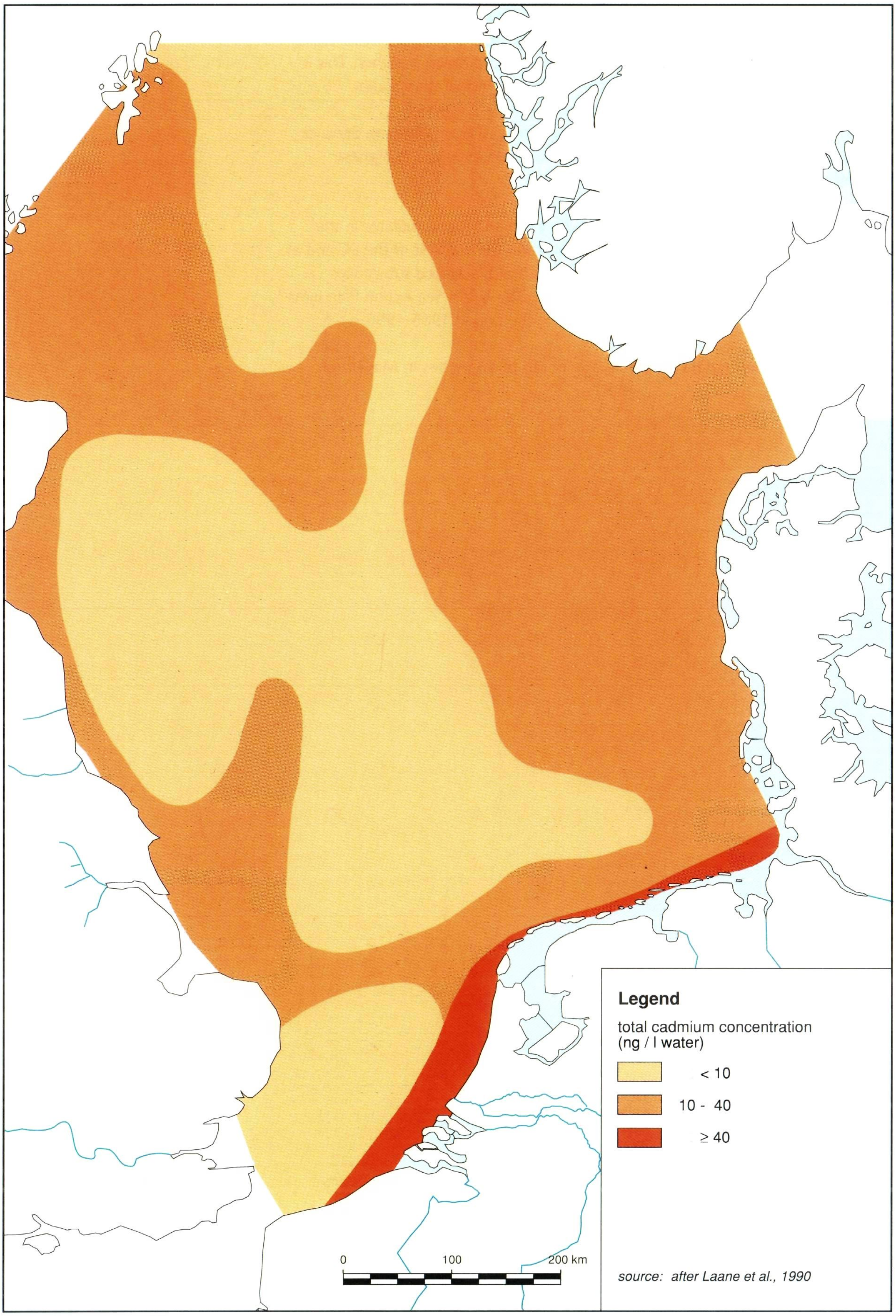
Cadmium pollution originates partly from point sources such as waste incineration plants, industrial discharges, including particularly those from artificial fertiliser factories, and industrial emissions into the air.

Because of the many uses of the metal and the related contribution to waste flows, it also gives rise to diffuse pollution. This can be dealt with effectively at source only by reducing the emission of the substance.

The measurements on which the map is based were carried out at a depth of 10 metres in May/June 1986.

Source:
Van Eck, Turkstra, van 't Sant (1985). Voorstel referentiewaarden fysisch-chemische waterkwaliteitsparameters Nederlandse zoute wateren. V&W/RWS and Ministry of VROM.
Laane, R.W.P.M., Leewis, R.J., Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Cadmium concentration



Lead concentration

Seawater naturally contains a certain quantity of lead (Pb, less than 0.5 ng/l water). In the North Sea this value can still be measured only in the water which flows in from the Atlantic Ocean. Elsewhere the concentration is higher. This is because of the release of lead in industrial processes, incineration plants, combustion products of leaded petrol and various waste flows.

Lead is carried into the sea by river water and from the atmosphere. Because river water mixes poorly with seawater, the coastal areas have the highest concentrations of lead (up to 5 ng/l water).

Lead is highly poisonous; it does not break down and it accumulates in the food chain. For these reasons it has been placed on the blacklist of the EC and of the Oslo and Paris Commissions.The proposal is that blacklisted substances should be dealt with as far as possible at source. The North Sea Action Plan aims to reduce lead pollution bij at least 70% during the period 1985-1995.

The map is based on data measured at a depth of 10 metres in May/June 1986.

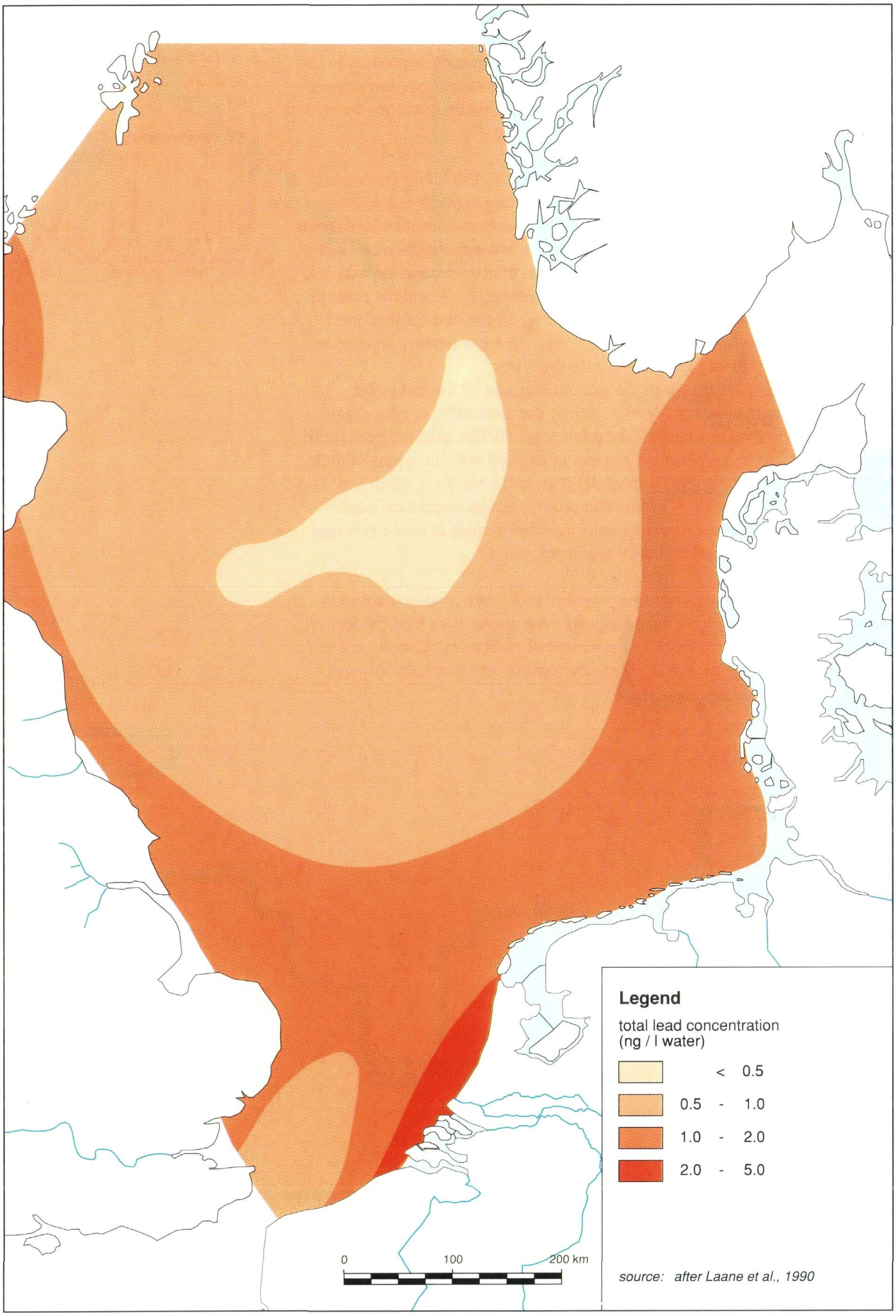
Source:

Laane, R.W.P.M., Leewis, R.J., Colijn, F., van Berge Henegouwen, A., Hisgen, R., (1990). De zee, de zee de Noordzee. SDU, The Hague.

Ministerial Declaration of the Third International Conference on the protection of the North Sea, The Hague, 8 March 1990.

Ministry of Transport, Public Works and Water Management (1990). North Sea Action Plan 1990, national implementation document of the Third International North Sea Conference. Second Chamber, 1990-1991, 21 884, nos. 1-2. SDU, The Hague.

Lead concentration



Primary production in winter

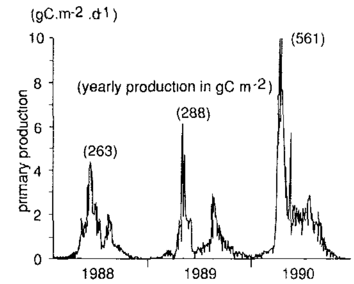
All the life in the sea forms a chain of eating and being eaten. The beginning of the food web in the sea, primary production, is the process of carbon dioxide-uptake by the phytoplankton (algae) by which nutrients such as phosphate and nitrate are absorbed with the help of sunlight and converted into new organic (algal) material and oxygen. Thus algae form the beginning of the food web and are therefore called the primary producers of the sea.

The map shows primary production in the winter of 1987. Primary production is not everywhere uniform in the North Sea. It is often higher in the southern North Sea and in the coastal areas where the nutrient concentration is relatively high [21, 23]. In places where the light can penetrate deep into the water and there is a good supply of nutrients, an increase in primary production may also be observed. Examples are the Dogger Bank in winter [21, 23] and the coast of Holland. Large quantities of mud in the water, as off the east coast of the United Kingdom and in the German Bight, result in a low primary production because the light cannot penetrate far into the water.

Primary production varies with the seasons. Because of the low water temperature and the low light-level in winter, the production of new organic material is lower than in summer. The primary production gradient from south to north is related to the declining amount of daylight with increasing latitude. In the north the days are shorter in winter than in the southern North Sea. The understanding of the primary production process and its magnitude is still limited, however, because measurements have been made at only a few sites *and annual cycles have seldom been measured.*

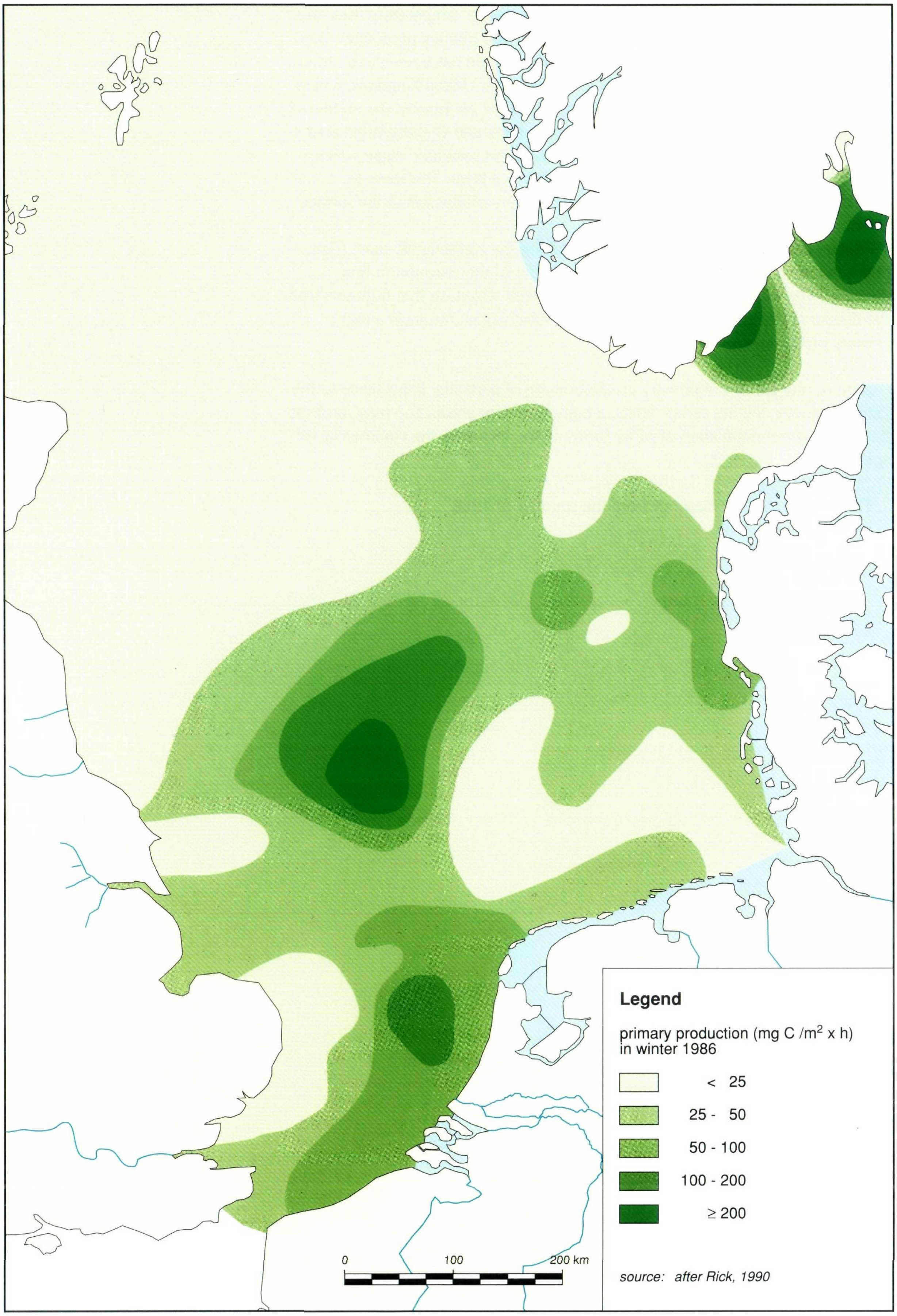
The map provides a snapshot from the winter of 1987. Wide variations in annual production can occur over the years even in one place (see the figure). Primary production is expressed in the weight of carbon (mg C) produced per square metre (m^2) per hour (h) in the water column at a particular location.

Daily production in the water colom at sampling station Noordwijk 20 (±20 km off the coast)



Source:
Peeters, J C H (V&W/RWS/DGW) (1991): oral information.
*Peeters, J C H, Haas, H.A., Peperzak, L. (1991) Eutrofiering, primaire produktie en zuurstofhuishouding in de Noordzee. Final report Euzout*2. V&W/RWS/DGW nota GWAO-91 083.*
Rick, H.J. (1990) Ein Beitrag zur Abschatzung der Wechselbeziehung zwischen den planktischen Primarproduzenten des Nordseegebietes und den Schwermetallen Kupfer, Zink, Cadmium und Blei auf Grundlage von Untersuchungen an naturlichen Planktongemeinschaften. Dissertation Aachen

Primary production in winter



Primary production in summer

As the sunlight grows stronger in spring and the water temperature rises, the activity of the phytoplankton greatly increases, so that primary production is higher in summer than in winter. A very high production has been measured in summer in the area of the Frisian Front and east of the United Kingdom, where the increase in biomass can exceed 1000 mg C per m^2 per hour in the middle of the day. Stratification occurs around the Dogger Bank and Oysterground area in the course of time. Because of this stratification of the seawater, algae which have sunk to the bottom do not return to the surface layer. This leads to adepletion of nutrients and a rapid decline in primary production in the surface layer.

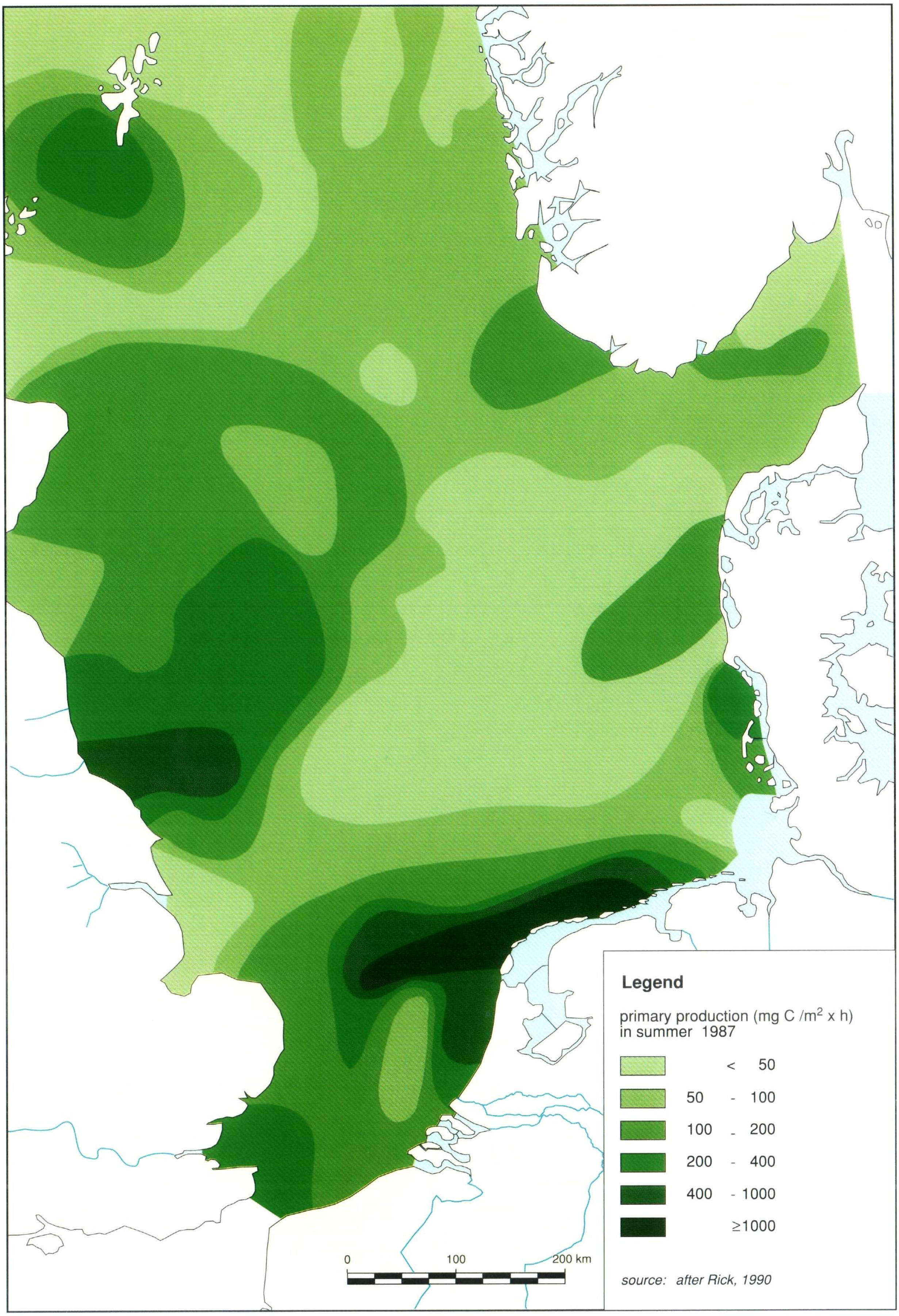
Primary production increases northwards along the Netherlands coast. This phenomenon is related to the decreasing turbidity of the seawater in that direction. The waters off the Shetland Isles are well mixed, so that nutrients from the deeper layers are brought to the surface, which again results in a higher primary production.

Data on the pattern of primary production are of particular importance to the fishing industry. Within certain limits, a higher primary production may form the basis for a larger population of other forms of life, including the commercial fish species.

The map provides a snapshot from the summer of 1986.

Source:
Peeters, J.C.H. (V&W/RWS/DGW) (1991) oral information
Rick, H.J. (1990) Ein Beitrag zur Abschatzung der Wechselbeziehung zwischen den planktischen Primarproduzenten des Nordseegebietes und den Schwermetallen Kupfer, Zink, Cadmium und Blei auf Grundlage von Untersuchungen an naturlichen Planktongemeinschaften. Dissertation Aachen

Primary production in summer



Seabed

Composition of the surface of the seabed

The upper 50 centimetres of the seabed of the Netherlands sector of the Continental Shelf (NCS) consist of gravel, sand, clay and glacial till. The pattern in which these deposits occur has been partly determined by current velocity, wave action and water depth. Thus the sediment in areas with a low current velocity and/or little wave action on the seabed is more fine-grained than in areas with a stronger water movement. This is because more current and wave energy is needed for the transport of coarser material than for that of fine material.

The surface of the seabed in the relatively shallow southern part of the NCS is exposed to strong current and wave action and consequently consists mainly of coarse sands. There is a gradual northwards transition to a bottom consisting predominantly of fine sand and mud.

There are a few exceptions to this general picture. In the northern half of the Continental Shelf formations occur which were deposited in the ice age by land ice or meltwater. Examples are the gravelly deposits of the Cleaver Bank (around 54° N and 3° E) and the glacial till and boulders northwest of Texel. Marine currents and wave action have not been able to shift this material.

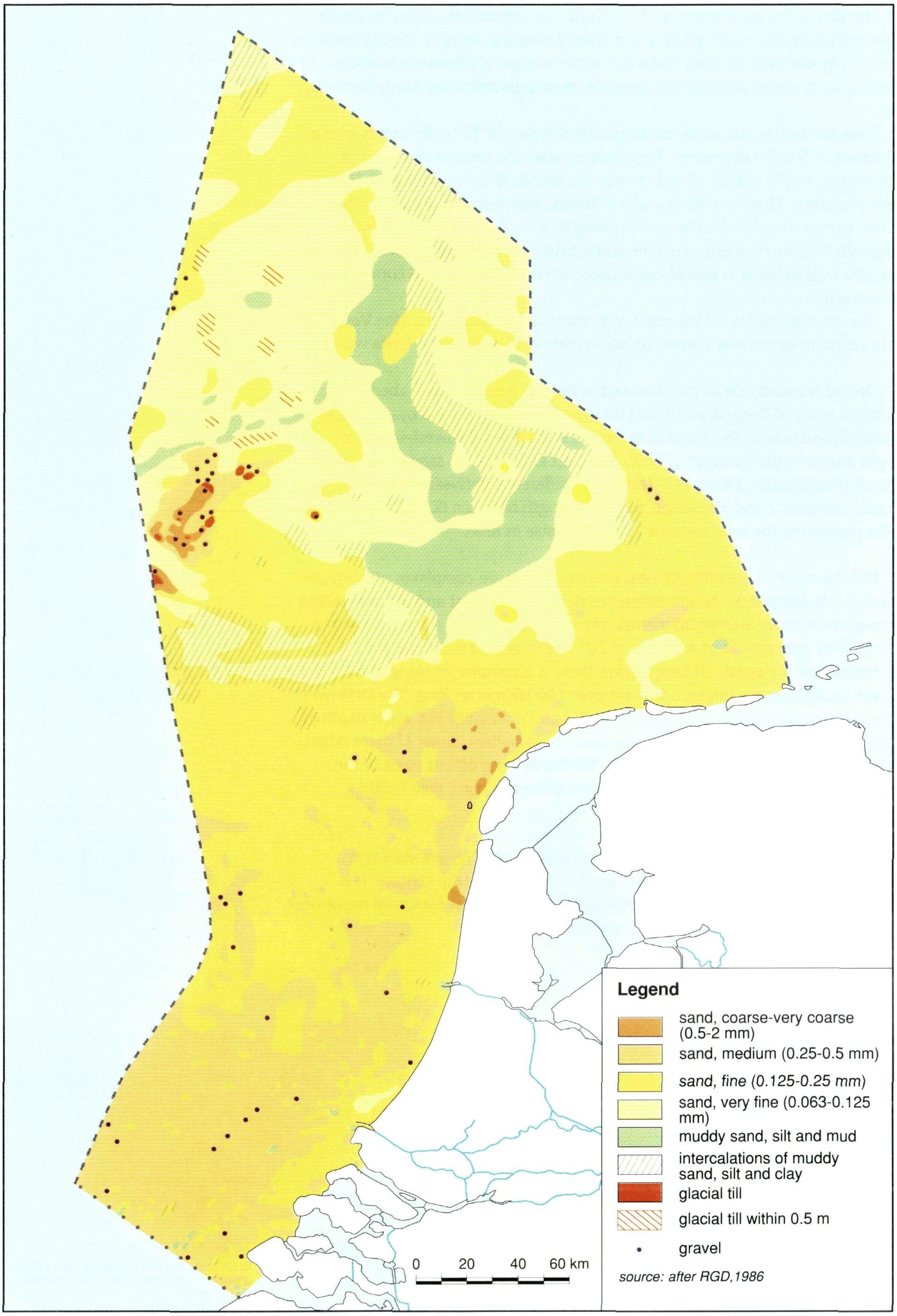
The Dogger Bank, in the most northerly part of the NCS, consists of coarser sands because of the shallow water depth, and consequently more intense wave action.

The differences in the composition of the seabed help to determine the opportunities for the seabed organisms to establish themselves. Thus the Cleaver Bank and the mud-rich Oystergrounds possess a species-rich benthic fauna. The sandy and dynamic bed of the southern North Sea, by contrast, is poorer in seabed life [42, 53].

Because of the decreasing number of sites for sand and gravel extraction on land, the demand for marine sand and gravel has been increasing in recent years. The gravel of the Cleaver Bank and Texel are of interest to the building industry. The sandy deposits along the coast are favoured for use as fill sand because of the short distance they need to be shipped [73].

Source:
Geological Survey of the Netherlands (RGD) (1986). Geologie van Nederland, deel 2. Delfstoffen en samenleving. RGD, Haarlem & the Physical Geographical and Pedological Laboratory of the University of Amsterdam.
Schüttenhelm, R.T.E. (1980). The superficial geology of the Dutch sector of the North Sea. Marine Geology 34, M.27-M.37.

Composition of the surface of the seabed



Seabed morphology

The bed of the southern part of the North Sea consists of sediments which were deposited by rivers, glaciers and wind during the ice ages. During and after the rise in sea level the tides and wave action created a submarine landscape of banks, sand waves and ebb tidal deltas in these predominantly sandy deposits.

From the beach, the water depth slowly increases to 15 to 20 metres over a distance of 5 to 10 kilometres. This slope is called the underwater slope or shoreface. At the coastal inlets between the islands there are ebb tidal deltas on the shoreface. These are semicircular shallows, bisected by a deep ebb channel. They consist of sand which is carried along by the powerful ebb tide and is deposited at the moment when the current slackens in the open sea. The sand on ebb tidal deltas is in almost continuous movement because of current and wave action.

The ebb tidal deltas off the coast of Zeeland and Zuid-Holland (the Voordelta) are adapting to the new current situation that resulted from the Delta works.

On the seaward side of the shoreface is the more or less flat seabed or shelf. Off the coast of Zeeland and Zuid-Holland the latter is covered by an extensive field of sand waves. The trend of the crests is roughly northwest-southeast, at right angles to the direction of flow. The crest length of the sand waves may reach several dozen kilometres. The height difference between crest and trough varies between 2 and 10 metres, the wave length between 60 and 600 metres. The position of the sand waves is relatively stable in time.

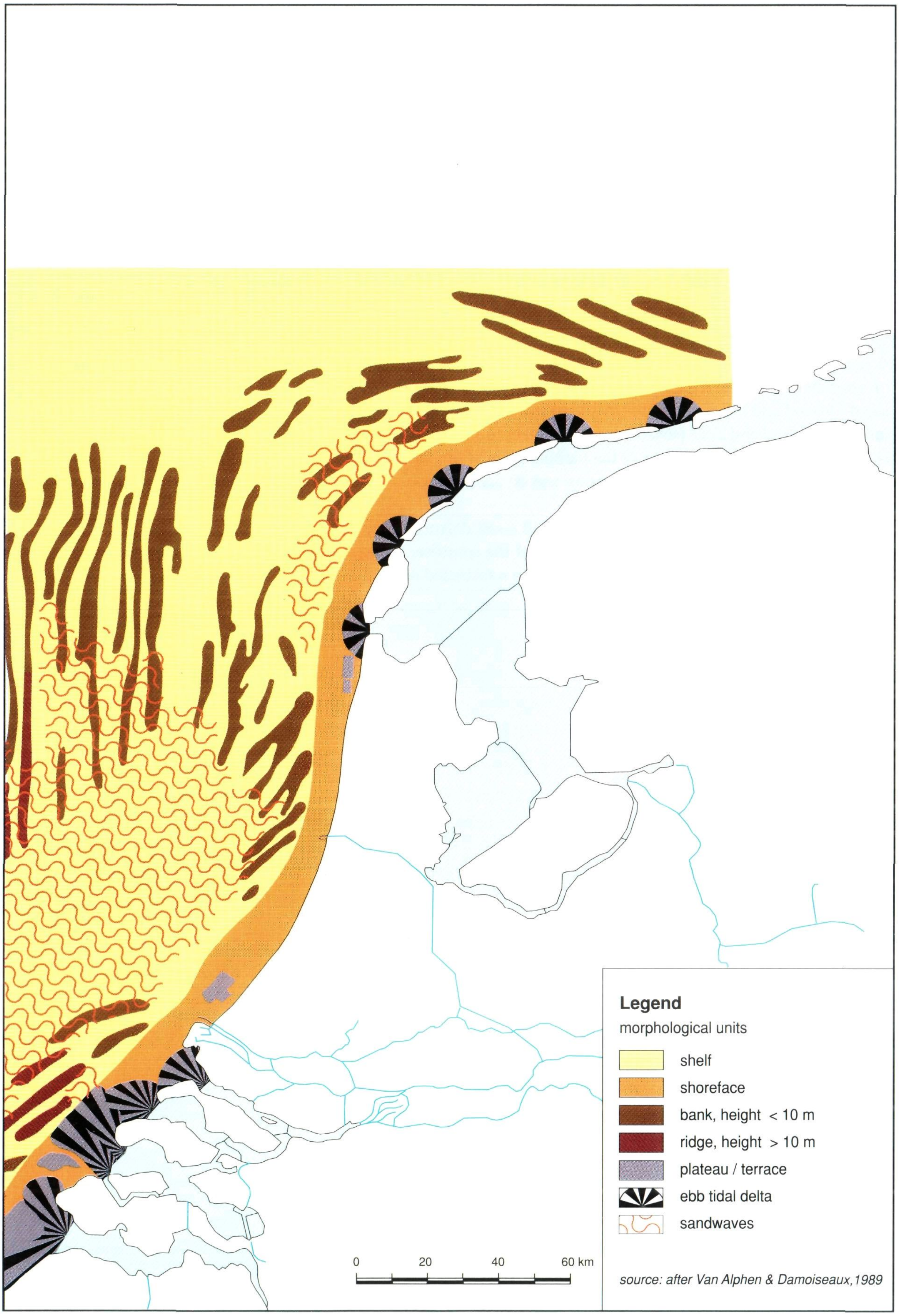
Off the coast of Zeeland and near IJmuiden there are complexes of elongated banks. Off Zeeland the height difference between the crest and the intervening trough sometimes reaches 20 metres. The banks are several dozen kilometres long. They generally lie at an angle of 20° to 35° against the shoreface.

Further off the coast, off Den Helder, there is a complex of elongated north-south oriented ridges. Some are over 100 kilometres long. The shallowest point (19 metres below MSL) lies on the Brown Bank, while the water depth in the neighbouring trough, 1 kilometre away, is 44 metres. Some of these ridges may have been pushed up by land ice. The banks lying off the coast of the Wadden Islands are generally only a couple of metres high; their height increases eastwards.

The origin of the banks has not yet been explained. They are shown in approximately the same position on old charts from the 16th century. It is assumed that their shapes are maintained by a more or less rotational movement of sand created by the alternating flood and ebb currents.

Source:
Van Alphen, J.S.L.J., Damoiseaux, M.A. (1989). A geomorphological map of the Dutch shoreface and adjacent part of the continental shelf. Geol. & Mijnb. 68, p. 433-443.

Seabed morphology



Coastline behaviour

The Netherlands coast largely consists of sand. Current and wave action constantly move the sand from the beach and the dunes to the breaker zone and the shoreface and vice versa. Sand is also moved along the coast. When at a particular section of coast the sand supply equals the sand loss, the coastline remains in its position. If the supply of sand is greater than the removal of sand, this results in coastal accretion; the reverse situation leads to coastal erosion.

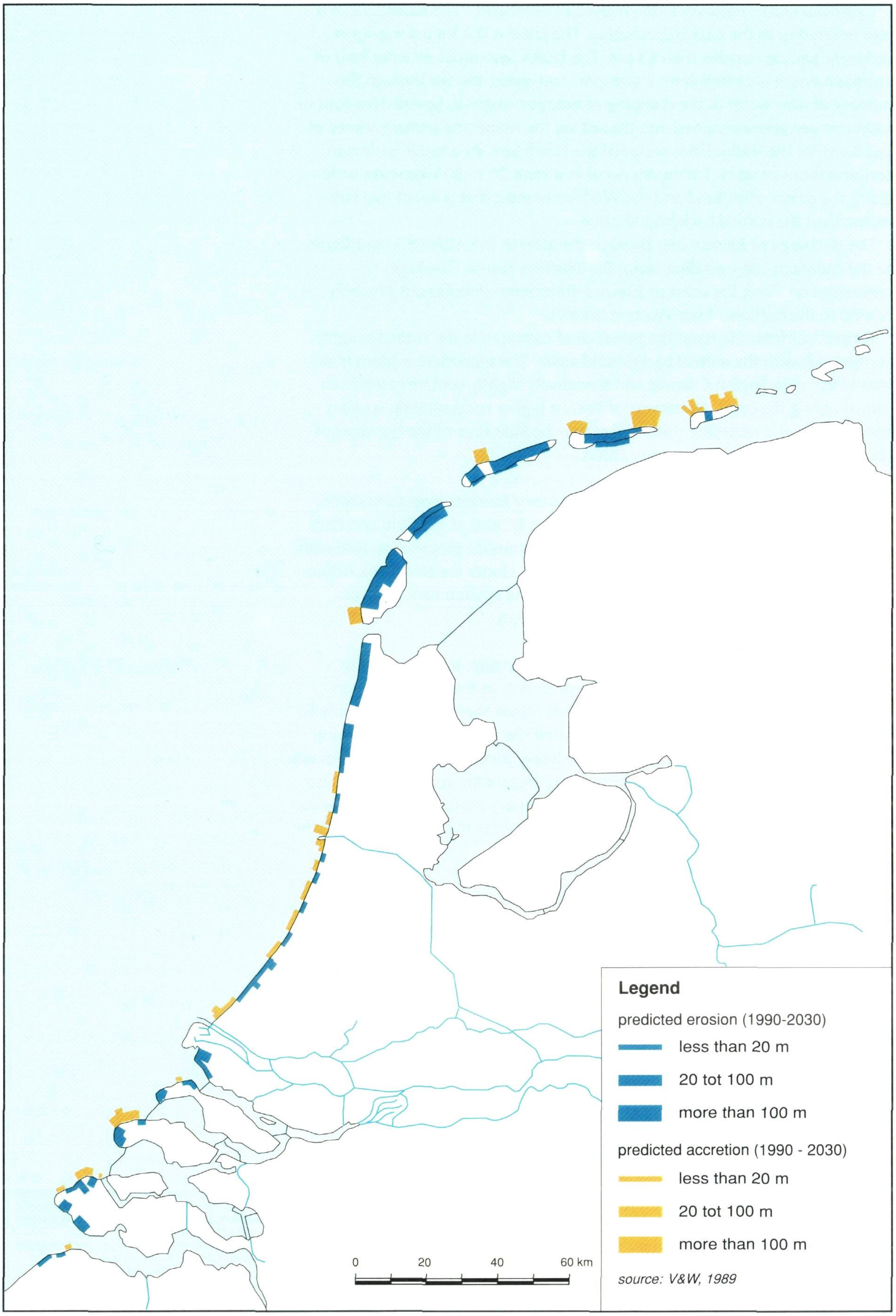
Coastal erosion and coastal accretion alternate along the coast. At a particulare location such an alternation also occurs in time: material removed from the beach in winter is naturally restored in summer. Structural coastal erosion, which occurs at the same place over a number of years in succession gives greater cause for concern. Such erosion may damage the dunes and, with them, the coastal defences. Where the latter happens, artificial sand must be brought in to restore the beach and dunes and thus keep the defences intact against flooding. The map shows how the coastline would change over the next 40 years in the absence of human intervention.

A considerable retreat is expected at a number of places along the coast of Noord-Holland and the coasts of the Wadden Islands. The promonteries of the islands of Zeeland and Zuid-Holland are also subject to structural erosion. Natural accretion occurs in the lee of the harbour piers of IJmuiden and on the east sides of Ameland and Schiermonnikoog and on Schouwen.

In 1990 the government laid down as part of its coast defence policy that central government would maintain the position of the coastline, giving the natural dynamics of the dune coast free play within a restricted margin.

Source:
Ministry of Transport, Public Works and Water Management (V&W) (1989). Kustverdediging na 1990 en bijbehorende technische achtergronds-rapporten. Second Chamber, 1989-1990, 21 136, no. 5-6. SDU, The Hague.

Coastline behaviour



Cadmium content of the seabed

Cadmium occurs naturally in the marine environment. The natural value is also referred to as the background value. The latter is 0.2 tot 0.4 mg/kg in sediment particles smaller than 63 µm. The North Sea carries an extra load of cadmium which is carried in mud transport and enters the sea through the outflow of river water or the dumping of dredged material. Several tens tons of cadmium per year are carried into the sea via the Rhine, the primary source of cadmium for the Netherlands sector of the North Sea. As a result, cadmium concentrations of up to 1.5 mg/kg occur in a zone 20 to 30 kilometres wide along the coasts of Holland and the Wadden Islands; that is about five times higher than the natural background value.

The discharge of Rhine water through the locks in the Afsluitdijk contributes to the cadmium concentration along the Wadden Islands. The high concentration along the coast of Zeeuws Vlaanderen (Breskens) is probably related to the outflow of the Western Scheldt.

Further out from the coast the presence of cadmium in the seabed roughly corresponds with the natural background value. The mud there is brought in mainly from the English Channel and is relatively slightly contaminated from sources along the coast. Northwest of Texel a higher concentration is again encountered at a recording station. This may be indicative of the transport of contaminants from English coastal waters.

Because of its toxicity, persistence and tendency towards bioaccumulation, cadmium has been placed on the blacklist of the EC and of the Oslo and Paris Commissions. The Third North Sea Ministers Conference proposed to deal with blacklisted substances as far as possible at source. Under the North Sea Action Plan (NAP) the transport of cadmium to the marine environment must be reduced by at least 90% over the period 1985-1995.

The concentration of a heavy metal, such as cadmium, in the seabed is generally determined by carrying out measurements in the seabed fraction smaller than 63 µm (mud), since heavy metals attach themselves particularly to these mud particles, which move freely through the water. Thus by following the mud movements one can also trace the heavy metals. The mud particles are also absorbed by organisms, so that the heavy metal may accumulate in these organisms. Another reason for determining the heavy metals in this fine fraction is that the measurable quantity of metal may fall below the detection limit if the seabed sample is too large.

The values relate to the mud fraction in the upper 10 centimetres of the seabed. The samples were taken in 1986.

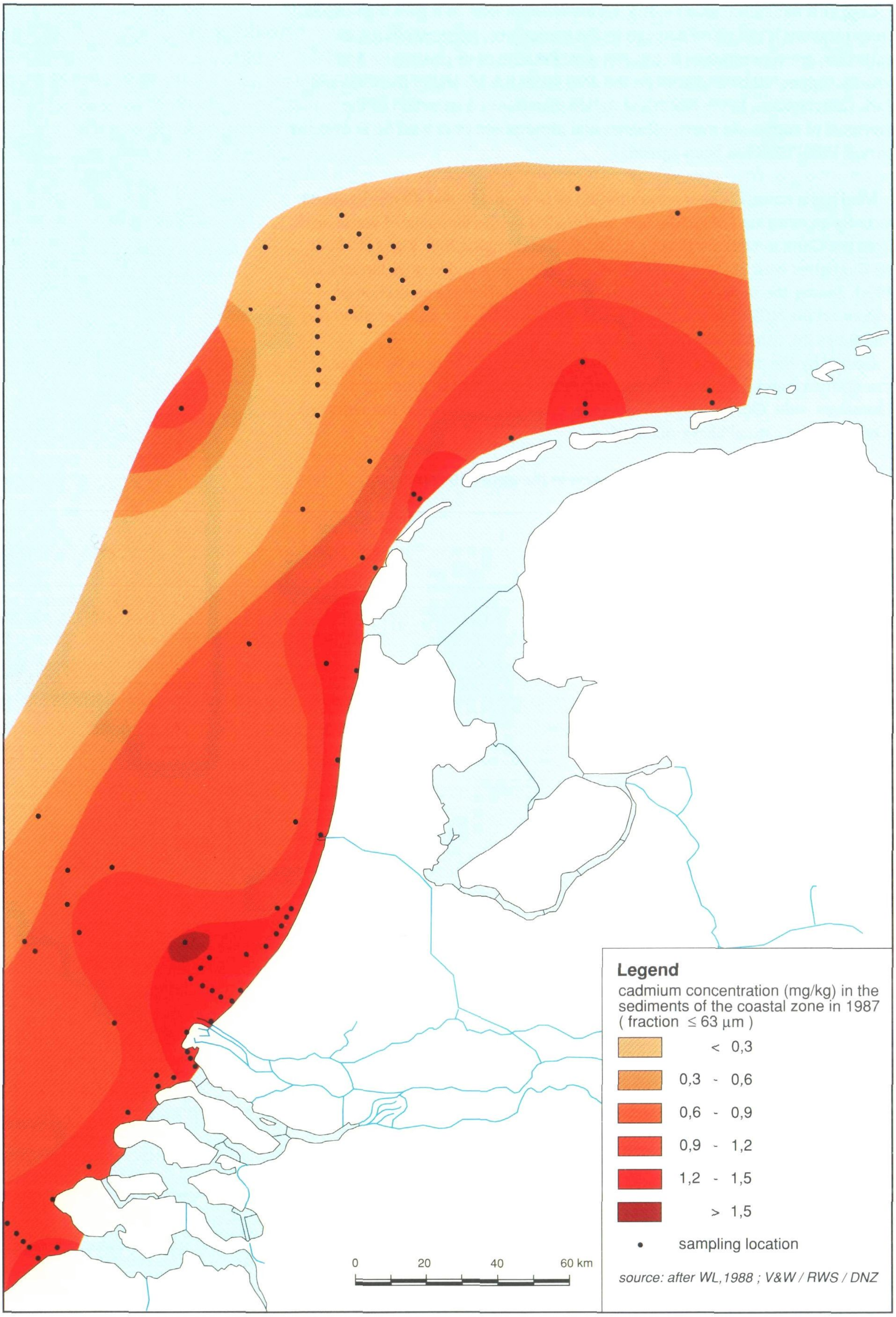
Source:

Van Eck, Turkstra, van 't Sant (1985). Voorstel referentiewaarden fysisch-chemische water-kwaliteitsparameters Nederlandse zoute wateren. V&W/RWS and Ministry of VROM.

Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) unpublished data

Delft Hydraulics (WL) (1988). Microveront-reinigingen in sedimenten van de Noordzee, verslag bemonstering 1986

Cadmium content of the seabed



Copper content of the seabed

Copper is naturally present in the marine environment. In higher than natural concentrations it can cause damage to the marine ecosystem. Molluscs, in particular, are very sensitive to this element. Because of its persistence and toxicity copper has been placed on the grey list of the EC and of the Oslo and Paris Commissions. In the North Sea Action Plan (NAP) a reduction of the transport of copper via rivers, estuaries and atmosphere of at least 50% over the period 1985-1995 has been agreed.

Mud has a natural copper concentration of between 15 and 40 mg/kg. Until recently an extra load of copper was contributed by the dumping of waste acids from the German titanium dioxide industry. This dumping took place at about 50 kilometres west of Hoek van Holland. The dumping ended on 1 January 1990. During the sampling campaign in 1986 the highest concentration of copper on the NCS were measured at the dumping site. The concentration was four times the natural background value.

Carried by the prevailing water and mud movements, the pollution spread out in a northeast and southwest direction from the dumping site over a zone 50 kilometres wide. Outside this zone the concentration of copper in the sediment is equal to the natural background value.

The values relate to the < 63 µm fraction in the upper 10 centimetres of the seabed. The samples were taken in 1986.

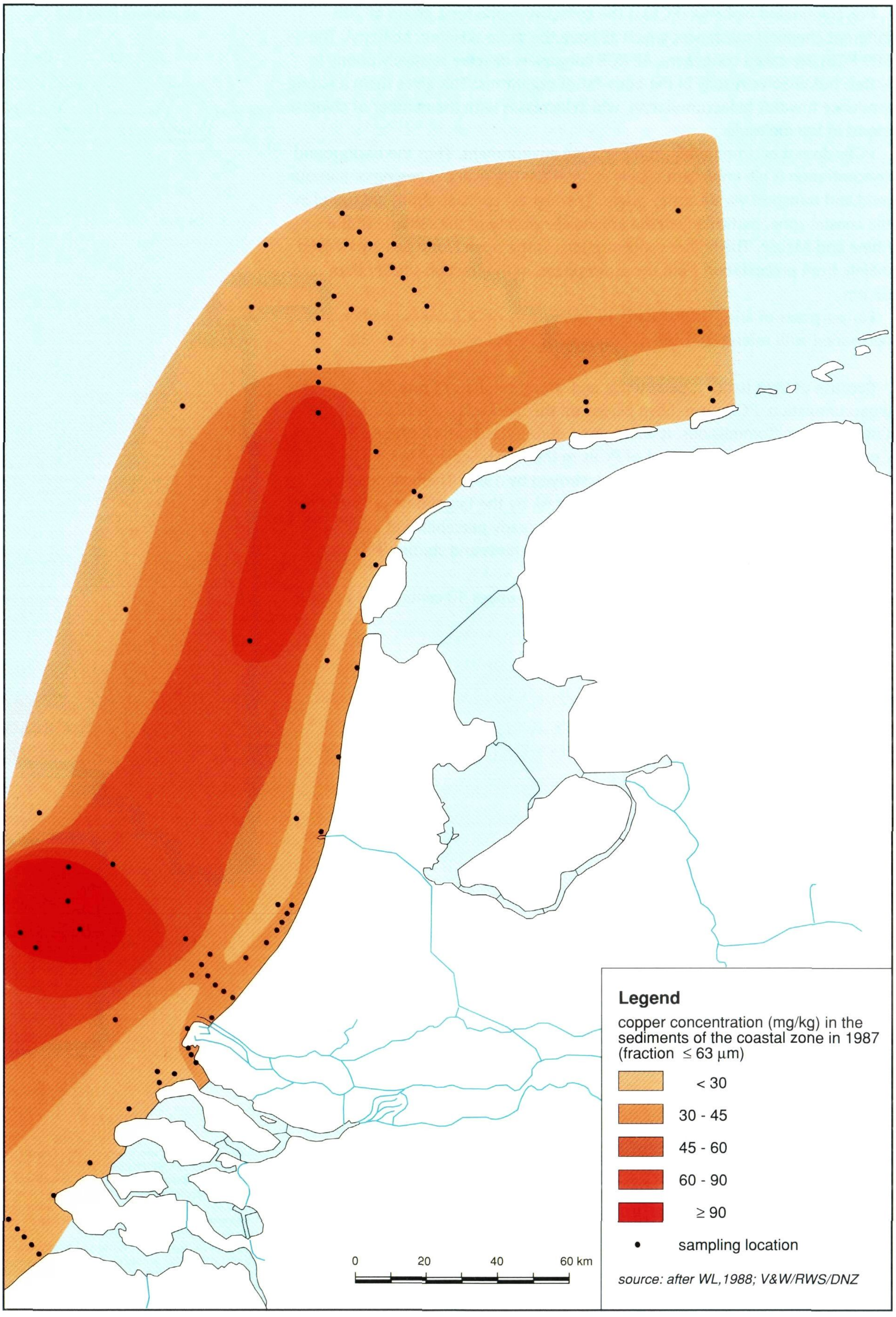
Source:

Van Eck, Turkstra, van 't Sant (1985). Voorstel referentiewaarden fysisch-chemische waterkwaliteitsparameters Nederlandse zoute wateren. V&W/RWS and Ministry of VROM.

Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ): unpublished data.

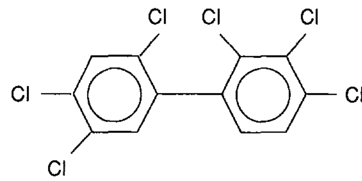
Delft Hydraulics (WL) (1988). Microverontreinigingen in sedimenten van de Noordzee, verslag bemonstering 1986.

Copper content of the seabed



PCB 138 content of the seabed

structure of PCB 138



Polychlorinated biphenyl (PCB) is the collective name for a group of 209 different chemical substances which all have the same skeleton: biphenyl. The 209 PCBs are called congeners. All PCB congeners dissolve relatively poorly in water, but dissolve readily in the body fat of organisms. This gives them a strong tendency towards bioaccumulation, which increases with the number of chlorine atoms in the molecule.

PCBs do not occur naturally in the marine environment. Thus the background concentration is nil. Important supply sources are the rivers, dumping of harbour mud and transport via the atmosphere. The highest concentrations are found in the coastal zone, particularly in the immediate vicinity of the outflow of the Rhine and Meuse. The higher concentrations in the open North Sea are derived mainly from precipitation from the atmosphere, in the fraction smaller than 63 µm.

For purposes of analysis, standard measurements of PCB contamination are performed with reference to a small number of PCBs, including PCB 138.

Because of their toxicity, persistence and strong tendency towards bioaccumulation, PCBs have been placed on the blacklist of the EC and of the Oslo and Paris Commissions. It was agreed during the Third North Sea Ministers Conference to stop the transport of PCBs to the North Sea and to take measures to have these substances banned and destroyed by 1995. The final deadline for countries which are unable to complete the task by the target date is 1999.

The effects of PCBs on living organisms are already perceptible at low concentrations, e.g. on the reproduction of seals, birds and starfish [88].

The values relate to the < 63 µm fraction in the upper 10 centimetres of the seabed. The sampling was carried out in 1986.

Source:

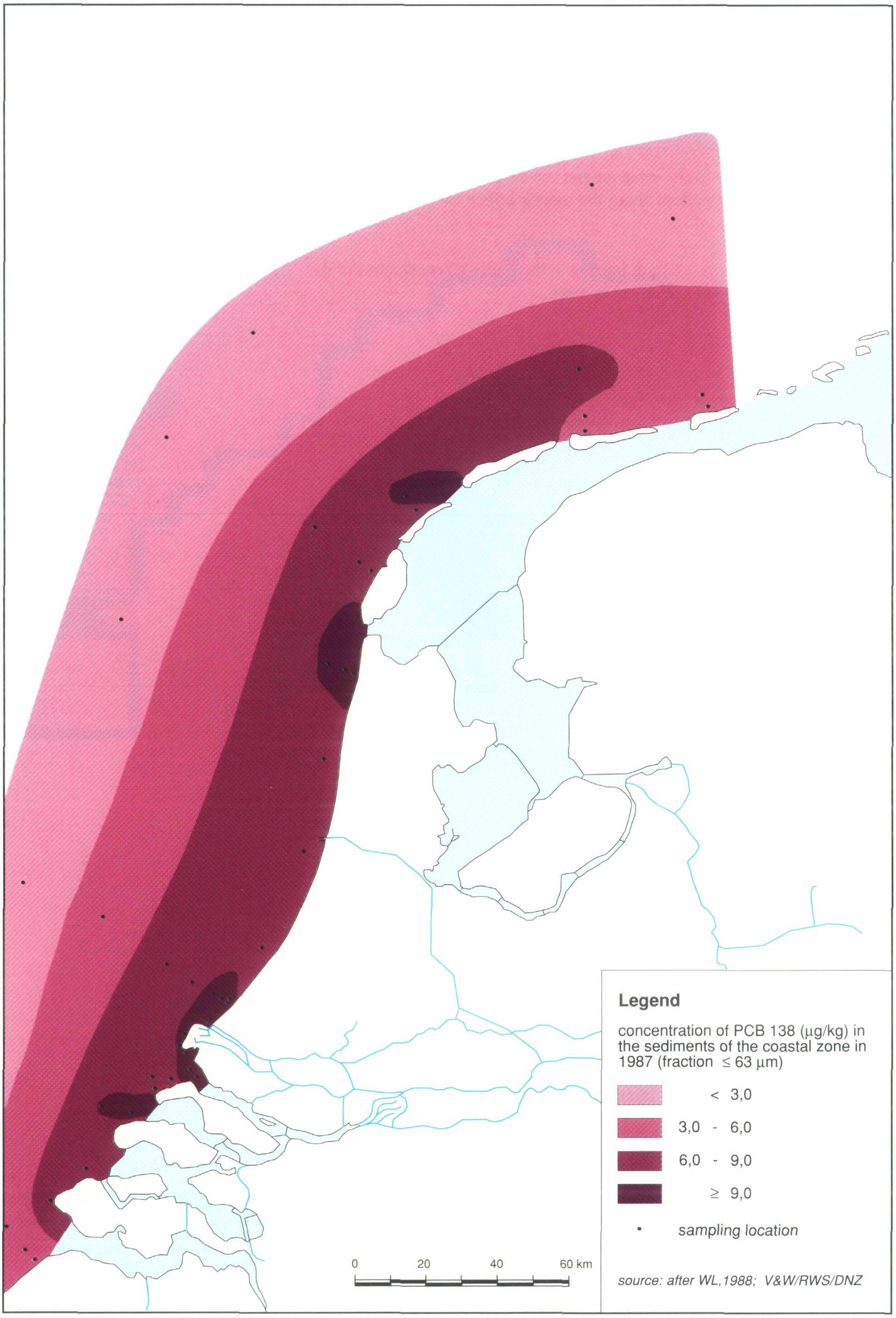
Van Eck, Turkstra, van 't Sant (1985). Voorstel referentiewaarden fysisch-chemische waterkwaliteitsparameters Nederlandse zoute wateren. V&W/RWS and Ministry of VROM.

Reijnders, P.J.H. (1987). Reproductive failure in common seals feeding on fish from polluted coastal waters. Nature 324, 456-457.

Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ): unpublished data.

Delft Hydraulics (WL) (1988). Microverontreinigingen in sedimenten van de Noordzee, verslag bemonstering 1986.

PCB 138 content of the seabed



HCB content of the seabed

Hexachlorobenzene (HCB) is a substance which appears on the blacklist of the EC and of the Oslo and Paris Commissions. The natural background value of HCB is nil; the substance derives wholly from organic chemistry. This explains the relatively high values found in the coastal zone, particularly where water from the rivers Rhine and Meuse flow into the sea via the New Waterway and the Lake IJssel.

The North Sea Action Plan (NAP) provides for a reduction of at least 50% in the supply of HCB from rivers, estuaries and the atmosphere between 1985 and 1995. Little is known at present about the specific effects of HCB on the marine ecosystem.

The values relate to the < 63 µm fraction in the upper 10 centimetres of the seabed. The sampling was carried out in 1986.

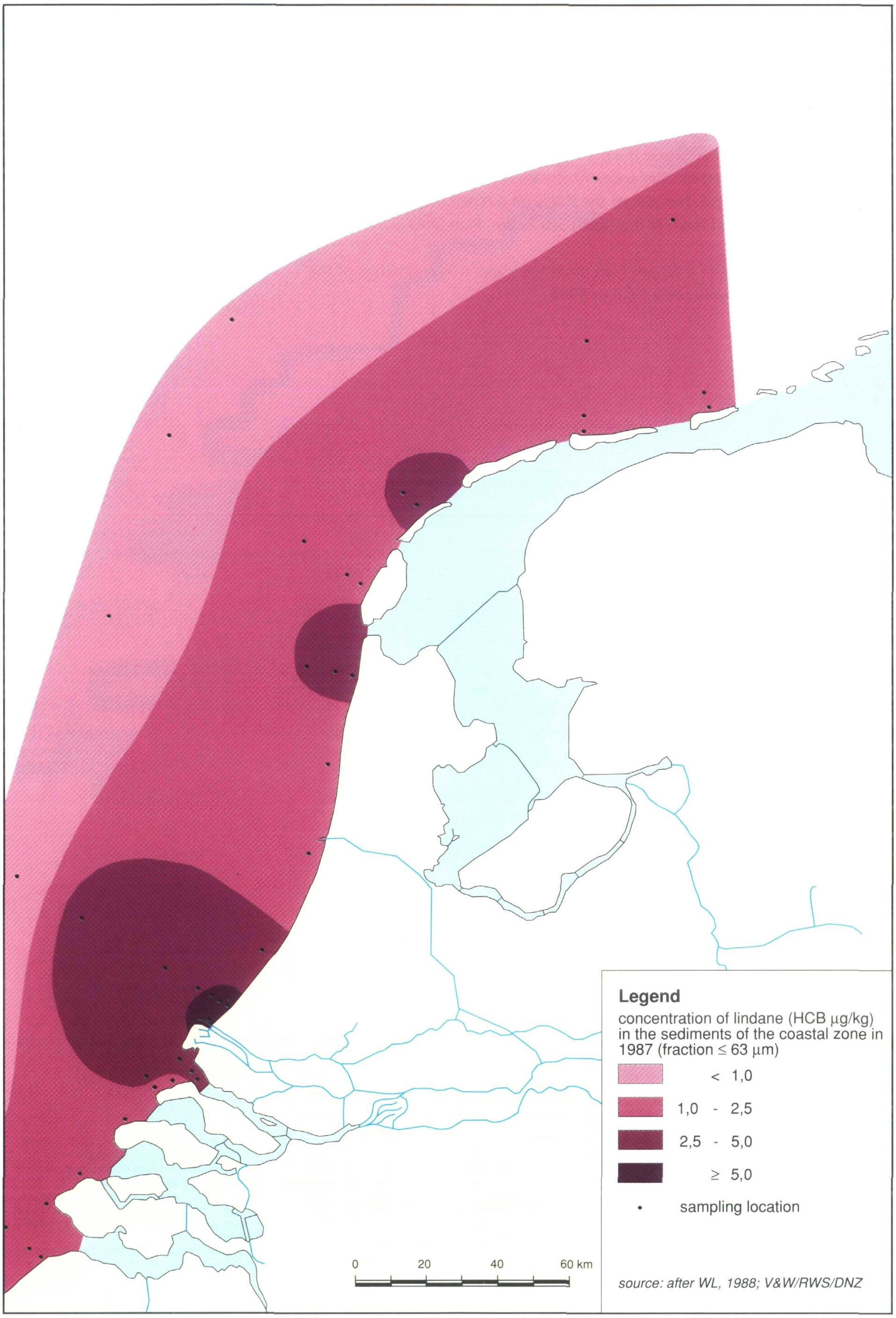
Source:

Van Eck, Turkstra, van 't Sant (1985). Voorstel referentiewaarden fysisch-chemische waterkwaliteitsparameters Nederlandse zoute wateren. V&W/RWS and Ministry of VROM.

Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ): unpublished data.

Delft Hydraulics (WL) (1988). Microverontreinigingen in sedimenten van de Noordzee, verslag bemonstering 1986.

HCB content of the seabed



PAH content of the seabed

Polycyclic Aromatic Hydrocarbons (PAHs) occur naturally in very low quantities in marine mud. The higher concentration in the coastal zone is a result of transport via the rivers and the dumping of dredged material. The high concentration found north of the Wadden Islands are probably the result of transport by the atmosphere.

A relationship has been been demonstrated between the occurence of liver tumours among flounder [90] and the presence of certain PAHs. PAHs are currently included in a list of substances which are eligible for placing on the blacklists. The Netherlands has placed the PAHs on a national list of priority substances and included them in the North Sea Action Plan (NAP).

The values relate to the < 63 μm fraction in the upper 10 centimetres of the seabed. The sampling was carried out in 1986.

Source:

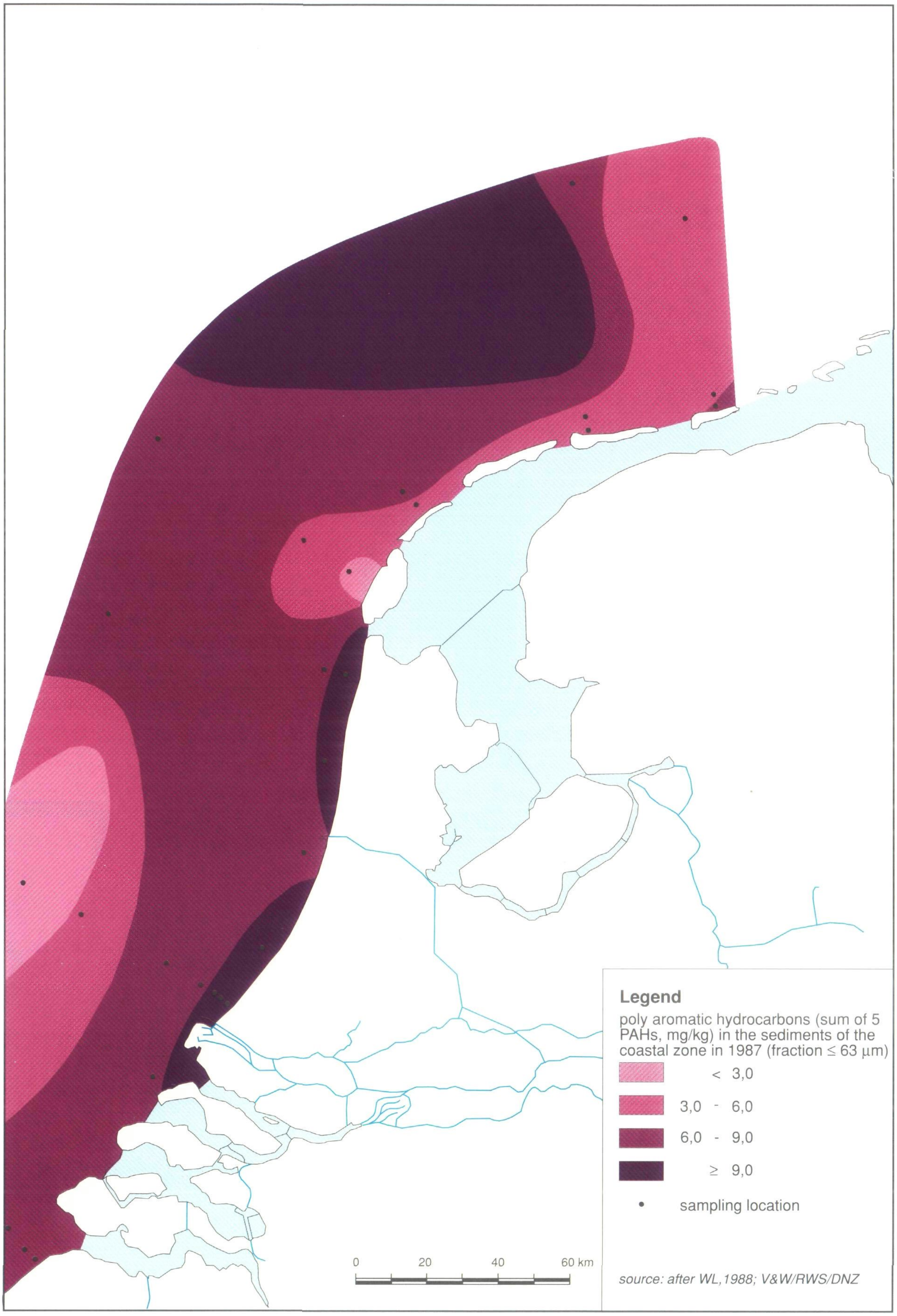
Van Eck, Turkstra, van 't Sant (1985). Voorstel referentiewaarden fysisch-chemische water-kwaliteitsparameters Nederlandse zoute wateren. V&W/RWS and Ministry of VROM.

Marquenie, J., Vethaak, A.D. (1988). Effecten van verontreinigingen op zoutwater ecosystemen. Verslag studiedag Vereniging voor Milieuweten-schappen, Ede, 1988.

Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ): unpublished data.

Delft Hydraulics (WL) (1988). Microveront-reinigingen in sedimenten van de Noordzee, verslag bemonstering 1986.

PAH content of the seabed



Air

Physical features (map 37 to 39)

Precipitation from October to March

The map gives a picture of precipitation in the "wet" season; i.e. the period from October to March. The months of November, December and January are the wettest.

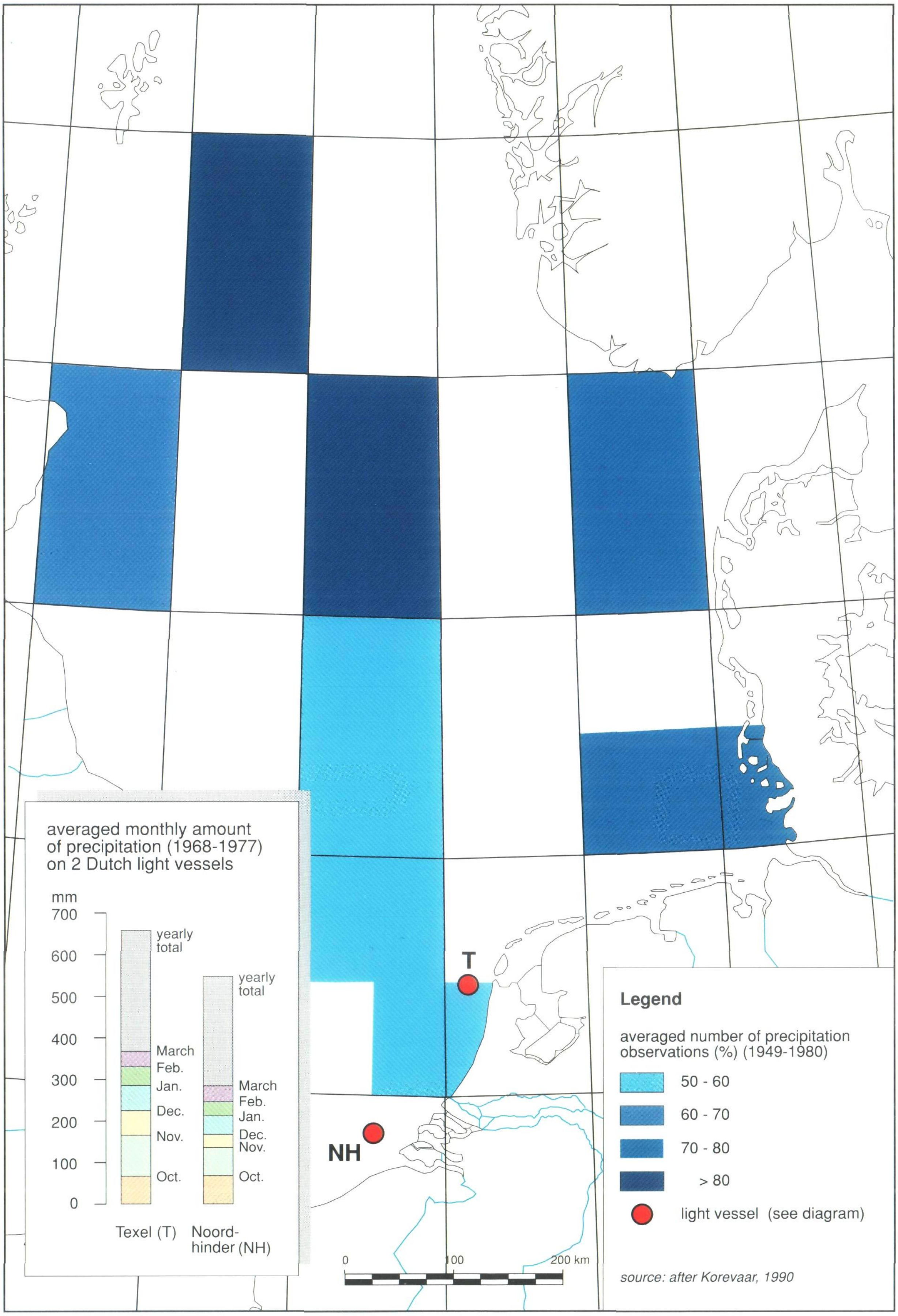
Precipitation is recorded with reference to the "averaged number of precipitation observations" expressed as percentages. In other words, this gives the percentage of the total number of observations in which precipitation, in the form of rain, snow, hail etc., has been reported for the area concerned. The number of observations is greatest in the northern part of the North Sea.

In January and February a large part of the precipitation consists of snow. The rainfall observations on board lightships have been averaged over the period 1949-1980. The observations originating from voluntarily observing ships have been averaged over the period 1961-1980.

The map also shows the amount of precipitation measured each month. These measurements cannot be made on moving ships. The figures concerned came from the Texel and Noordhinder lightships and were averaged over the period 1968-1977.

Source:
Korevaar, C.G. (1990). North Sea Climate: based on observations from ships and lightvessels.

Precipitation from October to March



Precipitation from April to September

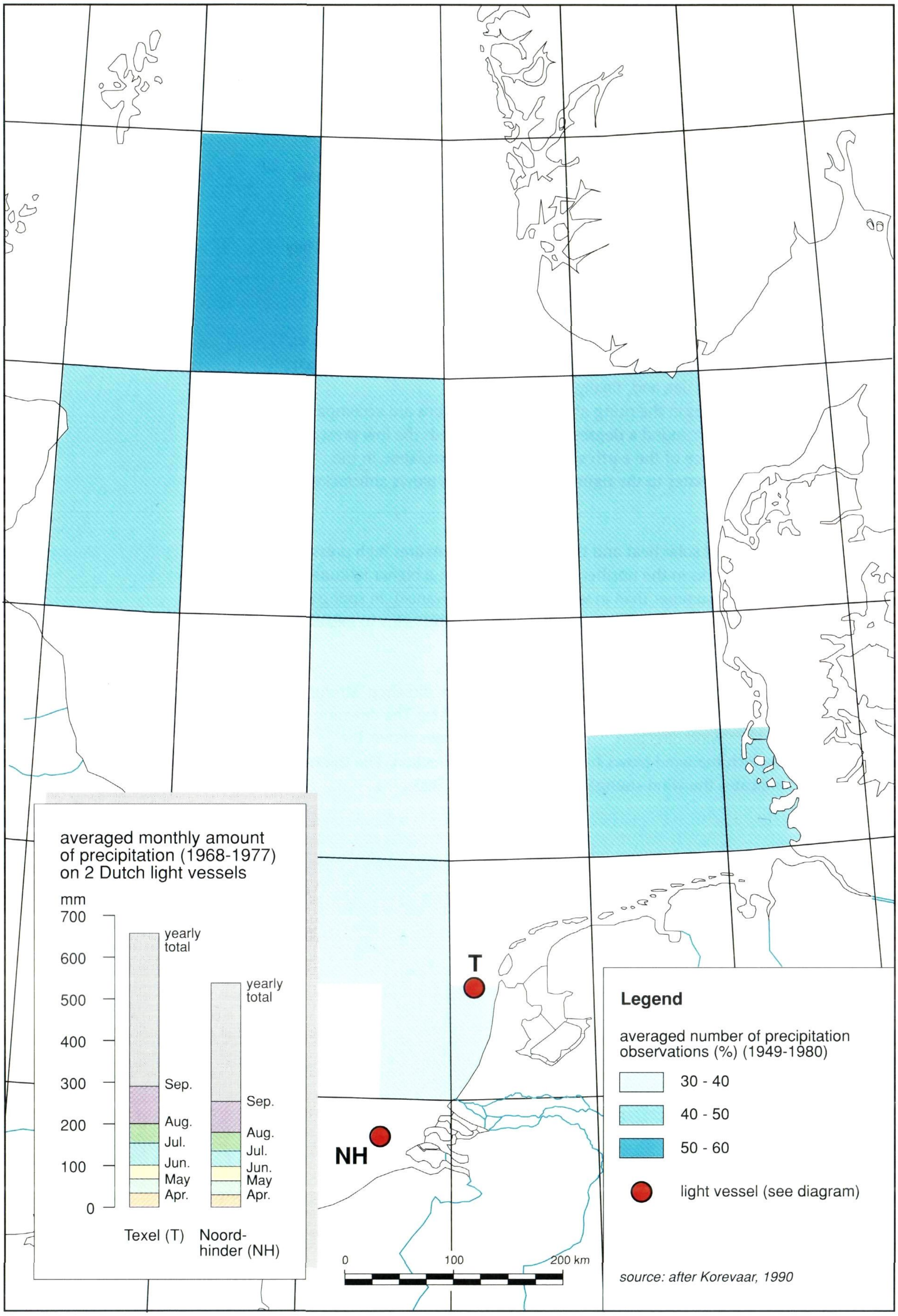
The map gives the averaged number of precipitation observations (in percentages) for a number of areas in the "dry" season; that is the period from April to September. The driest months are May, June and July. Most precipitation falls in the form of drizzle. The precipitation observations on board lightships have been averaged over the period 1949-1980. The observations from voluntarily observing ships have been averaged over the period 1961-1980.

The map also indicates the average amount of precipitation per month, measured over the period 1968-1977. These measurements were carried out on the Texel and Noordhinder lightships. The amount of precipitation is greatest in autumn and reaches a maximum in September. Precipitation is least in spring.

The lightships and voluntarily observing ships form part of a worldwide network of the World Meteorological Organization (WMO). Other climatic data collected by these ships include air temperature, air humidity, surface temperature of the seawater, air pressure, cloud cover, precipitation, visibility, wind and wave height.

Source:
Korevaar, C.G. (1990). North Sea Climate: based on observations from ships and lightvessels.

Precipitation from April to September



Wind velocity and direction in November

The wind regime of the North Sea is largely determined by the average air pressure differences above the North Atlantic Ocean and the European continent. A large high pressure area is centred permanently near the Azores and a low pressure area between Iceland and Greenland. An airflow is maintained between these systems which is predominantly southwesterly over the southern North Sea and turns off southerly over the northern North Sea. This airflow is strongest in winter, when the air pressure difference is greatest under the influence of the icy polar air. The highest wind velocities are recorded in the winter months.

Depressions occur on a smaller scale within the large-scale air circulation. They are characteristic of the changeable weather picture over the North Sea. Depressions arise along the separation plane of cold polar air, originating from high latitudes, and warm subtropical air from the south. Along the separation plane the warm air is forced to rise up over the cooler air in the bottom air layer.

The large-scale air circulation carries the depressions with it from west to east: over the ocean, the North Sea and, finally, the continent.

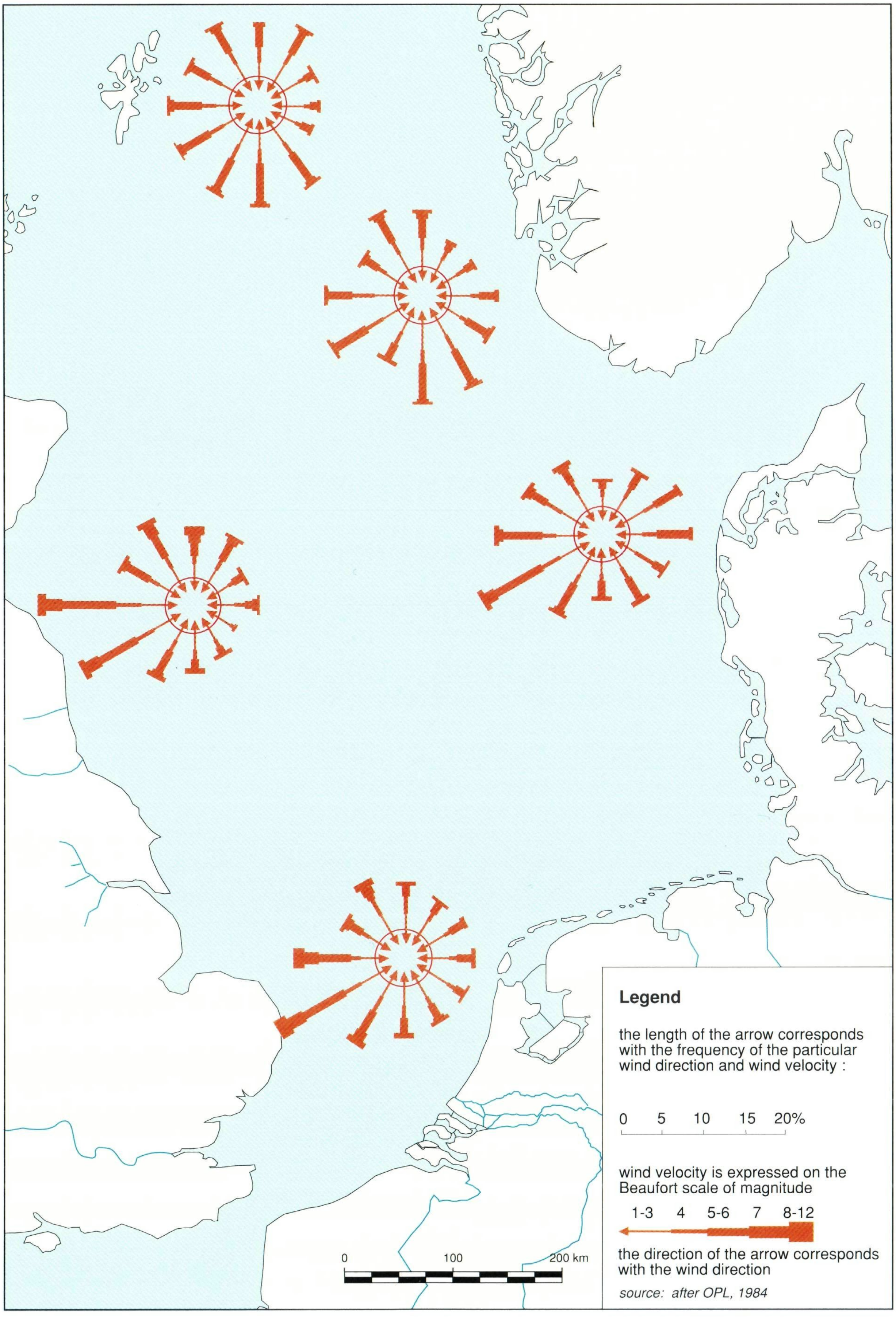
Water vapour condenses in the rising air, so that depressions are accompanied by clouds and rain. The air round a depression moves towards the low pressure centre. Under the influence of the earth's rotation the air circulation in the northern hemisphere deviates to the right. The wind always blows anticlockwise round a depression.

Under the influence of solar heat and the position of the Azores high pressure area, the depression tracks in the northern hemisphere lie at a higher latitude (latitude of Norway) in summer than in winter (latitude of France). In spring and autumn the depression belts shift across the Netherlands. This helps to explain the phenomenon of spring and autumn storms.

Wind roses have been drawn on the map which show the direction, strength and frequency of the wind for different parts of the North Sea. The direction of the arrows shows the wind direction. The length of the arrows shows the frequency with which the wind blows from the indicated direction. The thickness of the arrows indicates the wind strengths on the Beaufort Scale.

Source:
Børresen, J.A. (1987). Wind atlas for the North Sea and the Norwegian Sea. Norwegian University Press/ The Norwegian Meteorological Institute, Oslo.
Oilfield Publications Limited (OPL) (1984?). The North Sea Environmental Guide.
Wieringa, J., Rijkoort, P.J. (1983). Windklimaat van Nederland. SDU, The Hague.

Wind velocity and direction in November



Legend

the length of the arrow corresponds with the frequency of the particular wind direction and wind velocity :

0 5 10 15 20%

wind velocity is expressed on the Beaufort scale of magnitude

1-3 4 5-6 7 8-12

the direction of the arrow corresponds with the wind direction

source: after OPL, 1984

Flora and fauna

Large benthic fauna: number of species on the NCS

The benthic fauna is divided into the classes large and small. Large benthic or macrobenthic fauna (macrozoobenthos) consists of animals living in and on the seabed which remain behind in a sieve with a 1 mm mesh. Small benthic fauna (meiozoobenthos) is smaller than 1 mm.

The distribution of the macrozoobenthos in the North Sea is determined by temperature, depth, the composition of the sediment, food supply and grazing. Temperature plays a secondary role on the relatively shallow NCS. The macrobenthic fauna can be further divided according to the manner in which they take up their food. The suspension feeders filter food particles from the water; the sediment feeders take it up from or out of the sediment.

The most important animal groups among the macrozoobenthos are the polychaetes *(Polychaeta)*, molluscs *(Mollusca)*, echinoderms *(Echinodermata)* and crustaceans *(Crustacea)*. The number of macrozoobenthos species on the NCS ranges between 25 and 68 per sampling station. The number of species and the total biomass are lowest in the southern North Sea. The most species-rich areas are the Oystergrounds and the north side of the Dogger Bank (46-63 species per sampling station). Within the coastal zone the number of species ranges from 5 or less to 38 species per sampling station. The numbers of the sea urchin *(Echinocardium cordatum)* have increased in the Dogger Bank area during the past 6 years.

The map data are derived from the ICES Benthic Mapping programme of 1986. Five seabed samples were taken at each sampling station, and the macrofauna of the samples was identified. The data are reworked for the North Sea Atlas by S.A. de Jong (DNZ).

Source:

Creutzberg, F., Wagenaar, P., Duineveld, G., Lopez-Lopez, N. (1984). Distribution and density of the benthic fauna in the southern North Sea in relation to bottom characteristics and hydrographic conditions. Rapp. P.-v. Réun. Cons. int. Explor. Mer. 183. 101-110

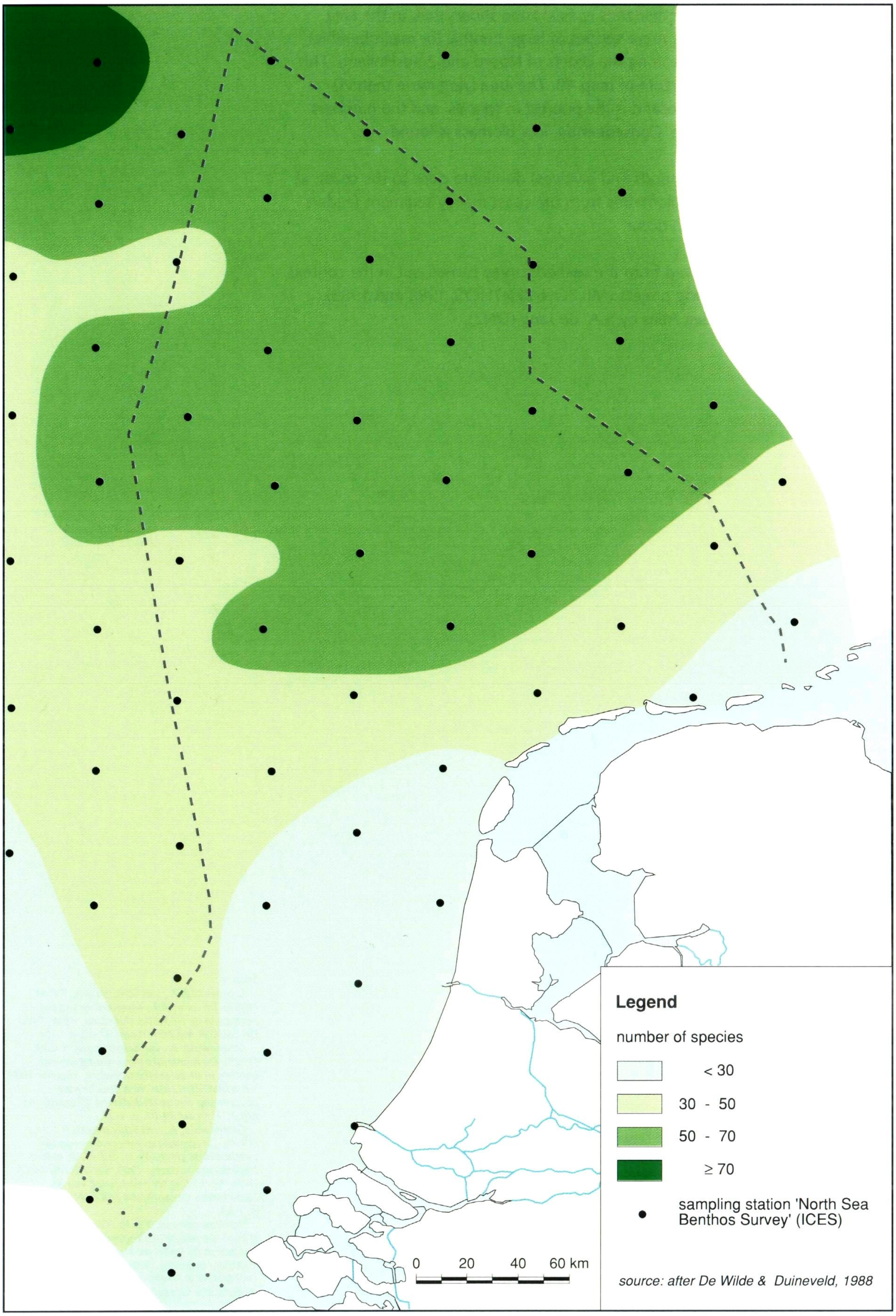
Duineveld, G.C.A., de Wilde, P.A.J.W., Kok, A. (1990). A synopsis of the macrobenthic assemblages and benthic ETS-activity in the Dutch sector of the North Sea. Neth. J. Sea Res. 26: 125-138.

Heyman, R. (1990). Benthic front systems of the Dogger Bank. In: Beukema J.J. (ed.). Annual Report NIOZ 1989, p. 50.

ICES (1986). Macrozoobenthic Mapping Programme 1986. Sixth report of the ICES Benthos Ecology Working Group.

De Wilde, P.A.W.J., Duineveld, G.C.A. (1988). Macrobenthos van het Nederlands Continentale Plat, verzameld tijdens de ICES 'North Sea Benthos Survey', April 1986. NIOZ, p. 1-3.

Large benthic fauna: number of species on the NCS



Large benthic fauna: number of species in the coastal zone

The detailed map of the Netherlands coastal zone shows that, in the area north of the Wadden Islands, more species of large benthic (or macrobenthic) fauna occur at each site than along the coasts of Noord and Zuid-Holland. This accords very well with the picture of map 40. The area lying more than 20 kilometres off the coast of Holland is the poorest in species, and the numbers per species are also low there. Consequently, low biomass is found.

Suspension feeders (chaetopods and bivalves) dominate close to the coast; at a distance of more than 20 kilometres from the coast mainly sediment feeders (chaetopods and sea urchins) occur.

The data have been derived from the seabed survey carried out in the context of the Environmental Zoning project (MILZON-BENTHOS, 1988 and 1989), reworked for the North Sea Atlas by S.A. de Jong (DNZ).

Source:

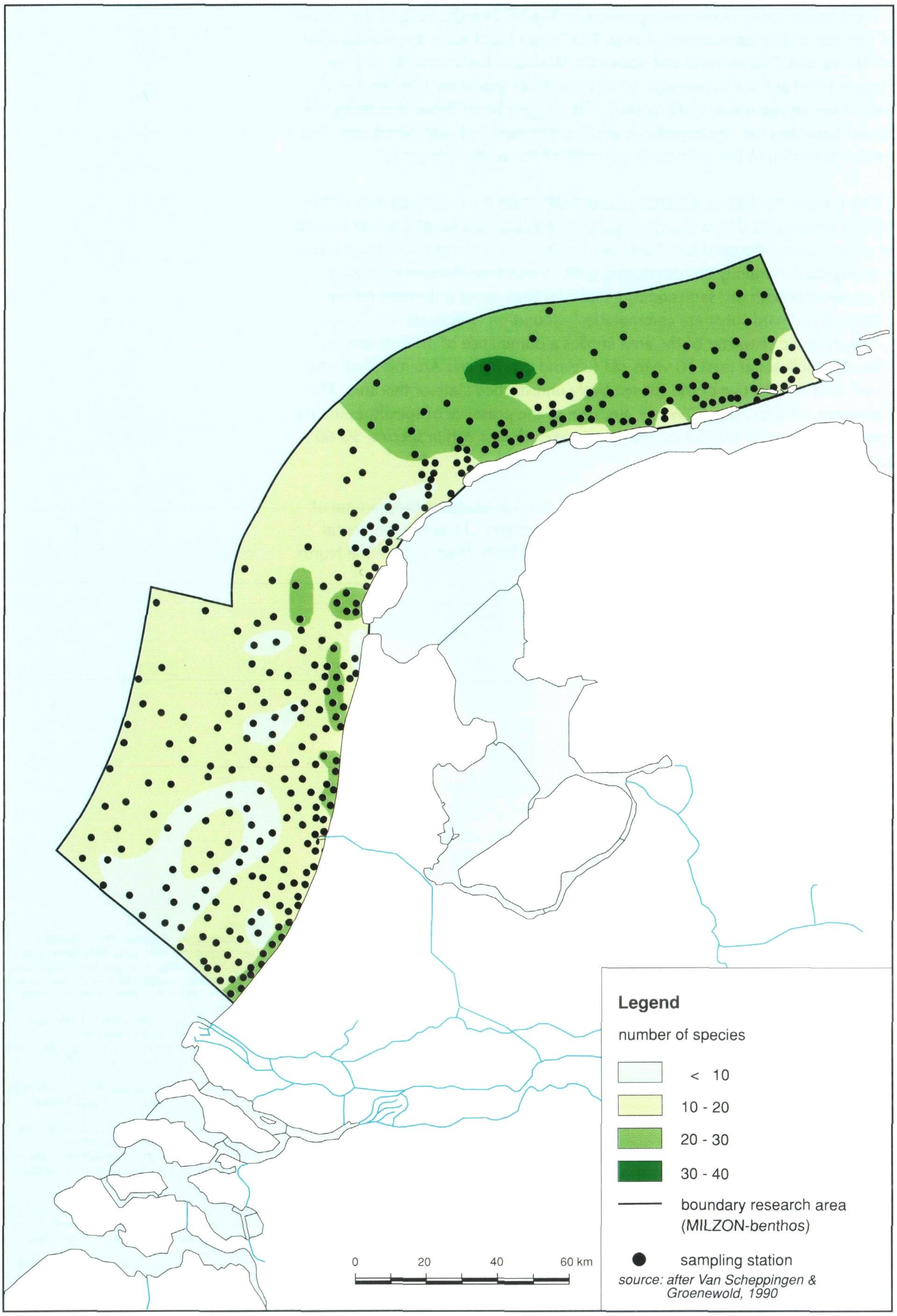
Groenewold, A., van Scheppingen, Y.C M. (1987). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee. V&W/RWS/DNZ&DGW MILZON report 87-12, p. 1-14.

Groenewold, A., van Scheppingen, Y.C.M. (1989). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, voorjaar 1988. V&W/RWS/DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 89-01, p. 1-27.

Groenewold, A., van Scheppingen, Y C.M. (1990). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, de Noord-Nederlandse kustzone 1989. V&W/RWS/DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-01, p. 1-24.

Van Scheppingen, Y.C.M., Groenewold, A. (1990). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, de Nederlandse kustzone: overzicht 1988-1989. V&W/RWS/DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-03, p. 1-27.

Large benthic fauna: number of species in the coastal zone



Large benthic fauna: biomass on the NCS

Eight broad zones can be distinguished on the NCS on the basis of the volume of biomass of the macrobenthic fauna. The Frisian Front zone, the coastal zone off Noord and Zuid-Holland and above the Wadden, the Voordelta and the Dogger Front are rich in biomass: 10 to 20 or more grammes ash-free dry weight per square metre (g ADW/m^2). The Dogger Bank, Broad Fourteens, the Brown Bank and the Oystergrounds are characterised by lower biomasses. This pattern is related to the richness in nutrients of the water brought in.

The Cleaver Bank area, situated at about 54° N on the northwest side of the NCS, is characterised by a changing pattern of gravel and sandbanks. In periods of severe storms the sand is shifted over the 0.5 to 1.3 metre thick gravel layer. A biological community has developed under these conditions which shows characteristics both of "sand communities" (as they occur elsewhere on the NCS) and of "hard substrate communities" (found on wrecks etc.).

The dynamic character of the area implies a dominance of pioneer species, although molluscs at least 10 years old (Iceland cyprine and Artemis shell) also occur. This is indicative of the still relatively undisturbed state of this area. The biomasses are 6 to 23 g ADW/m^2. Because of the presence of specific epifauna species, attached to the stones, the area is nevertheless rich in species, 30-60 species per sampling station.

The data have been derived from the ICES Benthic Mapping programme of 1986 and the seabed survey carried out in the context of the Environmental Zoning project (MILZON-Klaverbank, 1988 and 1989), reworked for the North Sea Atlas by S.A. de Jong (DNZ).

Source:

Creutzberg, F., Wagenaar, P., Duineveld, G., Lopez-Lopez, N. (1984). Distribution and density of the benthic fauna in the southern North Sea in relation to bottom characteristics and hydrographic conditions. Report P.-v. Réun. Cons int. Explor. Mer. 183: 101-110.

Duineveld, G.C.A., de Wilde, P.A.J.W., Kok, A. (1990) A synopsis of the macrobenthic assemblages and benthic ETS-activity in the Dutch sector of the North Sea. Neth. J. Sea Res. 26.125-138.

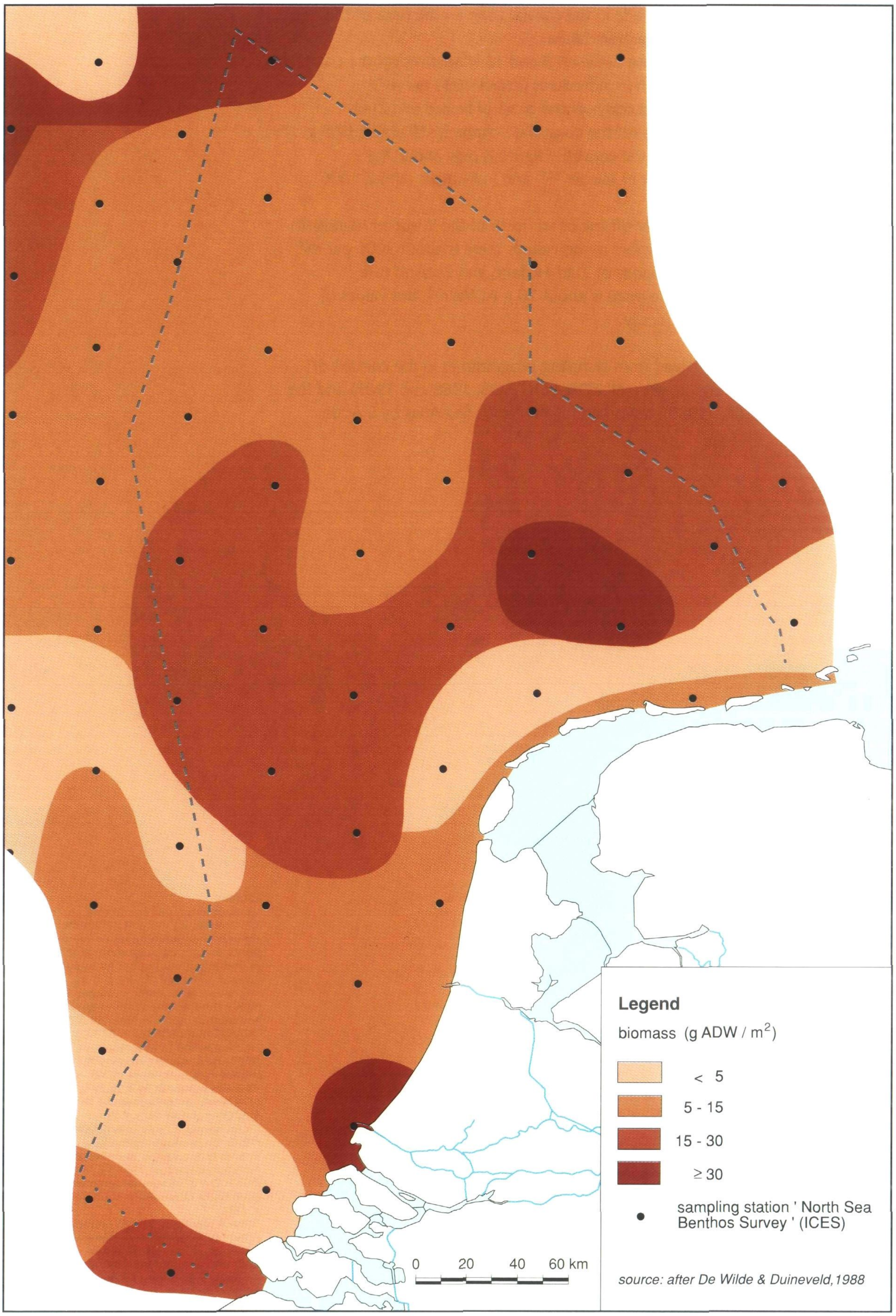
Heyman, R. (1990). Benthic front systems of the Dogger Bank. In: Beukema, J.J. (ed.). Annual Report NIOZ 1989, p. 50

Van Moorsel, G.W.N.M., Waardenburg, H.W (1990). Impact of gravel extraction on geomorphology and the macrobenthic community of the Klaverbank (North Sea) in 1988. Bureau Waardenburg, p 1-53.

Sips, H.J.J., Waardenburg, H.W. (1989). The macrobenthic community of gravel deposits in the Dutch part of the North Sea (Klaverbank): ecological impact of gravel extraction. Bureau Waardenburg, p. 1-34.

De Wilde, P.A.W.J., Duineveld, G.C A. (1988). Macrobenthos van het Nederlands Continentale Plat, verzameld tijdens de ICES 'North Sea Benthos Survey', April 1986. NIOZ, p. 1-3.

Large benthic fauna: biomass on the NCS



Large benthic fauna: biomass in the coastal zone

The following division can be made in the coastal zone on the basis of the biomass of large benthic (macrobenthic) fauna :

- the biomass is highest in the zone between 5 and 12 kilometres off the coast, at about 50 g ADW/m^2 and rich in individuals (about 4000 per m^2);
- the biomass declines relatively quickly off the coast of Noord and Zuid-Holland. At 12 to 25 kilometres off the coast the volume is still about 12.5 g ADW/m^2; at 65 kilometres off the coast the figure is only about 7 g ADW/m^2. This area is also poor in species [(41)] and individuals (about 1000 individuals per m^2);
- the biomass declines less sharply off the coast north of the Wadden Islands (to about 18 g ADW/m^2). The number of individuals there is about 3000 per m^2;
- the average biomass off the islands of Zuid-Holland and Zeeland (the Voordelta is not shown on the map) is about 20 g ADW/m^2, but values of 60 g ADW/m^2 are possible locally.

The results have been derived from sampling programmes in the context of the Environmental Zoning project (MILZON-BENTHOS, 1988 and 1989) and the Voordelta project (1987-1989), reworked for the North Sea Atlas by S.A. de Jong (DNZ).

Source:

Craeymeersch, J.A., Hamerlynck, O., Hostens, K., Vanreusel, A., Vincx, M. (1990) De ekologische ontwikkeling van de Voordelta Deelrapport 1 De huidige ekologische situatie van de Voordelta Delta Institute for Hydrological Research/University of Gent, p. 1-92

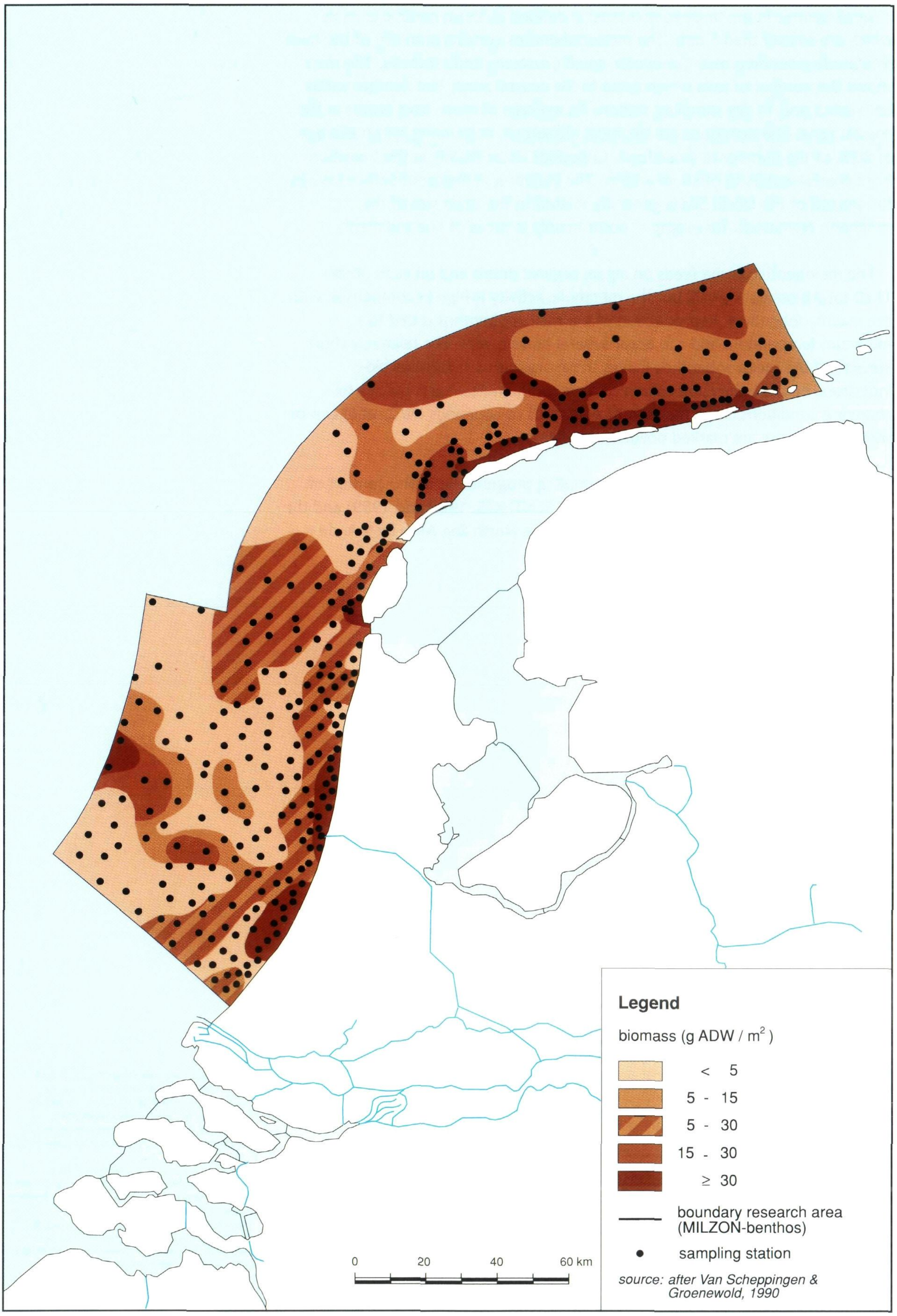
Groenewold, A., van Scheppingen, Y C M (1987) De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee V&W/RWS/-DNZ&DGW MILZON report 87-12, p 1-14

Groenewold, A., van Scheppingen, Y C M (1989). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee voorjaar 1988 V&W/RWS/DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 89-01, p. 1-27.

Groenewold, A., Van Scheppingen, Y C M (1990) De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee de Noord-Nederlandse kustzone 1989. V&W/RWS/DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-01, p 1-24

Van Scheppingen, Y C.M., Groenewold, A (1990) De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee de Nederlandse kustzone overzicht 1988-1989 V&W/RWS/DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-03, p 1-27

Large benthic fauna: biomass in the coastal zone



source: after Van Scheppingen & Groenewold, 1990

Small benthic fauna: number of taxa in the coastal zone

Small benthic fauna (meiozoobenthos) is defined as those benthic animals which are smaller than 1 mm. The meiozoobenthos consists primarily of the taxa *Nematoda* (roundworms), *Copepoda*, small *Crustacea* and *Protozoa*. The map shows the number of taxa which occur in the coastal zone. The number varies between 3 and 11 per sampling station. An average of seven taxa occurs in the coastal zone. The nematods are the most numerous, accounting for an average of 80% of the number of individuals. Copepods occur mainly in the transition from coastal waters to offshore waters. The variation in meiozoobenthos taxa in the seabed of the North Sea is generally related to the grain size of the sediment. Nematods, for example, occur mainly in areas of fine sediment.

The meiobenthic fauna feeds on algae, organic debris and on each other. Their total biomass is small, but the metabolic activity is high in comparison with the macrozoobenthos. Reproduction of the meiozoobenthos is tied to a minimum temperature and can occur several times a year. The relatively short lifespan of the meiozoobenthos makes these organisms suitable as bio-indicators, because the composition of their communities reacts quickly to changing conditions. Thus the ratio of nematods to copepods (N/C ratio) can be used where there are marked pollution gradients.

The results have been derived from sampling programmes in the context of the Environmental Zoning project (MILZON-BENTHOS, 1988 and 1989) and the Voordelta project (1987-1989), reworked for the North Sea Atlas by S.A. de Jong (DNZ).

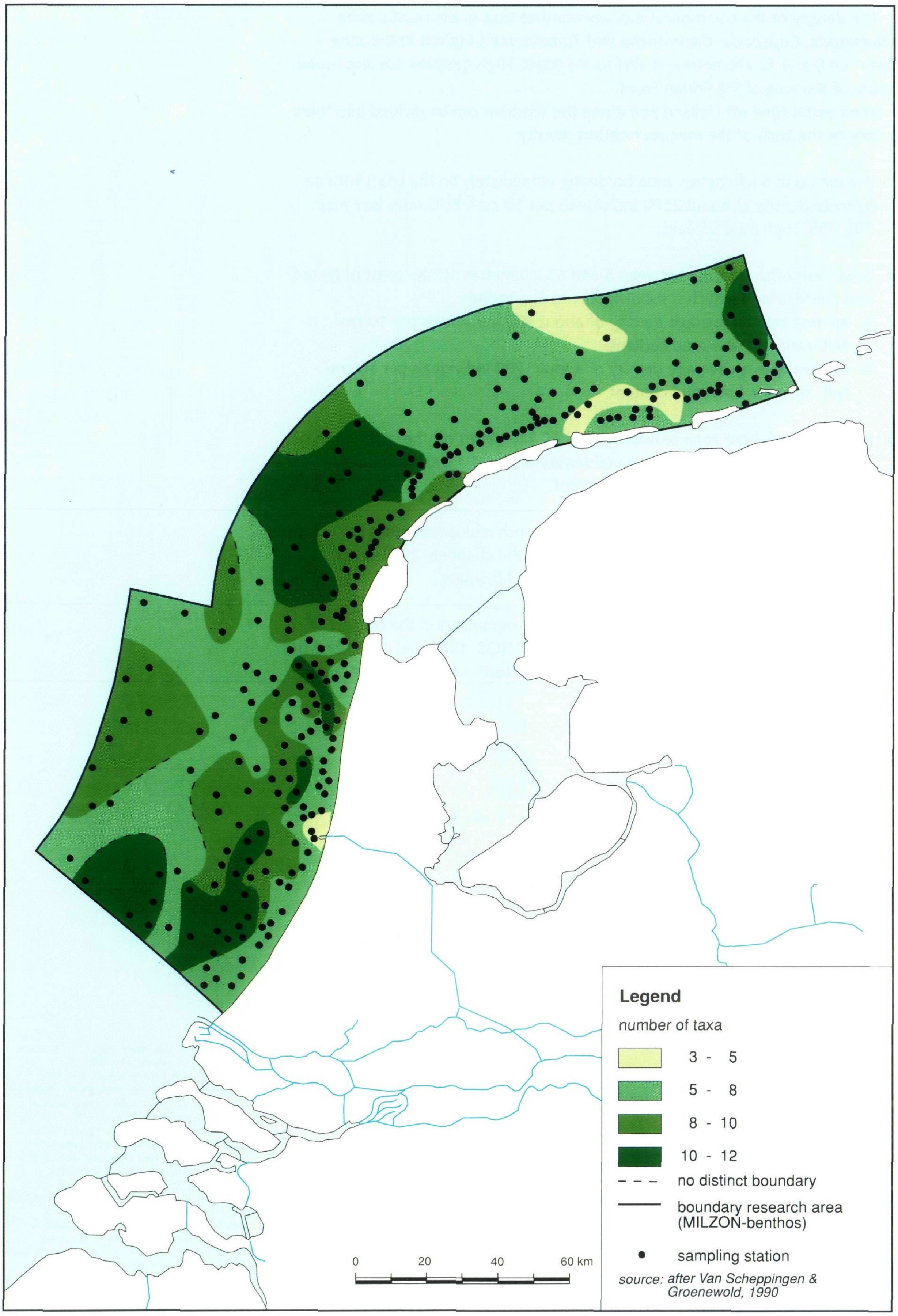
Source:

Groenewold, A., van Scheppingen, Y.C.M (1990). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, de Noord-Nederlandse kustzone 1989. V&W/RWS/ DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-01, p. 1-24.

Huys, R., Heip, C.H.R., Herman, P.M.J., Soetaert, K. (1990). The meiobenthos of the North Sea: preliminary results of the North Sea Benthos Survey. ICES. C.M. 1990/Mini:8.

Van Scheppingen, Y.C.M., Groenewold, A. (1990). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, de Nederlandse kustzone: overzicht 1988-1989. V&W/RWS/ DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-03, p. 1-27.

Small benthic fauna: number of taxa in the coastal zone



Small benthic fauna: density in the coastal zone

The density of the commonest meiozoobenthos taxa in the coastal zone (*Nematoda*, *Copepoda*, *Gastrotricha* and *Turbelleria*) is highest in the zone between 0 and 12 kilometres parallel to the coast. High densities are also found south of the area of the Frisian Front.

The coastal zone off Holland and along the Wadden can be divided into three zones on the basis of the meiozoobenthos density:

1. A zone up to 5 kilometres wide bordering immediately on the coast with an average density of about 2500 individuals per 10 cm^2. N/C ratio (see map 44): 458. High mud content.

2. A western offshore zone between 5 and 65 kilometres off the coast of Noord and Zuid-Holland, which is subdivided into 2 subzones:
   a. an area with an average density of about 900 individuals per 10 cm^2. N/C ratio 15. Low mud content.
   b. an area with an average density of about 1700 individuals per 10 cm^2. N/C ratio 19. Low mud content.

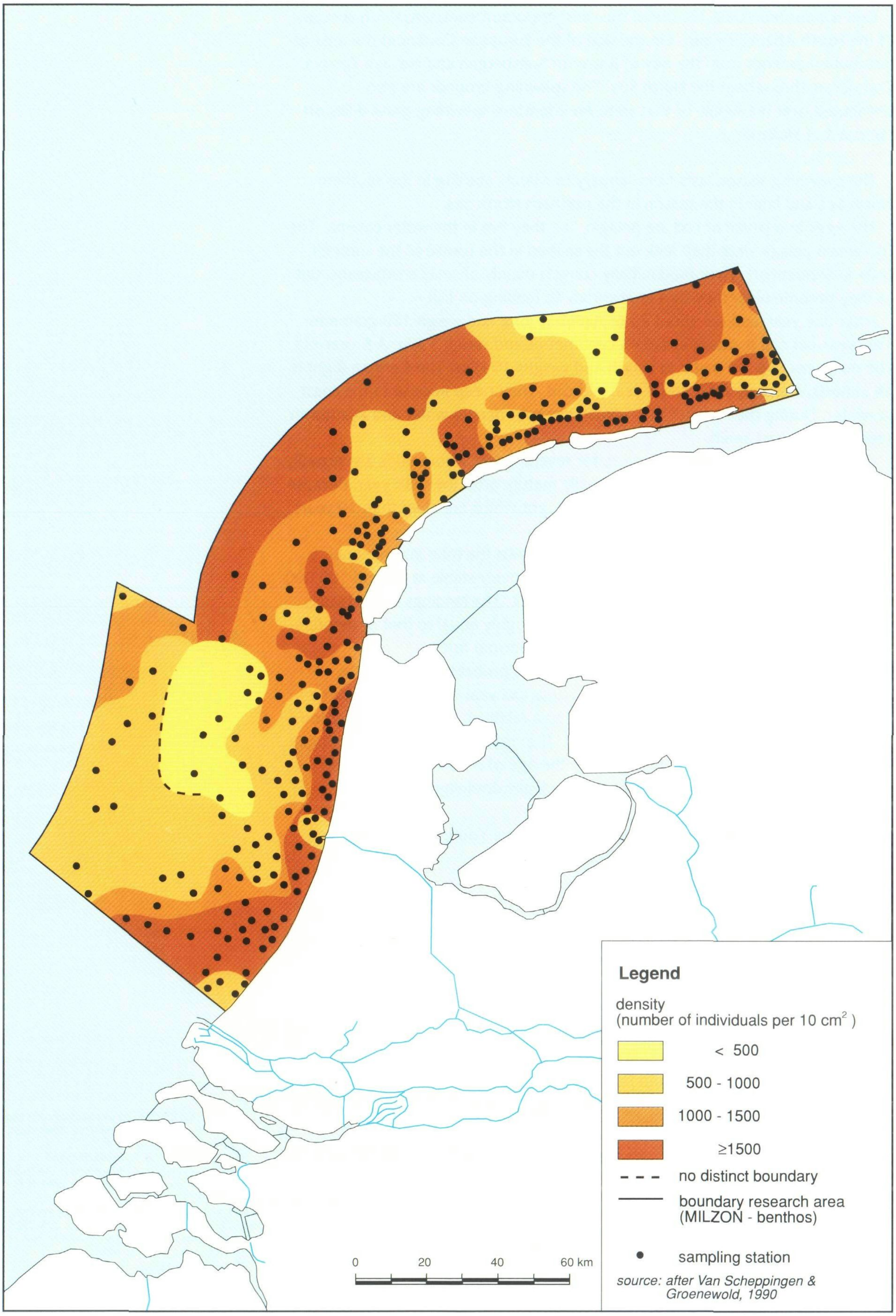
3. A northern offshore zone between 5 and 40 kilometres off the coast north of the Wadden Islands with an average density of about 1100 individuals per 10 cm^2. N/C ratio 101. Average mud content.

The Voordelta (coastal zone of Zeeland) has a rich meiozoobenthos community. The area off the Brouwers Dam and the channels, in particular, score high in numbers of individuals and volume of biomass.

The results have been derived from sampling programmes in the context of the Environmental Zoning project (MILZON-BENTHOS, 1988 and 1989) and the Voordelta project (1987-1989), reworked for the North Sea Atlas by S.A. de Jong (DNZ).

Source:
Craeymeersch, J.A., Hamerlynck, O., Hostens, K., Vanreusel, A., Vincx, M. (1990). De ekologische ontwikkeling van de Voordelta. Deelrapport 1. De huidige ekologische situatie van de Voordelta. Delta Institute for Hydrological Research/University of Gent, p. 1-92
Groenewold, A., van Scheppingen, Y.C.M. (1990). De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, de Noord-Nederlandse kustzone 1989. V&W/RWS/ DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-01, p. 1-24
Van Scheppingen, Y.C.M., Groenewold, A. (1990): De ruimtelijke verspreiding van het benthos in de zuidelijke Noordzee, de Nederlandse kustzone: overzicht 1988-1989. V&W/RWS/ DNZ&DGW & Stichting ter bevordering van de Nederlandse Oceanografie MILZON report 90-03, p. 1-27.

Small benthic fauna: density in the coastal zone



Distribution of one-year old cod

Cod (*Gadus morhua L.*) is one of the most important commercial fish species of the North Atlantic Ocean. On the side of the European Continent the area of distribution extends from the Bay of Biscay to Spitsbergen and Novaya Zemlya. Cod occurs throughout the North Sea. The spawning grounds are also distributed over the whole of that area. An important spawning ground lies off the coast of Holland.

The spawning season lasts from January to March, starting in the southern North Sea and later in the season in the northern North Sea.

The eggs and larvae of cod are pelagic, i.e.: they live in the water column. The fry remain pelagic until they seek out the seabed in the course of the summer (July to September). Their food initially consists mainly of small crustaceans, but as they become older they turn increasingly to feeding on fish.

After one year, cod are about 25 centimetres long and weigh 160 grammes. Two year-old cod measure about 45 centimetres and weigh 1 kilo. A 6 year-old cod measures about 1 metre in length and weighs 10 kilos. The German Bight is an important nursery for 1 and 2 year-old cod. They creep in close to the coast in winter. During the summer they spread out over deeper water and in autumn seek out the coast again.

Cod do not become sexually mature for several years. About 60% are sexually mature at four years old. 100% are sexually mature after the sixth year. Because of the intensive fishing only a few fish are caught which are older than 10 years.

From the beginning of this century until the 1960s the total international landings of cod from the North Sea remained relatively stable at around 100,000 tons. A peak of 340,000 tons was reached in 1972. The landings have steadily fallen since 1981 to the present level, which is roughly equal to that of before 1960. The catches consist mainly of 1, 2 and 3 year-old fish.

The rapid increase in the catch in the 1960s was probably related to the succession, from 1963, of a series of very numerous year classes. At the same time, fishing mortality also slowly increased to a relatively constant, but far too high, level, that was reached in about 1980. The result of this was that young cod simply did not get the chance to reach the age of sexual maturity. As a result, the spawning population has been gradually declining since 1970.

The data have been derived from the International Young Fish Survey, 1983-1987, and reworked by H.J.L. Heessen (RIVO).

Source.

Daan, N (1978) Changes in cod stocks and cod fisheries in the North Sea Rapp P -v Réun Cons. int Explor Mer, 172 39-57

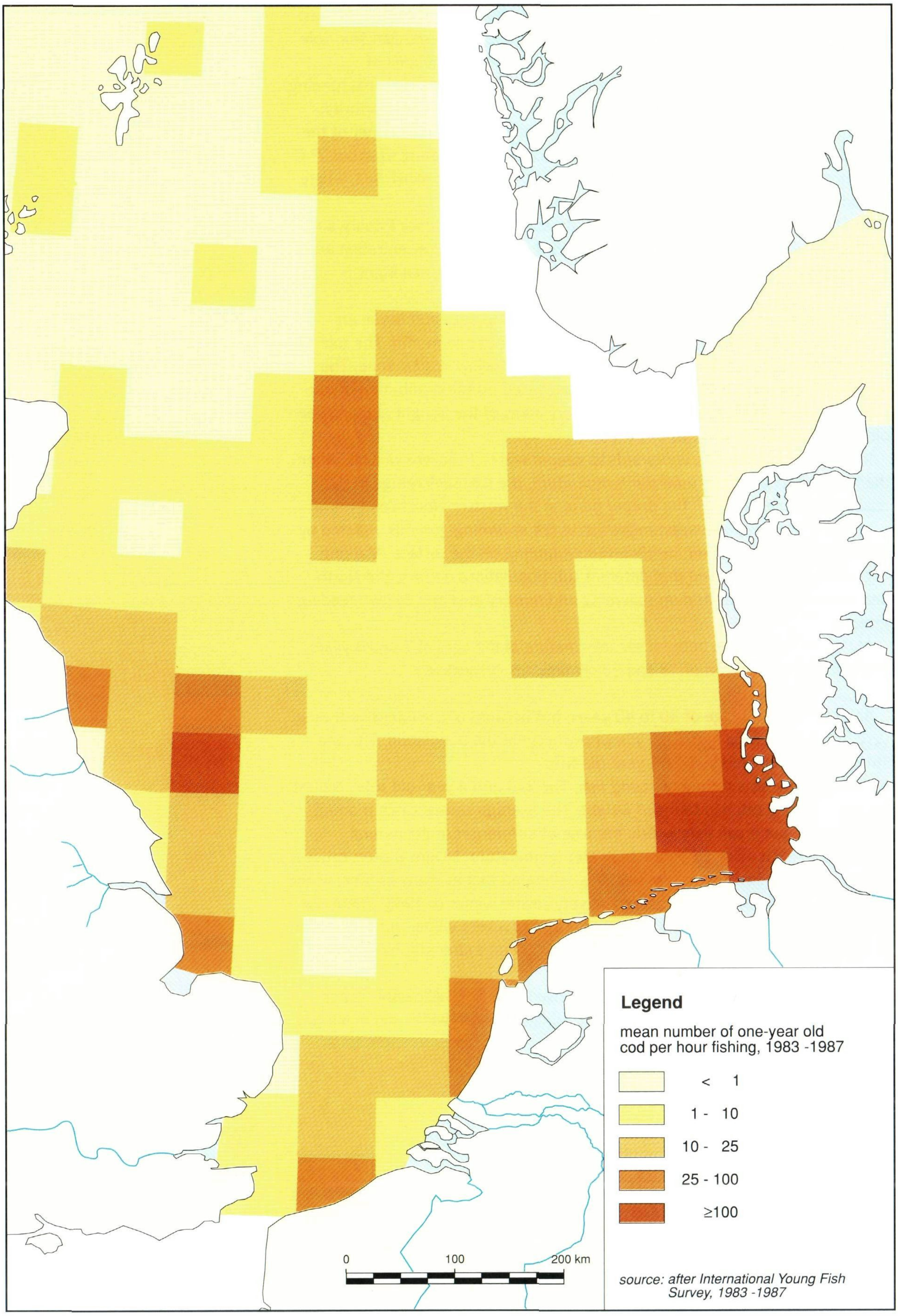
Heessen, H.J L (1983) Distribution and abundance of young cod and whiting in the South-eastern North Sea in the period 1980-1982 ICES C M 1983/G 30

Heessen, H.J L (1990) Visserij In de Wolf, P, (ed) De Noordzee Terra Zutphen, pp 139-152

International Young Fish Survey, 1983-1987 Adapted by H.J.L Heessen (RIVO)

Rijnsdorp, A D , Daan, N , van Beek, F A , Heessen, H.J L (1991) Reproductive variabiblity in North Sea plaice, sole and cod J Cons int Explor Mer, 47 352-375

Distribution of one-year old cod



Distribution of one-year old sole

The area of distribution of sole (*Solea solea*) extends along the Atlantic coast from Africa to Northern Ireland. Sole also occur in the Mediterranean Sea. Sole are generally found in water less than 50 metres in depth. The area of distribution in the North Sea is bounded on the north side by a diagonal running from the English east coast (Flamborough) to the Skagerrak in the northeast. This line corresponds with the division between the cold stratified water of the central and northern North Sea, which has a bottom temperature of about 7° C in summer, and the warm, fully mixed water of the southern North Sea, where the bottom temperature rises to 17° C in summer.

The most important spawning grounds for sole are the Thames Estuary and the coastal zone of the continent south of 55° N. There are concentration areas in the Belgian-Zeeland coastal zone, off Texel and in the German Bight.

The spawning season lasts from March to June. The eggs and larvae are pelagic, i.e.: suspended in the water column, for about one month. The sole fry establish themselves during metamorphosis in the shallow coastal zone. The map shows the most important nursery areas based on the distribution of one year-old sole in the third quarter. The nursery areas of the nought and one year-old sole all lie within 12 miles of the coast.

In autumn, sole migrate westwards to deeper water. In severe winters, when there is a steep fall in the seawater temperature, the sole seek refuge in the relatively warmer water of the deeper parts of the western North Sea.

In spring there is a west-east migration to the spawning grounds, assisted by the tides. The sole can then be observed swimming on the surface. Marking experiments have revealed that different sub-populations occur in the North Sea, each of which has its own spawning and nursery area and its own feeding grounds.

Male and female sole become sexually mature at the ages of 2 and 3 years, when they reach lengths of 18 and 28 centimetres, respectively.

Sole can live to an age of 30 to 40 years, but because of the intensive fishing, very few fish over the age of 15 years now occur in the population. The age structure is dominated by 0 to 4 year-old fish.

The catch consists mainly of young fish. The 2, 3 and 4 year-old sole account for over half the catch in terms of weight. The average annual catch is about 20,000 tons, but it can vary widely because of differences in the natural increase, which is affected by the seawater temperature. Severe winters cause a higher mortality among juvenile sole. It is estimated that as many as 60% of the adult sole died from the cold during the very severe winter of 1963. There is a good chance of a large natural recruitment after a severe winter, however. The highest annual cohort strengths, five times the average strength, have been observed after a cold spring.

Fishing for North Sea sole has been controlled by a Total Allowable Catch since 1975. Technical measures, such as a minimum mesh width and minimum landing dimensions, also apply [95].

Source:

Bannister, R.C A. (1978) Changes in plaice stocks and plaice fisheries in the North Sea. Rapp. P -v. Reún. Cons int. Explor. Mer 172 86-101.

Van Beek, F.A., Rijnsdorp, A.D., de Clerck, R. (1989). Monitoring juvenile stocks of flatfish in the Wadden Sea and the coastal areas of the south-eastern North Sea. Helgolander Meeresunters. 43: 4761-477.

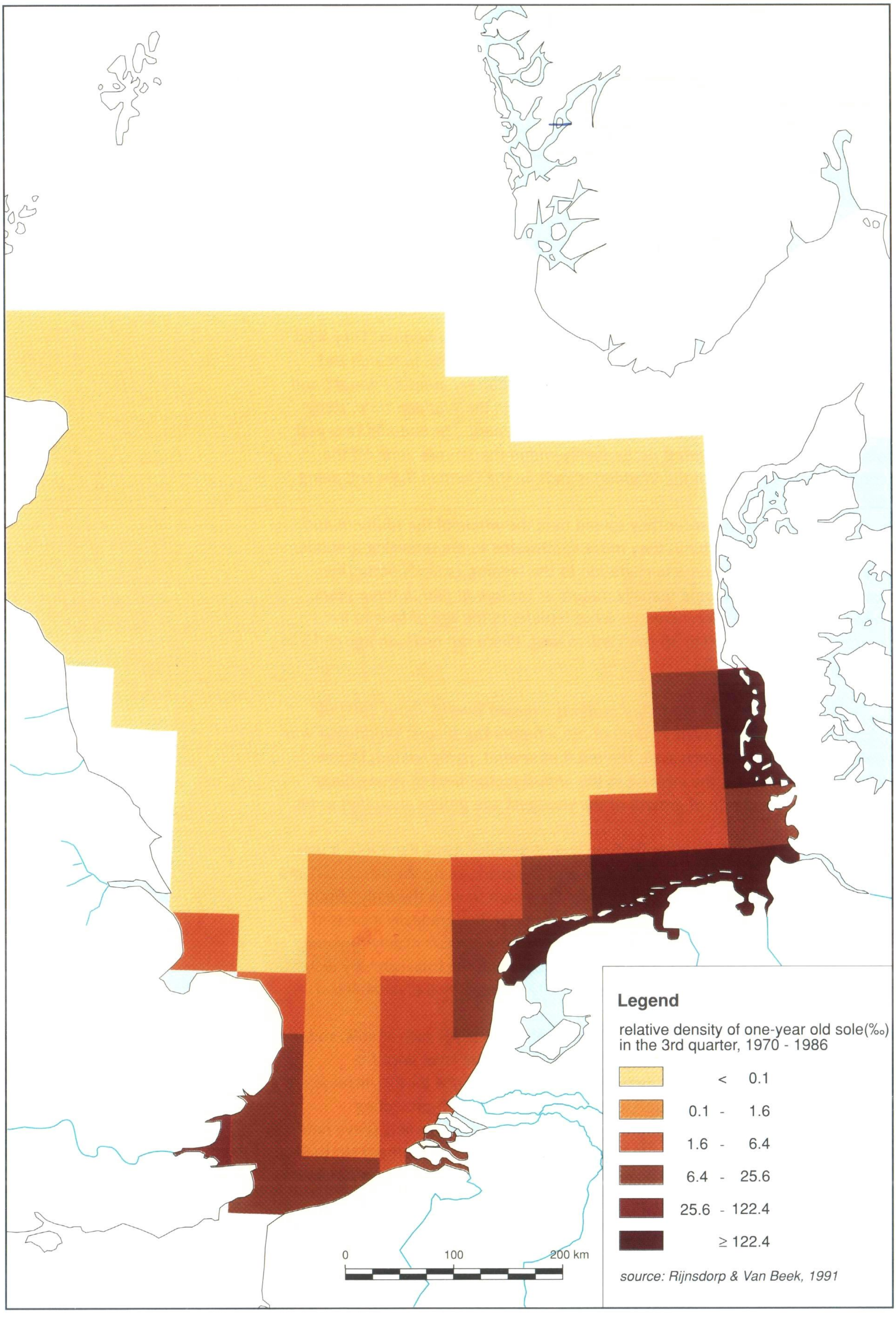
Harding, D., Nichols, J., Tungate, D.S. (1978). The spawning of the plaice, Pleuronectes platessa L. in the southern and English Channel. Rapp. P.-v Réun. Cons. int. Explor Mer 172: 102-113.

Rijnsdorp, A D., van Beek, F.A. (1991). Changes in growth of plaice Pleuronectes platessa L. and sole Solea solea (L.) in the North Sea Neth. J Sea Res. 27: 441-457.

Rijnsdorp, A.D., Daan, N., van Beek, F.A., Heessen, H.J.L (1991). Reproductive variability in North Sea plaice, sole and cod. J. Cons. int. Explor. Mer 47: 352-375.

De Veen, J.F. (1978). Changes in North Sea sole stocks (Solea solea L.) Rapp P -v. Réun. Cons. int Explor. Mer 172: 124-136.

Distribution of one-year old sole



Distribution of one-year old plaice

The area of distribution of the plaice (*Pleuronectes platessa L.*) extends from the Iberian peninsula in the south to Iceland and the Barents Sea in the north. The most important stocks occur in the North Sea, in Faxabay (Iceland) and in the Barents Sea. In the North Sea, plaice live in the southern and central parts up to a maximum depth of 100 metres.

The most important spawning grounds are situated in the southern and southeastern North Sea, including the eastern part of the English Channel at a depth of over 20 metres. There is local spawning along the east coast of England and Scotland.

The spawning period runs from December to late March, with a peak which shifts from early January in the eastern part of the English Channel to mid-February in the German Bight. A plaice can lay several hundreds of thousands of eggs.

Plaice eggs and larvae are pelagic; i.e. independent of the bottom. They float around passively in the sea for a period of about two months. In March and April they enter the estuaries. The most important nursery areas for nought and one year-old plaice (<18 centimetres) are situated in the Wadden zone, along the continental coast from the Netherlands to Denmark. The one and two-year old plaice (18-27 centimetres) occur mainly within the 30-mile zone off the continental coast north of the Wadden Islands, in the German Bight and along the coast of Jutland.

As the plaice become older they spread over the whole of the southern and central North Sea. In autumn they move southwards to the spawning grounds, assisted by the tides. A reverse migration to the feeding grounds occurs in spring. Male plaice become sexually mature at the age of two to three years, when they are 20 to 24 centimetres long; females at the age of four to five years, when they are 30 to 35 centimetres long. Plaice can reach an age of 15 to 25 years.

The plaice catch in the North Sea reached a record level of about 150,000 tons in the 1980s. The average level of catch before the Second World War was only 50,000 tons. This increase is the result of several, partly related, factors. The most important is the increase in the annual recruitment of young plaice. The increase in the rate of growth of the youngest age groups also plays some part.

Plaice fishing has changed radically in recent decades. Until the 1960s it was practised mainly by the United Kingdom and Denmark, using the otter trawl and the Danish seine. Since the introduction of the beam trawl in the early 1960s, the share of the Netherlands in the total plaice catch has gradually increased. It amounted to over 60% in the 1980s. The catch now consists mainly of young fish. The 2, 3 and 4 year-old fish account for over half the total catch by weight. This means that the catch prospects are greatly affected by the variations in annual recruitment.

The size of the latter fluctuates less than with fish species such as sole, cod and haddock. Recruitment has been at a higher average level since the mid-1970s than in the preceding twenty years. The reasons for this increase are not yet known. It may be related to the introduction of fish-protecting processing equipment (rinsing sorting machines) and selective nets (sieve nets) in the shrimp fishery. The change in the hydrography of the southern North Sea may also play a part. The civil engineering works in the Southwest Netherlands may have made the estuaries more accessible to plaice larvae. See the commentary to map 95 for control measures.

Source:

Bannister, R.C.A. (1978). Changes in plaice stocks and plaice fisheries in the North Sea. Rapp. P.-v. Réun. Cons. int. Explor. Mer 172: 86-101.

Van Beek, F.A., Rijnsdorp, A.D., de Clerck, R. (1989). Monitoring juvenile stocks of flatfish in the Wadden Sea and the coastal areas of the south-eastern North Sea. Helgolander Meeresunters.43: 4761-477.

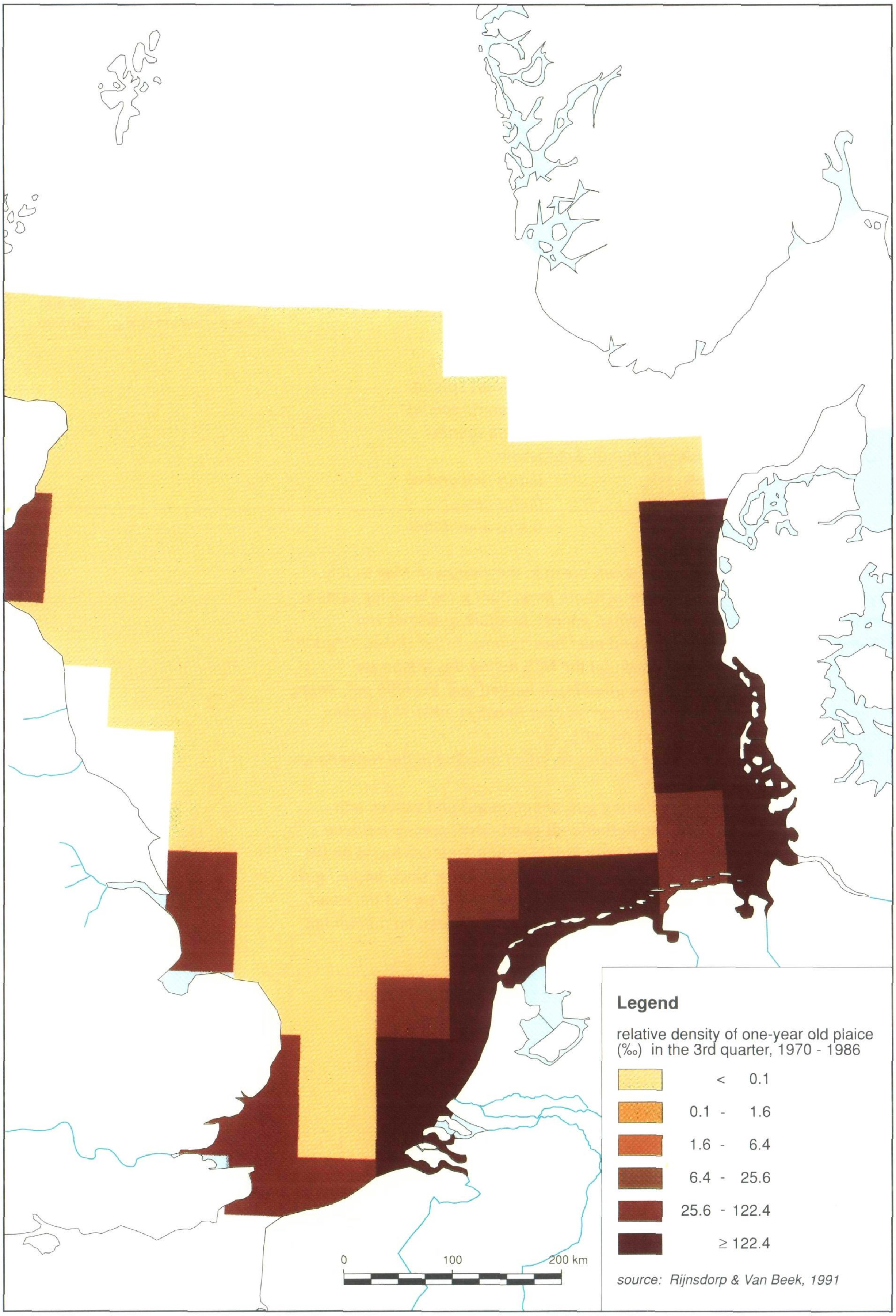
Harding, D., Nichols, J., Tungate, D.S. (1978). The spawning of the plaice, Pleuronectes platessa L. in the southern and English Channel. Rapp. P.-v. Réun. Cons. int. Explor. Mer 172: 102-113.

Rijnsdorp, A.D., van Beek, F.A. (1991). Changes in growth of plaice Pleuronectes platessa L. and sole Solea solea (L.) in the North Sea. Neth. J. Sea Res. 27: 441-457.

Rijnsdorp, A.D., Daan, N., van Beek, F.A., Heessen, H.J.L. (1991). Reproductive variability in North Sea plaice, sole and cod. J. Cons. int. Explor. Mer 47: 352-375.

De Veen, J.F. (1978). Changes in North Sea sole stocks (Solea solea L.) Rapp. P.-v. Réun. Cons. int. Explor. Mer 172: 124-136.

Distribution of one-year old plaice



Seabird species in the breeding season

The seabirds of the Netherlands Continental Shelf (NCS) can be divided generally into four different groups:

Birds of the open sea:

Fulmar	(*Fulmarus glacialis*)
Gannet	(*Sula bassana*)
Razorbill	(*Alca torda*)
Guillemot	(*Uria* species)

Gulls with a seawards distribution:

Kittiwake	(*Rissa tridactyla*)
Great Black-backed Gull	(*Larus marinus*)
Lesser Black-backed Gull	(*Larus fuscus*)
Skuas	(*Stercorarius* species)
Little Gull	(*Larus minutus*)

Coastal species:

Divers	(*Gavia* species)
Grebes	(*Podiceps* species)
Seaducks	(*Melanitta* species)
Terns	(*Sterna* species)

Gulls with a coastal or fishing grounds distribution:

Black-headed Gull	(*Larus ridibundus*)
Common Gull	(*Larus canus*)
Herring Gull	(*Larus argentatus*)

Depending upon the species, seabirds breed in the months of May to July. There are generally few birds in the offshore areas during the breeding season. The pelagic seabirds such as the fulmar, gannet, razorbill, guillemot and kittiwake are then mainly to be found near their colonies in the United Kingdom and Norway. The birds which remain on the NCS during this season are non-breeding, immature birds. The great black-backed gull, the little gull, skuas, divers, grebes and seaducks also remain on their (mostly northern) breeding grounds and are therefore rare on the NCS.

The table gives the numbers of seabirds (in pairs) breeding in the Netherlands.

The lesser black-backed gull, herring gull, common gull and various tern species breed scattered along the Netherlands coast. Some species are even limited to a few colonies. The most important breeding areas are found on the Wadden Islands and in the Delta region. Terns and the lesser black-backed gull forage mainly in areas of clear water. Other gull species and part of the lesser black-backed gull population feed mainly behind fishing boats, on rubbish tips, in the inter-tidal zone and farther inland.

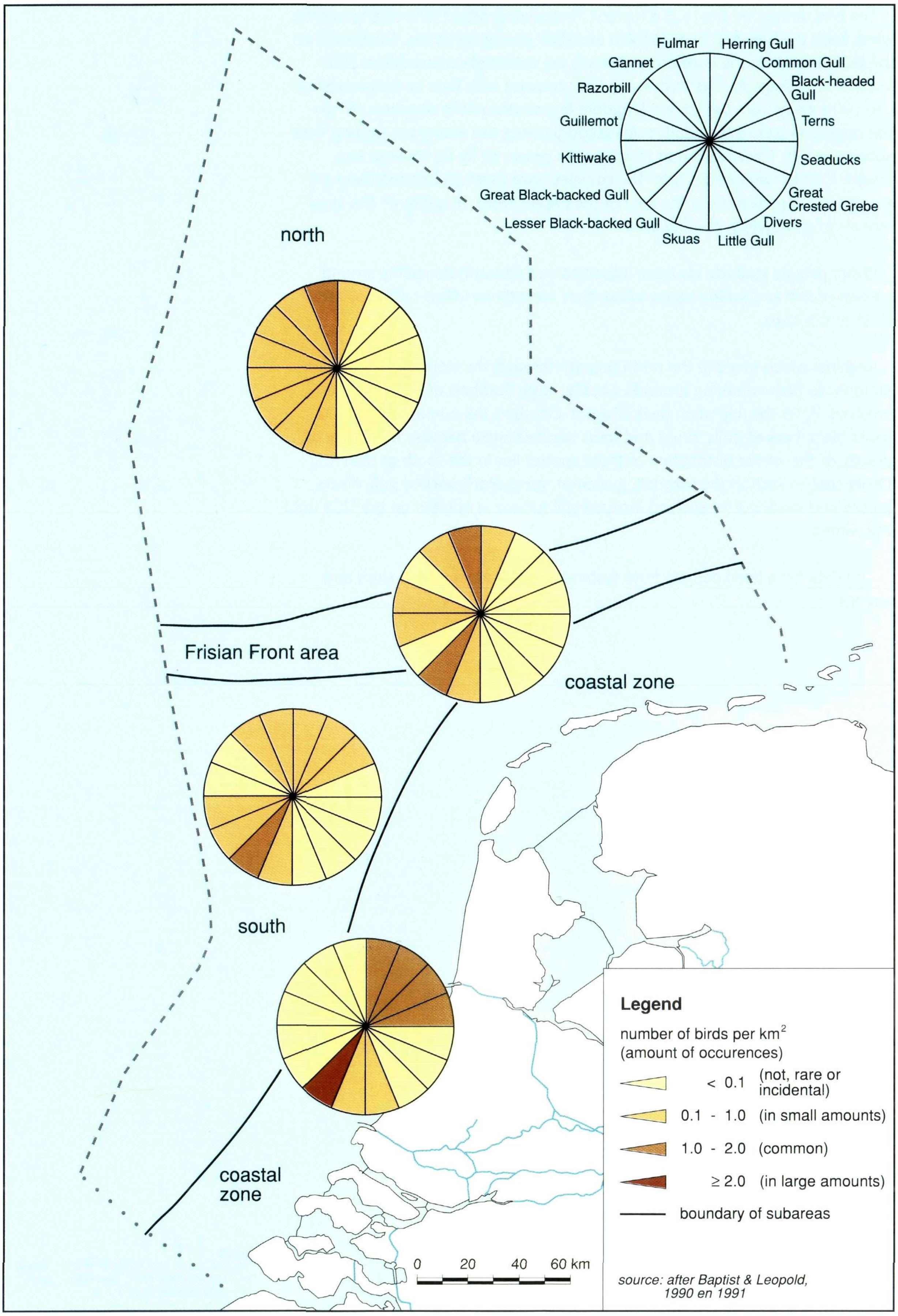
The data have been derived from systematic counts taken from ships and aircraft [9] and from counts taken on land.

The number of seabirds breeding in the Netherlands

species	number of pairs
Little Gull	45
Mediterranean Gull	125
Little Tern	450
Arctic Tern	1500
Sandwich Tern	9000
Common Gull	11.000
Common Tern	19.000
Lesser Black - backed Gull	19.000
Herring Gull	90.000
Black - headed Gull	250.000

Source:
Baptist, H.J.M. (V&W/RWS/DGW), Leopold, M.F. (NIOZ) (1990, 1991): unpublished data.
SOVON and Meininger, P.L.M. (V&W/RWS/DGW): oral information.

Seabird species in the breeding season



Seabird species in the migration season

The bird density on the NCS is highest immediately after the breeding season, when both the breeding birds (adults) and their young are at sea. Guillemots on the NCS, especially the northern guillemot, are extremely vulnerable at this season (June-August). The birds leave their colonies with their immature young and swim away from the United Kingdom in a southeasterly direction. When this migration begins the adult males accompanying the young are starting their autumn moult. This means that they lose the power to fly for three to four weeks. One to two months after the colonies have been abandoned there are about 10,000 guillemots in the area of the Frisian Front, foraging on the large schools of sprat which abound there.

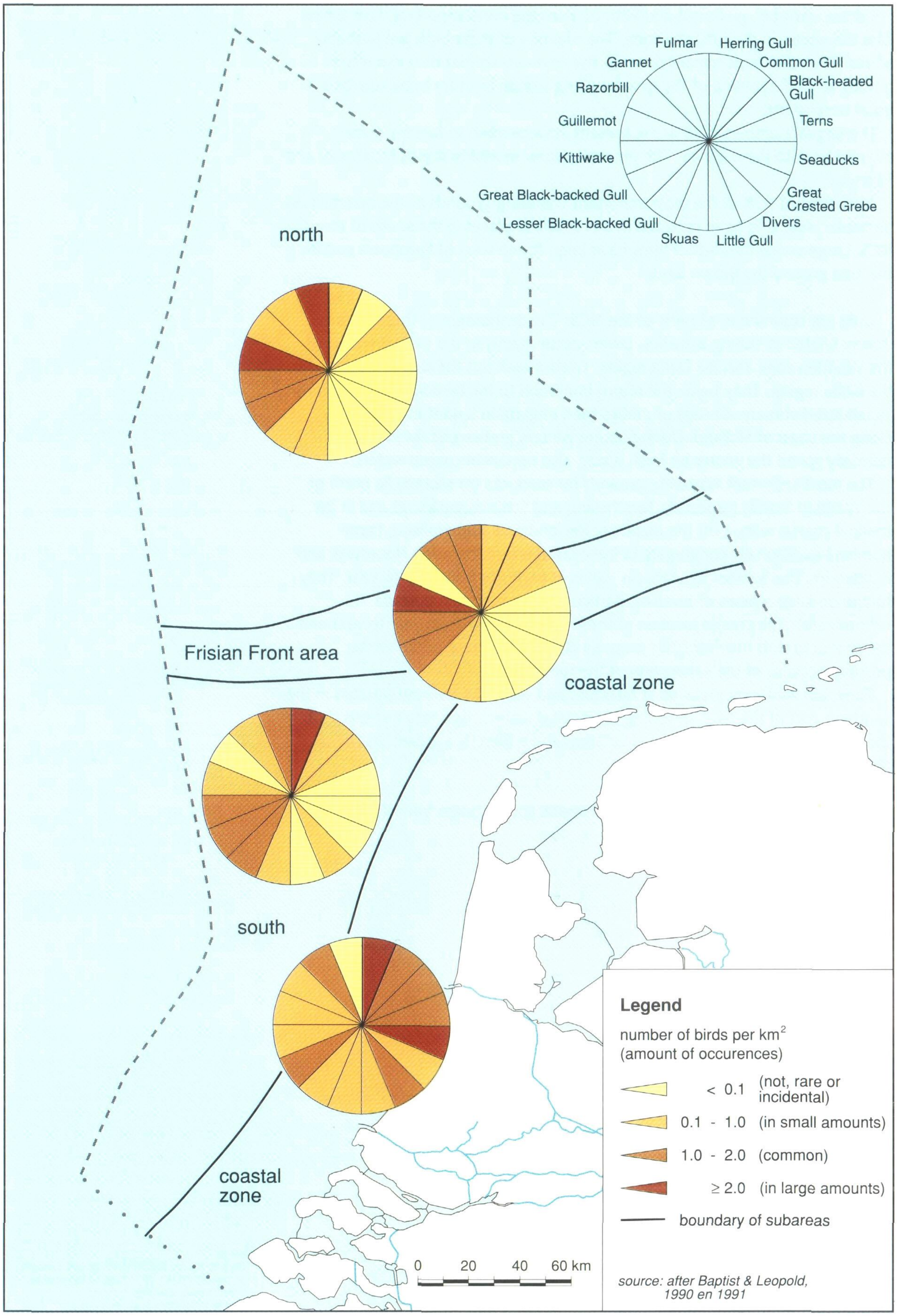
Other pelagic seabirds are more dispersed and concentrate mainly around schools of fish and fishing boats, which they sometimes follow until they are close to the coast.

Seabirds which breed in the north migrate through the North Sea in autumn en route to their wintering grounds. Locally, large numbers of birds may be involved. After the migration peak (August-October) the number of gannets, lesser black-backed gulls, skuas and terns declines again because the centre of gravity of the winter distribution of these species lies in the south of the NCS. Other species such as the razorbill, guillemot, great black-backed gull, divers, grebes and seaducks (or scoters) increase still further in number on the NCS until the winter.

The data have been derived from systematic counts taken from ships and aircraft.

Source:
Baptist, H.J.M. (V&W/RWS/DGW), Leopold, M.F. (NIOZ) (1990, 1991): unpublished data.
SOVON and Meininger, P.L.M. (V&W/RWS/DGW): oral information.

Seabird species in the migration season



Seabird species in winter

Fulmar, razorbill, guillemot and kittiwake are the most important birds which pass the winter in the offshore zone. The majority of these birds are probably adults. The adult birds remain closer to the colonies, so that they can return quickly at the beginning of the new breeding season in order to be sure of a good nesting site.

The largest numbers of birds are present in December; in January some migrate back to the colonies. The greatest winter mortality occurs in January and February.

A southward shift of the most important wintering grounds of the razorbills, in particular, seems to have occurred in the 1980s to places in the south of the NCS. Large concentrations of birds have been found west of Europoort and in the area around the Brown Bank.

Gulls are common in all parts of the NCS. The distribution of these birds is closely related to fishing activities. Divers occur mainly in the coastal waters of the Wadden zone and the Delta region. Grebes seek out the calmer waters of the Delta region. They begin the return migration to the breeding areas as early as January-February. Groups of grebes then migrate in a northerly direction along the coast of Holland. During severe winters grebes and ducks, which normally spend the winter on fresh water, also remain in coastal waters.

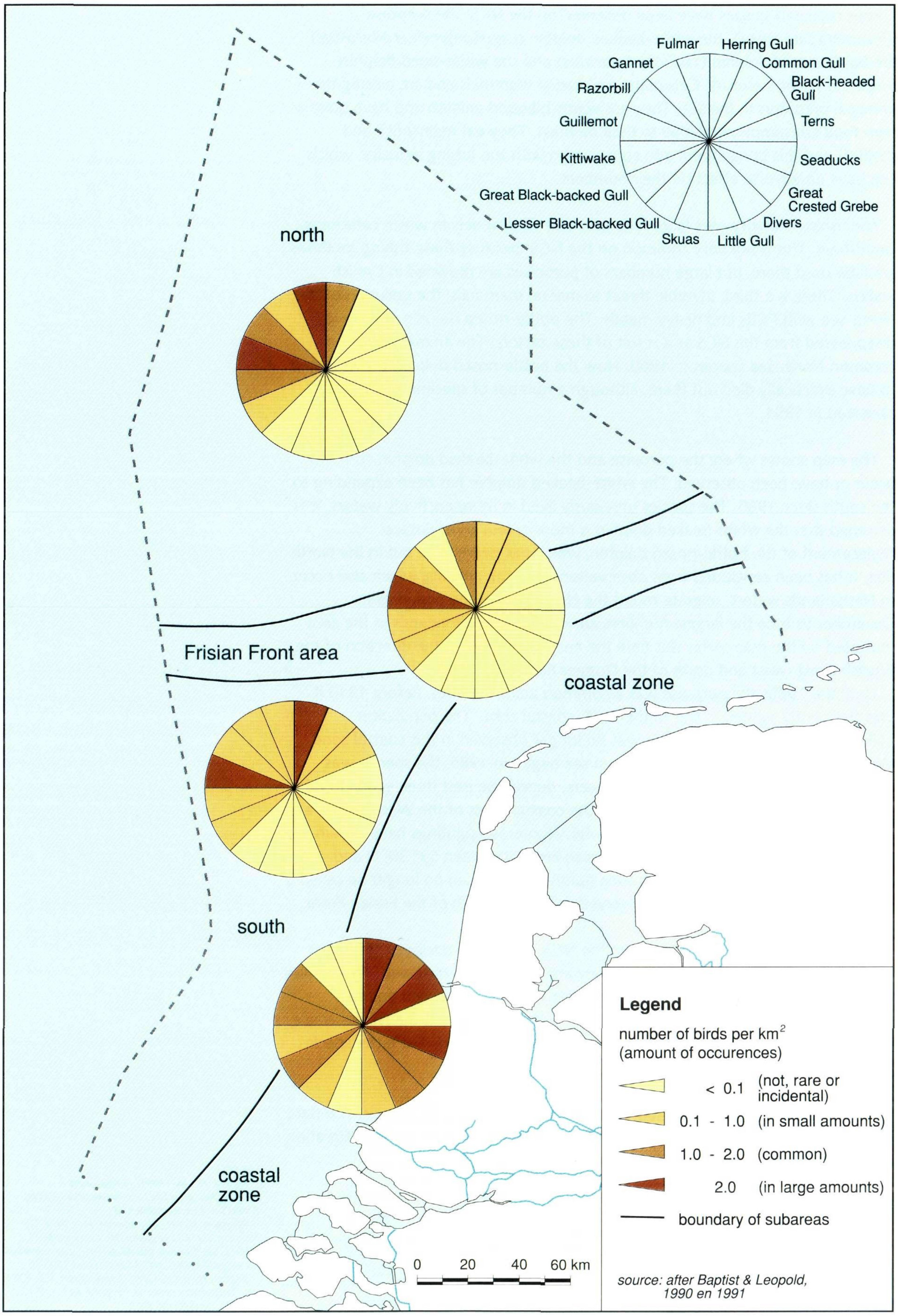
The most important wintering grounds for seaducks (or scoters) lie north of the Wadden Islands (especially Terschelling and Schiermonnikoog) and in the shallow coastal waters off the islands of Zeeland and Zuid-Holland. Large numbers occasionally congregate in the coastal waters between Noordwijk and Zandvoort. The number of seaducks varies at each site from year to year. They forage on large masses of bivalves, particularly the surf clam (*Spisula subtruncata*). The precise location of these masses varies from year to year and the seaducks shift their foraging grounds during the course of the winter, possibly because of the exhaustion of the food source.

The main wintering grounds of razorbills and seaducks are now situated in the southern part of the NCS, including the coastal waters. As a result of this shift the birds are now overwintering in an area where there is a greater risk of oil pollution.

The data have been derived from systematic counts taken from ships and aircraft.

Source:
Baptist, H.J.M. (V&W/RWS/DGW), Leopold, M.F. (NIOZ) (1990, 1991): unpublished data.
SOVON and. Meininger, P.L.M. (V&W/RWS/DGW): oral information

Seabird species in winter



Whales

Four cetacean species have been observed on the NCS: the porpoise (*Phocoena phocoena*), the white-beaked dolphin (*Lagenorhynchus albirostris*), the bottle-nosed dolphin (*Tursiops truncatus*) and the white-sided dolphin (*Lagenorhynchus acutus*). Cetaceans are marine mammals and are among the principal predators in the sea. They are warm-blooded animals and have quite a high food consumption relative to their biomass. They eat mainly fish and shellfish and this brings them into competition with the fishing industry, which can have an adverse effect on their numbers.

The fishing industry uses large fyke nets and vertical nets in which cetaceans can drown. This is not very common on the NCS, because these fishing methods are little used there, but large numbers of porpoises are drowned in Danish waters. There is a third, invisible threat to marine mammals: the pollution of the North Sea with PCBs and heavy metals. The bottle-nosed dolphin may have disappeared from the NCS as a result of these factors. The animal was still a common North Sea species in 1960. Now the bottle-nosed dolphin is considered to have practically died out there, although a number of specimens was observed in 1991.

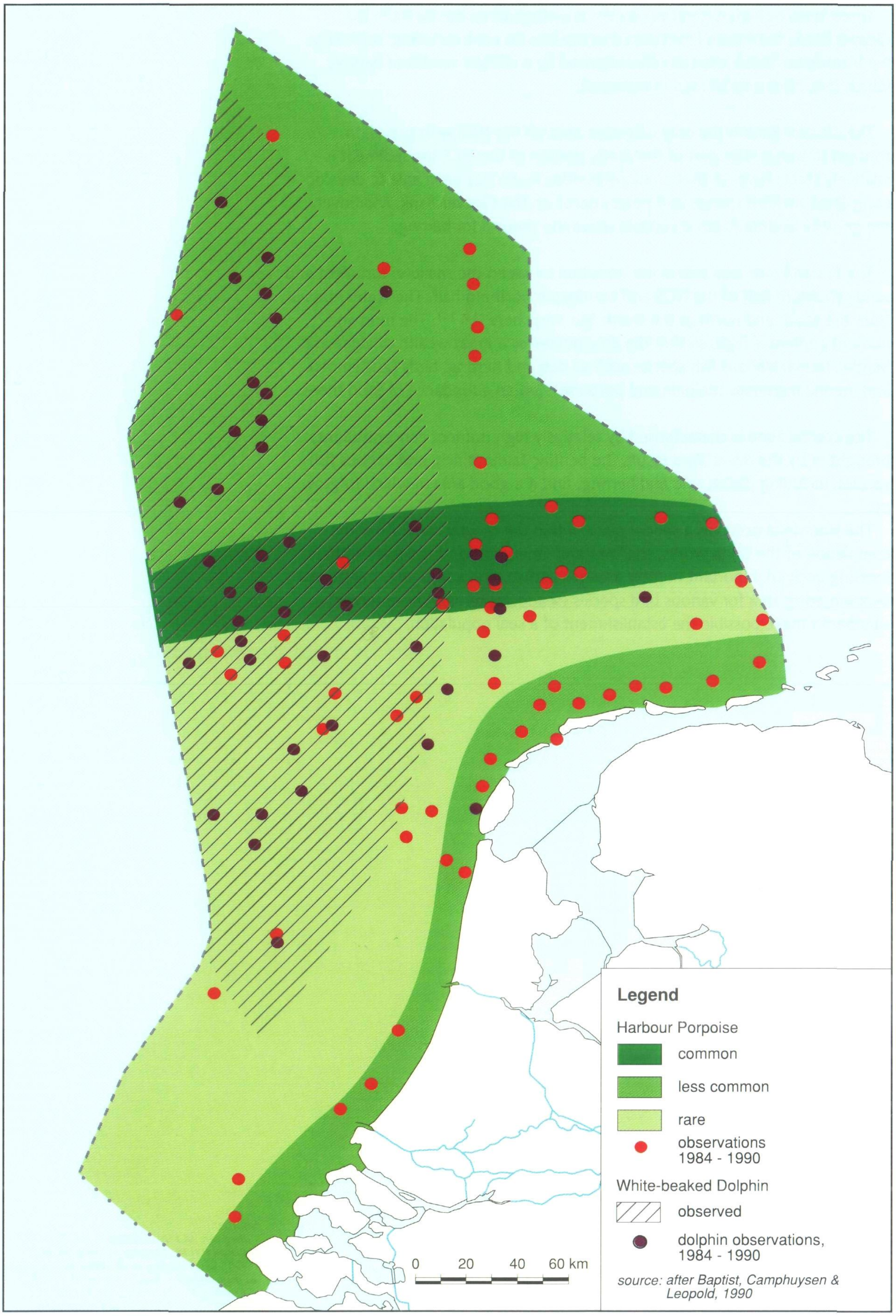
The map shows where the porpoise and the white-beaked dolphin currently occur or have been observed. The white-beaked dolphin has been expanding to the south since 1960. The species previously lived in more northerly waters. It is assumed that the white-beaked dolphin is more or less an ecological replacement of the bottle-nosed dolphin, which has nearly died out in the North Sea. It has been concluded from observations that the animals, which also occur in Netherlands waters, migrate round the North Sea. In the period from December to June the largest numbers are seen in the Netherlands in the area indicated on the map. After this time the animals migrate in the direction of the English coast (west and north of the Dogger Bank).

Until the 1960s the porpoise was a common animal species. Before 1940 it was frequently sighted in the Netherlands coastal zone. The population collapsed after 1960. The species was no longer observed in this coastal zone. When regular observations on the open sea began in 1985, the species was regularly encountered there. It also appears, during the past three years, to be returning to the coastal zone, including the coastal inlets of the Wadden Sea and the Zeeland channels, particularly in winter. Numerous sightings have shown that the porpoise now occurs off the Frisian Front (between 53° 30' N and 54° 10' N) throughout the year in such numbers that it can no longer be called a rare animal. The porpoise is also observed north and south of the Frisian Front.

Because of their rare occurrence on the NCS, the other species of cetaceans are not shown on the map, although they are occasionally observed. This applies to the white-sided dolphin and, recently, also to the bottle-nosed dolphin. Outside the NCS, the pilot whale (*Globicephala melaena*) and the Minke whale (*Balaenoptera acutorostrata*) have been occasionally sighted. The latter species is increasing in the areas bordering the NCS.

The map is based on observations made from ships and from the air. The data have been derived from the NIOZ (M.F. Leopold), the Club of Marine Migration Observers (C.J. Camphuysen) and from DGW (H.J.M. Baptist).

Source:
Baptist, H.J.M. (1991). Voorkomen zeezoogdieren op het NCP. V&W/RWS/DGW, GWAO-notitie (unpublished).
Bergman, M.J.N., Lindeboom, H.J., Peet, G., Nelissen, P.H.M., Nijkamp, H., Leopold, M.F. (1991). Beschermde gebieden Noordzee, noodzaak en mogelijkheden. NIOZ/LNV-report 1991-3.
Baptist, H.J.M. (DGW), Camphuijsen, C.J. (Club van Zeetrekwaarnemers), Leopold, M.F. (NIOZ) (1990): unpublished data.


Legend
Harbour Porpoise
common
less common
rare
observations 1984 - 1990
White-beaked Dolphin
observed
dolphin observations, 1984 - 1990
0 20 40 60 km
source: after Baptist, Camphuysen & Leopold, 1990

Areas of high natural value

Three areas of high natural value can be distinguished on the NCS: the Cleaver Bank, the Frisian Front area and the coastal zone including, especially, the Voordelta. These areas are characterised by a relative wealth of benthic fauna, fish, birds and/or marine mammals.

The Cleaver Bank is the only extensive area on the NCS with gravel. In contrast to the greater part of the sandy portion of the NCS the sediment is relatively stable here, so that a unique benthic fauna has been able to develop. Long-lived shellfish species and polyps occur on the Cleaver Bank. Moreover, the gravelly bottom forms a suitable spawning ground for herring.

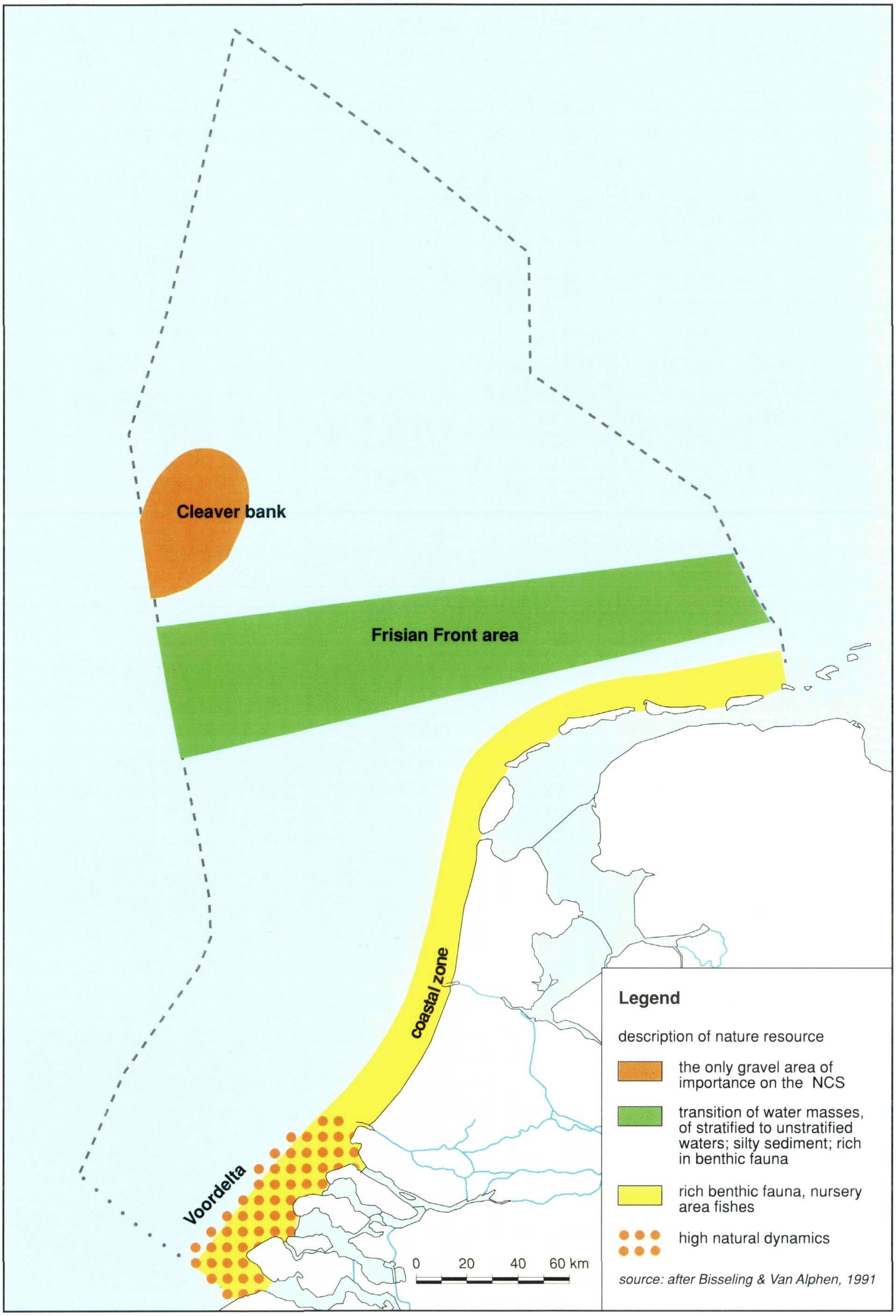
The Frisian Front area marks the transition between the shallow, turbulent and sandy southern half of the NCS and the deeper northern half. The water masses from the south and north of the North Sea meet here [13, 14]. The mud and nutrient content is high, so that the area possesses a great wealth of algae and benthic fauna. Various fish species such as dab and herring, birds (guillemots) and marine mammals (dolphin and porpoise) find an abundance of food there.

The coastal zone is characterised by relatively high nutrient concentrations, brought in by the rivers. As a result, the benthic fauna is rich, and various fish species, including plaice, sole and herring, find it a good area in which to grow up.

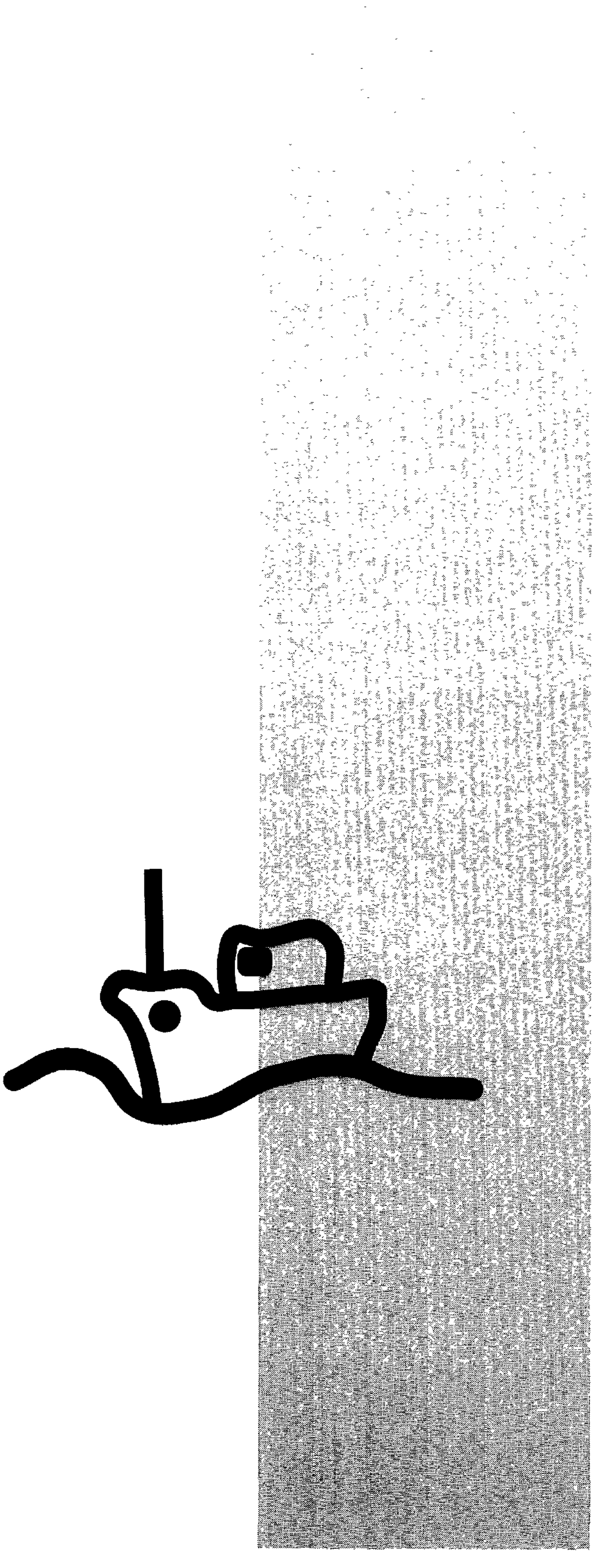
The Voordelta occupies a special place within the coastal zone. After the completion of the Delta works, shallows and emergent sandbanks arose there, creating both an important nursery area for flatfish, and a foraging, transit and overwintering area for various bird species (seaducks, terns). The emergent sandbanks make possible the establishment of a seal population.

Source:
Bergman, M.J.N., Lindeboom, H.J., Peet, G., Nelissen, P.H.M., Nijkamp, H., Leopold, M.F. (1991). Beschermde gebieden Noordzee, noodzaak en mogelijkheden. NIOZ/LNV-report 1991-3.
Bisseling, C. (LNV/NMF), van Alphen, J.S.L.J. (V&W/RWS/DNZ) (1991): oral information.

Areas of high natural value



Use of space



The use of maritime space on the NCS in 1975

The map shows only the uses which occupy space on the sea surface. Pipelines, cables and military aircraft exercise areas are not shown.

The 1975 map shows a relatively comprehensive use of space on the North Sea. Some uses occupy space permanently or for a long period. This applies particularly to the placing of offshore installations. Other uses occupy space in a manner that varies in time and place: shipping, for example.

- Shipping
  Ships do not occupy much space in themselves, but the special "traffic lanes" which have been marked out for shipping do occupy a lot of space. This applies particularly to the traffic separation schemes and deep water routes. These were still modest in extent in 1975. The intensity of shipping traffic was then not as high as now and there was still insufficient knowledge of the traffic flows off the Netherlands coast. Moreover, it did not appear from practice that ships had too little room for manoeuvre. The development of offshore industry on the North Sea changed this situation [55]. The main function of the deep water routes in 1975 was to mark where there was sufficiently deep water for deep-draught ships.

- Dumping
  A striking feature is the reservation of space for discharging industrial waste immediately off the coasts of Zeeland and Holland. There was still little knowledge in 1975 about the environmental effects of that kind of discharging in the coastal zone. Nor was there sufficient understanding of the importance of the coastal zone for the functioning of the North Sea ecosystem.

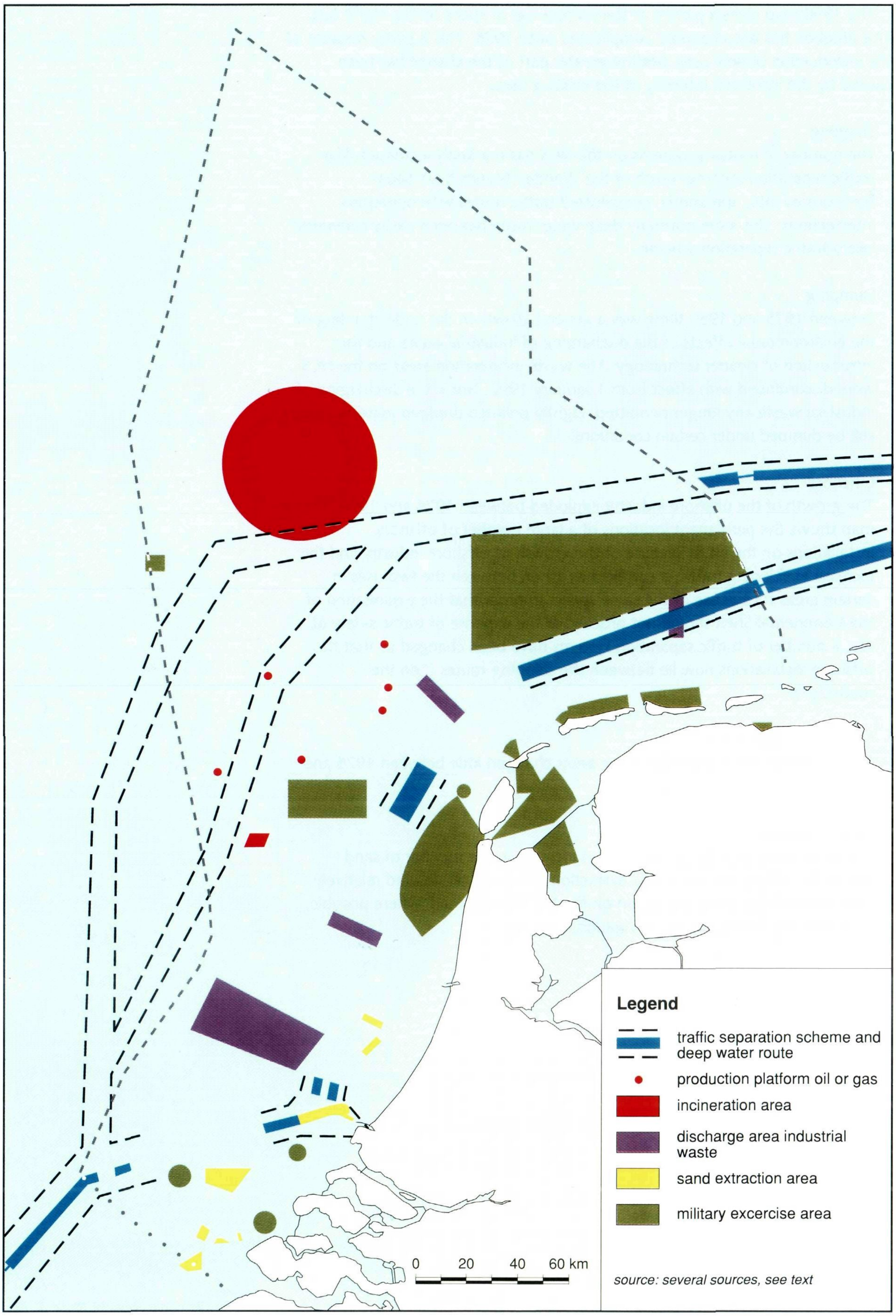
- Offshore
  The 1975 map clearly shows that the exploitation of the oil and gas reserves was still in its infancy. Six offshore installations with their safety zones occupied relatively little permanent space. Moreover, these installations occupied sites where their presence did not yet produce any conflicts with other uses. That this would later change is shown by the 1990 map.

- Military exercise areas
  Two kinds of military exercise areas are distinguished on the map: the exercise areas situated at sea (notably off the Zeeland coast and on the edge of the NCS) and the exercise areas which extend from the land out over the sea (e.g. the areas on the North Sea side of the Wadden Islands and on the coast of Noord-Holland).

- Sand extraction
  The map shows that the sand extraction areas are situated relatively close to the coast. This is an important condition to enable sand to be extracted profitably. Sand extraction on the NCS is combined, where possible, with the maintenance of the navigation channels.

Source:
Hydrographic Office (1975) Bericht aan zeevarenden. Hydrographic Service of the Royal Netherlands Navy, BAZ no 1
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ): unpublished data.
see also the sources of map 58, 69, 76.

The use of maritime space on the NCS in 1975



The use of maritime space on the NCS in 1990

The 1990 map gives a picture of the present use of space on the North Sea. The situation has become more complicated since 1975. This is partly because of the introduction of new uses, but the greater part of the change has been caused by the increased intensity of the existing uses.

- Shipping
  The number of routeing systems on the NCS has markedly increased. The traffic separation schemes north of the Wadden Islands have been transformed into, apparently, complicated traffic routes with numerous intersections. The more northerly deep water route has been partly converted into a traffic separation scheme.

- Dumping
  Between 1975 and 1990 there was a general growth in the understanding of the environmental effects of the discharging of industrial waste and the introduction of cleaner technology. The waste incineration areas on the NCS were discontinued with effect from 1 January 1992. Nor is the discharging of industrial waste any longer permitted. Lightly polluted dredged materials may still be dumped under certain conditions.

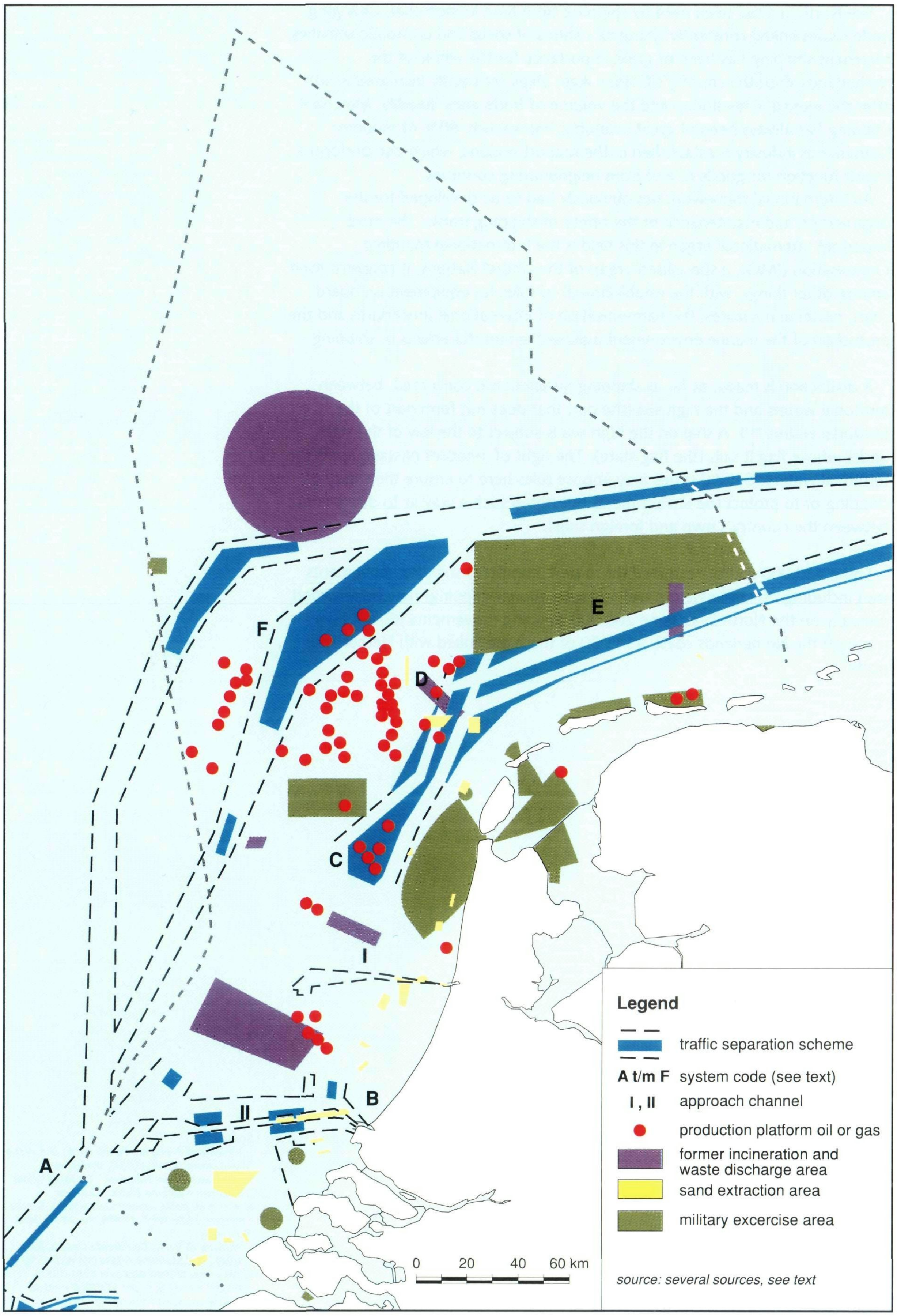
- Offshore
  The growth of the offshore industry exploded between 1975 and 1990. The map shows the permanent locations of a large number of offshore installations on the NCS. Because of the growth of offshore industry and the increase in shipping traffic, a conflict has arisen between the two uses in certain areas for the use of the same space. In order that the exploitation of the Continental Shelf should not proceed at the expense of traffic safety at sea, a number of traffic separation systems have been changed so that the offshore installations now lie between the shipping routes ("on the roadside").

- Military exercise areas
  The locations of the military exercise areas changed little between 1975 and 1990.

- Sand extraction
  The map shows that there has been an increase in the number of sand extraction areas since 1975. The extraction areas are still situated relatively close to the coast. Sand extraction on the NCS is combined, where possible, with the maintenance of the navigation channels.

Source:
see also the sources of map 58, 69, 72, 77, 76.

The use of maritime space on the NCS in 1990



Shipping lanes and traffic intensity

The North Sea has been used by shipping from time immemorial. Changing trade routes linked constantly changing centres of social and economic activities. Merchant shipping has been of great importance for the whole of the Netherlands since the country's Golden Age. Ships constantly increased in size after the industrial revolution and the volume of trade grew steadily. Merchant shipping has always been of great economic importance. 80% of modern Netherlands industry is established in the seaport regions, which also perform a transit function for goods to and from neighbouring countries.

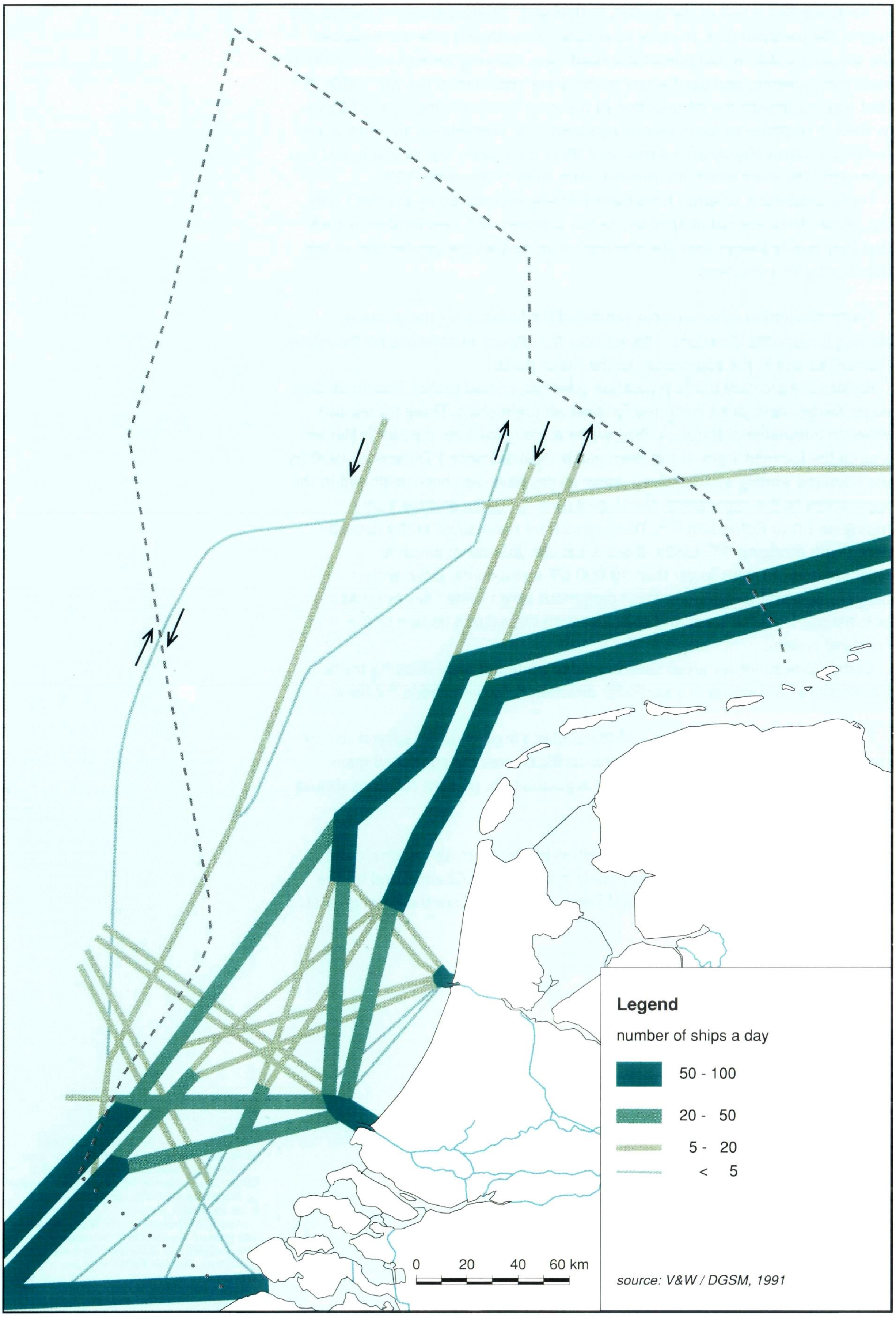
An international framework has obviously had to be developed for the organisation and maintenance of the safety of shipping traffic. The most important international organ in this field is the International Maritime Organisation (IMO), a specialised organ of the United Nations. It concerns itself, among other things, with the establishment of rules for equipment on board ships, routeing measures, the harmonisation of international procedures and the protection of the marine environment against the harmful effects of shipping.

A distinction is made, as far as shipping jurisdiction is concerned, between territorial waters and the high sea (the part that does not form part of the territorial waters [4]). A ship on the high sea is subject to the law of the state under whose flag it sails (the flag state). The right of innocent passage applies in territorial waters. Coastal states may impose rules here to ensure the safety of shipping or to protect the environment, but not in such a way as to discriminate between the country's own and foreign ships.

Some 420,000 course-restricted (or route-committed) shipping movements (not including fishing vessels, naval and recreational shipping) may be recorded annually on the North Sea. Some 260,000 shipping movements (60%), take place off the Netherlands coast. 154,000 of these are linked with Netherlands ports.

Source:
Ministry of Transport, Public Works and Water Management (V&W) (1987). Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.
Ministry of V&W, Directorate-General for Shipping and Maritime Affairs (V&W/DGSM) (1991): unpublished data over 1981-1987, collected according to the VONOVI-method (publication expected in spring 1992).

Shipping lanes and traffic intensity



Traffic separation schemes and deep water routes in the North Sea

The North Sea is one of the world's busiest seas. Traffic intensity is particularly high in the southern part. In order to ensure a smooth and safe movement of the shipping traffic in that part of the North Sea, routeing systems in the form of separation schemes and deep water routes were instituted in the late 1960s. A start was made with the introduction of routeing systems in the Strait of Dover in 1967 in response to some serious accidents. The Netherlands also introduced routeing systems shortly afterwards, and these have been regularly adjusted and extended. The most recent adjustment dates from 1 December 1990.

Traffic separation schemes have been formally established by the IMO since the 1970s. Ships are not obliged to use the schemes, but their location is such that they nearly always form the shortest route, so that the greater part of the shipping traffic uses them.

Traffic separation schemes have separated traffic lanes for the shipping moving in opposite directions. This reduces the chance of collisions on the routes themselves and in the approaches to the major ports.

Besides the ordinary traffic separation schemes, special routes, known as deep water routes, have been instituted for deep-draught ships. These routes also enjoy an international status. A deep water route leads from the North Hinder area to the German Bight. It has been partly replaced since 1 December 1990 by the Friesland routing system. Deep water routes have also been instituted in the approaches to the major ports: the IJ-geul (I) to IJmuiden and the Euro-Maasgeul (II) to Rotterdam [(58)]. These routes are maintained at the desired depth with dredging [(59)]. Lastly, there is a route, the use of which is recommended to ships larger than 10,000 GT (gross tons), laden with dangerous substances in bulk. This "dangerous cargo route" lies as far as possible out from the coast and coincides with the eastern section of the Friesland system.

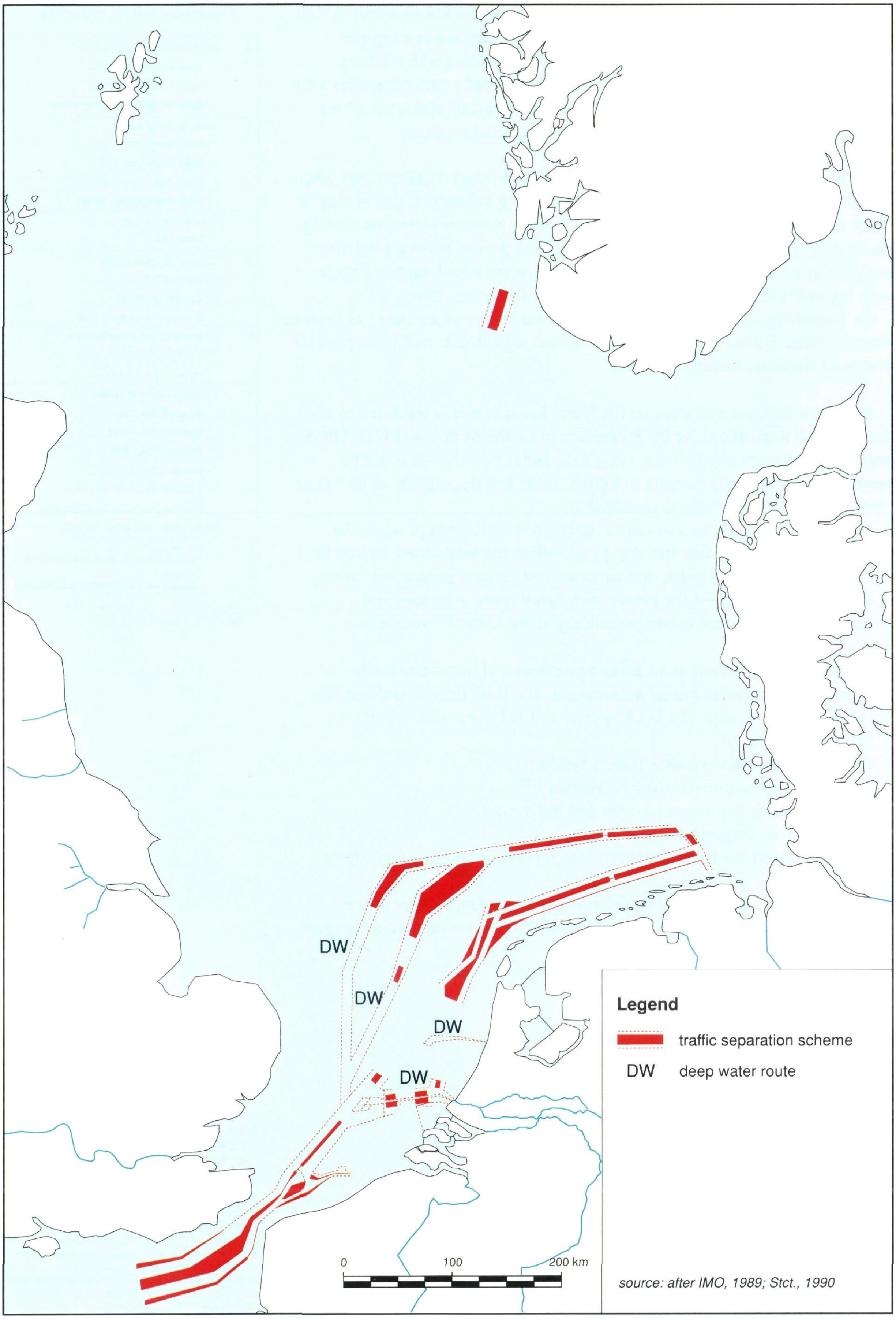
Certain precautionary areas have been designated at busy shipping traffic intersections, and sailing in a particular direction is recommended for these.

Traffic between the continent and the United Kingdom is not subject to any specific routeing regulations. Where this traffic crosses the controlled main traffic flow, it is very important that the regulations to prevent collisions should be strictly observed.

The map gives an overview of the location of the routeing systems in the North Sea. These are concentrated mainly in the English Channel and on the Netherlands sector of the Continental Shelf. The systems are shown in greater detail on the next map.

Source:
Publication of the establishment of traffic separation schemes, 1990, Stct. 1990, no. 233.
International Maritime Organization (IMO) (1989). Ships' routeing. 5th edition IMO, London (as adapted by the North Sea Directorate of Rijkswaterstaat).
Ministry of Transport, Public Works and Water Management (V&W) (1987). Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.

Traffic separation schemes and deep water routes in the North Sea



Traffic separation schemes and deep water routes on the NCS

Traffic separation schemes and other routeing measures are necessary on the North Sea not only to ensure the safety of shipping, but also to integrate shipping traffic with other uses. The integration of shipping with offshore minerals extraction is mainly regulated in the Mining Act which designates areas where no minerals extraction may take place (closed areas) and areas where conditions can be placed on minerals extraction (restriction areas).

A medium-term arrangement has been established since 1985 in zones where spatial use gives rise to conflicts between competing interests. Changes may be made to the shipping routes every 5 years to assist minerals extraction. During the intervening years the shipping routes are kept clear of mineral extraction activities involving fixed installations. The most recent adjustment was made with the institution of the Friesland system on 1 December 1990.

No formal shipping routes with IMO status are in zones established as defence exercise areas. Fishing and recreational craft are regarded as traffic components and must therefore observe the rules.

The traffic behaviour of ships on the North Sea is primarily regulated by the International Regulations for the Prevention of Collisions at Sea (1972). These regulations concern priority rules, navigation behaviour, the use of traffic separation schemes, the carrying of signals, lights and day-signals, as well as all other matters relating to good seamanship.

As part of its obligations as a coastal state, the Netherlands provides the following services to enable shipping to sail within the established standards:

- the issuing of nautical charts and various other nautical publications by the Hydrographic Service of the Netherlands Royal Navy. Additions and corrections to these are issued periodically in the form of "Notices to Mariners";
- the marking of channels as an aid to navigation and to indicate traffic separation schemes and deep water routes. The IMO recommended a new system of sea buoyage (the IALA system) in 1981; it consists in part of lightships and buoys;
- the use of orientation systems (Decca system);
- the issuing of hydro-meteorological reports (10);
- guiding shipping (by means of radar and radio links);
- the pilotage of seagoing-ships.

The Coastguard has the task of ensuring compliance with the regulations.

The map shows the routeing systems on the Netherlands sector of the Continental Shelf in detail. The explanation of the codes is illustrated alongside.

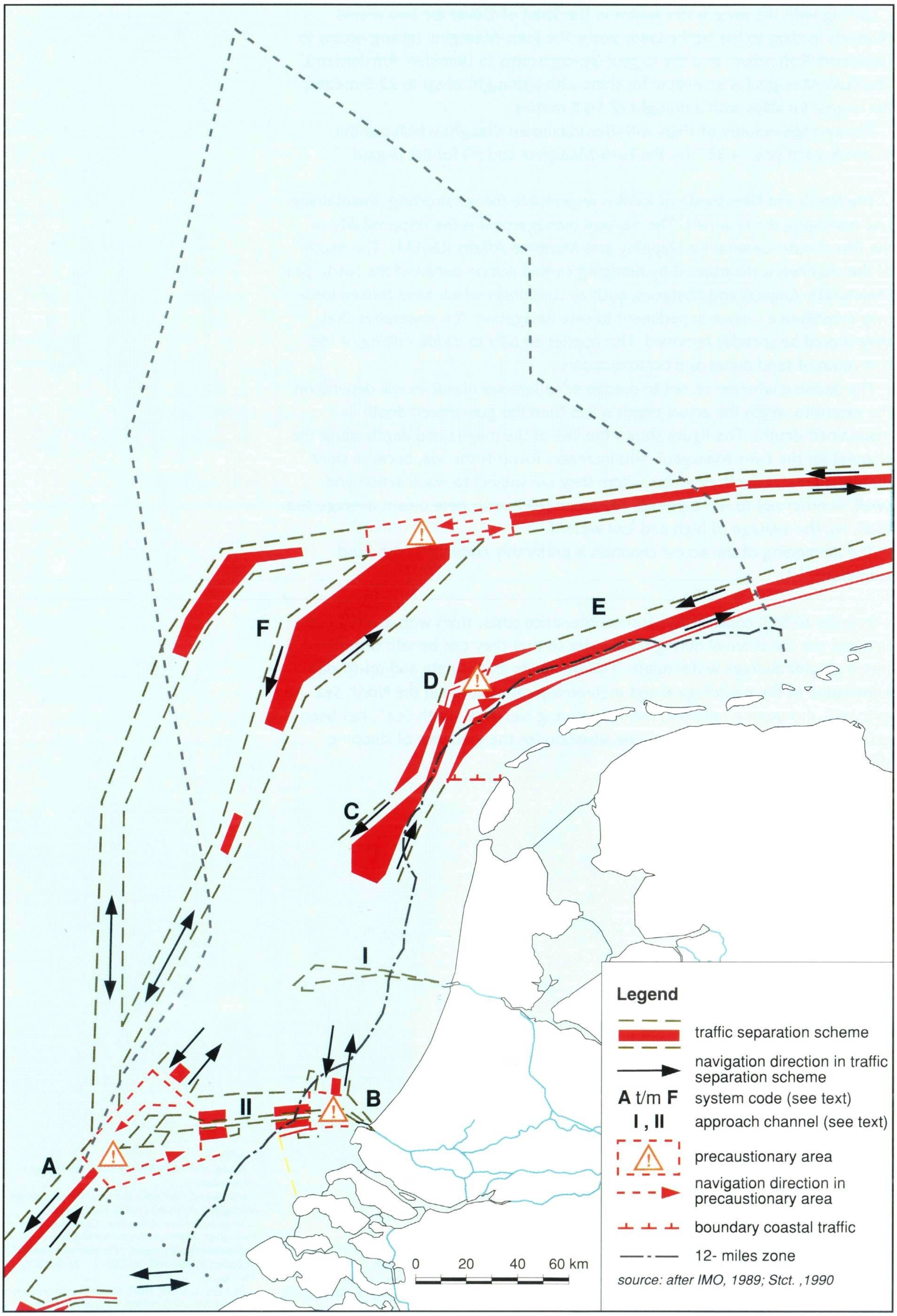
Explanation codes on map 58

A	North Hinder routeing system - North Hinder South TSS * - North Hinder North TSS - North Hinder Precautionary Area
B	Maas Routeing system - Maas North TSS - Maas West Inner TSS - Maas West Outer TSS - Maas Precautionary Area
C	Texel Routeing system - Texel TSS
D	Vlieland Routeing system - Vlieland TSS - Vlieland North TSS - Vlieland Precationary Area
E	Terschelling and in the German Bight Routeing system - Terschelling and in the German Bight TSS
F	Friesland Routeing system - Brown Ridge TSS - Friesland West TSS - Friesland East TSS - Botney Ground TSS - Friesland Precautionary Area - Four deepwater routes (in)between North Hinder and above routeing measures
I	- IJ - geul deepwater route leading to IJmuiden
II	- Eurogeul deepwater route leading to Europoort

* TSS (Traffic Separation Scheme)

Source:
Publication of the establishment of traffic separation schemes, 1990, Stct. 1990, no. 233
International Maritime Organization (IMO) (1989). Ships' routeing. 5th edition IMO, London (as adapted by the North Sea Directorate of Rijkswaterstaat).
Ministry of Transport, Public Works and Water Management (V&W) (1987). Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.

Traffic separation schemes and deep water routes on the NCS



Harbour approach routes and navigation channels

Linking with the deep water routes in the Strait of Dover are two access channels leading to the Netherlands ports: the Euro-Maasgeul (giving access to Europoort/Rotterdam) and the IJ-geul (giving access to IJmuiden/Amsterdam). The Euro-Maasgeul is accessible for ships with a draught of up to 22.5 metres, the IJ-geul for ships with a draught of 16.5 metres.

The average number of ships with this maximum draught which use the channels each year, is 357 for the Euro-Maasgeul and 90 for the IJ-geul.

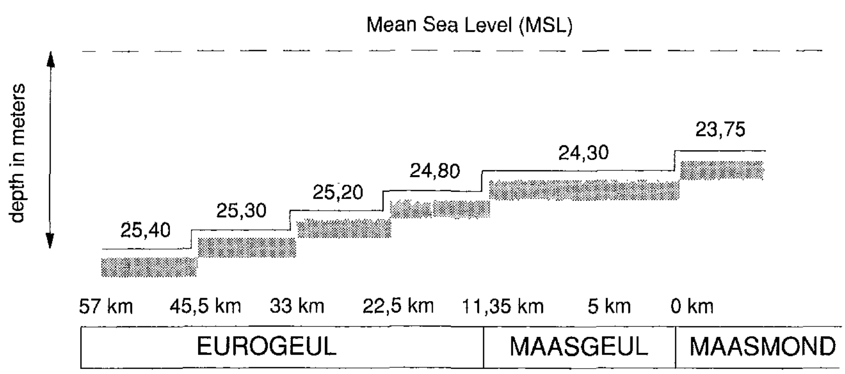
The North Sea Directorate of RWS is responsible for constructing, maintaining and managing the channels. The nautical management is the responsibility of the Directorate-General for Shipping and Maritime Affairs (DGSM). The depth of the channels is maintained by dredging carried out on behalf of the North Sea Directorate. Objects and obstacles, such as containers which have broken loose, may constitute a serious impediment to safe navigation. It is imperative that they should be speedily removed. This applies equally to sudden silting or the formation of sand dunes and bottom ripples.

The decision whether or not to dredge or to remove obstacles will depend on the extent to which the actual depth is less than the guaranteed depth (= maintained depth). The figure shows the line of the maintained depth along the channel for the Euro-Maasgeul. This increases towards the sea, because ships require a greater depth of water where they are subject to wave action and swell, in order not to run aground. (By mean sea level is here meant average sea level, i.e. the average of high and low water.)

The deepening of the access channels is preferably combined with sand extraction (72).

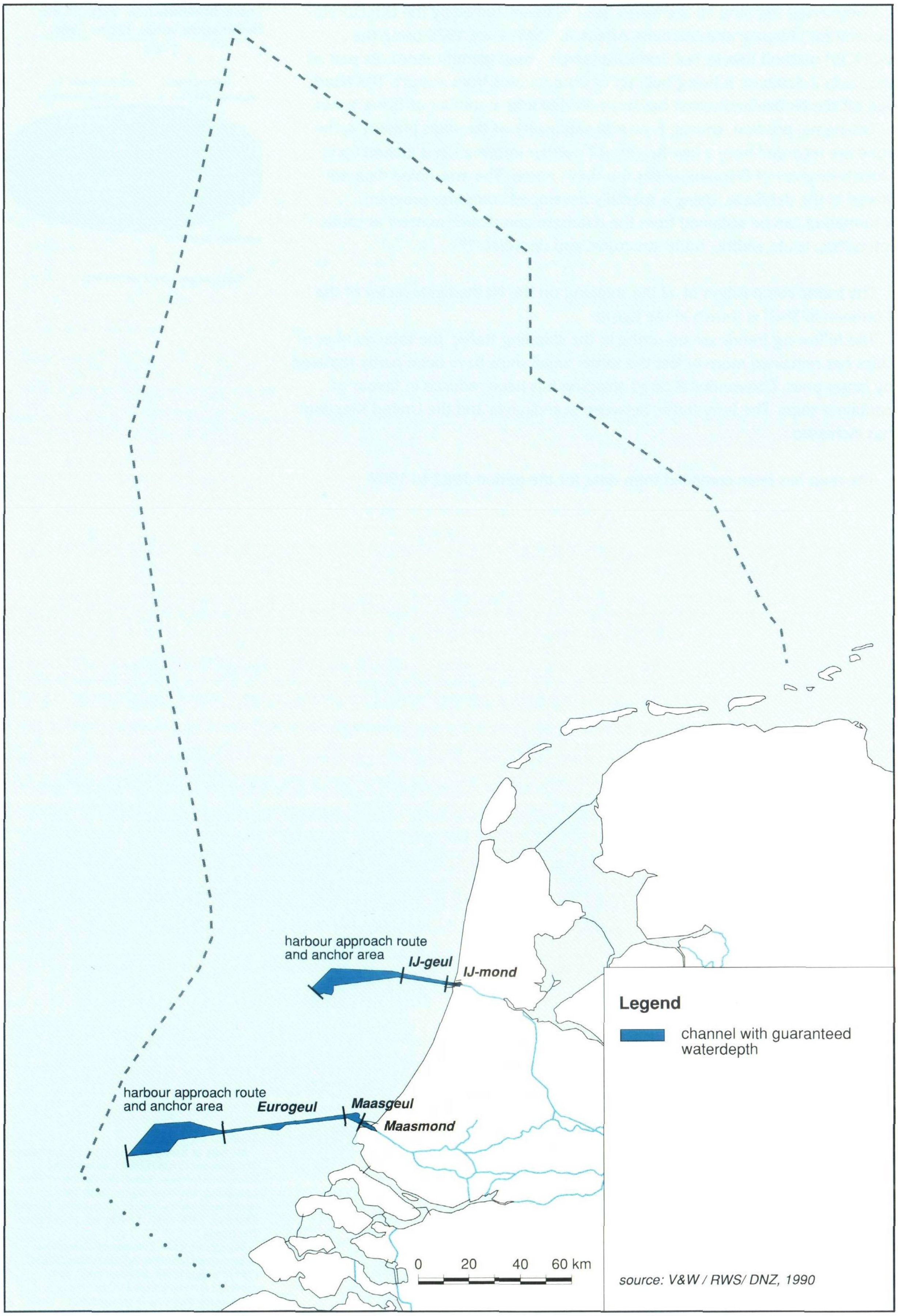
In order to limit construction and maintenance costs, ships with a very deep draught use the channel during high water so that they can benefit from the 1.5 metre greater average water depth. This demands an accurate and up-to-date knowledge of the hydrological and meteorological situation in the North Sea. An extensive monitoring network, the "Measuring Network North Sea", has been established to provide reports on the situation for the guidance of shipping (hydro-meteorological reports) (10).

Maintained depth



Source:
Pollen, R.A.W. (V&W/DGSM) (1991): oral information.
Ministry of Transport, Public Works and Water Management (V&W) (1987). Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1990). unpublished data.

Harbour approach routes and navigation channels



Traffic density: total shipping

Commercial shipping on the North Sea has been studied by the Directorate-General for Shipping and Maritime Affairs (DGSM) since 1975 using the VONOVI method (North Sea Traffic Research Visual Identification). As part of the study a database is being built up of observations from aircraft. The North Sea off the Netherlands coast has been divided into a number of flying zones.

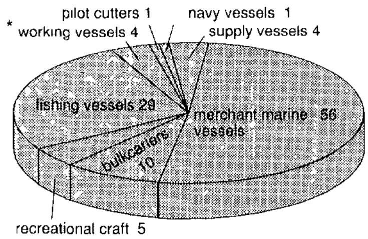
The name, position, course, type and nationality of the ships present in the zone are recorded from a low height. All further information is looked up in Lloyd's Register of Shipping under the ship's name. The assembled data are stored in the database. Using a specially developed computer program, information can be obtained from the database about such matters as route intensities, route widths, route structures and densities [56].

The traffic composition of all the shipping on the Netherlands sector of the Continental Shelf is shown in the figure.

The following trends are occurring in the shipping traffic: the total number of ships has remained more or less the same. Small ships have been partly replaced by larger ones. Conventional cargo shipping has been reduced in favour of container ships. The ferry traffic between Scandinavia and the United Kingdom has increased.

The map has been compiled from data for the period 1982 to 1987.

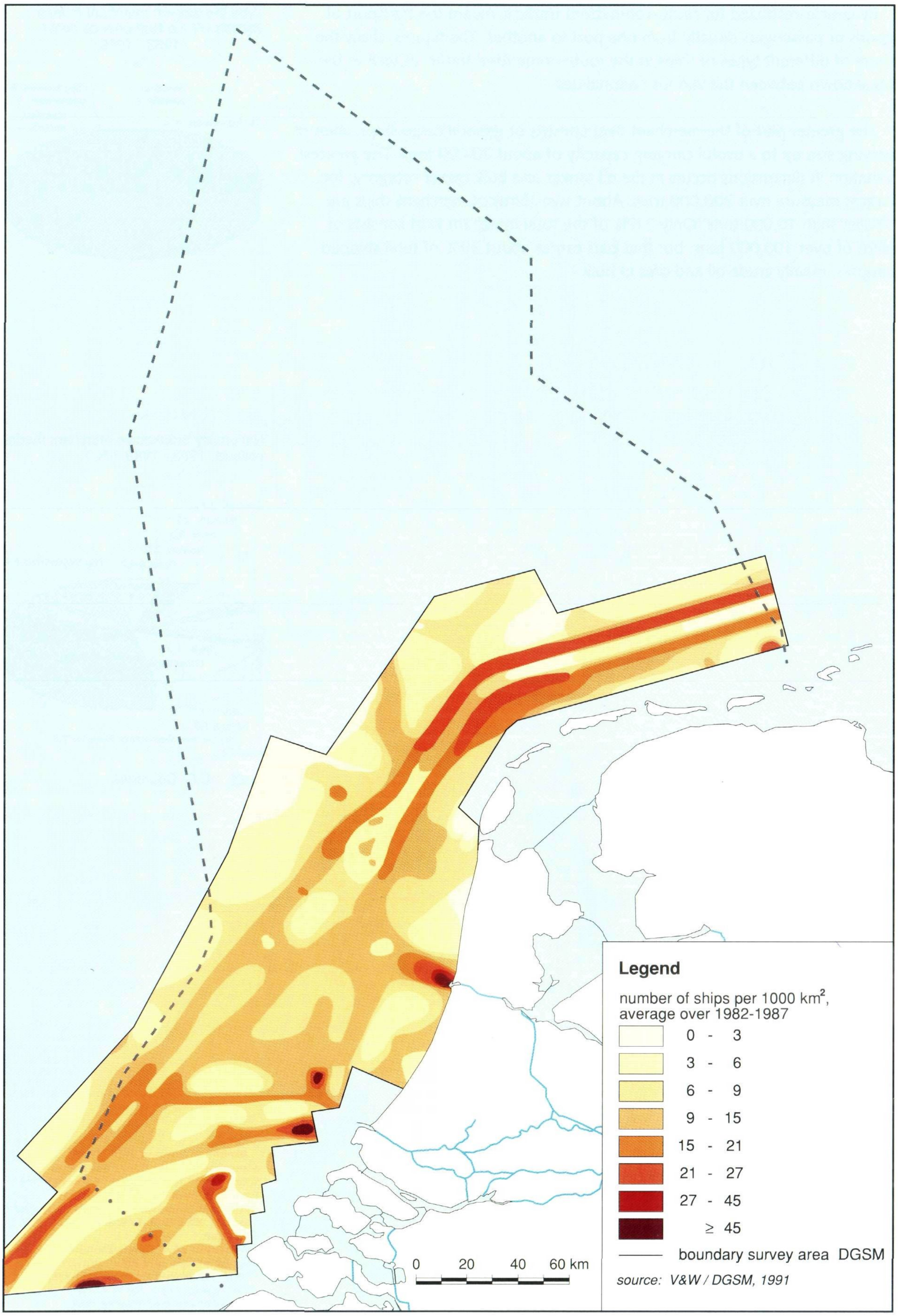
Traffic breakdown all ships off the Netherlands coast, 1983 - 1986 (%)



* tugs , barges , cranevessels etc

Source:
Ministry of Transport, Public Works and Water Management (V&W) (1987). Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course") Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague
Ministry of V&W, Directorate-General for Shipping and Maritime Affairs (V&W/DGSM) (1991): unpublished data over 1981-1987, collected according to the VONOVI-method (publication expected in spring 1992).

Traffic density: total shipping

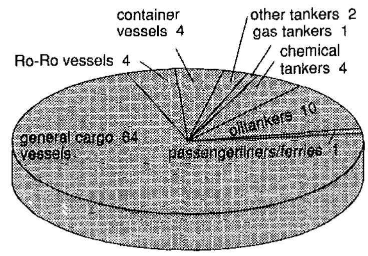


Traffic density: course-restricted traffic

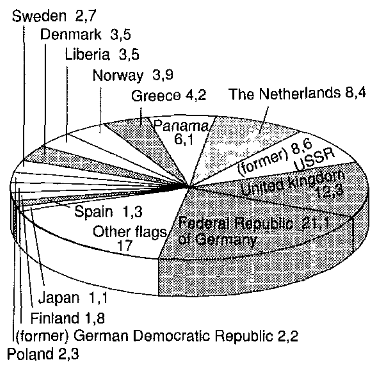
By course-restricted (or route-committed) traffic is meant the transport of goods or passengers directly from one port to another. The figures show the share of different types of ships in the route-committed traffic, as well as the breakdown between the various nationalities.

The greater part of the merchant fleet consists of general cargo ships; ships of varying size up to a useful carrying capacity of about 20,000 tons. The greatest variation in dimensions occurs in the oil tanker and bulk carrier category; the largest measure over 300,000 tons. About two-thirds of merchant ships are smaller than 10,000 tons. Only 2.6% of the total merchant fleet consists of ships of over 100,000 tons, but that part carries about 30% of total shipped cargoes, mainly crude oil and ores in bulk.

Type breakdown merchant marine vessels off the Netherlands coast, 1983 - 1986 (%)

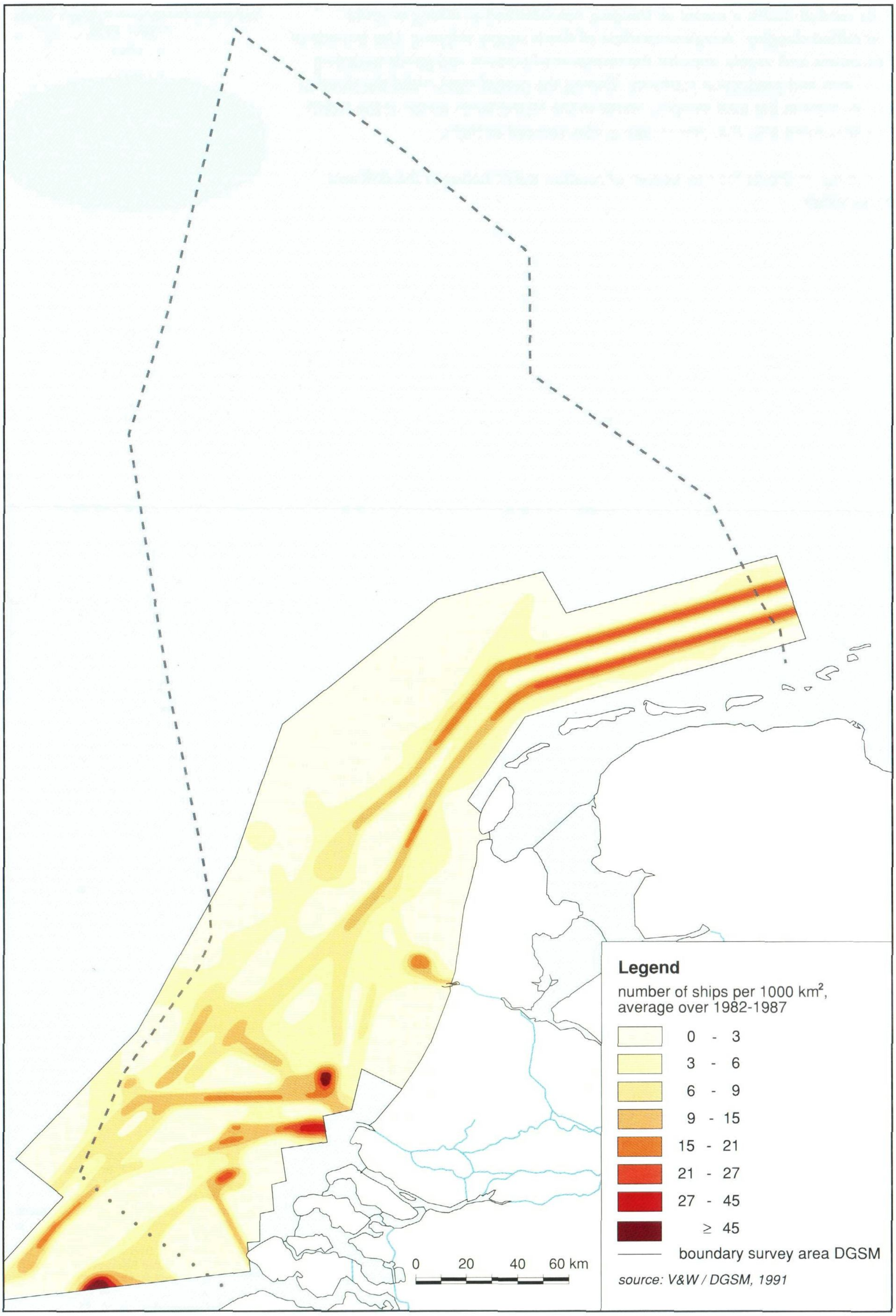


Nationality breakdown merchant marine vessels, 1983 - 1989 (%)



Source:
Ministry of Transport, Public Works and Water Management (V&W) (1987). Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.
Ministry of V&W, Directorate-General for Shipping and Maritime Affairs (V&W/DGSM) (1991): unpublished data over 1981-1987, collected according to the VONOVI-method (publication expected in spring 1992).

Traffic density: course-restricted traffic

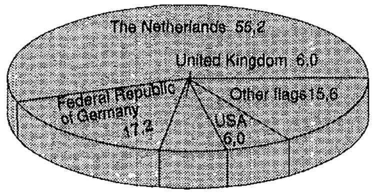


Traffic density: random traffic

By random traffic is meant all shipping not classified as fishing or route-committed shipping. A high proportion of this is supply shipping. Use is made of helicopters and supply ships for the transport of persons and goods to drilling platforms and production platforms. During the period 1983-1986 the share of supply ships in the total shipping traffic in the Netherlands sector of the North Sea amounted 4%; that percentage is now somewhat higher.

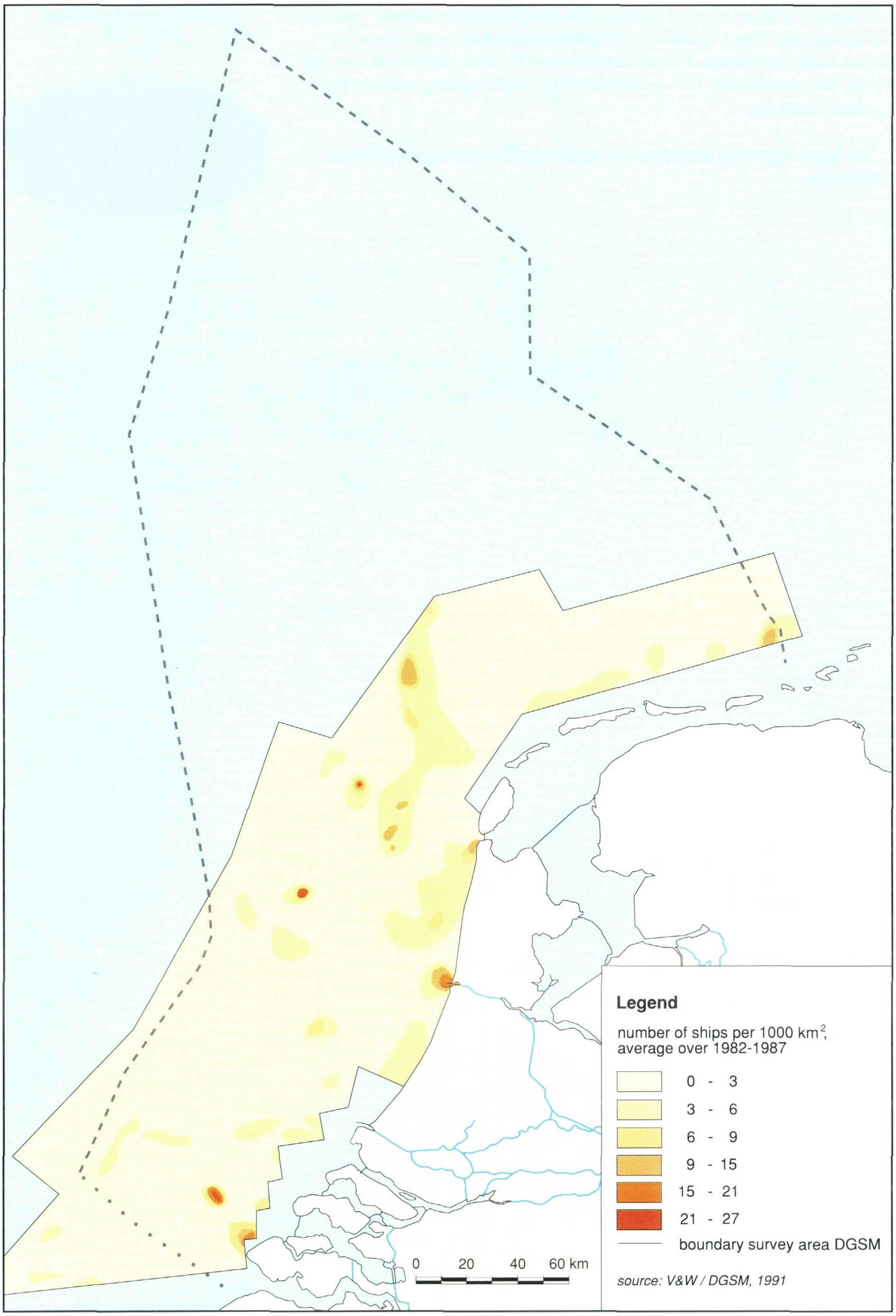
The figure shows the breakdown of random traffic between the different nationalities.

Nationality breakdown supply vessels, 1983 - 1986
(%)



Source:
Ministry of Transport, Public Works and Water Management (V&W) (1987).Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.
Ministry of V&W, Directorate-General for Shipping and Maritime Affairs (V&W/DGSM) (1991): unpublished data over 1981-1987, collected according to the VONOVI-method (publication expected in spring 1992).

Traffic density: random traffic

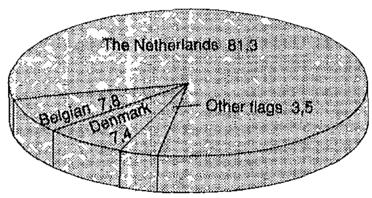


Traffic density: fishing traffic

Shipping routes are situated in areas with a large amount of mainly small sea fishing activities. This is the fishing for flatfish (plaice, sole), some roundfish species (cod) and shrimps. Fishing boats account for 29% of the total shipping traffic. This proportion is 15% in the area of the main shipping routes in the southern North Sea.

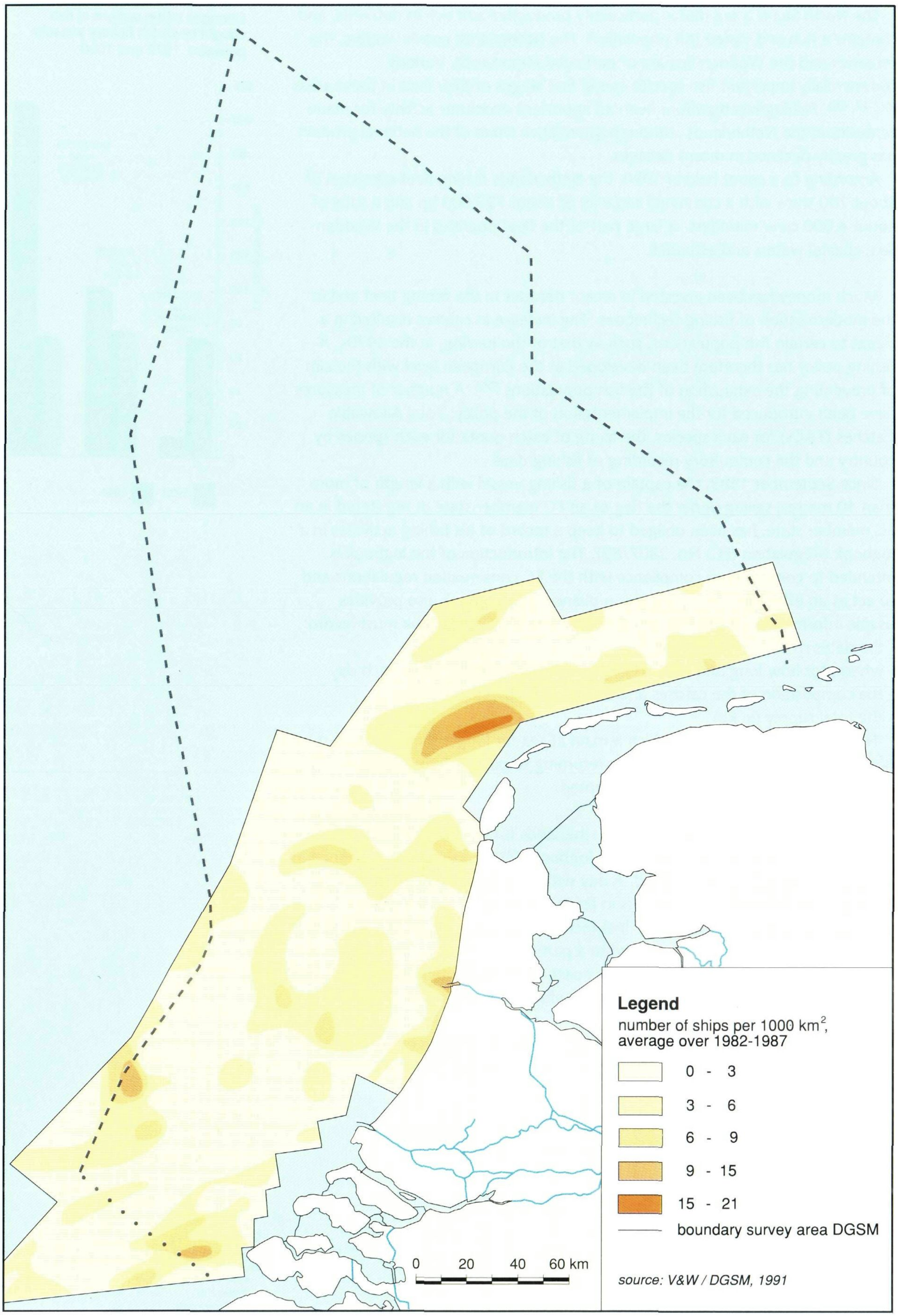
The figure shows the breakdown of random traffic between the different nationalities.

Nationality breakdown fishery,
1983 - 1986
(%)



Source:
Ministry of Transport, Public Works and Water Management (V&W) (1987).Beleidsnota Scheepvaartverkeer Noordzee" Op koers" (free translation: Maritime Traffic North Sea: Netherlands policy report "On course"). Second Chamber, 1986-1987, 17 408, no. 25-26. SDU, The Hague.
Ministry of V&W, Directorate-General for Shipping and Maritime Affairs (V&W/DGSM) (1991). unpublished data over 1981-1987, collected according to the VONOVI-method (publication expected in spring 1992)

Traffic density: fishing traffic



Total number of Netherlands fishing days in 1990

The North Sea is a sea that is particularly productive and rich in nutrients, and contains a rich and varied fish population. The Netherlands coastal waters, the estuaries and the Wadden Sea are of particular importance. Various commercially important fish species spend first stages of their lives in these areas [46, 47, 48]. Fishing has therefore been an important economic activity for many centuries in the Netherlands, although the relative share of the national product has greatly declined in recent decades.

According to a count held in 1990, the Netherlands fishing fleet consisted of about 700 ships with a combined capacity of about 720,000 hp and a total of about 4,000 crew members. A large part of the fleet operates in the Wadden Sea, coastal waters and estuaries.

Much money has been invested in recent decades in the fishing fleet and in the modernisation of fishing techniques. The increase in catches resulted in a threat to certain fish populations, such as that of the herring, in the 1970s. A fishing policy has therefore been developed at the European level with the aim of preventing the exhaustion of the fish populations [95]. A number of measures have been introduced for the implementation of the policy: Total Allowable Catches (TACs) for each species, the fixing of catch quota for each species by country and the compulsory recording of fishing days.

Since September 1983, the captain of a fishing vessel with a length of more than 10 metres, sailing under the flag of an EC member state or registered in an EC member state, has been obliged to keep a record of his fishing activities in a logbook (Regulation (EC) No. 2807/83). The introduction of the logbook is intended to contribute to compliance with the EC conservation regulations and to act as an effective check on this compliance. The logbook also provides usable information for the fish population estimates. The logbook must record:

- the dates of departure and return
- where, for how long and with what gear fishing has taken place each day
- the composition of the catches and the returned by-catch
- the total supply (in kg).

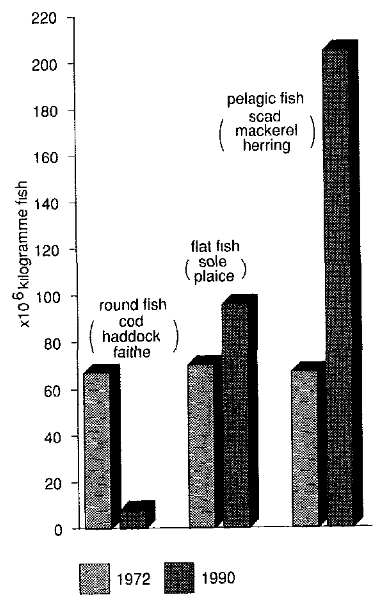
Netherlands fishing vessels which remain at sea for longer than 24 hours must hand in their completed logbook after returning to port. Fishing vessels which return to port within 24 hours are exempted.

The number of fishing days for the Netherlands fishing fleet for each ICES quadrant has been derived from the EC logbooks [95]. A fishing day is defined as a day on which a catch is recorded. A day without a catch is therefore not recorded, but the latter rarely occurs in fishing practice.

In 1990 the Netherlands fishing fleet recorded a total of 68,689 fishing days, 6,596 of which could not be assigned to a particular ICES bloc. The map shows that the sea area along the Netherlands coast is the most intensively fished. The fishing is done mainly with "Euro cutters", which have an engine capacity of up to 300 hp.

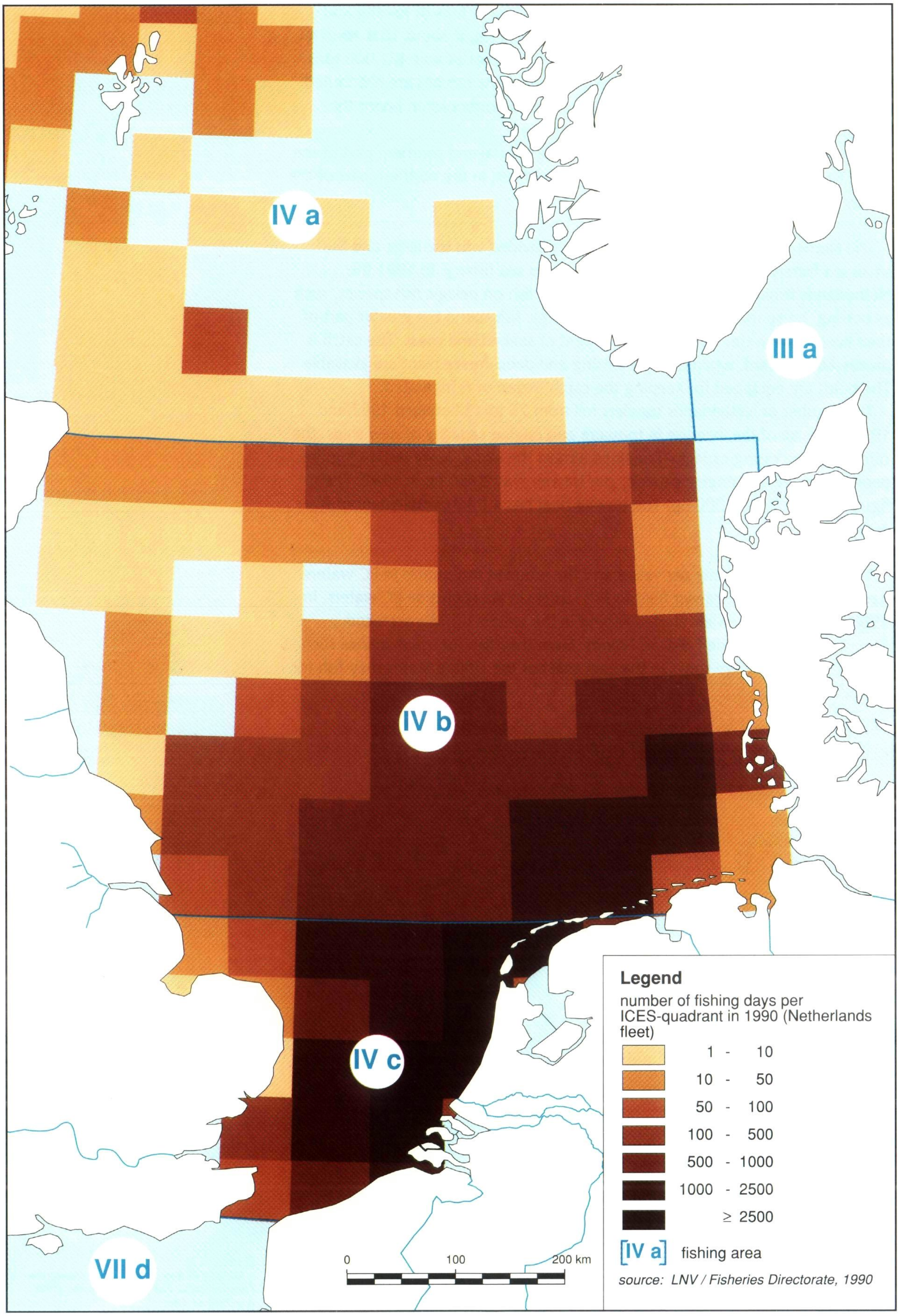
As a result of the changes in fish populations, the techniques employed, and the policy pursued, the pattern of catches changed radically between 1972 and 1990; see the accompanying figure.

Changes in the pattern of fish caught by Dutch fishery vessels between 1972 and 1990



Source:
FAO, Yearbook of fishery statistics, vol. 44 en 64.
Ministry of Agriculture, Nature Management and Fisheries (LNV), Fisheries Directorate, (1990): unpublished data.

Total number of Netherlands fishing days in 1990



Netherlands herring catch in 1990

The Netherlands fishing fleet caught a total of 74,811 tons of herring and brisling in 1990 in the area shown. This was an increase of about 10% relative to 1988. The relevant portion of the TACs for these species was 472,000 tons for all EC countries combined. The map shows how the catches are distributed over the ICES quadrants. The data are based on the logbooks on board the Netherlands ships.

The catches show an arbitrary pattern. In the central and southern part of the North Sea they were made mainly by the cutter fleet; in the northern part of the sea by the trawler fleet.

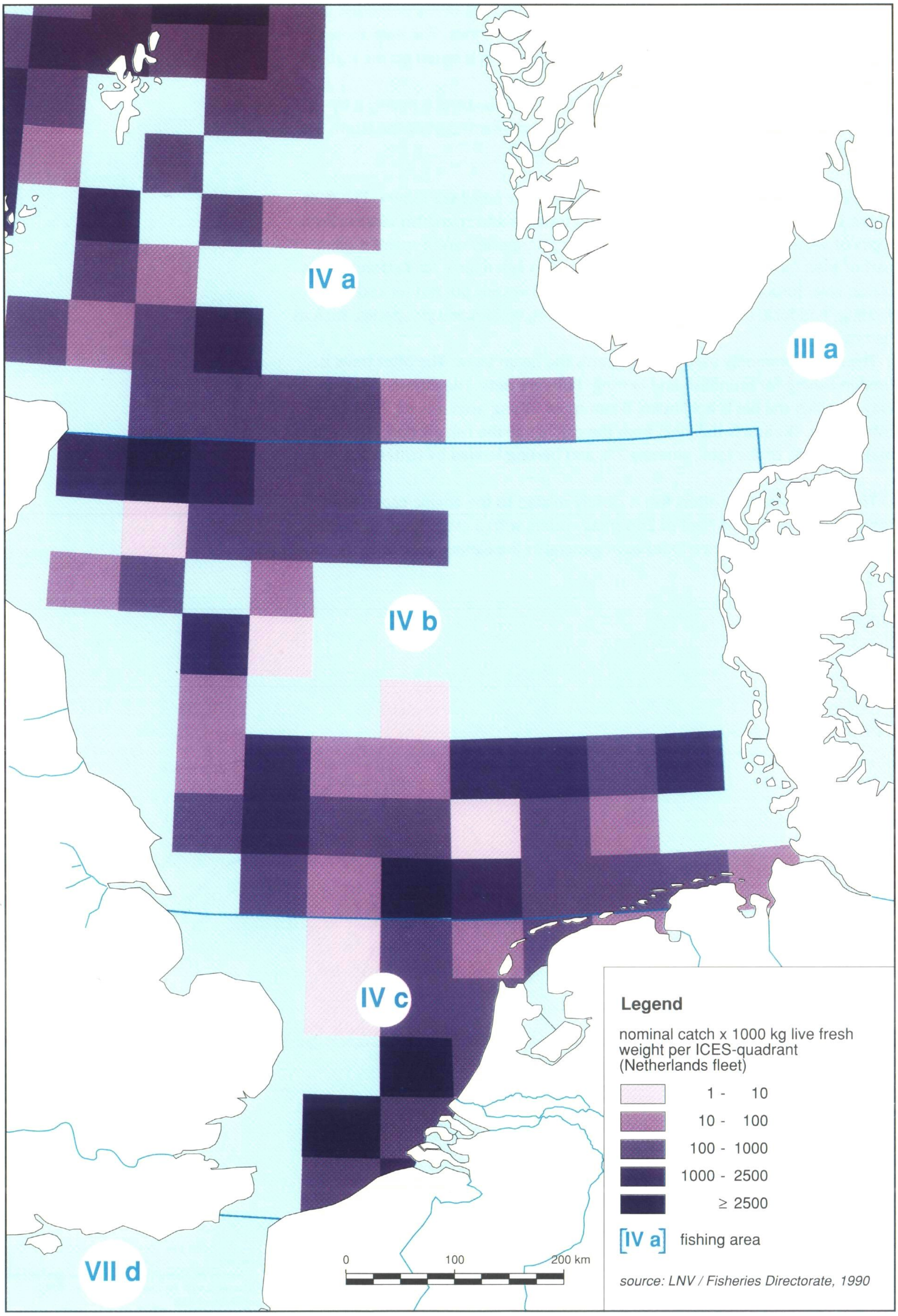
The Netherlands fishing fleet is traditionally divided into the large and the small sea fishery. Trawlers form part of the large sea fishery. In 1991 the Netherlands fishing fleet had 13 trawlers. They fish on pelagic fish species, such as herring, horse mackerel and mackerel. Pelagic fish spend the greater part of their lives in the water column, independent of seabed and coast. The catch is processed on board, where fish processing and deep-freeze plant are available. The holds are equipped for keeping the catch frozen or refrigerated.

The number of Netherlands trawlers fell from 26 to 13 between 1982 and 1991. Because of the increase in tonnage and engine capacity of new ships, the catch and processing capacity remained almost the same, however, during the period. The average engine capacity per trawler was 2,450 hp in 1982. The figure now is about 6,000 hp. The trawler fleet has a total complement of over 400 persons.

The increase in capacity per vessel and the reduced fish quotas in EC waters have encouraged the trawler fleet to fish largely in areas outside EC waters. In 1988 Netherlands trawlers started fishing in the waters off Morocco and Mauritania and near the Falkland Islands. Here they fish for squid species such as *Illex spp.* and *Loligo spp.* On the east coast of the United States they fish for mackerel.

Source:
Ministry of Agriculture, Nature Management and Fisheries (LNV), Fisheries Directorate, (1990): unpublished data.

Netherlands herring catch in 1990



Netherlands mackerel catch in 1990

In 1990 the Netherlands fishing fleet caught 1118 tons of the permitted quota of 1650 tons of mackerel. In 1988 the catch was 2265 tons. The map shows the distribution of the catches over the ICES quadrants and is based on the logbook returns of the Netherlands ships.

In the central and southern part of the North Sea mackerel is mainly a by-catch of the cutter fleet (about 450 tons). In the northern part of the North Sea the trawlers fish specifically for mackerel (670 tons).

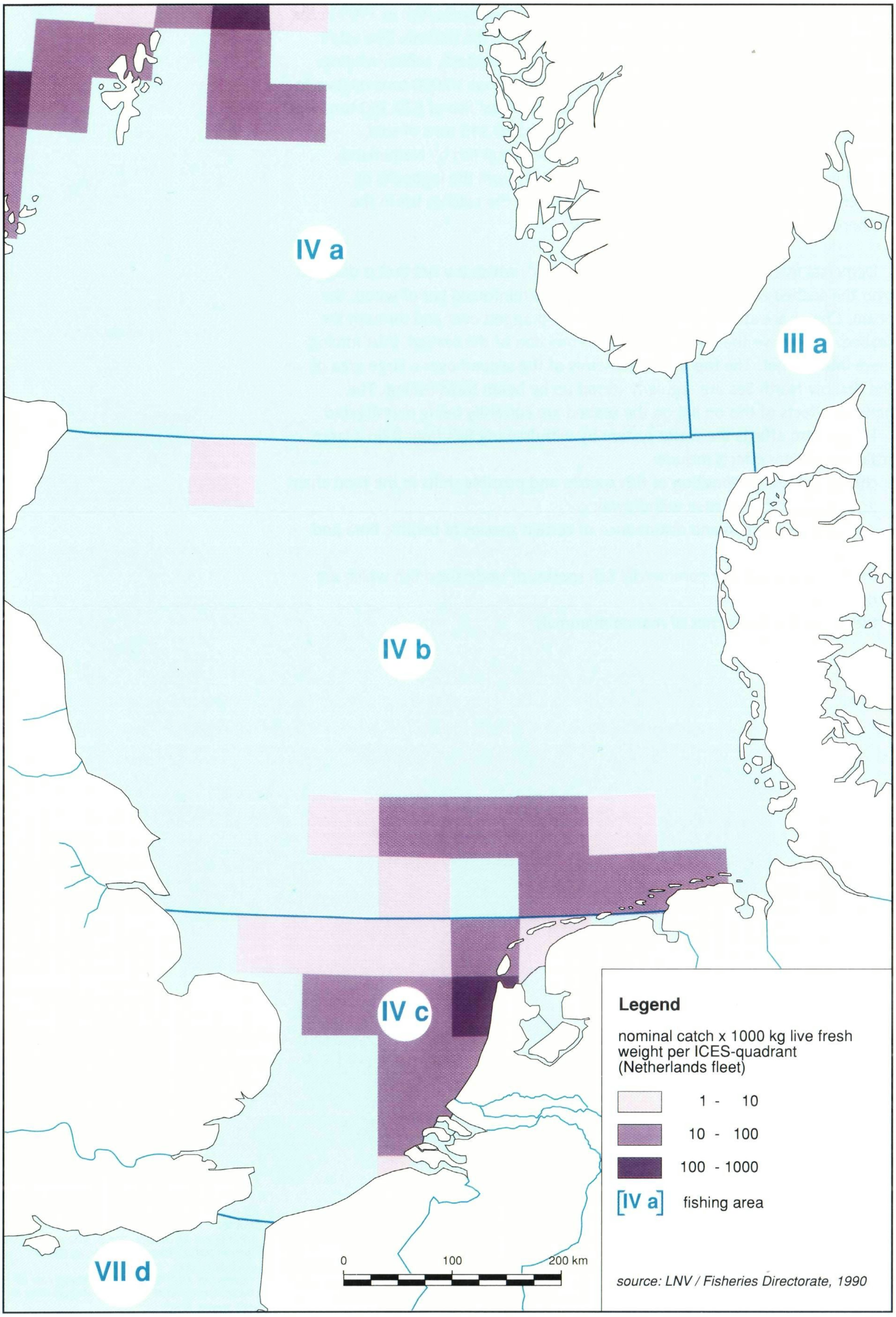
Besides the large (trawler) fishing there is also the small sea fishery. The fleet of the small sea fishery can be divided into trawlers and roundfish vessels. Both types of vessel fish for demersal fish species, i.e.: species which spend a great part of their (adult) lives on the seabed. Trawlers fish mainly for flatfish such as plaice, sole, turbot, flounder and brill. Roundfish vessels put out for cod, whiting, haddock, latchet and, to a lesser extent, certain pelagic species, such as herring.

The most commonly used fishing gear is the beam trawl. The otter trawl is used in fishing for roundfish and herring. Both are nets. The difference lies in the way in which the net is held open. Beam trawl fishing accounts for 79% of the total return. (Return is the yield from the catches at the fish auction.) Roundfish make up 12% of the total, shrimps 7% and herring landed by cutters 2%.

The area where the cutters fish is closely related to the engine capacity and tonnage of the ships. A fleet of 256 small cutters with a capacity of up to 300 hp (known as "Euro cutters") fishes in general in the Netherlands fisheries zone (12-mile zone).

Source:
Ministry of Agriculture, Nature Management and Fisheries (LNV), Fisheries Directorate, (1990): unpublished data.

Netherlands mackerel catch in 1990



Netherlands demersal fish catch in 1990

Netherlands fishing vessels caught 99,844 tons of demersal fish in 1990 in the area shown. Demersal fish are species which live near the bottom. The catch consisted of plaice, sole, megrim, halibut, brill, cod, haddock, saithe, whiting, hake, catfish and wolffish. This was an increase of about 10,000 tons relative to 1988. The Netherlands quota of the TACs for demersal fish of 620,350 tons was 102,590 tons, including 66,120 tons of plaice and 20,315 tons of sole.

The map gives an overview of the catch of demersal fish by Netherlands fishing vessels in 1990 and is based on data taken from the logbooks of Netherlands fishing boats. The centre of gravity of the catches lies in the Netherlands sector of the Continental Shelf.

Demersal fish are caught using the beam trawl, which is a net that is dragged over the seabed and held open at the front by a reinforced bar of wood, the beam. Chains are attached to the beam to be dragged over and through the seabed. They drive the fish up from the protection of the seabed, thus forcing them into the net. The top few centimetres of the seabed over a large area of the shallow North Sea are regularly stirred up by beam trawl fishing. The harmful effects of this on life on the seabed are currently being investigated.

Fishing also affects the water system by withdrawing fish from it on a large scale. Secondary effects include:

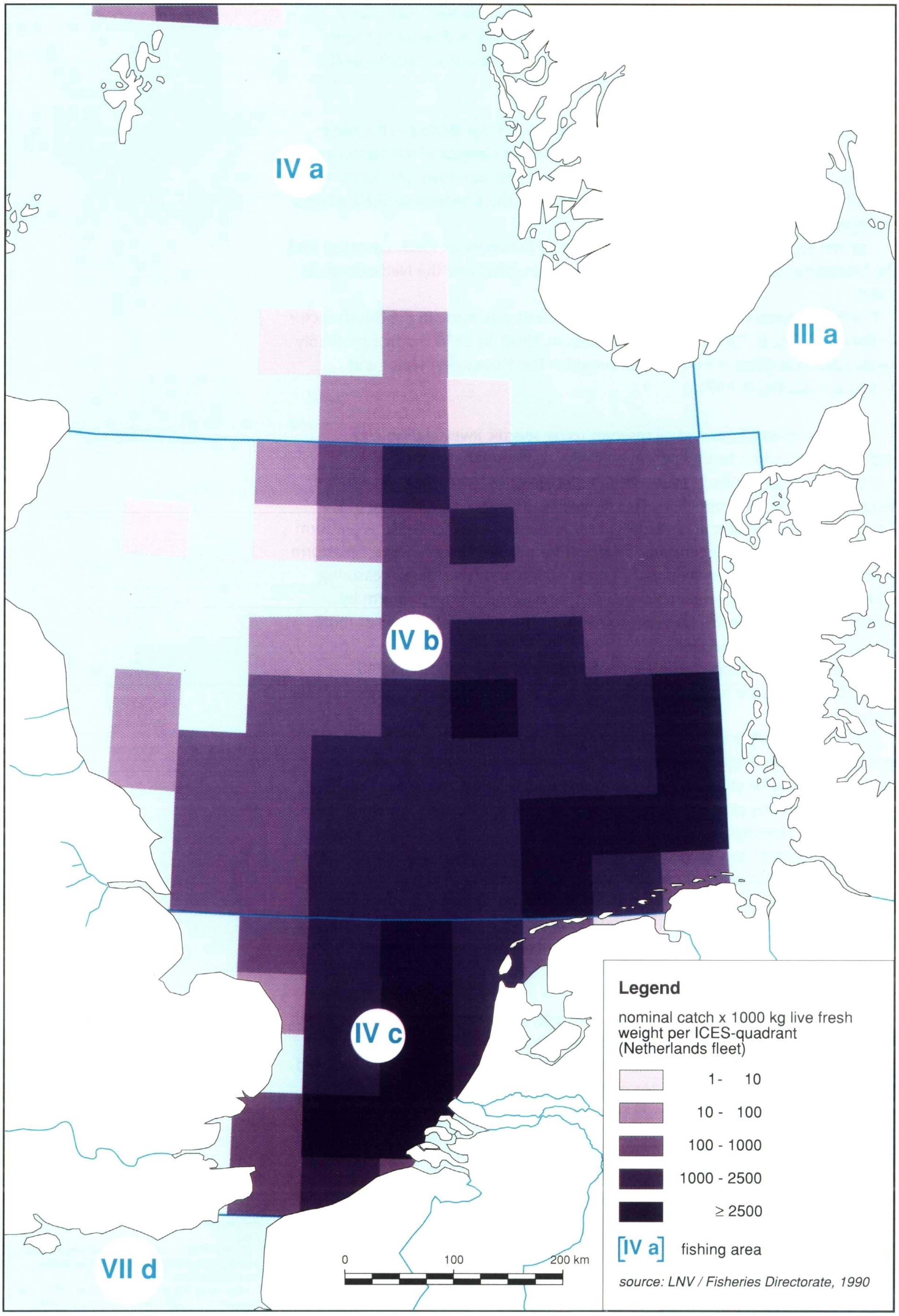
- changes in the composition of fish species and possible shifts in the food chain as a result of this massive withdrawal;
- damage, destruction and disturbance of certain species of benthic flora and fauna;
- the by-catches of non-commercial fish species or undersized fish which are discarded;
- the incidental by-catches of marine mammals.

Source:

Ministry of Agriculture, Nature Management and Fisheries (LNV), Fisheries Directorate, (1990): unpublished data.

Welleman, H. (1989). Literatuurstudie naar de effecten van de bodemvisserij op de bodem en het bodemleven. RIVO.

Netherlands demersal fish catch in 1990



Production platforms and pipelines in the North Sea

Maps 68 to 73 deal with the activities on the North Sea and, particularly, on the NCS concerned with the extraction of raw materials. A division has been made between oil and gas production and the extraction of surface minerals. The latter are dealt with by maps 72 and 73.

Exploration of the gas and oil reserves in the North Sea started in the early 1960s. The conclusion in 1958 of the Convention of Geneva which introduced rules for the delimitation of the Continental Shelf and laid down the rights of the coastal states in respect of the natural resources of the Continental Shelf, played an important part in this (4).

The first exploration licences were granted by Denmark in 1963. Germany and the United Kingdom followed in 1964; Norway in 1965 and the Netherlands in 1968.

The first commercially attractive natural gas find was made in the British sector of the North Sea in 1965. Production began in 1968. In 1970 the first profitably exploitable quantities of oil were discovered in the Norwegian sector and production started in 1971.

The exploration of gas and oil reserves using seismic investigation and exploratory drilling is further described in the commentary to map 71.

If an exploratory drilling is successful, a decision has to be made on whether to open the field for production. This decision is influenced by the size of the field, the depth of water and nearness to the coast or to other fields. A platform of sometimes gigantic dimensions is erected for production. The largest platform stands on the Norwegian shelf, is 271 metres high and has a deck measuring 114 by 55 metres. A considerable area can be covered from a platform by drilling a number of wells, however to deplete a field fully, often one or more satellite platforms are needed.

Oil and gas are transported mainly by pipeline. In the mid-1970s 940 kilometres of pipeline in the North Sea were available and 2000 kilometres in the early 1980s.

Gas fields are often connected together for transporting the gas to the mainland through a collection pipeline. The same applies to oil. However offshore loading (in ships) does occur in some parts of the North Sea.

Work is currently proceeding on "Zeepipe". This gas pipeline will transport gas from the Norwegian fields to Zeebrugge in Belgium. From there it will be further transported to six Western European countries which have contracted to receive it. 800 kilometres of pipeline will be constructed in the first stage. Later there will be extensions of 300 and 155 kilometres, respectively, to other Norwegian gas fields. When it is complete, Zeepipe will be the longest marine pipeline in the world. The gas reserve in the Norwegian fields concerned is 1790 milliard m^3.

The map shows the production platforms and pipelines on the whole of North Sea. Because the data from different sources do not exactly correspond, this map gives only an overall impression. The reliability of the data can be vouched for only for the Netherlands sector of the North Sea (69).

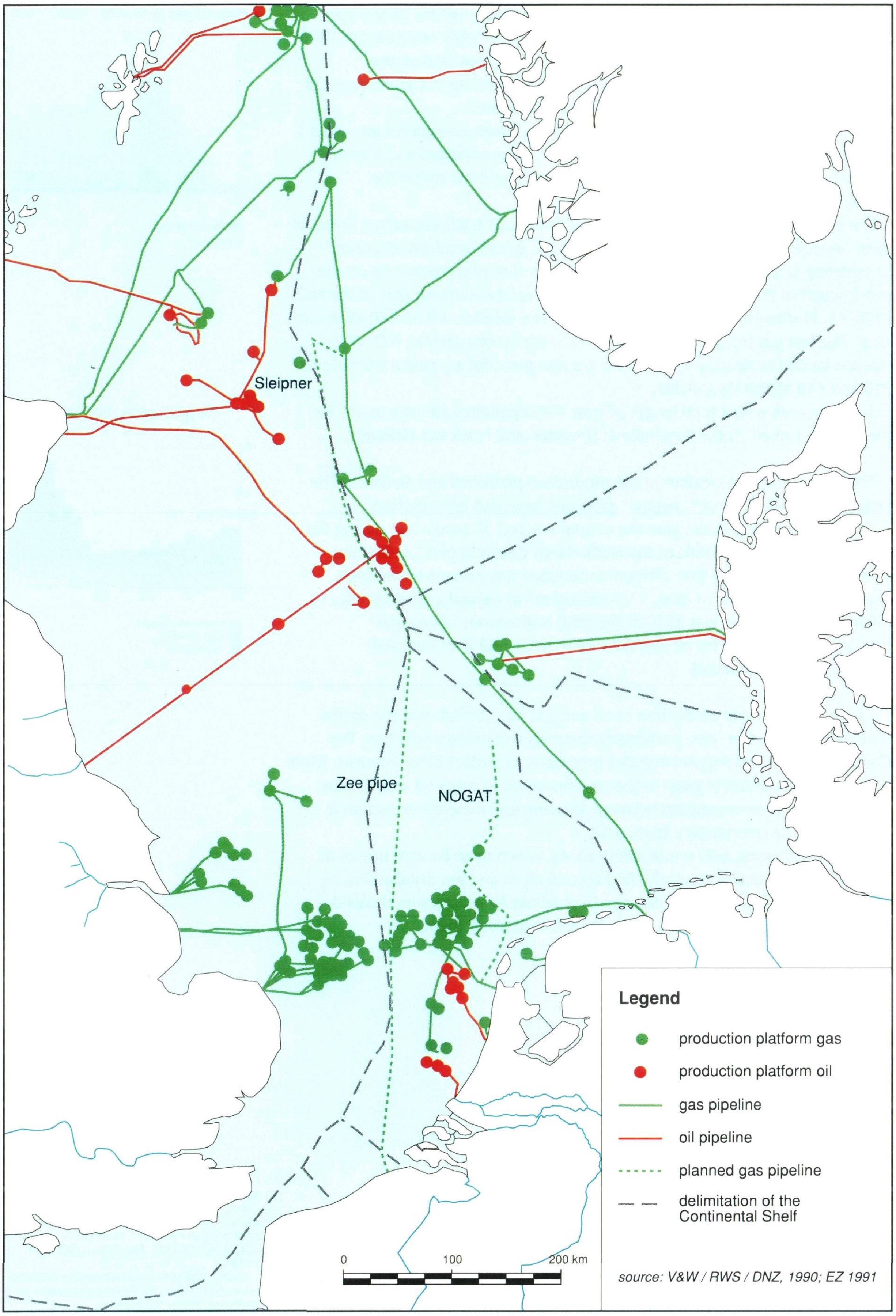
Source:

Ministry of Economic Affairs, Directorate-General for Energy, Information Directorate (EZ) (1991). Oil and gas in the Netherlands, exploration and production 1990. The Hague. ISSN: 0925-7993.

ICONA (1981). Inventarisatierapport Noordzee. Interdepartmental Co-ordinating Committee for North Sea Affairs. The Hague.

Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1990): unpublished data.

Production platforms and pipelines in the North Sea



Production platforms and pipelines on the NCS

The Netherlands sector of the North Sea has been opened for oil and gas prospecting since 1968. The first gas find was made in 1969 northwest of Texel. Production started in 1975. This gas, from block L10, was landed near Uithuizen, quickly followed by gas from block K13, landing in Callantsoog. Oil production did not begin until 1982, in block Q1 (Helm).

At 1 January 1991, 67 production platforms had been erected for gas and 13 for oil on the NCS. Some of these platforms are interconnected and form a system of installations. There are two further gas platforms within the Netherlands territorial sea.

The length of the gas pipelines on the NCS is about 1000 kilometres. Some of them are collection pipelines. They transport the gas to terminals in Velsen, Callantsoog (2 pipelines) and Uithuizen. Work is currently proceeding on the construction of the "NOGAT" pipeline to open up the northern part of the NCS (NOGAT: Northern Offshore Gas Transport). This pipeline will be 460 kilometres long. The first gas trough the, at the moment partial operational, NOGAT pipeline landed in January 1992. There are also plans for a pipeline from blocks P15 and P18 to the Maasvlakte.

Two pipelines with a total length of over 100 kilometres are now in use for the transport of oil. These terminate at IJmuiden and Hoek van Holland.

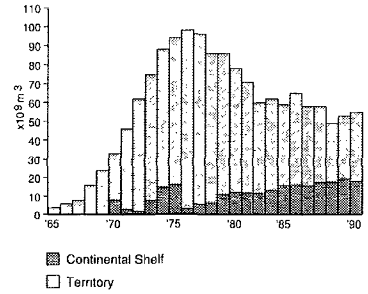
The map shows the location of the production platforms and pipelines. The projected "NOGAT" and "Zeepipe" pipelines have also been plotted.

The accompanying tables give the natural gas and oil production during the past few years for the whole of the Netherlands (territory plus Continental Shelf). The figures show that offshore production has become increasingly important in the course of time. 17.9 milliard m^3 of natural gas was produced offshore in 1990. That was 25% of the total Netherlands natural gas production. The figure for oil was 2.7 million m^3, or 69% of the total Netherlands oil production.

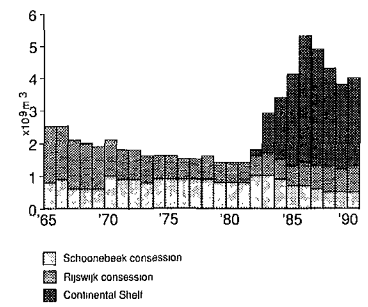
The exploration and production of oil and gas can conflict with the spatial requirements of other uses, particularly shipping and military activities. The Continental Shelf Mining Act includes provisions to protect other interests. More information about this is given in the commentaries to maps 92 and 93. The medium-term accommodation between shipping and minerals extraction is discussed in the commentary to map 58.

For safety reasons, 500-metre safety zones, which must be kept free of all other activities, have been established around all oil and gas installations. In order to reduce the chance of damage to pipelines to a minimum, detailed requirements can be laid down for laying and inspecting them.

Natural gas production,1965 - 1990



Oil production,1965 - 1990

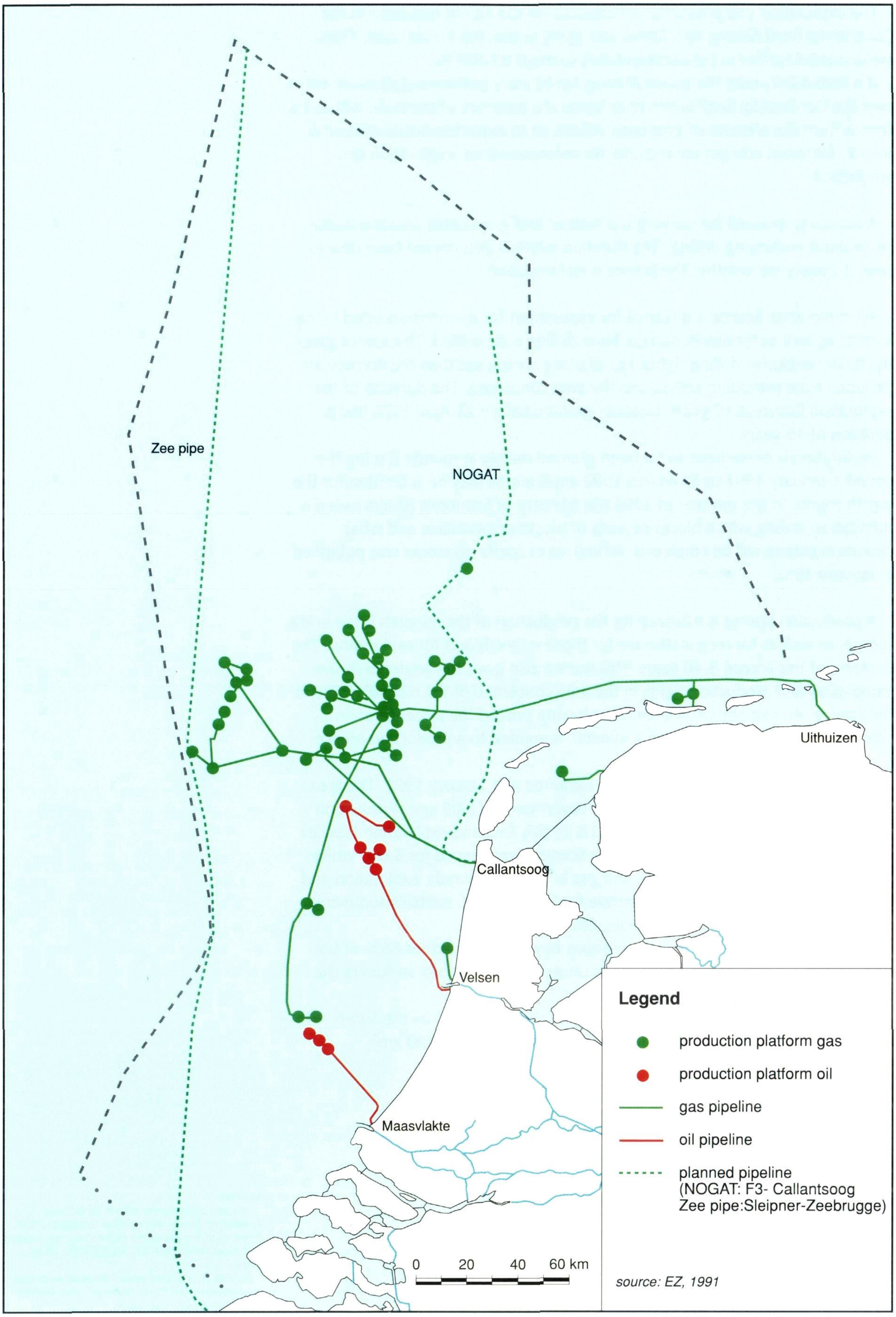


Source:

Ministry of Economic Affairs, Directorate-General for Energy, Information Directorate (EZ) (1991). Oil and gas in the Netherlands, exploration and production 1990. The Hague. ISSN: 0925-7993.

ICONA (1981). Inventarisatierapport Noordzee. Interdepartmental Co-ordinating Committee for North Sea Affairs. The Hague.

Production platforms and pipelines on the NCS



Exploration and production licences

The exploration and production of minerals on the NCS is regulated in the Continental Shelf Mining Act. Other acts apply within the 3-mile zone. These are discussed further in the commentaries to maps 92 and 93.

It is forbidden under the above Mining Act to carry out investigations in, on or over the Continental Shelf which may reveal the presence of minerals, without a licence from the Minister of Economic Affairs, or to extract minerals without a licence. Different licences are required for reconnaissance, exploration and production.

A licence is required for carrying out seismic and gravimetric reconnaissance, i.e. without employing drilling. The duration which is determined from case to case, is usually six months. The licence is not exclusive.

An exploration licence is a licence for exploration for the minerals listed in the licence, as well as for reconaissance. Now drilling is permitted. The licence gives the holder exclusive drilling rights, i.e. all other companies than the licensee are excluded from preceding activities in the area concerned. The duration of the exploration licence is 10 years. Licences granted before 23 April 1976 had a duration of 15 years.

Exploration licences have so far been granted mainly in rounds. During the period 1 January 1992 to 31 March 1992 applications may be submitted for the eighth round. In the summer of 1991 the Ministry of Economic Affairs issued a publication stating which blocks or parts of blocks are available and what allocation criteria will be employed. A final list of (parts of) blocks was published in January 1992.

A production licence is a licence for the production of the minerals listed in the licence, as well as for reconnaissance for those minerals and for exploration. The duration of this licence is 40 years. This licence also gives the holder exclusive exploration and production rights in the area concerned of the minerals listed in the licence. An exploration licence, after having proved the presence of an economic exploitable quantity of a mineral, is entitled to a production licence.

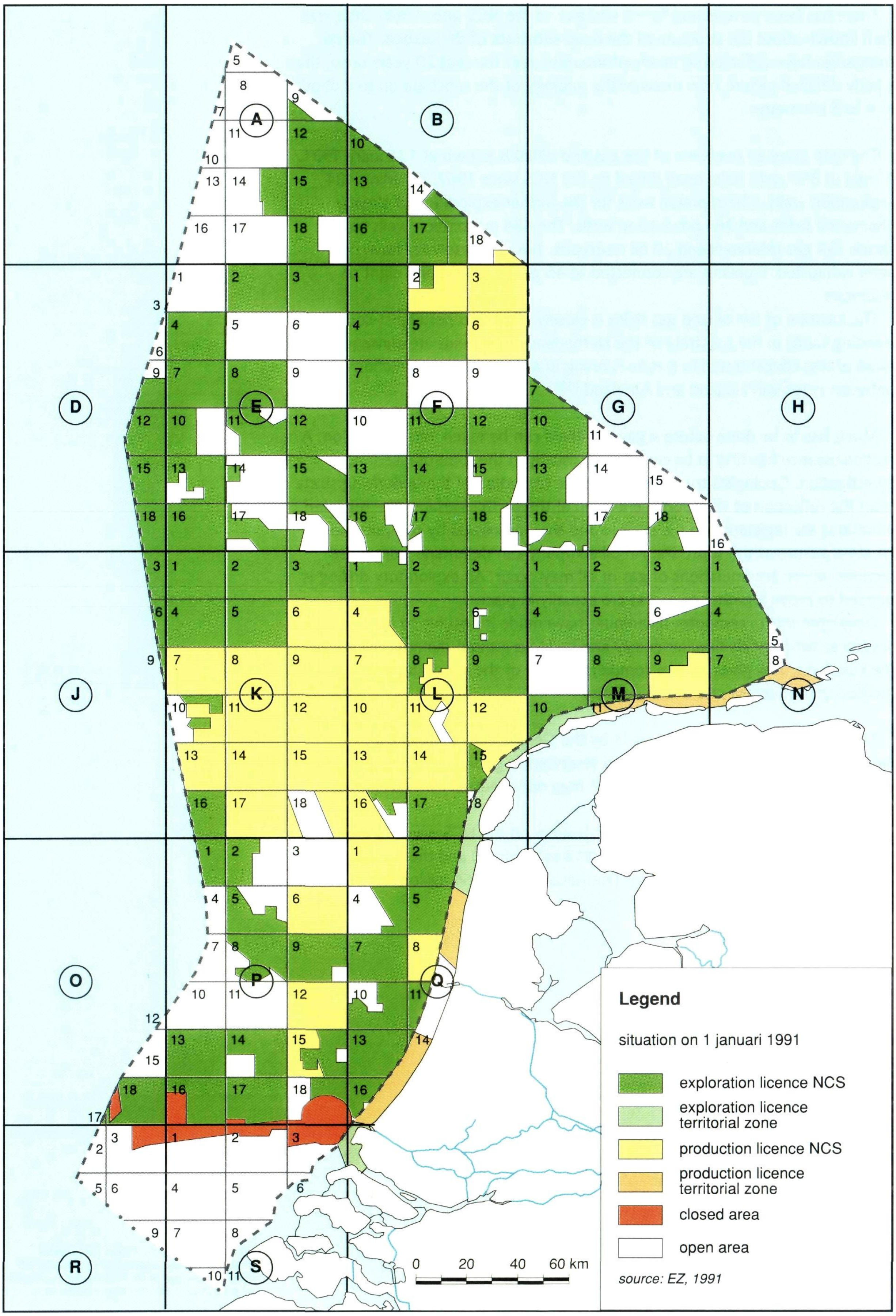
The map gives an overview of licences granted at 1 January 1991. The area available for exploration and production covers over 57,000 km^2. Production licences have already been issued for 20% of this area and exploration licences for approximately 50%. Reconnaissance licences were issued for 3,690 km^2 in 1990. The annual publication "Oil and gas in the Netherlands, exploration and production" of the Directorate-Generale for Energy of EZ, contains summaries of licence holders, duration of licences, etc.

Offshore drilling licences and concessions have been issued for 66% of the surface of the whole of the Netherlands territory (41,785 km^2). Including the territorial sea (3-mile zone).

The NCS is divided into a number of segments, designated by the letters A to T. Each of these segments is subdivided into blocks of about 400 km^2, numbered from 1 to 18.

Source:
Ministry of Economic Affairs, Directorate-General for Energy, Information Directorate (EZ) (1991). Oil and gas in the Netherlands, exploration and production 1990. The Hague. ISSN: 0925-7993.
ICONA (1981). Inventarisatierapport Noordzee. Interdepartmental Co-ordinating Committee for North Sea Affairs. The Hague.

Exploration and production licences



Oil and gas reserves

There has been prospecting for oil and gas on the NCS since 1968. Little was then known about the structure of the deep substrata of the seabed. The oil companies have collected so much information over the past 20 years or so, that a fairly detailed picture now exists of the geology of the substrata up to a depth of 4 to 5 kilometres.

The map gives an overview of the gas and oilfields known at 1 January 1991. A total of 858 wells have been drilled on the NCS since 1967, including 484 exploration wells, 110 appraisal wells for the further exploration of already discovered fields and 264 production wells. The 484 exploration wells have struck 137 gas reservoirs and 20 oil reservoirs. Two gas reservoirs have now been exhausted. Pipelines are connected to 45 gas reservoirs and eight oil reservoirs.

The location of the oil and gas fields is closely related to northwest-southeast trending faults in the substrata of the Netherlands. The fields are consequently more or less concentrated in a zone running in a northwesterly direction between Hoek van Holland and Ameland [68].

Much has to be done before a gas or oilfield can be taken into production. A reconnaissance has first to be carried out, usually in the form of a seismic investigation. Geologists try to determine the formation of the underlying strata from the reflection of vibrations generated at the earth's surface. The reflected vibrations are registered on the surface and then processed by computer to create a picture of the substrata. An oil company can determine from these pictures where accumulations of gas or oil may occur. An exploratory drilling is needed to prove whether oil or gas are actually in place.

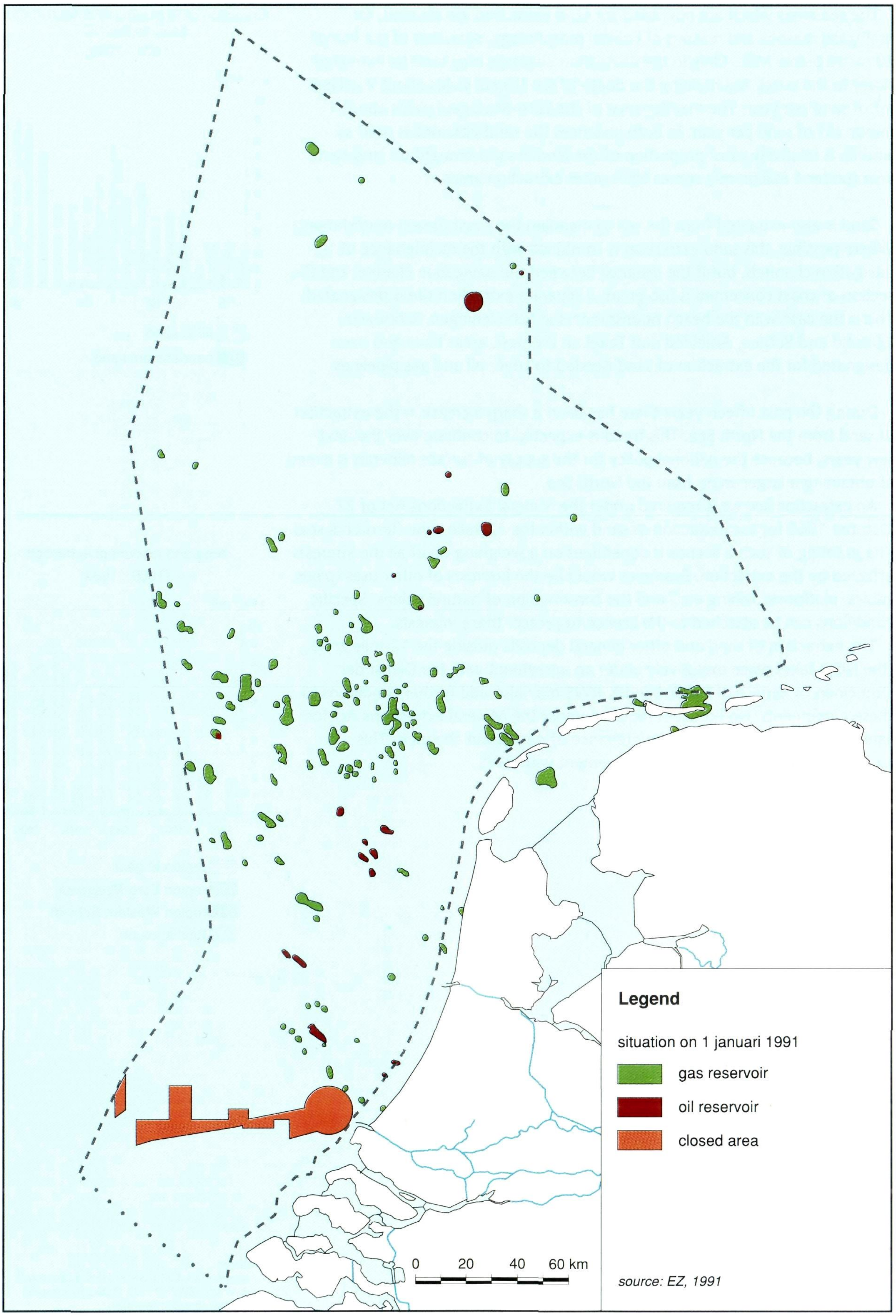
Developments in computer techniques have made it possible to process several seismic signals simultaneously and build up a three-dimensional image of the substrata. This gives a more complete picture of the substrata, thus increasing the success rate of the drillings.

The estimates of reserves are made by the Geological Survey of the Netherlands. They relate to the proved reservoirs in geological structures. All the fields are covered, including those which may not eventually be taken into production.

The remaining anticipated natural gas reserve on the NCS was 333 milliard m^3 at 1 January 1991 (Netherlands total: 2,113 milliard m^3) and the remaining anticipated oil reserve 24 million m^3 (Netherlands total: 64 million m^3).

Source:
Ministry of Economic Affairs, Directorate-General for Energy, Information Directorate (EZ) (1991). Oil and gas in the Netherlands, exploration and production 1990. The Hague. ISSN. 0925-7993.

Oil and gas reserves



Current sand extraction areas

The sea areas which are now used for sand extraction are situated, for ecological reasons and reasons of coastal morphology, seawards of the line of 20 metre below MSL. Only in the navigation channels may sand be extracted closer to the coast. Maintaining the depth of the IJ-geul yields about 7 million m^3 of sand per year. The maintenance of the Euro-Maasgeul yields about 1 million m^3 of sand per year. In both instances the sand obtained is used as landfill. A relatively small proportion of the landfill sand brought on land each year (under 1 million m^3) comes from other extraction areas.

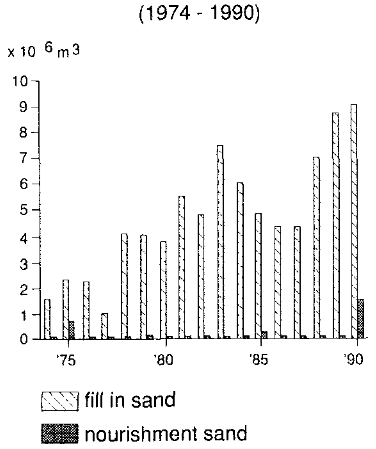
Sand is also extracted from the sea to maintain the coast (beach nourishment). Where possible, this sand extraction is combined with the maintenance of navigation channels, but if the distance between the navigation channel and the section of coast concerned is too great, a separate extraction site is designated. This is the case with the beach nourishments at Scheveningen, Schouwen, Egmond and Bergen, Ameland and Texel. In the past, areas have also been designated for the extraction of sand needed to cover oil and gas pipelines.

During the past fifteen years there has been a sharp increase in the extraction of sand from the North Sea. This trend is expected to continue over the next few years, because the national policy for the supply of surface minerals is aimed at obtaining a larger share from the North Sea.

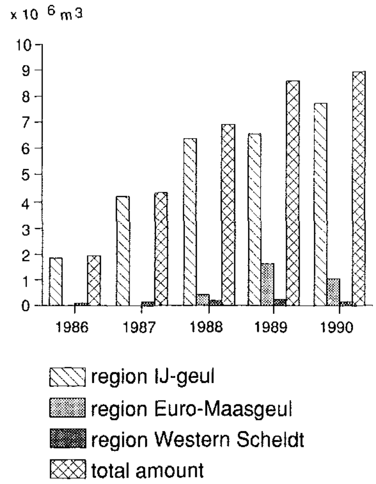
An extraction licence is required under the Mineral Extractions Act of 27 October 1965 for the extraction of sand within the 12-mile zone (territorial sea). The granting of such a licence is dependent on a weighing up of all the interests affected by the extraction. Examples would be the interests of other uses (pipes, cables, platforms, fishing etc.) and the conservation of natural values. Specific conditions can be attached to the licence to protect these interests.

The extraction of sand and other mineral deposits outside the 12-mile zone (the NCS) takes place exclusively under an agreement with the Dienst der Domeinen (= Service of Public Lands). RWS may also add further conditions to these agreements. No licence is required under the Mineral Extractions Act for sand extraction as part of the maintenance of navigation channels. This extraction is carried out under an agreement with RWS.

Extraction of fill in sand and nourishment sand on the NCS
(1974 - 1990)

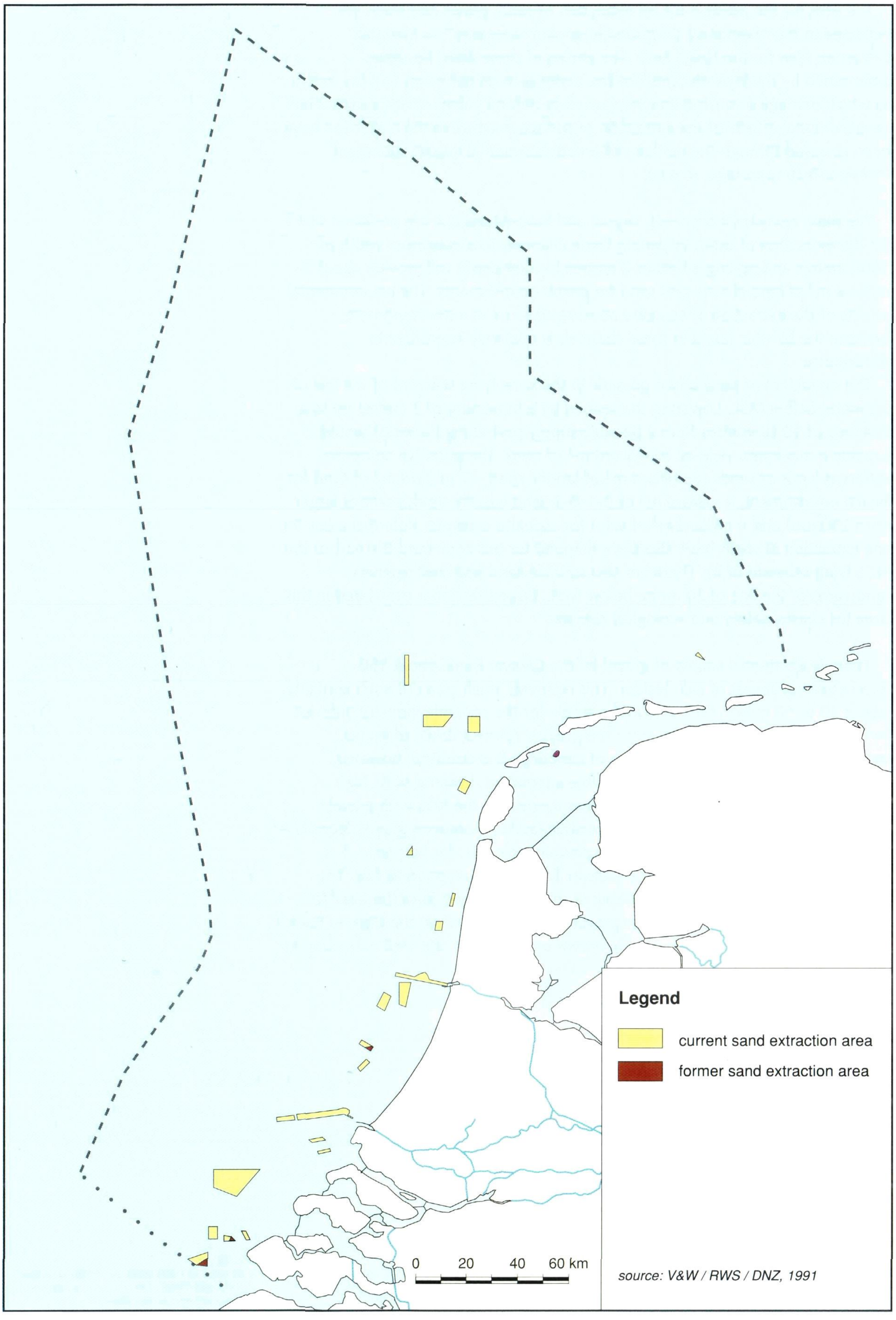


Area and amount of extraction
(1986 - 1990)



Source:
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991). Ontwerp Regionaal Ontgrondingenplan Noordzee.

Current sand extraction areas



Potential surface mineral extraction areas

The sites for the possible future extraction of sand, gravel and shells are indicated in the "Regionaal Ontgrondingenplan Noordzee" (= Regional Extraction Plan for the North Sea). The choice of these areas has been determined by the layer thickness of the material to be extracted and the extent to which damage or obstruction are caused to natural values or other uses. The environmental effects of the extraction of surface minerals in the North Sea have been assessed through the medium of an environmental impact statement (milieu-effectrapportage: m.e.r.).

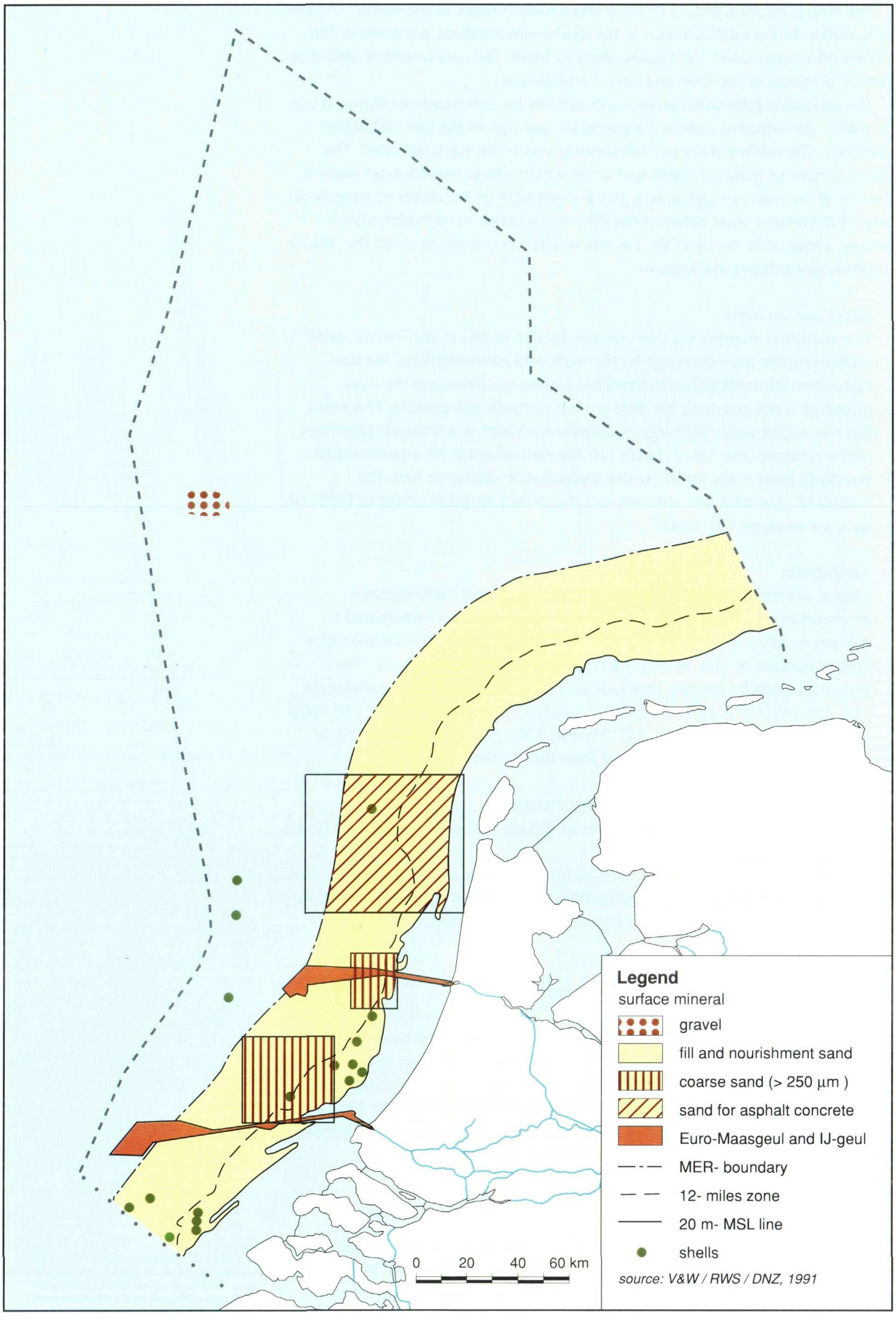
The main navigation channels, IJ-geul and Euro-Maasgeul, are preferred sites for the extraction of sand. Widening these channels to a maximum width of 1500 metres and adding a further 2 metres to their depth will provide about 1 milliard m^3 of landfill sand and sand for beach nourishments. The environmental effects of the extraction of sand are considered to be at a minimum here, because the benthic fauna in these channels is relatively insensitive to disturbance.

The extraction of sand is also possible in the zone lying seaward of the line of 20 metre below MSL. Lowering the seabed by a maximum of 2 metres up to a distance of 50 kilometres from a possible supply port along the coast would provide a maximum yield of 36 milliard m^3 of sand. The potential comprises different kinds of sand: 16 milliard m^3 of landfill sand, 12 milliard m^3 of sand for beach nourishment, 4 milliard m^3 of 0-1/0-2 sand (course sand; particles larger than 250 µm) and 4 milliard m^3 of sand for asphalte concrete. Potential areas for the extraction of shells have also been mapped for this zone (and the part of the NCS lying seaward of it). There are also suitable sand and shell reserves landwards of the line of 20 metre below MSL, but extraction is prohibited in this area for coastal safety and ecological reasons.

There is a potential source of gravel on the Cleaver Bank, about 150 kilometres northwest of Den Helder. This relatively small area (18 km^2) contains about 30 to 50 million tons of gravel suitable for the concrete industry. Interest in the Cleaver Bank has grown since the gradual running down of gravel extraction on the mainland (province of Limburg). It is doubtful, however, whether the Cleaver Bank offers a suitable alternative, because of its high ecological value. The Cleaver Bank is the only area on the NCS with gravel deposits and consequently an unique benthic fauna. Moreover, gravel deposits have been found to provide attractive spawning grounds for herring. Observations have shown that the Cleaver Bank is no exception to this. The results of a separate m.e.r. to be drawn up for this area will form the basis for determining in due course whether gravel can be extracted on the Cleaver Bank. A separate m.e.r. will also have to be drawn up for large-scale shell extraction in the North Sea.

Source:
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991). Ontwerp Regionaal Ontgrondingenplan Noordzee.

Potential surface mineral extraction areas



Sources of pollution

The map provides a picture of the relative contributions of the various sources of pollution to the total pollution of the marine environment in the North Sea. Unless otherwise stated, the figures relate to 1988. They are estimates collected for the purposes of the Oslo and Paris Commissions.

The estimated total pollution of the North Sea by a particular substance is put at 100%. Atmospheric pollution is put at the average of the two calculation methods. The relative share of each country and/or source is indicated. The large number of question marks and uncertainties about the estimates make it clear that the map can give only a global impression of the orders of magnitude and of the relationships between the different sources. In particular, little is known about pollution by PCBs; this has resulted in overemphasis of the relative contribution entering via Belgium.

- Direct and via rivers

  The quantities entering via rivers or directly discharged at sea are calculated by multiplying the river discharge by the measured concentrations. Because calculation methods differ between the various countries and the river discharge is not constant, the data are not mutually comparable. The Rhine has the largest water discharge and therefore brings in a relatively large part of the nutrients and heavy metals (via the Netherlands). An adjustment has obviously been made for the water and pollution discharge from the hinterland. The data for Denmark and the United Kingdom relate to 1986. No data are available for France.

- Atmosphere

  Little is yet known about atmospheric deposition. QSR 1990 contains estimates made according to two methods, both with a minimum and a maximum value: estimate A is based on measurements in precipitation at a limited number of sites, estimate B is based on model calculations. The estimates made by the two methods vary considerably for some substances. The deposition of copper in 1988, for example, was between 1050 and 1680 tons according to method A, and between 130 and 135 tons according to method B. Lead is deposited mainly from the atmosphere.

- Dumping of sewage sludge and dredged material

  Only the United Kingdom dumps sewage sludge in the sea. It does this from ships. The map data relate to 1987.

  Half of the dredged material originates from harbours and the remainder from estuaries and nautical canals. The quantities of dumped dredged material vary from year to year. Germany does not dump directly at sea, but in inland waters.

- Discharge and incineration of industrial waste

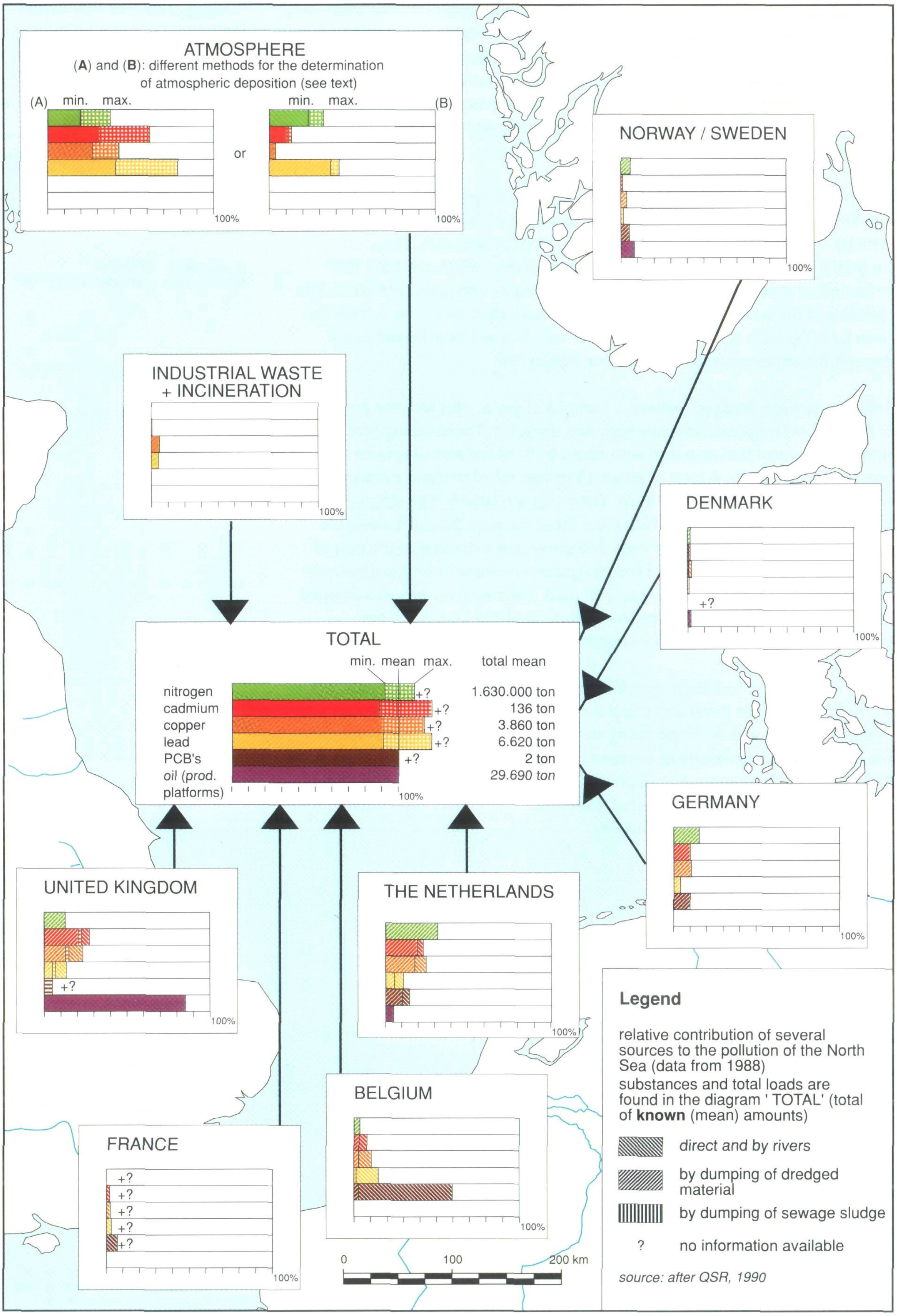
  In 1988 the United Kingdom, Belgium and West Germany discharged about 1.7 million tons of liquid industrial waste into the sea. The greater part of the waste originated from the titanium dioxide industry in the two latter countries [(76)]. In 1988 the United Kingdom dumped 2 million tons of solid industrial waste in the sea. This waste comes largely from the coal mines. In 1988 nearly 96,000 tons of waste originated from incineration at sea [(76)]. This was mainly chlorine-rich chemical waste. Solid industrial waste made the largest contribution to the pollution of the North Sea.

- Discharges from drilling platforms

  About 225,000 tons of oil find their way annually into the sea. A small proportion of this originates from drilling platforms (30,000 tons in 1988). The oil waste from the German drilling platforms is deposited on land.

Source:
Quality Status Report (QSR) (1990). 1990 Interim Report on the Quality Status of the North Sea. Third International Conference on the Protection of the North Sea; February 1990.

Sources of pollution



Dumping sites of dredged material

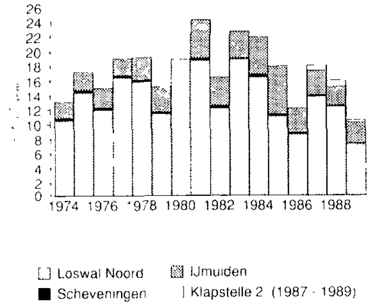
Sand and mud are transported along the Netherlands coast [17]. The rivers also bring in mud and sand. The mud from the sea is generally relatively clean, while the river mud has been polluted by the agriculture, industries and households along the rivers. Mud settles in a quiet environment, such as harbours, which mud up as a result. In order to keep the harbours and approach channels along the Netherlands coast accessible to shipping the deposited material must be removed by maintenance dredging.

The dumping of dredged material at sea is covered by the Pollution of the Sea Act. This act gives exemption only for the dumping of relatively clean dredged material. Polluted dredged material must be stored in land sites. The most important land site is the "Slufter" on the Maasvlakte, which can hold 150 million m^3 of dredged material. This is expected to be adequate until 2002. The objective of the water quality policy is that harbour mud should be sufficiently clean by 2000 for it again to be dumped at sea. This will be achieved partly through the implementation of the Rhine Action Plan.

Relatively clean dredged material is dumped at sea at sites near the harbours of Rotterdam Europoort, Scheveningen and IJmuiden. The dumping sites Loswal Noord and Loswal IJmuiden deal with about 95% of the annual volume (see the accompanying graph). A total of about 15 million m^3 of dredged material a year was dumped at sea in the late 1970s. There was a relatively high storm frequency in the early 1980s, which meant that the mud transport along the Netherlands coast was relatively high. Moreover, the extension of the port of Zeebrugge and the deepening of the navigation channels Euro-Maasgeul and IJ-geul resulted in an additional supply of mud. Polluted mud was also dumped at sea, as no more land sites were being made available because of the pollution. The quantity dumped increased during this period to about 22 million m^3 a year.

The above works had been completed by the second half of the 1980s, the storm frequency was lower and about 3 million m^3 of moderately polluted dredged material was no longer being dumped at sea, but in a special area on the Maasvlakte. The volume of dumped dredged material declined in the second half of the 1980s to about 13 million m^3 a year. Dredged material from other harbours, such as Eemshaven, Delfzijl, Harlingen, Den Helder and Flushing, is not dumped at sea, but in the estuaries.

Dumping of dredged material from Dutch harbours on the North Sea (1974 - 1989)



Source
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991); unpublished data

Dumping sites of dredged material

Former incineration and waste discharge areas

The North Sea was used until recently by the surrounding countries as a communal terminal for waste. Waste acids from the German titanium dioxide industry, for example, were discharged on the Netherlands sector of the Continental Shelf off Hoek van Holland, about 40 kilometres off the coast. Three smaller areas along the coast were also available for the discharge of industrial wastes, but these were seldom used in practice.

Research has been proceeding for many years into the possible effects of these discharges, but they have never been clearly established. This is partly because the diluted wastes are spread over the North Sea by currents. Some of the dumped heavy metals have probably found their way into the seabed, however [32, 33].

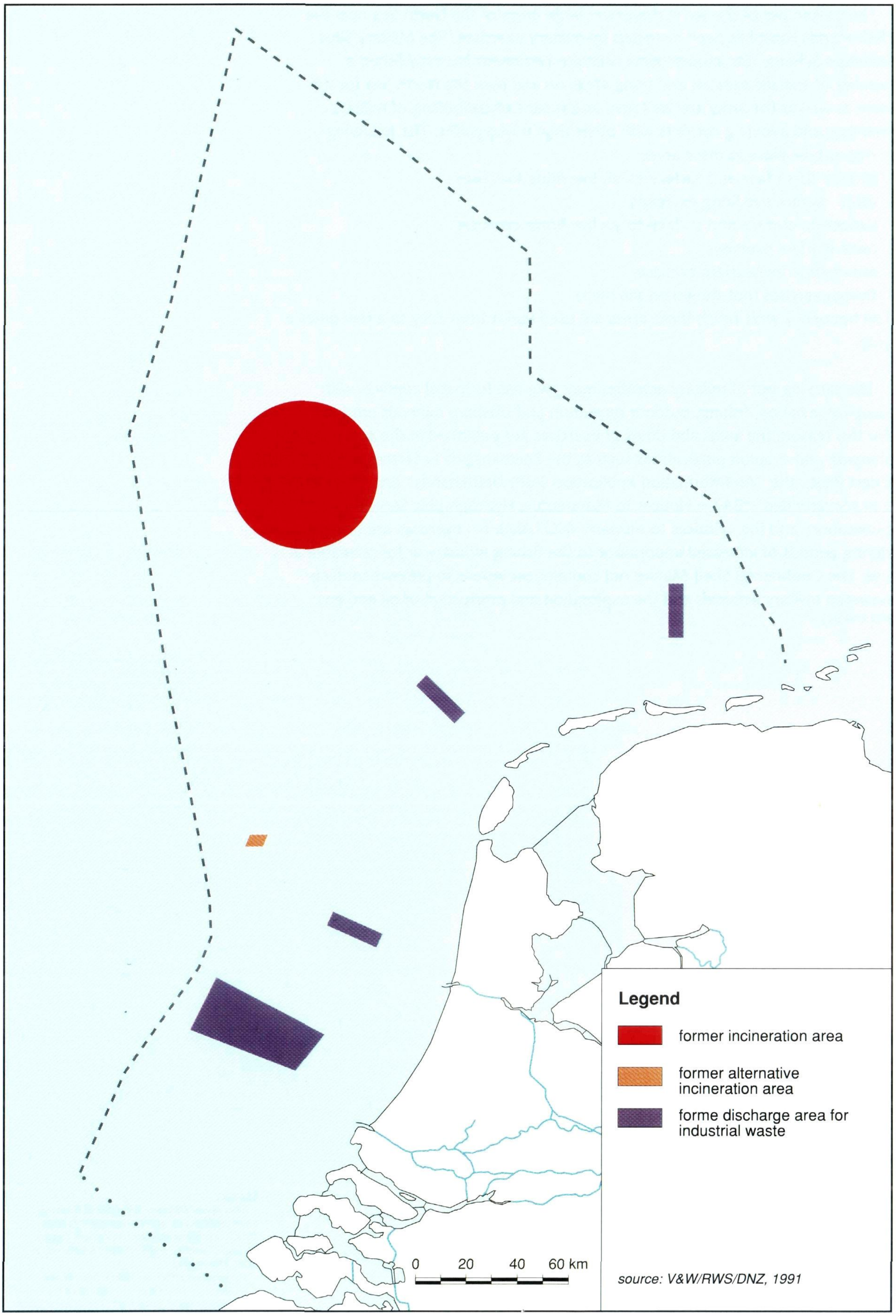
The only incineration area of the North Sea (about 2400 km^2) was also situated on the NCS, as well as an alternative area where chemical wastes from different European countries were incinerated. In 1987 and 1988 a total about 200,000 tons of waste originating from Belgium, Germany (48%), France, Italy, the Netherlands (2%), Norway, Austria, Spain, Switzerland and the United Kingdom was destroyed there.

An exemption is required under the Pollution of the Sea Act for the discharge and burning of wastes. Compliance with the exemption regulations was monitored in practice by means of black boxes installed on board, which recorded course, speed and combustion temperature.

The discharges were terminated on 1 January 1990 under the agreements made at the North Sea Ministers Conference, and burning was ended on 1 February 1991. The termination coincides with the introduction of manufacturing processes which release fewer or no wastes. The treatment facilities on land have also been further expanded.

Source:
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991): unpublished data.

Former incineration and waste discharge areas



Netherlands military exercise areas

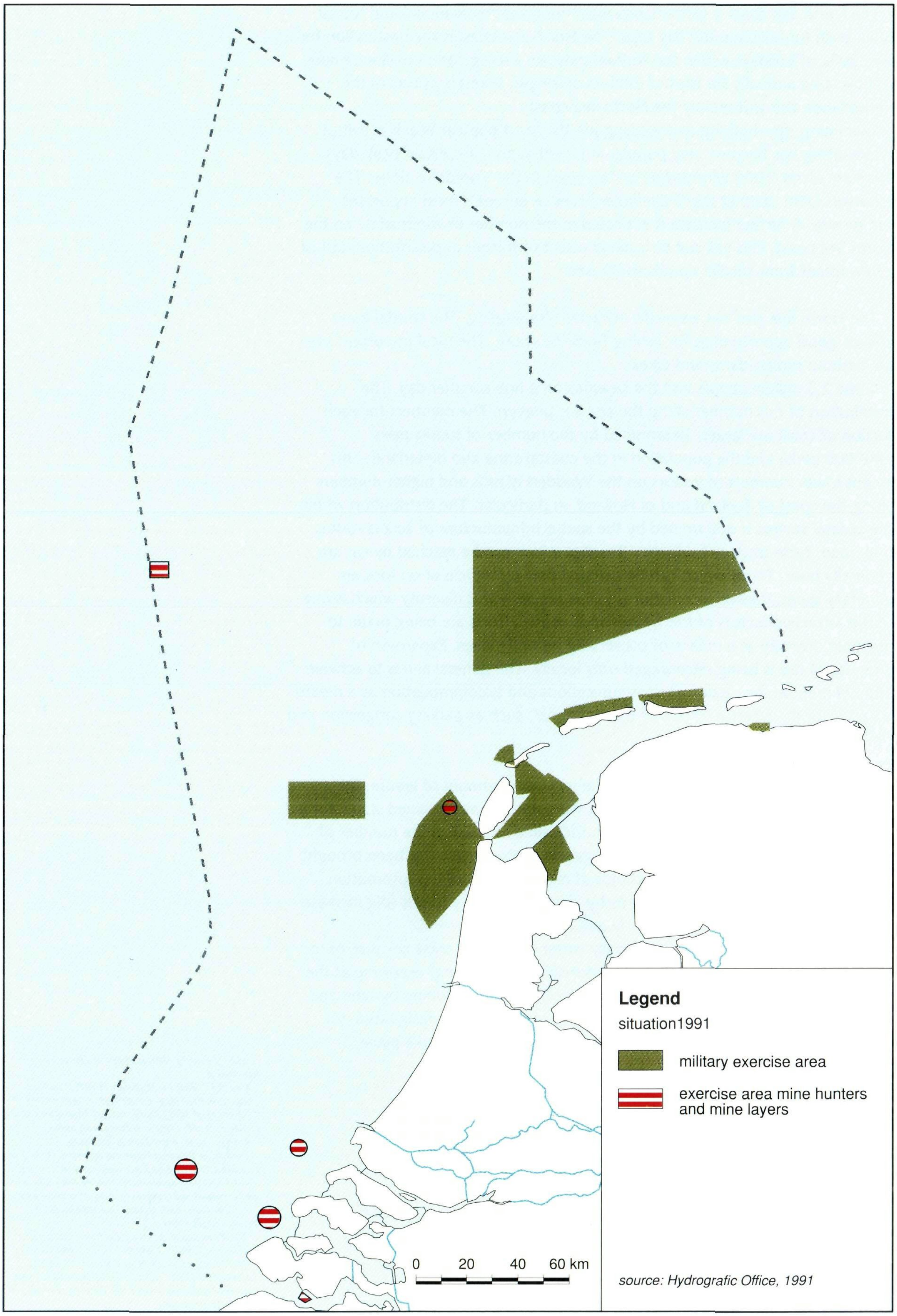
The civilian use of the sea surface over large areas of the North Sea near the Netherlands coast has been restricted by military exercises. The Military Sites Structure Scheme (Structuurschema Militaire Terreinen) has established a number of specific exercise and firing areas on and over the North Sea for the navy as well as the army and air force, as a means of controlling of military exercises and avoiding conflicts with other than military uses. The following activities take place in these areas:
- surface-to-surface and surface-to-air live firing exercises
- air-to-surface live firing exercises
- surface-to-surface and surface-to-air live firing exercises
- mine warfare exercises
- anti-submarine warfare exercises
- flying exercises (not shown on the map).

The frequency with which these areas are used varies from daily to a few times a year.

The carrying out of military activities may give rise to spatial conflicts with shipping, aviation, fishing, outdoor recreation and offshore minerals production. For this reason, the areas and times of exercises are published in the appropriate shipping and aviation publications such as the Zeemansgids (= Netherlands Coast Pilot), the "Air Information Publication (AIP) Netherlands" and "Berichten aan zeevarenden" (BAZ = Notices to Mariners), a Hydrographic Service publication, and the "Notices to Airman" (NOTAM). No exercises are held during periods of increased importance to the fishing industry or for recreational use. The Continental Shelf Mining Act contains provisions to prevent conflicts between military activities and the exploration and production of oil and gas (92 and 93).

Source:
Ministry of Defence, Ministry of Housing, Physical Planning and Environment (1984). Structuurschema Militaire Terreinen, Deel d. Second Chamber, 1983-1984, 16 666, no. 9-10. SDU, The Hague.
Hydrographic Office (1991). Bericht aan Zeevarenden. Hydrographic Service of the Royal Netherlands Navy. BAZ 1-39; 116 volume no. 1.

Netherlands military exercise areas



Beach and shoreline recreation

The North Sea coast is Netherlands most important recreational and tourist zone, both for holidays and day trips. The North Sea coast is the destination for over 20% of holidays within the Netherlands. An average of 38 million people visit the area annually for trips of 2 hours or longer. Foreign visitors to the Netherlands also visit mainly the North Sea coast.

Swimming, sun-bathing and walking are the most popular beach activities. Windsurfing has become very popular in recent years. On certain peak days there are some 6,000 windsurfers on the coast in the Voordelta alone. The Brouwers Dam (dam at the Grevelingen) is even Europe's most important surfing site. A further increase is expected in the number of windsurfers on the North Sea coast. This will not be a direct effect of further popularisation, but of a movement from smaller waters to the sea.

The North Sea also has a specific attraction for angling. The coastal zone affords good opportunities for fishing from the shore. The most important sites are harbour moles, dams and dikes.

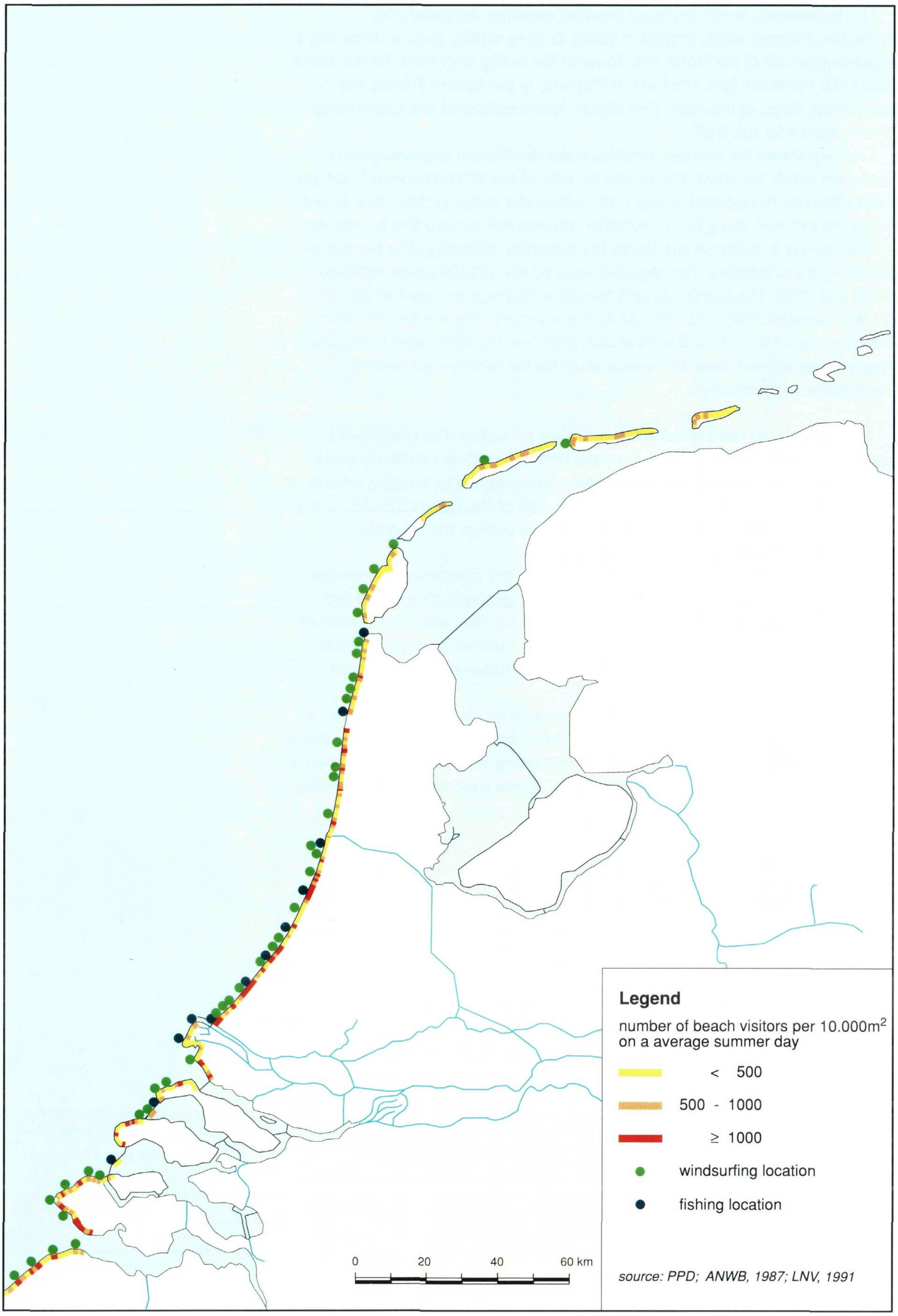
Some 2.5 million people visit the beaches on a fine summer day. The distribution of this number along the coast is uneven. The numbers for each section of coast are largely determined by the number of tourist beds (350,000 beds) and the population in the coastal zone and hinterland. This means lower numbers of visitors on the Wadden Islands and higher numbers along the coast of Zeeland and of Holland, in particular. The distribution within the coastal sectors is determined by the spatial infrastructure of access routes (rail, road, cycle track or footpath). Beaches which can be reached by car are generally busy. Those which can be reached only by bicycle or on foot are generally quiet. Viewed internationally, it is precisely this diversity which is one of the attractive factors of the Netherlands coast. Efforts are being made to maintain diversity as a means of conserving natural values. Expansion of intensity of use is being encouraged only locally. The general aim is to achieve improvement in the quality of communications and accommodation as a means of reducing the adverse effects of the motor car, such as parking congestion and traffic queues.

Despite the population growth and the increased amount of leisure, the number of visitors to the beaches during the summer has remained stable for a long time, although there has been a considerable increase in the number of visitors outside the summer. This prolongation of the season has been brought about by an improvement in the choice of recreational facilities (promotion, special arrangements, etc.), as well as by changing holiday trends (big increase in short breaks, especially in the early and late season).

Safety problems may arise in the busy water and beach areas because of too many activities (sailing, windsurfing, water-skiing, swimming) occurring at the same time. Many communities have therefore introduced zoning by time and place in order to regulate the various uses. Areas have been designated, for example, where windsurfing or waterskiing may or may not take place.

Source:
ANWB (1987). Windsurfinformatiekaart van Nederland.
Central Office for Statistics (1987). Stuctuur-onderzoek naar dag- en verblijfsrecreatie 1985.
Ministry of Agriculture, Nature Management and Fisheries (LNV) (1991): information about important near-shore fishery locations.
Provincial Physical Planning Agencies (PPDs) of Friesland, Noord and Zuid-Holland and Zeeland and Ministry of Agriculture, Nature Management and Fisheries: adaptation of data of several years.
Continu Holidays Survey Foundation (1991). Yearly report 1990.
The Provisional Advisery Body for Outdoor Recreation (1990). Kampeerregistratiebestand.
The Provisional Advisery Body for Outdoor Recreation (1990). Voordelta, op den duur - een toekomstverkenning voor toerisme en recreatie in en om de Voordelta.

Beach and shoreline recration



Water recreation

The Netherlands North Sea coast provides moorings for about 3000 recreational vessels which engage in sailing in open waters. Most of these ships make regular use of the North Sea. Some of the sailing craft from the hinterland also enter the North Sea. The locks at Flushing, in the Eastern Scheldt and Haringvliet dams, at IJmuiden, Den Oever, Kornwerderzand and Lauwersoog are important for this traffic.

The map shows the average densities in the distribution of pleasure craft along the North Sea coast. The counts (as part of the VONOVI-project, see also map 60) cover recreational fishing craft, sailing and motor yachts. They do not cover recreational sailing from the beach (catamarans, windsurfing boards, etc.).

The interest in sailing on the North Sea is steadily increasing. The number of permanent and transient moorings increased by about 1100 places between 1983 and 1991. The number of lock transits at Flushing increased by 30% to 21,424 between 1985 and 1990. At Kornwerderzand, the number of transits increased by 58% to 32,636 recreational craft over the same period. Because of this growing interest there are various plans for the further expansion of recreational craft moorings.

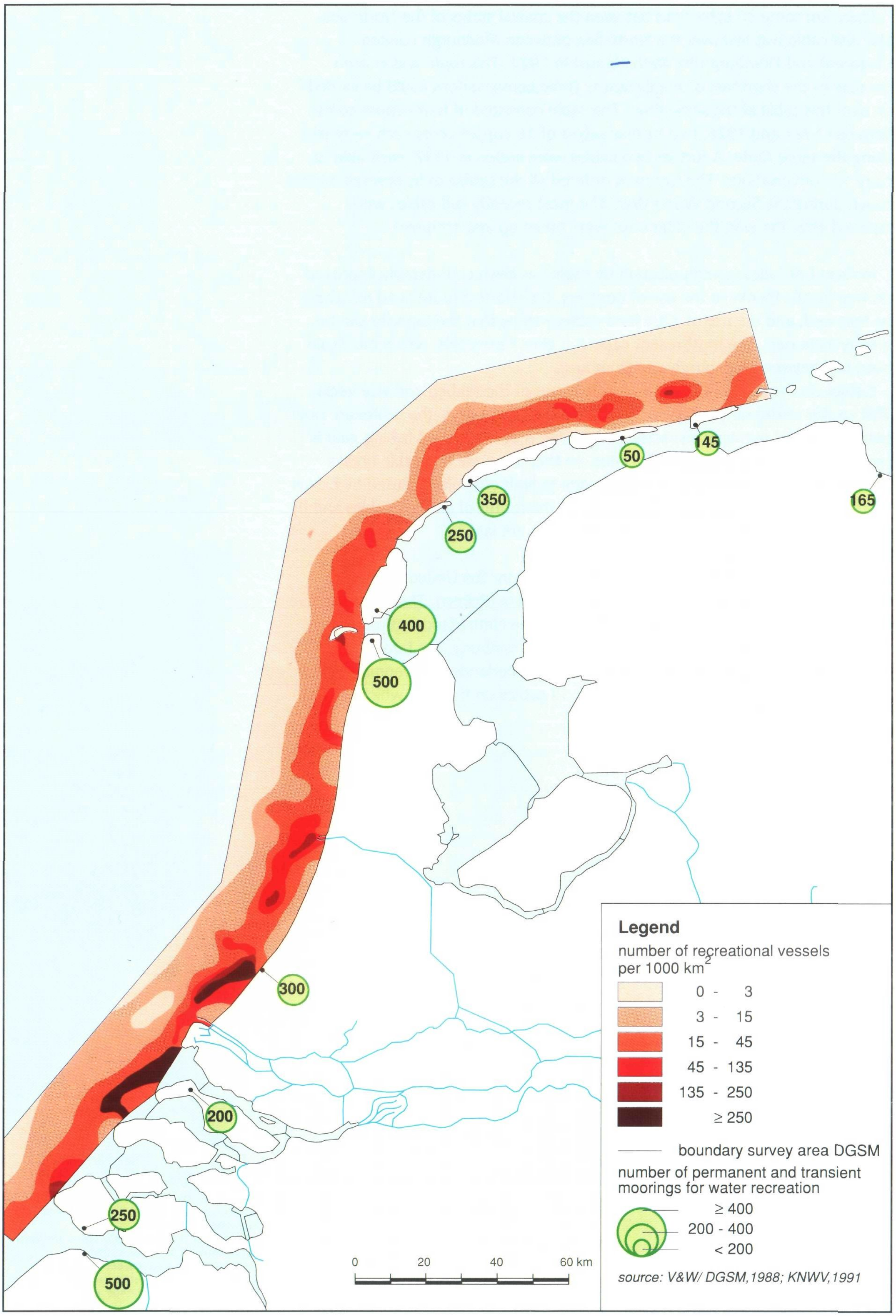
The Netherlands coast is not without its risks for sailing. The coast itself is generally weather shore and the distances between ports are relatively great. Efforts are being made to bring about some improvement by creating refuges, such as that near Neeltje Jans island at the mouth of the Eastern Scheldt, or even by constructing new yacht harbours. This will not change the generally unsheltered character of the coast, however.

A separate branch of water recreation is that of the commercially-operated hired ships for sea angling. These consist of thirty generally cleaned-up and converted fishing craft, stationed directly on the sea. They provide a combined capacity of nearly 1300 places for anglers. There a further 80 angling vessels with a capacity of 3300 places in the Delta and Wadden zones. These also largely set course for the North Sea.

There is also much angling from open fishing boats. On busy days there are many hundreds of these craft at sea. They like to find wreck sites because that is where fish congregate. Lastly, there is charter sailing with traditional commercial sailing craft, referred to as the "Brown Fleet". These ships also make increasing use of the North Sea.

Source:
Royal Netherlands Yachting Union (KNWV) (1991): information about 3000 permanent and transient places.
Dutch Association of Sportfish Federations (1991). Bootgids 1991.
Ministry of V&W, Directorate-General for Shipping and Maritime Affairs (V&W/DGSM) (1988): density of recreation off the Dutch coast.
Ministry of V&W, RWS, Transportation and Traffic Research Division and Regional Directorate Zeeland Rotterdam/Middelburg (1991): information about the amount of passages through locks.
Foundation on Recreation (1983). Waterrecreatie langs de Nederlandse kust.

Water recreation



Telecommunication cables

There are some 30 cable links between the coastal states of the North Sea. The first cable was laid over the North Sea between Aldeburgh (United Kingdom) and Domburg (the Netherlands) in 1922. This route was chosen because of the shortness of the distance. Three conversations could be carried on over this cable at the same time. The cable consisted of four copper cores. Between 1924 and 1926, two further cables of 16 copper cores each were laid along the same route. A further two cables were added in 1937, each able to carry 12 conversations. The Germans ordered all the cables to be severed on the beach during the Second World War. The most recently laid cables were repaired after the war; the older ones were taken up and scrapped.

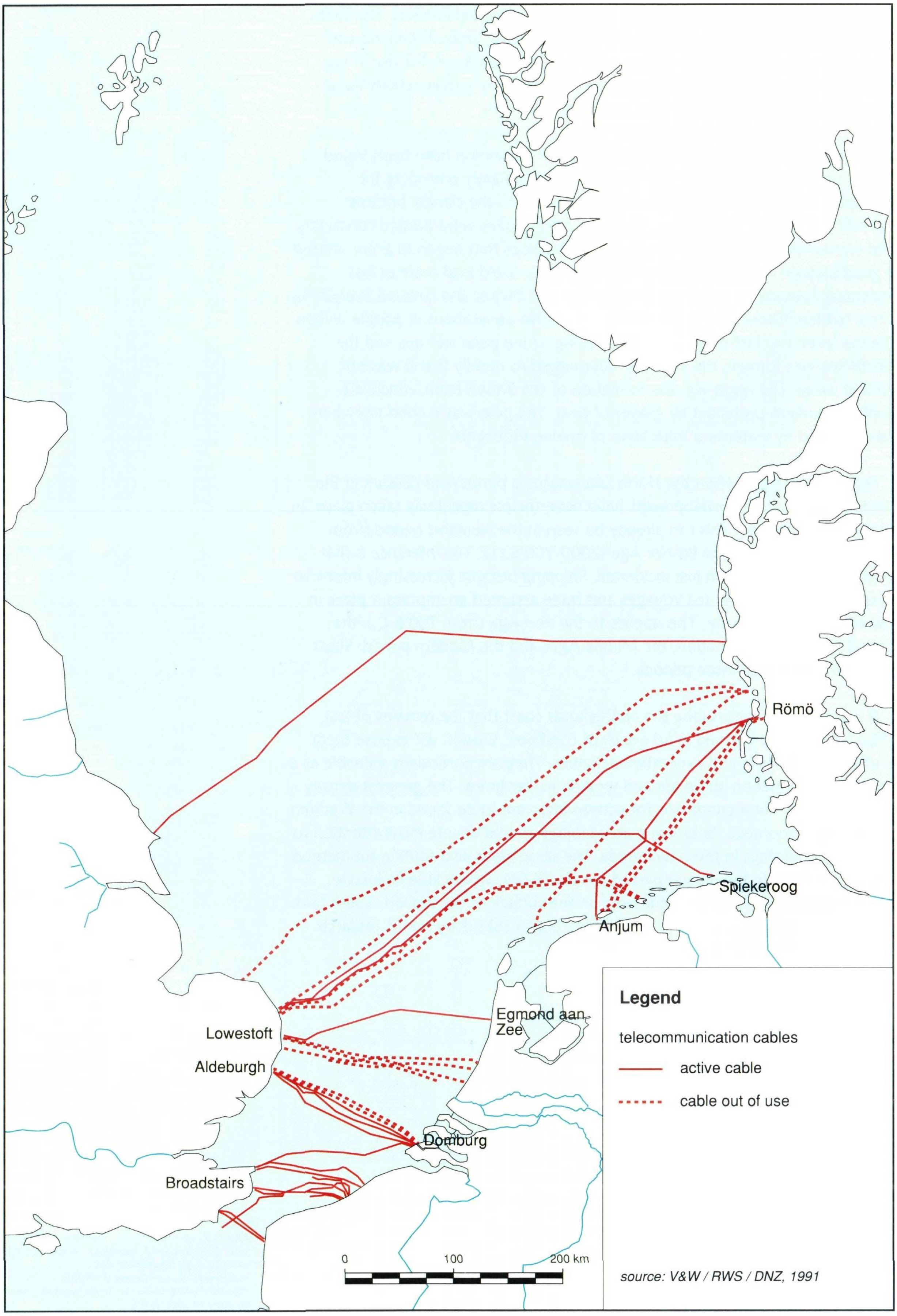
In recent decades, communication by cable has been considerably improved on two fronts: thanks to the use of boosters, the shortest route need no longer be followed, and the use of glass fibre cables means that the capacity can be greatly increased. The most recent cable is a glass fibre cable, which has again been laid between Aldeburgh and Domburg.

Cables on the seabed can obstruct other uses of the seabed and vice versa. This applies particularly to fishing. In contrast to earlier days, the cables are now entrenched and regularly inspected. Moreover, modern seabed fishing gear is provided with anti-cable fouling devices, so that there are few cable breaks caused by fishing. Attempts are being made to limit difficulties caused by cables on the seabed by improving the mapping of the routes of existing cables and by taking other uses into account when new cables are laid.

There are at present two cables over the NCS from the United Kingdom (Winterton) to Germany (Spiekeroog) and Denmark (RØmØ). There are also five connections between the United Kingdom and the Netherlands (Broadstairs-Domburg, three cables between Aldeburgh and Domburg, and Lowestoft-Egmond aan Zee) and one cable between the Netherlands and Denmark (Anjum-RØmØ). Lastly, there are a further 13 cables on the NCS which are out of use and have partly been removed.

Source:
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991). Overzicht offshore activiteiten Nederlands deel van het Continentaal Plat. Map April 1991.
Ministry of Transport, Public Works and Water Management (1990). Harmonisatie Noordzeebeleid; Noordzeebrief 1990 met voortgangsrapportage actieprogramma. Second Chamber, 1990-1991, 17 408, no. 54. SDU, The Hague.

Telecommunication cables



Sites of archaeological value

The Netherlands delta is extremely rich in archaeological remains. The Delta and coastal zone have been inhabited since prehistoric times. Both land and water were intensively used. Because of the subsiding sobsoil, the rise in sea level and a continuous supply of sediment, the traces of earlier activity have been particularly well covered over and protected.

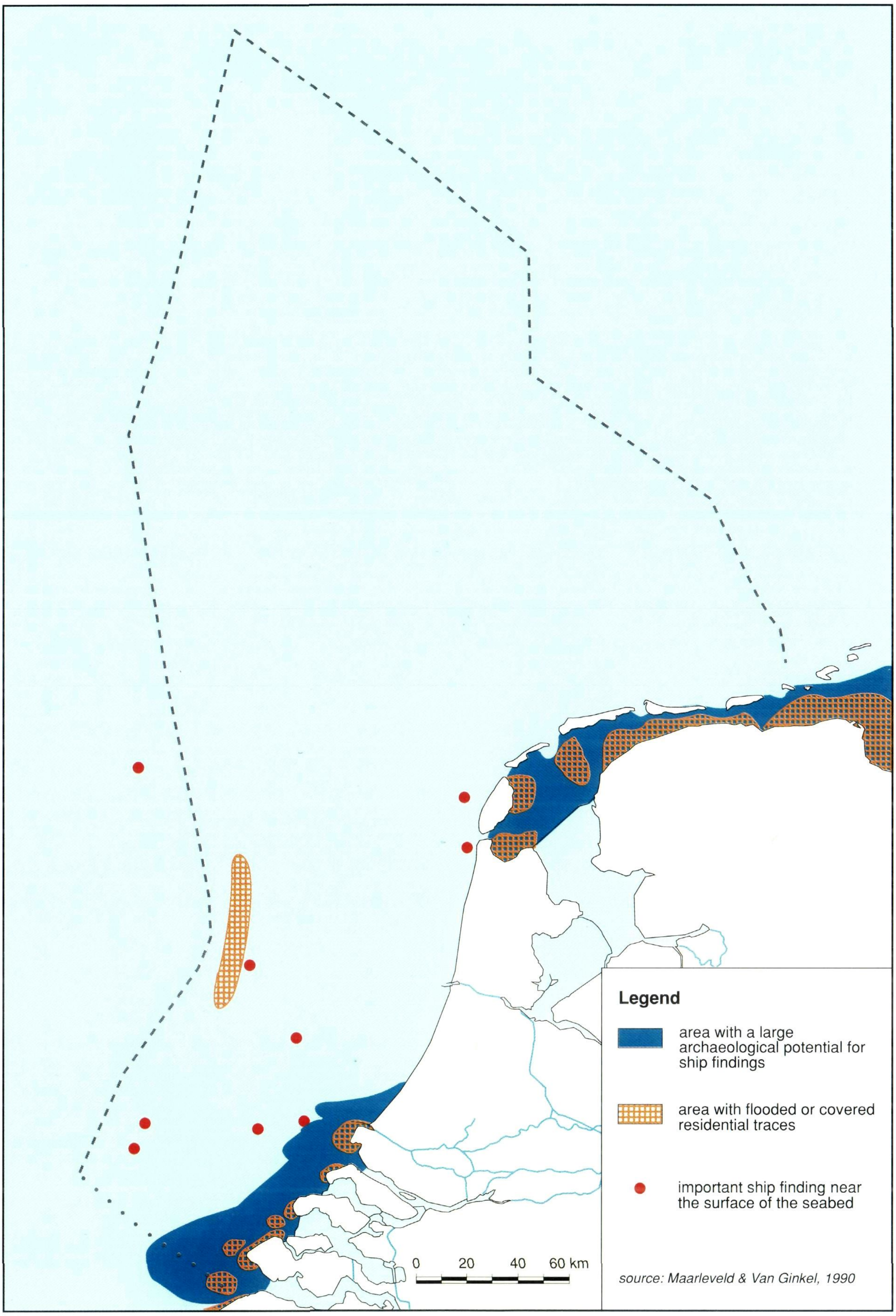
In the middle of the North Sea the remains of habitation have been found. These residential traces date from the period immediately preceding the formation of the North Sea (8000-5000 B.C.). When the climate became warmer and wetter at the end of the last Ice Age, lakes were formed containing and surrounded by a luxuriant vegetation. The bogs that began to grow offered a good biotope for people. For the first time they could lead more or less sedentary lives there. The bogs grew thicker and thicker and covered everything used, hidden, thrown away and lost by successive generations of people. When the sea level rose further through the melting of the polar ice caps and the North Sea was formed, the peat was submerged so rapidly that it was not eroded away. The result was the formation of the Brown Bank, which still contains remains protected by a layer of peat. The peat was eroded elsewhere and replaced by water or a thick layer of marine sediments.

From the moment when the North Sea created a permanent division in the land, parallel cultural developments have nevertheless repeatedly taken place on both sides of the sea. This can already be seen in the Neolithic period (from about 4000 B.C.) and the Bronze Age (2000-700 B.C.). The inference is that overseas contact was not just incidental. Shipping became increasingly intensive in later periods. Fishing, sea voyages and trade assumed an important place in the economy and culture. This applies to the Iron Age (from 700 B.C.), the period of Roman domination, the Middle Ages and the Modern period. Ships were sunk during all those periods.

It is precisely in areas along the Netherlands coast that the remains of lost ships have been preserved in an excellent condition. Erosion will expose them and so will dredging and excavation activities. They are particularly valuable as a source of information about life and work in earlier times. The greatest density of finds and the best conditions for conservation are to be found in the Wadden Sea and the Voordelta. Submarine archaeology should devote most attention to the remains of ships in these two areas. The same areas also contain submerged settlement sites. In the deeper part of the North Sea, where little Holocene sediment remains, finds are made only on the surface of the seabed. These finds are seldom undamaged, however, and they play a subsidiary role in research and conservation policy.

Source:
Adams, J., van Holk, A.F.L., Maarleveld, Th.J. (1990). Dredgers and Archaeology. Shipfinds from the Slufter. ISBN 90-800467-1-X.
Maarleveld, T., van Ginkel, E. (1990). Archeologie onder water. Verleden van een varend volk. ISBN 90-290-96196

Sites of archeological value



Effect of spatial use on the environment

Reported oil spills in 1989

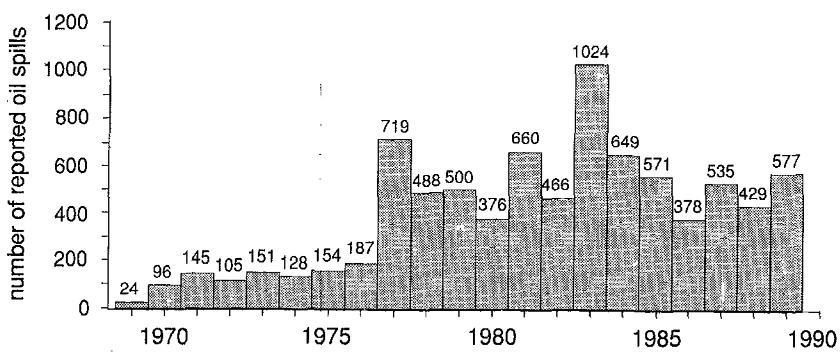
Shipping and offshore activities cause oil pollution. This may be the result of accidents, operational discharges or illegal discharges. Operational discharges are permitted. They occur during the washing out of tanks or drilling for oil [94]. Illegal discharges are discharges which exceed the permitted standards. They are usually visible in the form of slicks and currently constitute the most important source of oil pollution on the North Sea. Seabirds are their most frequent victim. Moreover, fishing and recreational interests may be harmed if an oil slick reaches the coast.

Oil spills have been recorded by RWS since 1969. An aircraft has been available for detection since 1975. It has been equipped with remote sensing apparatus since 1983, so that observations can also be made at night and in fog. This initially resulted in a steep increase in the number of oil slicks reported (see graph). Flights have been made by the Coastguard since 1987.

A total of 577 oil spills was reported on the NCS in 1989. In 61 instances the cause was a ship and in 74 instances an offshore installation. In the other instances the cause was unknown. The relationship between shipping and oil slicks is clearly visible in the shipping route along the Wadden Islands. Statistical studies have shown that most of the slicks have a volume of under 1 m^3. Slicks with a volume of 50 to 1000 m^3 seldom occur, but do make up the greater part of the total oil pollution by shipping and offshore activities. The provisions for cleaning up oil slicks are aimed mainly at these large slicks. In 1989 the magnitude of an oil slick was so great on five occasions, that it was dealt with by the Coastguard at sea.

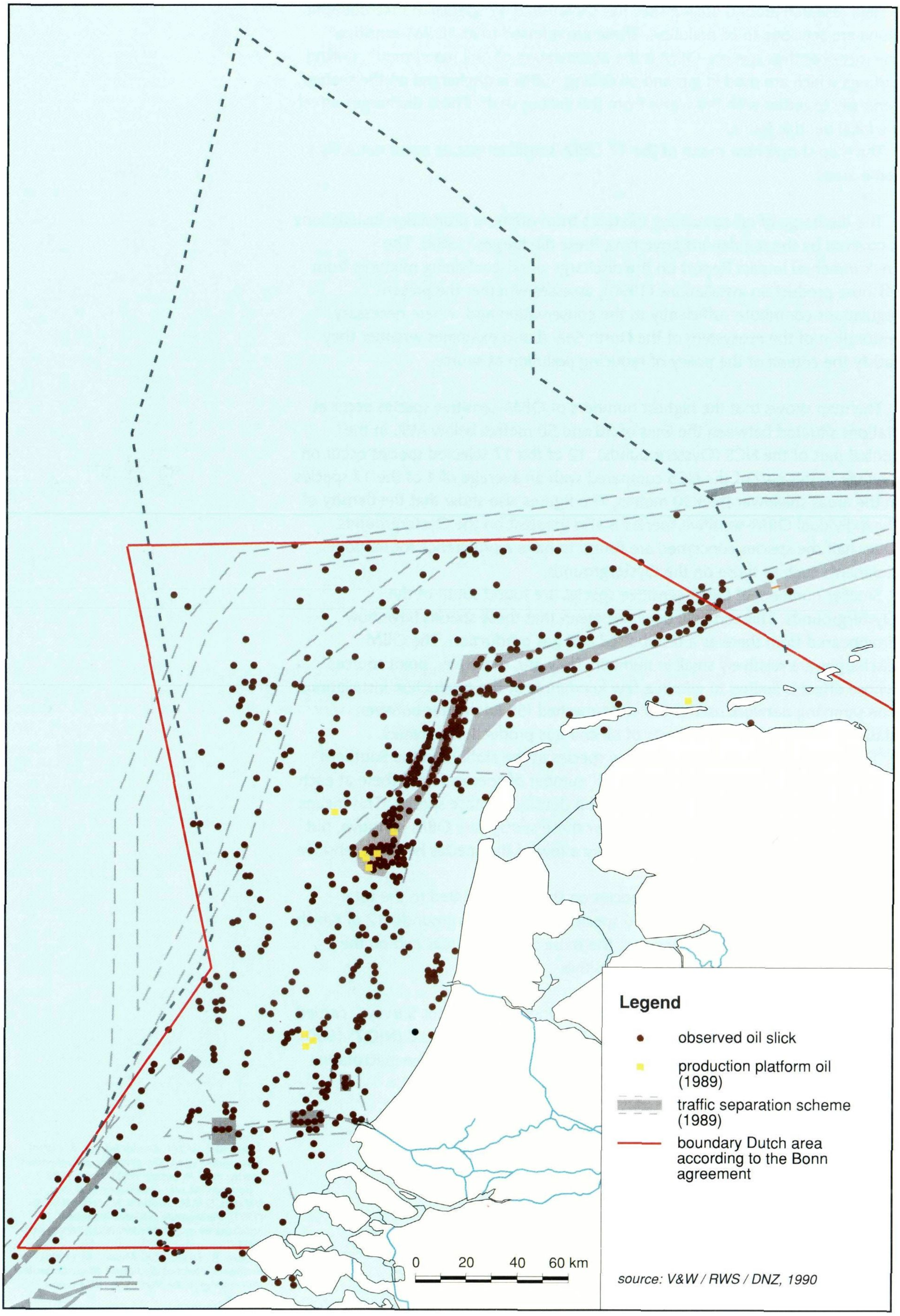
Because the map shows data for 1989, the traffic separation schemes existing at that time is shown.

Total number of reported oil spills in 1969 - 1989



Source:
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1990). Olieverontreinigingsrapportage 1989. Notitie NZ-N-90.05.

Reported oil spills in 1989



Macrobenthic species sensitive to oil pollution

Field research around drilling sites has shown that 17 species of macrobenthic fauna are sensitive to oil pollution. These are referred to as "OBM-sensitive" macrozoobenthos species. OBM is the abbreviation of "oil based mud", drilling cuttings which are used in gas and oil drilling. OBM is discharged on the seabed, generally together with the waste from the drilling shaft. These discharges affect the local benthic fauna.

The map shows how many of the 17 OBM-sensitive species occur naturally in some areas.

The discharge of oil-containing mixtures from offshore production installations is covered by the regulations governing these discharges (1988). The Environmental Impact Report on the discharge of oil-containing mixtures from offshore production installations (1990), assesses whether the present regulations contribute sufficiently to the conservation and, where necessary, restoration of the ecosystem of the North Sea. It also examines whether they satisfy the criteria of the policy of reducing pollution at source.

The map shows that the highest numbers of OBM-sensitive species occur at stations situated between the lines of 30 and 50 metres below MSL in the central part of the NCS (Oystergrounds). 12 of the 17 selected species occur on average in this part of the NCS compared with an average of 4 of the 17 species in the areas shallower than 30 metres. The figures also show that the density of the individual OBM-sensitive species is also greatest on the Oystergrounds. Over half the species concerned are found to have a preference for muddy sediments such as those on the Oystergrounds.

Smaller numbers of OBM-sensitive species are found south of the Oystergrounds. This certainly does not mean that these species have now disappeared from there as a result of oil and gas production. The OBM discharges are relatively small in number. They are, moreover, point sources whose effect is limited to within a few kilometres of the production installations. The sampling network used is too wide-meshed (55 kilometres between stations) to show the local effects of oil and gas production activities.

The small number of OBM-sensitive species at the stations in the Southern Bight is related to the relatively low total number of species found there at each station and to the naturally low population density of those species. This means that it is difficult to demonstrate whether these species are OBM-sensitive, but one may not conclude from this that only a few of the species here are sensitive to OBM pollution.

The number of OBM-sensitive species on the NCS is related to the total number of species. This averages 56 species on the Oystergrounds, 12 of which are OBM-sensitive, and 31 species in the more southerly areas and on the Dogger Bank, 4 of which are OBM-sensitive.

The map is based on data from the ICES "North Sea Benthos Survey", carried out in April-May 1986 and reworked by Bergman and Duineveld (NIOZ; 1990). Five seabed samples were taken at each sampling station and the macrofauna was identified.

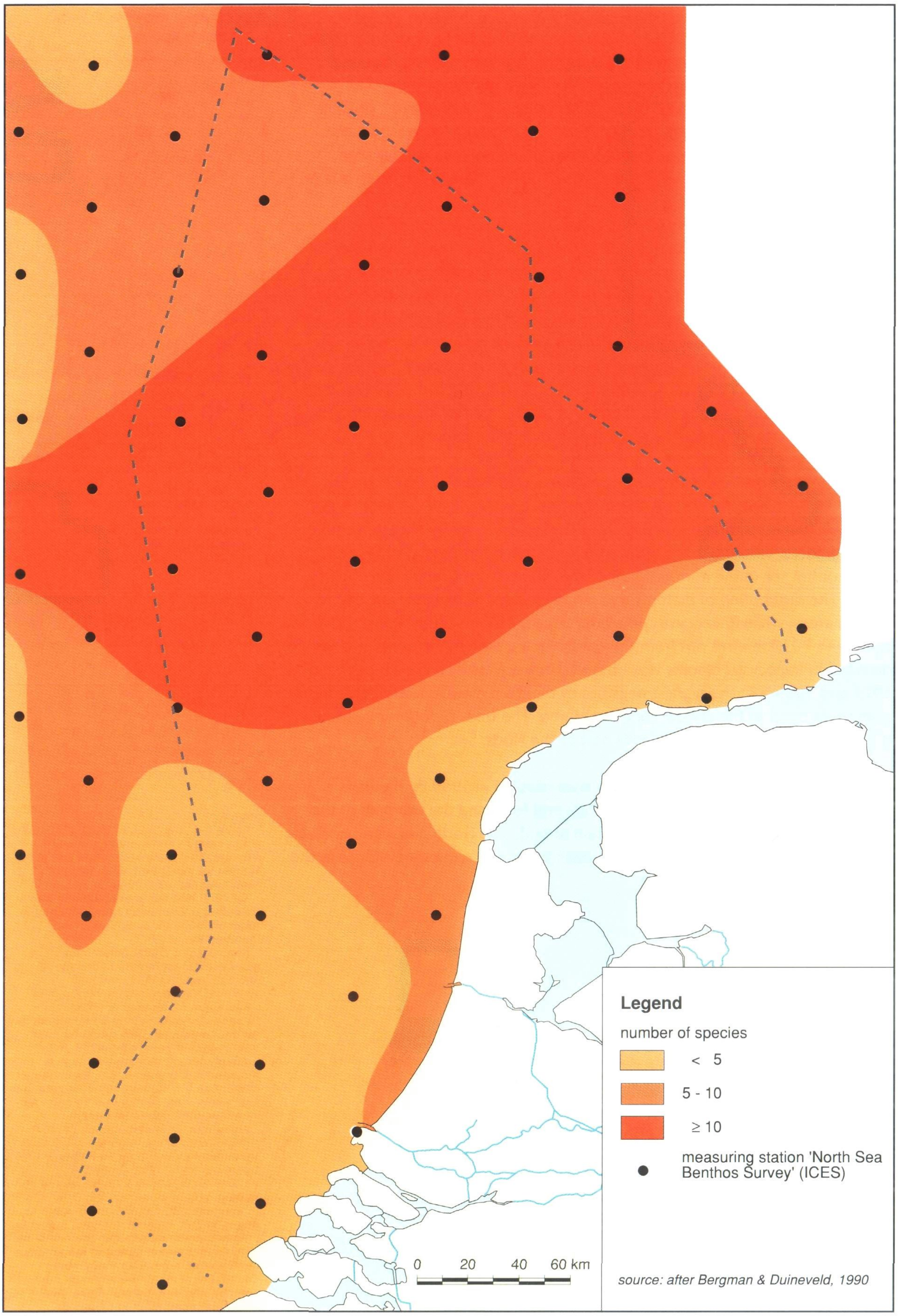
Source:

Bergman, .M.J.N., Duineveld, G.C.A. (1990). Verspreiding van OBM-gevoelige macrobenthos-soorten in de Noordzee. NIOZ-report 1990-7.

Bergman, M.J.N., Lindeboom, H.J., Peet, G., Nelissen, D.H.M., Nijkamp, H., Leopold, M.F. (1991). Beschermde gebieden Noordzee - noodzaak en mogelijkheden. NIOZ/LNV-report 1991-3.

Daan, R., Lewis, W.E., Mulder, M. (1990). Biological effects of discharged oil-contaminated drill cuttings in the North Sea. NIOZ-report 1990-5.

Macrobenthic species sensitive to oil pollution



Potentially toxic or inconvenient algae in 1989

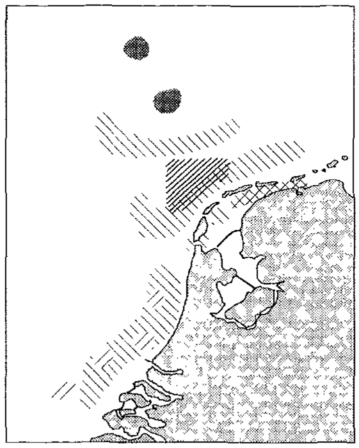
The phytoplankton in Netherlands coastal waters is dominated by diatoms (siliceous algae). In seasons of "algal blooms" the biomass increases steeply to five to ten times the average winter value. During summer periods the microflagellates and dinoflagellates, which include a number of potentially toxic species, predominate. The blooming and formation of floating layers of algae are partly caused by an excess supply of nutrients, notably nitrogen (N) and phosphorus (P) under suitable climatic conditions, i.e. sunny weather and absence of mixing of the water column, which often occurs when there is little wind.

Probably, there has been an increase in the size of algal blooms and the frequency of their occurrence since the 1950s. This is related to increased eutrophication over this period. During the period 1979 to 1990 between 30 and 10,000 km^2 of the sea surface on the NCS were covered with floating layers of algae for one or more days during the growing season (spring-summer-autumn). These massive surface algal layers, usually consisting of *Noctiluca*, are not toxic as such, but may cause a reduction in the oxygen content when they die off, thus threatening the lives of fish and benthic fauna. Areas where very low oxygen concentrations may occur are shown in the figure.

In spring the non-toxic microflagellate *Phaeocystis pouchetii* is dominant. This alga forms gelatinous colonies a few millimetres across, which are whipped up into foam in the surf and on the beaches. During calm weather in late summer, dinoflagellates, including toxic ones, may be dominant in coastal zones and farther out at sea in the northern part of the Netherlands Continental Shelf (NCS). The distribution of diatoms and dinoflagellates is generally not tied to specific areas, while *Phaeocystis pouchetii* usually blooms on the coast, but may also do so 70 kilometres out from the coast. An increase in the duration and density of *Phaeocystis* blooms was observed in the Marsdiep (Texel) between 1973 and 1985/88. The highest densities of the toxic dinoflagellate *Dinophysis acuminata* occur in the coastal zone in autumn. The toxic *Gyrodinium aureolum* is now also found in the Netherlands part of the North Sea.

The Algal Pollution Reporting System was installed in 1989 by the Paris Commission (Working Group on Nutrients) and following the example of the Bonn Agreement (combatting oil pollution at sea). The North Sea member states can use this system to inform and warn each other and request assistance in the event of toxic algal blooms at sea.

Oxygen deficiency in Dutch marine waters



4 - 8 mg O_2/l ('89 - '90) (during stratification)

Regular O_2 deficiency (high organic load)

6 - 7 mg O_2/l ('88) (during Noctulica bloom)

Potential O_2 deficiency ('79 - '90) (during Noctulica bloom)

Source:

Cadee, G.C., Hegeman, J. (1986). Seasonal and annual variation in Phaeocystis pouchetii (Haptophyceae) in the western most inlet of the Wadden Sea during the 1073 to 1985 period. Neth. J. Sea Res. 20: p. 29-36.

Kat, M. (1985). Dinophysis acuminata blooms, the distinct cause of Dutch mussel poisening. In: Anderson, White and Baden (eds.). Toxic Dinoflagellates, p. 73-77.

Rademaker, M. (1989). Determinatie fytoplankton in het Nederlands deel van de Noordzee, augustus 1988 - juni 1989. V&W/RWS/DNZ report NZ-N-89.17, p. 1-18

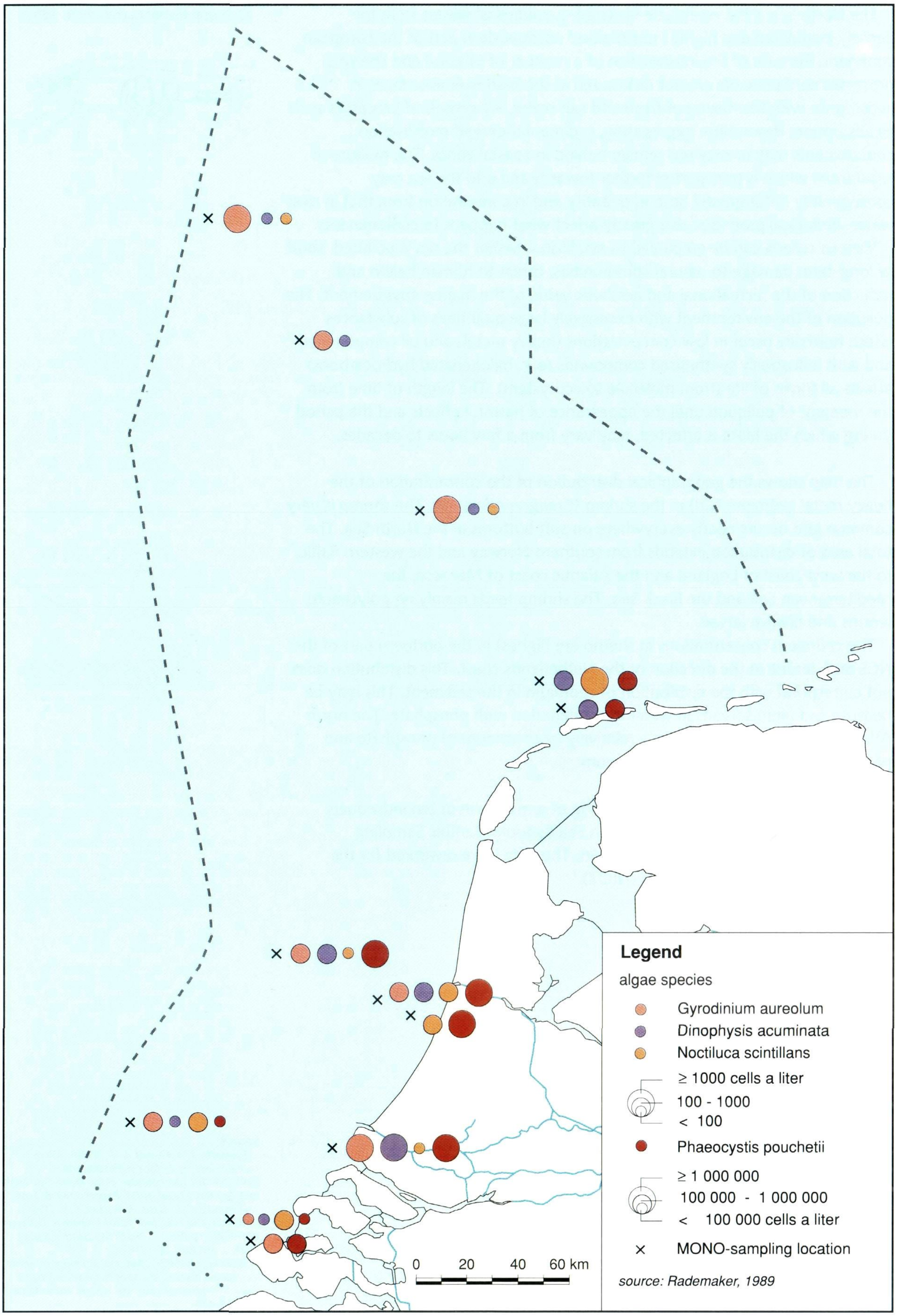
Rademaker, M., Koeman, R. (1990). Determinatie fytoplankton in het Nederlands deel van de Noordzee, juli 1989 - december 1989. V&W/RWS/DNZ report NZ-N-89.19, p. 1-7.

Zevenboom, W., de Vreugd, R.J., van de Nieuwendijk, L.J., Vransen, R.C., Rademaker, M. (1989). Trends in nutrients, NIP ratios, chl.a., and algal species in the Dutch part of the North Sea. V&W/RWS/DNZ nota NZ-N-89.13.

Zevenboom, W., Rademaker, M., Colijn, F. (1990). Exeptional algal blooms in Dutch North Sea waters. Int. Conf. North Sea Pollution, September, 10-14, 1990, Amsterdam. V&W/RWS/DNZ&DGW & TRIPOS nota NZ-N-90.06, p. 1-13.

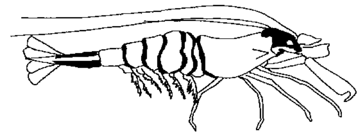
Zevenboom, W., Colijn, F., Laane, R.W.P.M., Peeters, W.C.H., Peperzak, L. (1991). Basic maps of agreed adverse eutrophiation phenomena and administration map of (potential) eutrophication problem areas in the Dutch marine waters. Contribution of the Netherlands to the mapping excercise. App. 3 revised NUT 6/6/4. V&W/RWS/DNZ&DGW report NZ-N-91.07; app. 3.

Potentially toxic or inconvenient algae in 1989



Cadmium concentration in shrimp

Crangon allmanni (Kinahan, 1857)



The North Sea is the receptacle for large quantities of wastes from the densely-populated and highly industrialised northwestern part of the European continent. Because of the intervention of a number of physical and chemical processes contaminants are not distributed in the marine environment in accordance with the mixing of fresh and salt water. As a result of processes such as adsorption, desorption, aggregation, sedimentation and mobilisation, contaminants may or may not remain behind in coastal zones. The mixture of substances which is transported further towards and into the sea may consequently differ greatly both in quantity and in composition from that in river water. Biological processes also greatly affect what happens to contaminants.

Various criteria can be employed to establish whether the sea is polluted: short or long-term damage to natural communities, threat to human health and reduction of the recreational and aesthetic value of the marine environment. The pollution of the environment with excessively large quantities of substances which normally occur in low concentrations (heavy metals and oil components) and with industrially synthesised compounds (e.g. halogenated hydrocarbons) affects all forms of life (from molecule to ecosystem). The length of time from the moment of pollution until the appearance of harmful effects and the period during which the biota is affected, may vary from a few hours to decades.

The map shows the geographical distribution of the concentration of the heavy metal cadmium (Cd) in the shrimp (*Crangon allmanni*). The shrimp is very common and occurs nearly everywhere on soft bottoms in the North Sea. The total area of distribution extends from southern Norway and the western Baltic, to the west coast of England and the Atlantic coast of Morocco, the Mediterranean Sea and the Black Sea. The shrimp feeds mainly on polychaete worms and bivalve larvae.

The cadmium concentrations in shrimp are highest in the northern part of the NCS and decline in the direction of the Netherlands coast. This distribution does not correspond with the distribution of cadmium in the sediment. This may be because cadmium spreads in water in combination with phosphate. The north Atlantic deep seawater contains a relatively large amount of phosphate and possibly, therefore, also a lot of cadmium.

The map is based on samples containing of a minimum of ten individuals. They were taken during the 1986 North Sea Synoptic Benthic Sampling Programme from 16 April to 2 May 1986. The data were reworked for the North Sea Atlas by J.M. Everaarts (NIOZ).

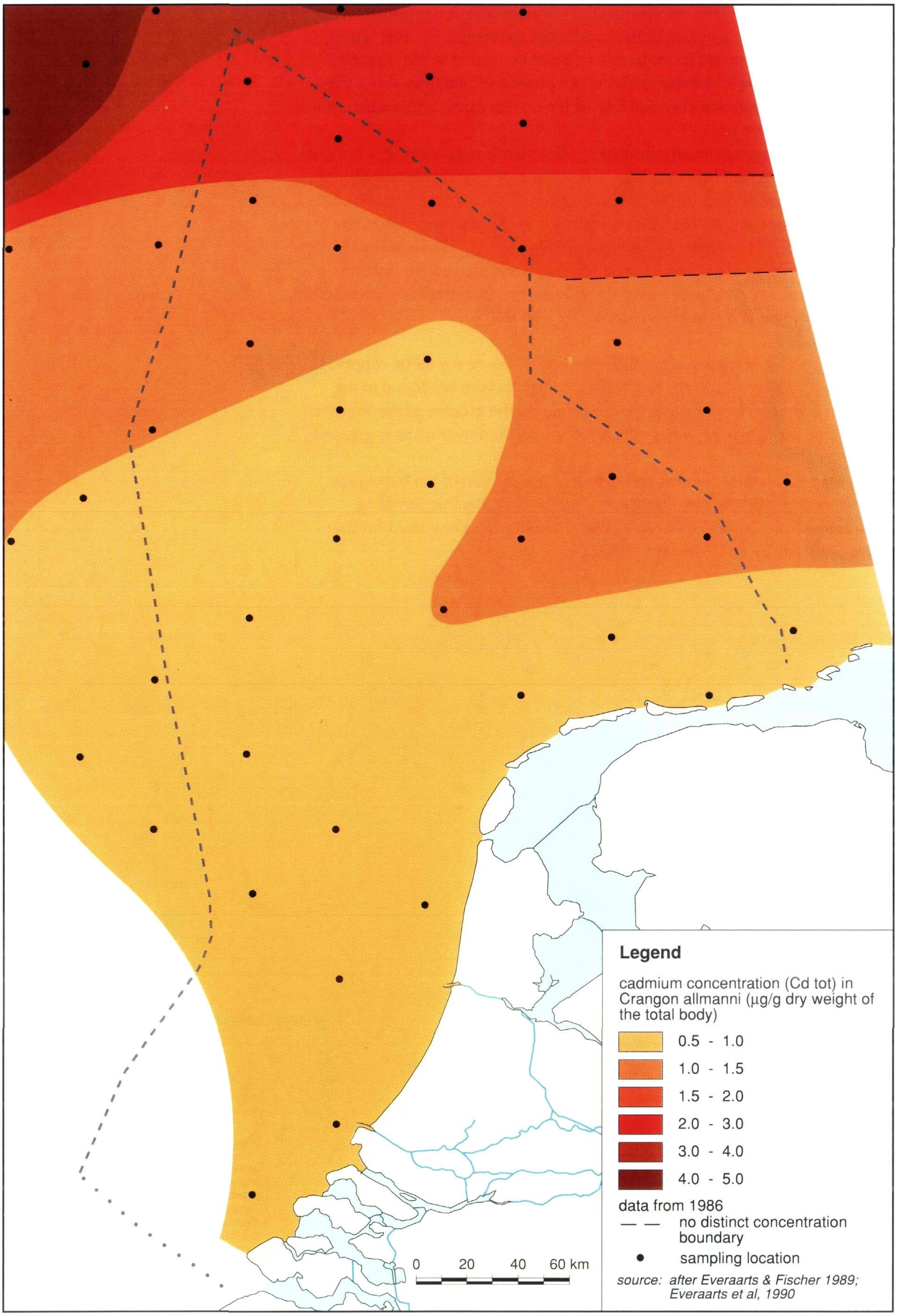
Source:

Everaarts, J.M. Fischer, C.V. (1989). Micro contaminants in surface sediments and macrobenthic invertebrates of the North Sea. Neth. Inst. Sea Res., Texel. NIOZ-Report 1989-6: 1-44.

Everaarts, J.M., Otter, E, Fischer, C.V. (1990). Cadmium and Polychlorinated biphenyls: Different distribution pattern in North Sea benthic biota. Neth. J. Sea Res. 26: 75-82.

Kröncke, I. (1987). Lead and cadmium contents in selected macrofauna species from the Dogger Bank and eastern North Sea. Helgol. Meeresunters. 41: 465-475.

Cadmium concentration in shrimp



Copper concentration in shrimp

In order to evaluate the harmful effect of contaminants it is essential to examine the emission and fate of the substances concerned. In other words, measurements of concentrations (residues) must be related to the quantities discharged. The results of these analyses can provide information about the transport, distribution and chemical fate of the contaminant, and enable a mass balance to be drawn up.

Contaminants are eventually absorbed in the marine organisms. It is not only the specific physical and chemical characteristics of the substances which determine the toxic effect of chemical compounds, but also the number of molecules which can penetrate to those parts or biological processes in the organism which are sensitive to the substance concerned. The following factors are the determining ones here: external exposure and load (dose), rate of absorption, relative distribution over the different parts of the body, metabolism, biotransformation and rate of elimination.

The map shows the geographical distribution of the heavy metal copper (Cu) in shrimp (*Crangon allmanni*). The highest concentrations are found in the Southern Bight and locally along the coast (e.g. at the mouths of the Western Scheldt and the Eems), i.e. where the effect of polluted river water is greatest.

The map is based on samples containing of a minimum of ten individuals. They were taken during the 1986 North Sea Synoptic Benthic Sampling Programme from 16 April to 2 May 1986. The data were reworked for the North Sea Atlas by J.M. Everaarts (NIOZ).

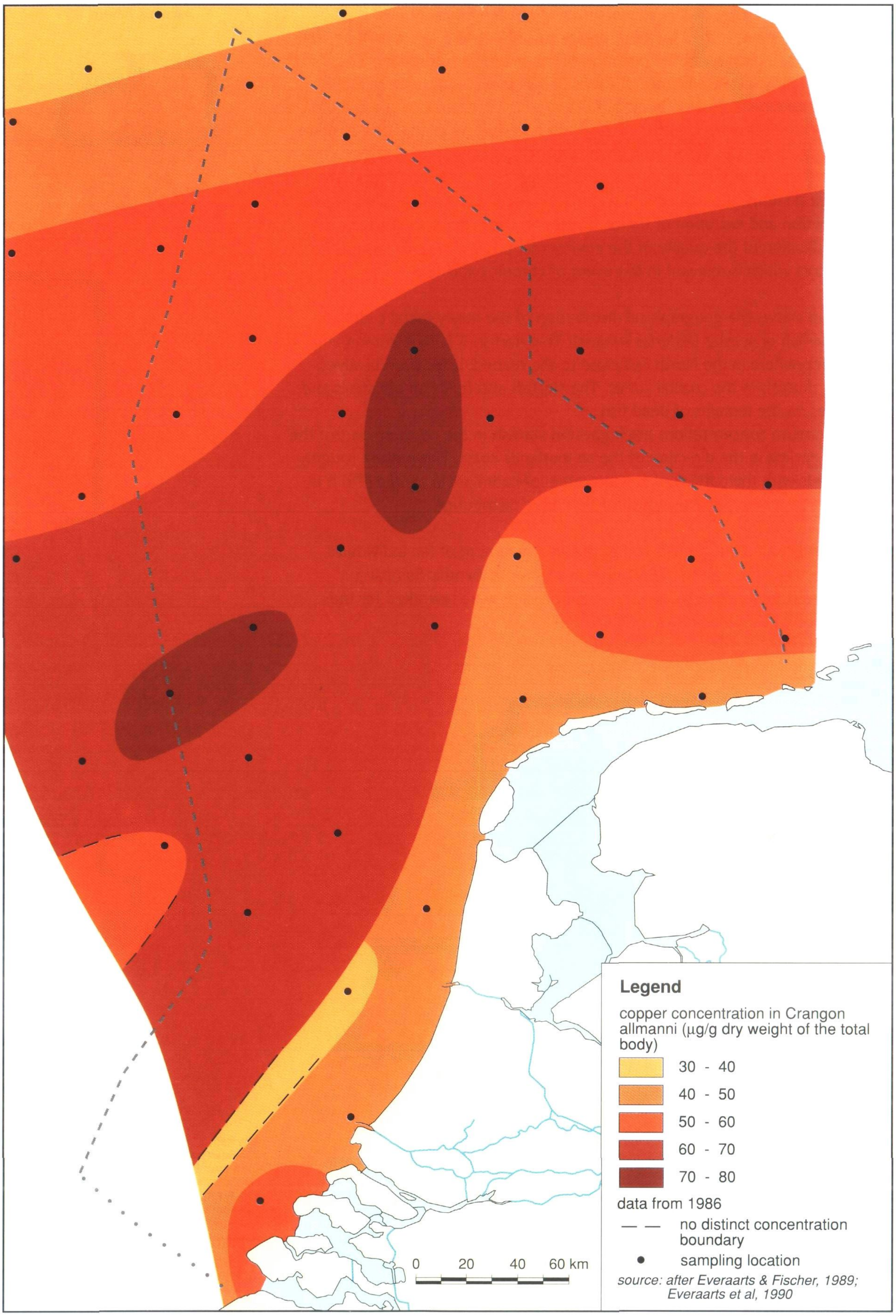
Source:

Everaarts, J.M , Fischer, C.V (1989). Micro contaminants in surface sediments and macrobenthic invertebrates of the North Sea. Neth. J. Sea Res , Texel. NIOZ-Report 1989-6: 1-44.

Everaarts, J.M., Otter, E., Fischer, C.V. (1990). Cadmium and Polychlorinated biphenyls: Different distribution pattern in North Sea benthic biota. Neth. J. Sea Res. 26: 75-82.

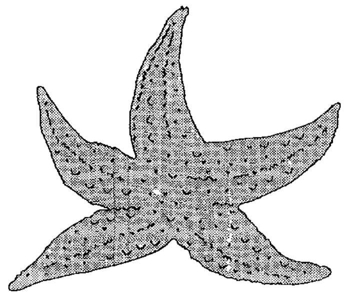
Kröncke, I. (1987). Lead and cadmium contents in selected macrofauna species from the Dogger Bank and eastern North Sea. Helgol. Meeresunters. 41: 465-475.

Copper concentration in shrimp



Cadmium concentration in starfish

Asterias rubens (l.)



Substances which are alien to the environment, such as chlorinated hydrocarbons, are absorbed by living organisms. The extent to which that occurs provides a first indication of the pollution of the marine environment. This also applies to greatly increased concentrations of substances which are naturally present in the marine environment.

Organisms, particularly benthic species, often remain for a long time at more or less the same area in the marine environment. Depending upon the immediate habitat of the organism, the manner in which it absorbs food, its physiological status, the nature of the contaminant and the relationship between the absorption and excretion of the contaminant, the organism will give a certain indication of the quality of the environment. It is especially the totality of these factors which is relevant in the event of chronic exposure.

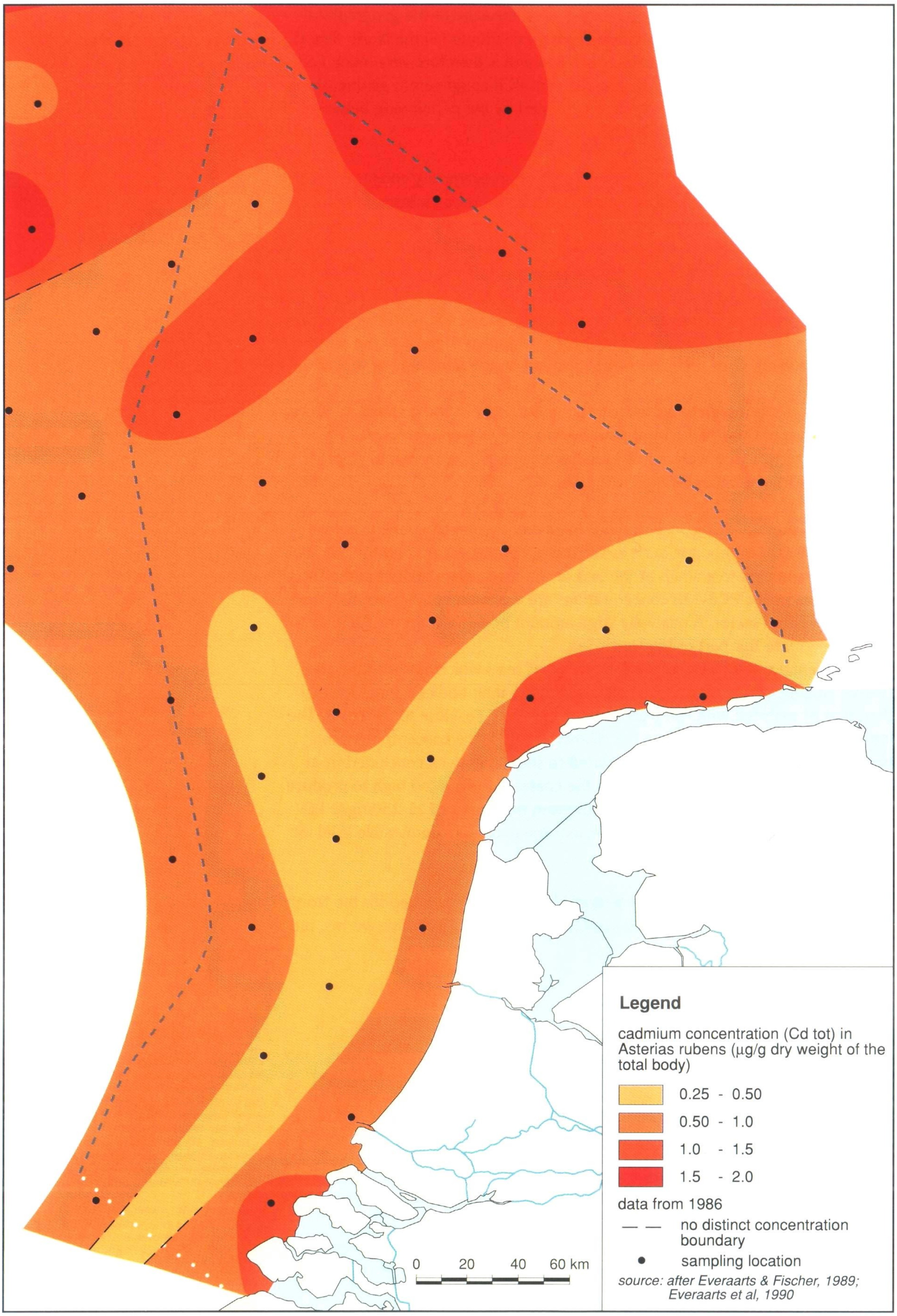
The map shows the geographical distribution of the heavy metal cadmium (Cd) in starfish or seastar (*Asterias rubens*). This starfish is fairly common and occurs everywhere in the North Sea close to the seabed. It feeds on bivalves, including mussels in the coastal zones. The starfish also feeds on sea snails and sometimes on the remains of dead fish.

The cadmium concentrations are highest in starfish in the northern part of the NCS and decline in the direction of the Netherlands coast. This pattern roughly corresponds with the pattern of concentration of cadmium in shrimp [85]. It is known that the heavy metal lead shows a similar distribution.

The map is based on samples containing of a minimum of ten individuals. They were taken during the 1986 North Sea Synoptic Benthic Sampling Programme from 16 April to 2 May 1986. The data were reworked for the North Sea Atlas by J.M. Everaarts (NIOZ).

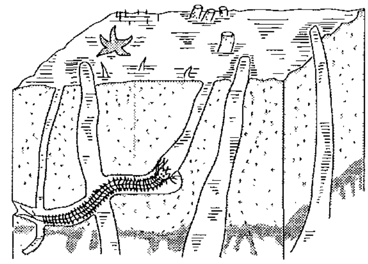
Source:
Everaarts, J.M., Fischer, C.V. (1989). Micro contaminants in surface sediments and macrobenthic invertebrates of the North Sea. Neth. Inst. Sea Res., Texel. NIOZ-Report 1989-6: 1-44.
Everaarts, J.M., Otter, E., Fischer, C.V. (1990). Cadmium and Polychlorinated biphenyls: Different distribution pattern in North Sea benthic biota. Neth. J. Sea Res. 26: 75-82.
Kröncke, I. (1987). Lead and cadmium contents in selected macrofauna species from the Dogger Bank and eastern North Sea. Helgol. Meeresunters. 41: 465-475.

Cadmium concentration in starfish



PCB-138 concentration in benthic worms

Habitat of Nephtys spp



Worms of the genus Nephtys spp. form a good measure of the geographical distribution of PCBs, because this worm is widely distributed in the North Sea. It lives in passages in the seabed of the North Sea and is therefore very much tied to one place. The concentrations of the different PCB congeners in gill-breathing organisms such as *Nephtys* are mainly determined by the partitioning between body fat, blood and the surrounding seawater.

The map shows the geographical distribution of an exemplary congener, with the number CB-138, in the benthic worm. See map 34 for an introduction to PCBs. It has been found that there is a concentration gradient of PCBs at right angles to the Netherlands coast which is very stable in time. This is caused by the poor mixing of the Netherlands coastal waters with water masses of oceanic origin which reach the North Sea through the English Channel and round the north side of Scotland. The range of concentrations in the southern North Sea amounts to a factor of 10-15 [34]. This factor also applies to most of the other congeners studied, since their concentrations vary in the same way as that of CB-138.

N.B. Very recent research has shown that about 25% of the mapped concentrations of CB-138 is contributed by two other CB congeners. For purposes of comparison with map 34 we have nevertheless chosen to plot CB-138 instead of a better defined congener.

It appears that the PCB concentrations in environmental components which are relatively easy to monitor, such as sediment, benthic worms and fish, can be linearly extrapolated to animals at the end of the food chain, such as seals. The map shows that the PCB-138 concentrations are lowest in benthic worms from the northwestern sector. A relatively large amount of water from the Atlantic Ocean flows into this part of the North Sea.

Experimental research on seals has shown that seals which eat fish from the cleaner Atlantic water have a PCB concentration in their bodies 5 times lower than that of seals fed with fish from the Wadden Sea, i.e. close to the coast. The latter group reproduced less than the cleaner group. If the concentrations in benthic worms can be linearly extrapolated to seals, it may be concluded from the map that the PCB concentrations in the coastal zone are too high to produce a healthy seal population. The concentrations in the zone of 125-250 ng/g PEV (Pentane Extractable Fat) therefore represent the maximum permissible level for a healthy seal population.

The map is based on data for the period 1981 to 1988 reworked for the North Sea Atlas by J.P. Boon (NIOZ). Each sample consisted of at least five worms, but often of a multiple of that number.

Source:

Boon & Nieuwenhuize (NIOZ): unpublished data.

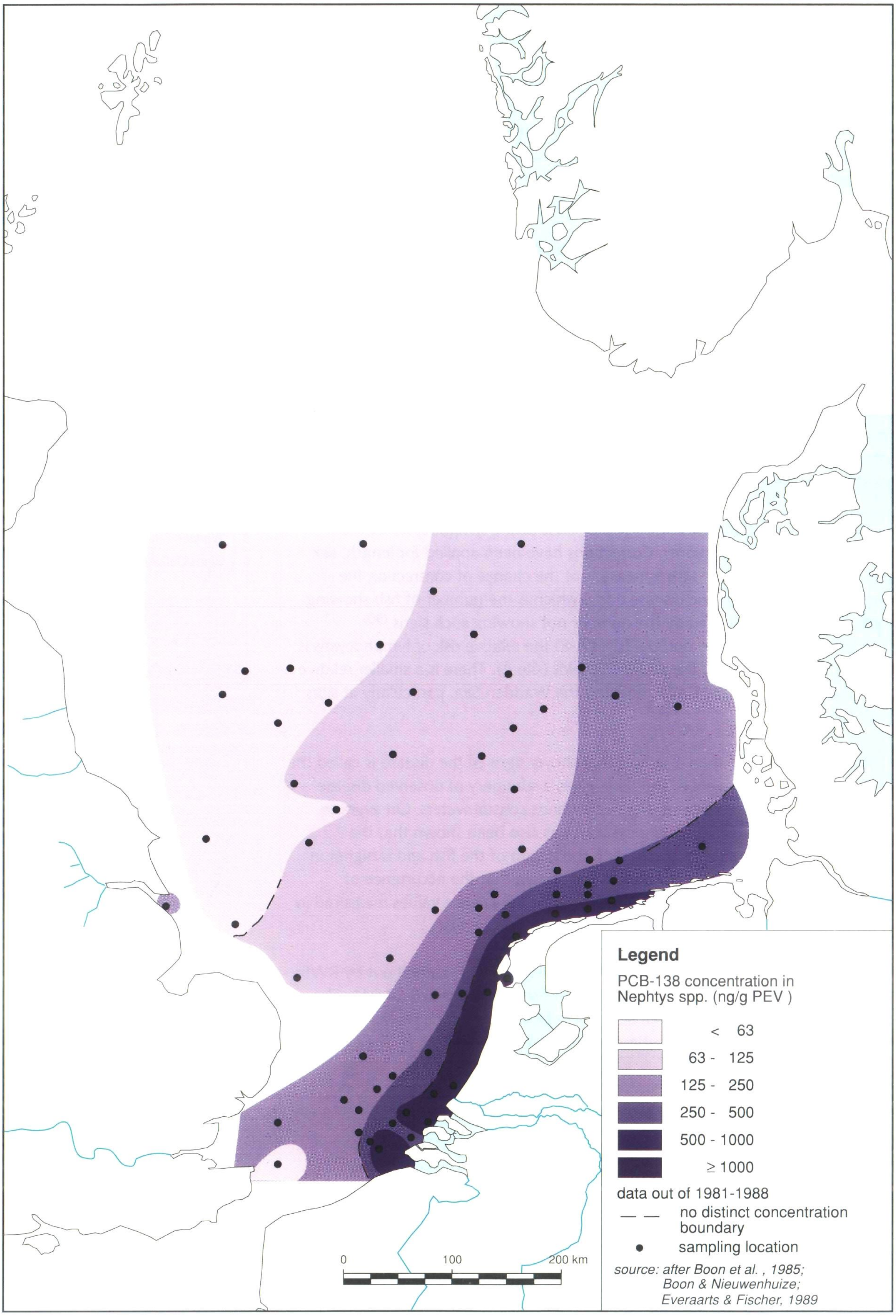
Boon, J.P., van Zantvoort, M.B., Govaert, M.J.M.A., Duinker, J.C. (1985) Organochlorines in benthic polychaetes (Nephtys spp) and sediments from the southern North Sea Identification of individual PCB components Neth J. Sea Res. 19: 93-109

Duinker, J.C. (1991). Consequenties van polychloorbiphenylen in sediment van de Waddenzee voor mariene zoogdieren. Report of the Technical Committee on Soil Protection: 134 pp.

Everaarts, J.M., Fischer, C.V. (1989) Microcontaminants in surface sediments and macrobenthic invertebrates of the North Sea. Rep. 1989-6 of the Netherlands Institute for Sea Research: 44 pp.

Reijnders, P.J.H. (1986). Reproductive failure in common seals feeding on fish from polluted coastal waters. Nature 324: 456-457.

PCB-138 concentration in benthic worms



Lymphocystis in flounder

Since 1983 a number of fish species have been regularly examined for internal and external disorders at various sites in the coastal waters. The flounder (*Platichthys flesus*), in particular, has been the subject of detailed study. This fish species is a typical inhabitant of coastal waters and estuarias, as well as of some inland bodies and the Wadden Sea. Adults return to the same feeding grounds each year and are more or less sedentary during the summer. Because contaminants tend to be tranported along the coast close to the shore, the flounder is suitable for the study of their effects, it is also particularly susceptible to certain disorders.

Lymphocystis is a very common viral infection among flounder. The virus causes proliferation of the connective tissue cells of the skin. Characteristic off-white pearly nodules or warts then form on the skin of the body and/or fins. Often clusters of these nodules are formed, which may assume a tumorous appearance.

The visible signs of the disease may diminish or even disappear in the course of time, but the virus remains dormant in the fish following the primary infection and can be reactivated by natural causes or pollution-induced stress. The monitoring of this disease therefore provides good opportunities for obtaining information about changes in the environment which reduce the immunological resistance of the fish.

The map shows the relative risk (RR) of contracting lymphocystis at the different study sites (locations). Corrections have been applied for length, sex and study year. Relative risk is a measure of the chance of contracting the disease and is based on the disease odds, which is the number of fish showing signs of the disease divided by the number not showing such signs [90].

In the area of the Rhine outflow (sites 6-8) the relative risk of lymphocystis is about 4 to 5 compares to the Eastern Scheldt (site 4). There is a smaller relative risk (about 2 tot 3) in the Delta zone and the Wadden Sea, particularly at sites with low salinity.

The percentage of fish in a sample that shows signs of the disease is called the observed disease prevalence. The table gives a summary of observed disease prevalence in three subzones in the Netherlands coastal waters. On average, 13.2% of flounder exhibit lymphocystis. It has also been shown that the prevalance of the disease increases with the length of the fish and is higher in males than in females. Recent research has shown that the occurrence of lymphocystis is positivily correlated with salinity. Prevalence values measured in brackish and salt water are therefore not directly comparable.

The map is based on the results of the fish disease study carried out by RWS during the period 1983-1989; the number of fish examined was 14,041. The Eastern Scheldt (site 4) was taken as reference (RR=1.00). The results relate to flounder with a length of 20 centimetres or more.

Observed prevalence of lymphocystosis in flounder in different areas of the Dutch coastal waters in September
(1983 - 1989)

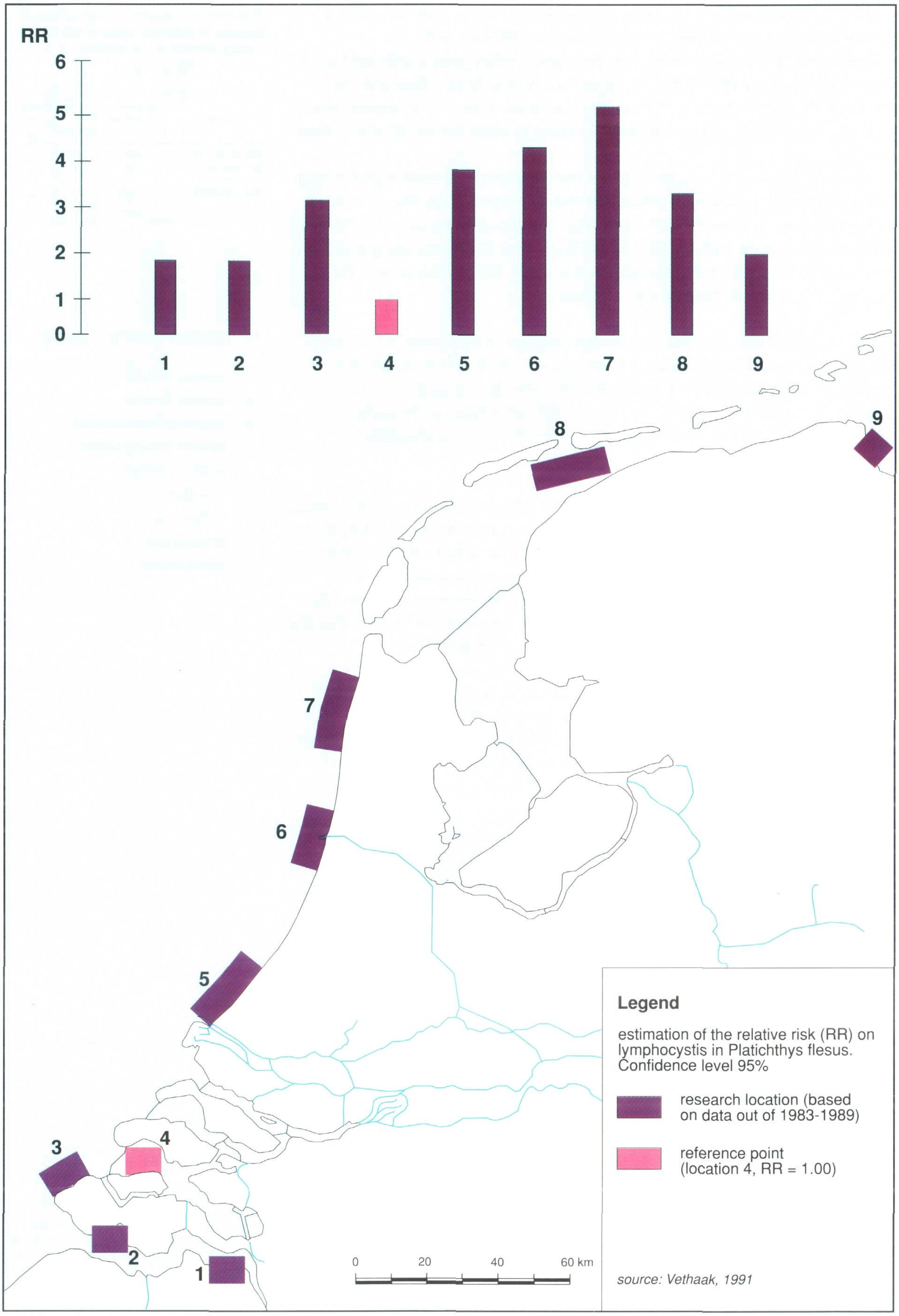
LYMPHOCYSTOSIS	Total number of fish examinated	Number of fish affected	Observed prevalence (%)
Delta area (loc 1 4)	6167	426	6.9
North Sea coast (loc 5 - 7)	5976	1265	12 2
Wadden Sea (loc 8 - 9)	1871	161	8 6
Total (loc 1 - 9)	14041	1852	13 2

Research locations map 89

1	Western Scheldt
2	Western Scheldt
3	Eastern Scheldt/Voordelta
4	Eastern Scheldt/Hammen
5	Hoek van Holland
6	IJmuiden
7	Callantsoog
8	Wadden Sea
9	Eems/Dollard

Source:
Vethaak, A.D. (1985). Prevalence of fish diseases with reference to pollution of Dutch coastal waters. Neth. Inst. of Fishery Investigations, IJmuiden Rep CA 85-01, 70 pp
Vethaak, A.D. (1987) Fish diseases, signals for a diseased environment? In: Peet, G (ed.). Reasons For Concern (Proceedings of the 2nd North Sea Seminar '86) Vol 2. Amsterdam: North Sea Working Group, pp. 41-61
Vethaak, A.D. (1991). Het voorkomen van visziekten in de Noordzee in relatie tot vervuiling. V&W/RWS/DGW nota GWAO-91 005
Vethaak, A.D. (1991). Trends visziekten Nederlandse kustwateren 1983-1989. V&W/RWS/DGW notitie 91.10.140 (map).
Vethaak, A.D., Rheinhallt, T.A. (1991) Fish disease as a monitor of marine pollution. the case of the North Sea Reviews in Fish Biology and Fisheries (in press).

Lymphocystis in flounder



Legend

estimation of the relative risk (RR) on lymphocystis in Platichthys flesus. Confidence level 95%

research location (based on data out of 1983-1989)

reference point (location 4, RR = 1.00)

source: Vethaak, 1991

Liver tumours in flounder

Epidemiological research has been conducted into fish in order to obtain a picture of disease prevalences at sites exposed to different levels of contaminants. The risk of disease from pollution is often greatly affected by the length (age) and sex of the fish, as well as by the time of sampling and the nature of the sampling site. Consequently, corrections have to be applied when local disease prevalences are compared, in order to allow for the effects of these variables.

Disease odds are used as a criterion for the comparison of disease prevalences. These odds are the number of individuals showing signs of the disease divided by the number not showing such signs. The map shows these values as relative risk, with the disease odds for the various study sites (locations) being expressed in relation to those of a reference site. In this study, the disease odds in the Eastern Scheldt (site 4) serve as the reference.

Visually identifiable liver tumours (neoplasms) occur frequently in flounder (*Platichthys flesus*). The flounder is a fish species which lives in or near the seabed. There appears to be a relationship between the occurrence of liver tumours in flatfish and pollution by PAHs which are present in the sediment. This disorder is therefore used to investigate the effect of carcinogenic contamination on fish.

The map gives an estimate of the relative risk (RR) of liver tumours in flounder at various study sites in September. A correction has been applied for length, sex and study year. The data relate to nodules on the liver which are larger than 2 mm and are visible to the naked eye. The final diagnosis was made in the laboratory with the aid of histological techniques. The research has shown that the occurrence of liver tumours increases with the length of the fish and that the tumours occur more frequently among females than among males.

As the map shows, flounder has a greatly enhanced relative risk of liver tumours in coastal waters, particularly near IJmuiden and Callantsoog. This pattern corresponds with the presence of carcinogenic PAHs in the sediment, but shows no correspondence with the presence of PCBs in the liver of the fish itself. The disease does not occur in brackish or fresh water, even where it is polluted.

The table gives a summary of the observed prevalences of liver tumours in flounder originating from three subzones in Netherlands coastal waters. An average of 1% of the larger flounder were found to be affected.

The map is based on the results of the fish disease study carried out by RWS during the period 1985-1989; the number of fish examined was 9,750. The Eastern Scheldt (site 4) was taken as reference (RR=1.00). The results relate to flounder with a length of 25 centimetres or more.

Observed prevalence of liver tumors in flounder in different areas of the Dutch coastal waters in September (1985 - 1989)

LIVER TUMORS	Total number of fish examinated	Number of fish affected	Observed prevalence (%)
Delta area (loc 1 - 4)	4332	14	0 3
North Sea coast (loc 5 - 7)	4489	84	1 9
Wadden Sea (loc 8 - 9)	929	3	0 3
Total (loc 1 - 9)	9790	101	1 0

Research locations map 90

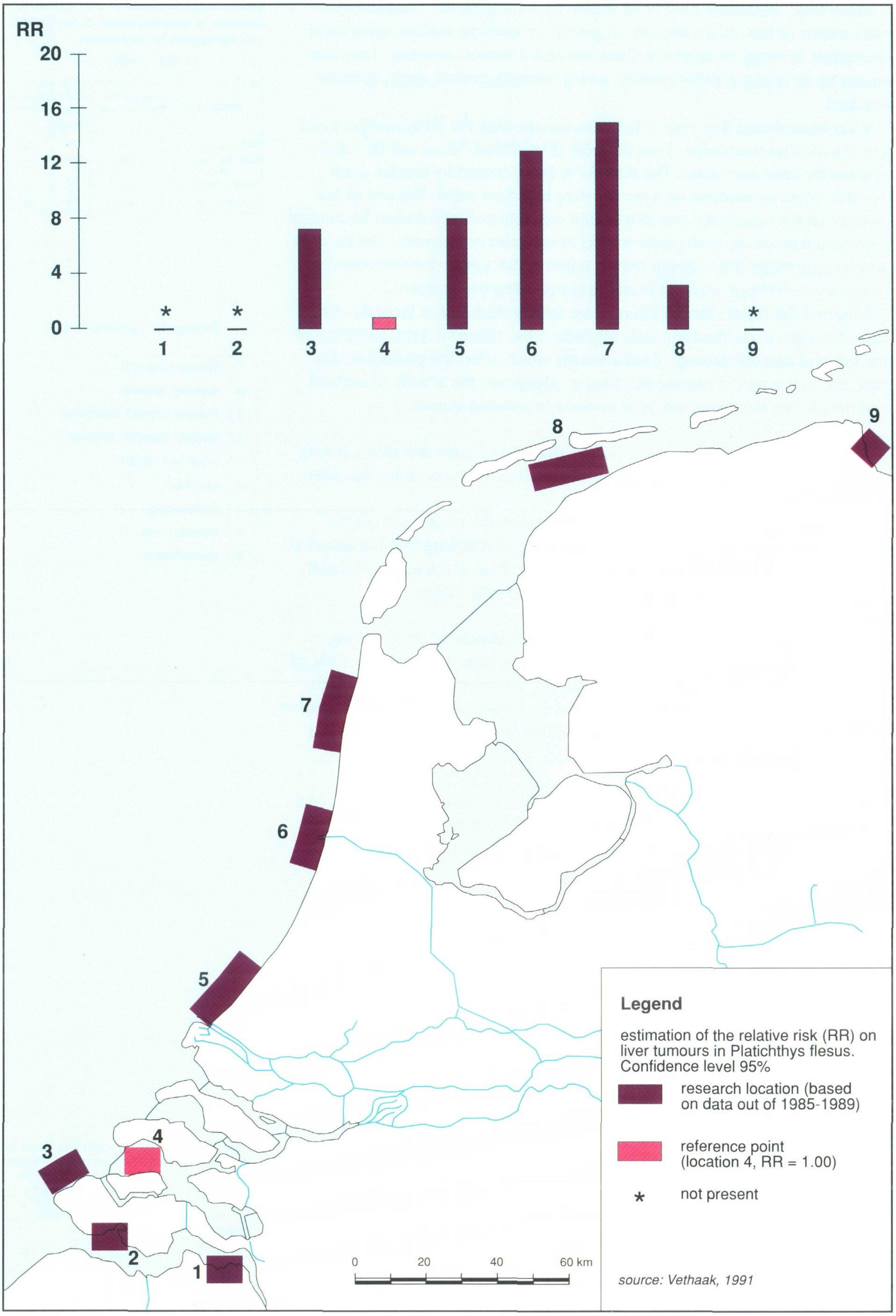
1	Western Scheldt
2	Western Scheldt
3	Eastern Scheldt/Voordelta
4	Eastern Scheldt/Hammen
5	Hoek van Holland
6	IJmuiden
7	Callantsoog
8	Wadden Sea
9	Eems/Dollard

Source:

Vethaak, A.D. (1991). Diseases of flounder (Platichthys flesus) in the Dutch Wadden Sea and their relation to stress factors. Neth J Sea Res. (in press).

Vethaak, A.D. (1991). Trends visziekten Nederlandse kustwateren 1983-1989. V&W/RWS/DGW notitie 91.10.140 (map).

Liver tumours in flounder



Skin ulcers in flounder

Many toxic substances have been shown to undermine the immunological mechanisms of fish, or are strongly suspected of doing so, making them more susceptible to many kinds of infectious and non-infectious diseases. They also enable bacteria of low pathogenicity, which normally inhabit water, to cause infection.

It has been shown that toxic substances can damage the internal organs and also the mucous membrane. Thus flounder (*Platichthys flesus*) can be heavily affected by open skin ulcers. The disorder is characterised by circular, open wounds, often surrounded by a rim of white bloodless tissue. It is one of the diseases which occurrence and distribution are systematically studied because of a possible relationship with contaminants in seawater or sediment. The bacteria which cause these ulcers do not remain latent in fish (unlike the virus causing lymphocystis [89]) but originate from the surrounding environment.

Assumed risk factors for the disorder are salinity fluctuations (osmotic stress), lack of oxygen in combination with sulphide in the sediment, poor condition of the fish and parasite damage. Contaminants which affect the protective skin, may also play a part in causing the disease. Moreover, the activity of bacteria, and hence their infectionsness, may increase in polluted waters.

The map shows estimates of the relative risk (RR) of open skin ulcers among flounder at various study sites (locations) in September. A correction has been made for length, sex and study year.

The map shows that there is an increased relative risk of ulcers in coastal waters, especially near IJmuiden and Callantsoog. It is striking that the values at the Western Scheldt sites are even lower (RR < 1) than at the Eastern Scheldt reference site. Its occurence is positively correlated with salinity.

The table gives a summary of the observed prevalences of ulcers among flounder in three subzones in Netherlands coastal waters. On average, 2.3% of flounder (20 centimetres or more in lenght) are affected by ulcers. Very high prevalences of skin ulcers have recently been observed (locally attaining 50%) in the immediate vicinity of discharge sluices in the Wadden Sea, the North Sea Canal and the Delta zone.

The map is based on the results of the fish disease study carried out by RWS during the period 1983-1989; the number of fish examined was 14,041. The Eastern Scheldt (site 4) was taken as reference (RR=1.00). The results relate to flounder with a length of 20 centimetres or more.

Observed prevalence of skin ulcers in flounder in different areas of the Dutch coastal waters in September (1983 - 1989)

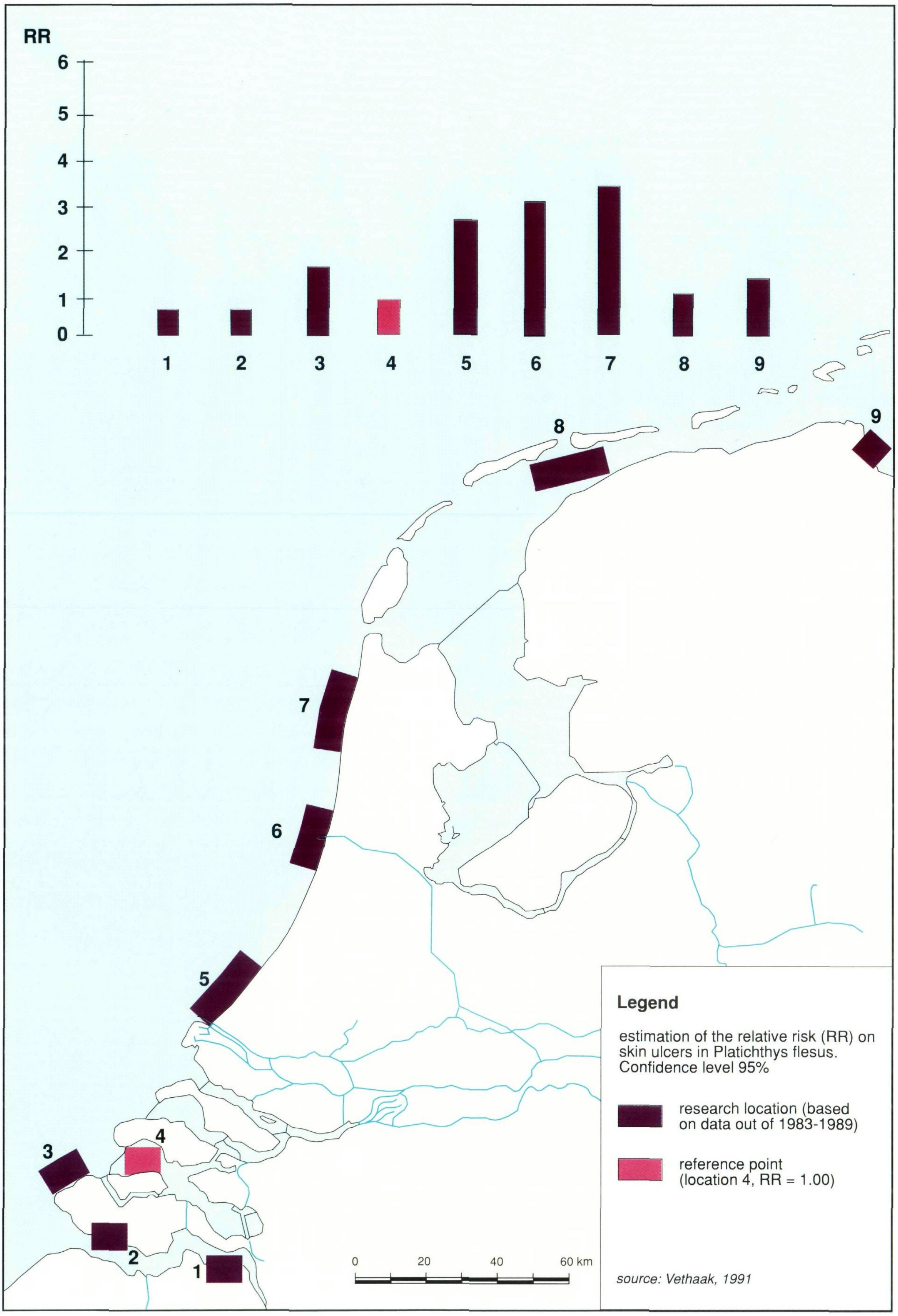
SKIN ULCERS	Total number fish examinated	Number of fish affected	Observed prevalance (%)
Delta area (loc. 1 - 4)	6167	95	1.5
North Sea coast (loc. 5 - 7)	5097	200	3.4
Wadden Sea (loc 8 - 9)	1871	34	1.8
Total (loc. 1 - 9)	14041	329	2 3

Research locations map 91

1	Western Scheldt
2	Western Scheldt
3	Eastern Scheldt/Voordelta
4	Eastern Scheldt/Hammen
5	Hoek van Holland
6	IJmuiden
7	Callantsoog
8	Wadden Sea
9	Eems/Dollard

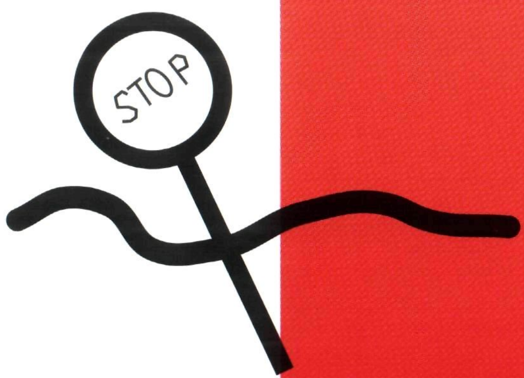
Source:
Vethaak, A.D. (1987). Fish diseases, signals for a diseased environment? In: Peet, G. (ed.). Reasons For Concern (Proceedings of the 2nd North Sea Seminar '86) Vol. 2. Amsterdam: North Sea Working Group, pp. 41-61.
Vethaak, A.D. (1991). Trends visziekten Nederlandse kustwateren 1983-1989. V&W/RWS/DGW notitie 91.10.140.
Vethaak, A.D., Rheinhallt, T.A. (1991). Fish disease as a monitor of marine pollution: the case of the North Sea. Reviews in Fish Biology and Fisheries (in press).

Skin ulcers in flounder



Spatial measures

Coordination of user functions (map 92 and 93)
Coordination of user functions with the environment (map 94 to 96)



Previous versions of the Mining Legislation Chart

As was stated in the commentary to map 70, the exploration and production of minerals on the NCS are regulated by the Continental Shelf Mining Act of 1965. The Mineral Exploration Act, the Mining Act of 1810 and the Mining Act of 1903 apply within the Netherlands territorial sea. These acts will not be considered further here.

Many spatial conflicts occur between offshore mineral activities and other uses of the North Sea. The Continental Shelf Mining Act contains a number of provisions under which measures can be taken to protect interests other than those of oil and gas. In particular, the Royal Decrees implementing Articles 3 and 12 form the basis for the Mining Legislation Chart.

Restriction areas have been designated under Sections IX, X and Xa of the Royal Decree implementing Article 12 of the Continental Shelf Mining Act. Within these areas conditions can be attached to licences for carrying out minerals activities in order to protect shipping and/or defence interests. In addition, a number of areas have been declared "closed" to mineral activities by virtue of Article 3.

The map shows versions of the Mining Legislation Chart for 1967, 1968, 1976 and 1983. There is also a version for 1986. The 1986 version was identical to the current (1991) version, which dates from 1988 (93).

It is striking that the Mining Legislation Chart has been constantly adapted to new circumstances over the years. A number of closed areas (used by the Ministry of Defence) have now been included as special restriction areas (93). In addition, shipping routes have been adjusted to comply with international agreements (58). The approach route to Europoort and its associated anchorages has been declared a closed area. The boundary between the German and Netherlands Continental Shelf was adjusted in 1971.

The Decrees on which the different Mining Legislation Charts are based, are indicated in the list of sources.

Holders of exploration and production licences must conform with the Mining Legislation Chart in force at the date when the licence was granted. This may result in the different uses appearing to be harmonised as shown on the Mining Legislation Chart, but conflicting with each other in practice.

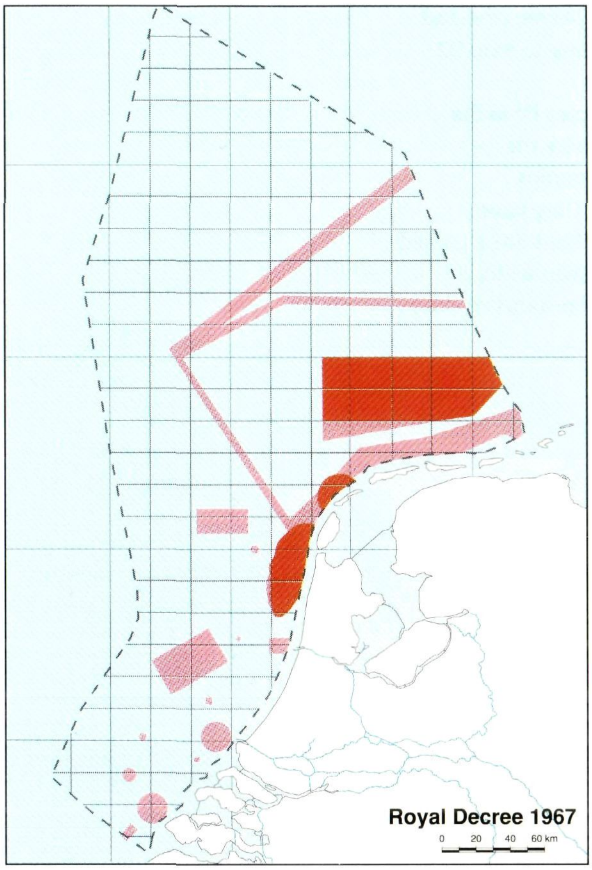
Source:

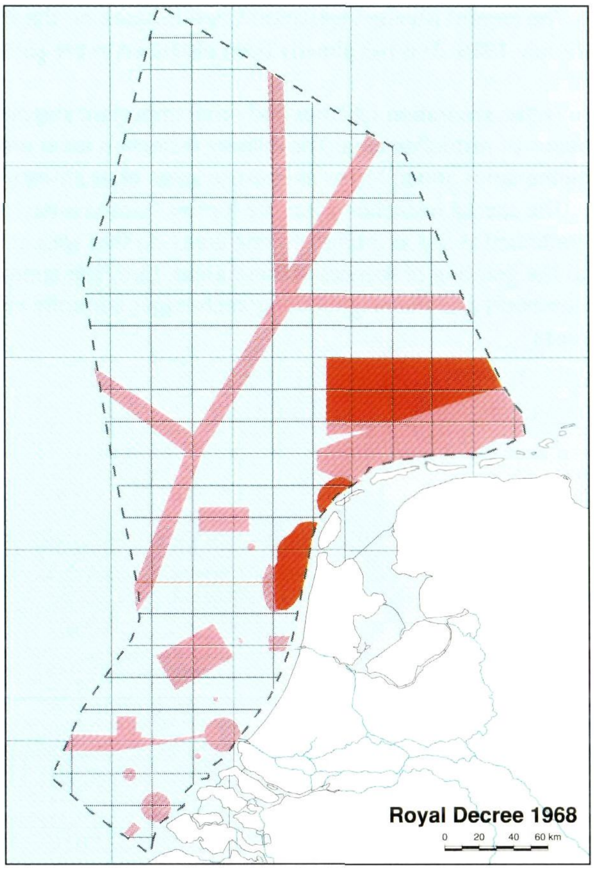
ICONA (1981). Inventarisatierapport Noordzee. Interdepartmental Co-ordinating Committee for North Sea Affairs, The Hague.

Royal Decree of 27 January 1967 (as amended on 15 November 1968, 6 February 1976, 9 November 1983, 20 February 1986 and 4 July 1988), containing Mining Maps based on the Continental Shelf Mining Act 1965 (elaborated by the North Sea Directorate of V&W/RWS).

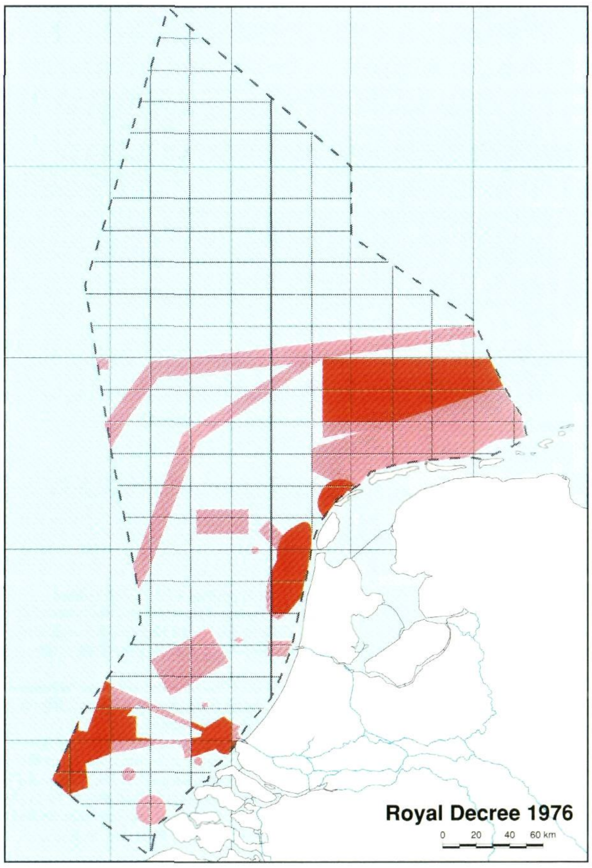
Ministry of Economic Affairs, Directorate-General for Energy, Information Directorate (EZ) (1991). Oil and gas in the Netherlands, exploration and production 1990. The Hague. ISSN: 0925-7993.

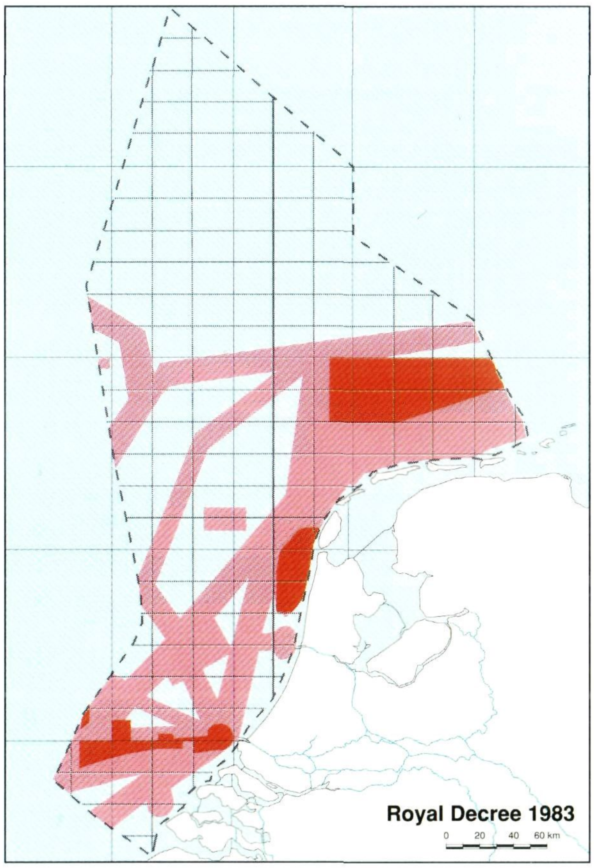
Previous versions of the Mining Legislation Chart





Legend: restriction area closed area *source: after Royal Decree of 1967, 1968, 1976, 1986 and 1988*





Current Mining Legislation Chart

The current Mining Legislation Chart is based on the Royal Decree of 4 and 22 July 1988. This has already been discussed in the commentary to map 92.

Traffic separation schemes and other important shipping routes have the status of restriction area. The military restriction areas are used by the Netherlands armed forces as exercise areas or as ammunition dumps.

The special restriction areas are former "closed areas" (92). They have continued in use as intensive firing areas, so that special conditions are attached to the granting of licences in these areas. Only the approach channel to Europoort and the neighbouring anchorages currently enjoy the status of closed areas.

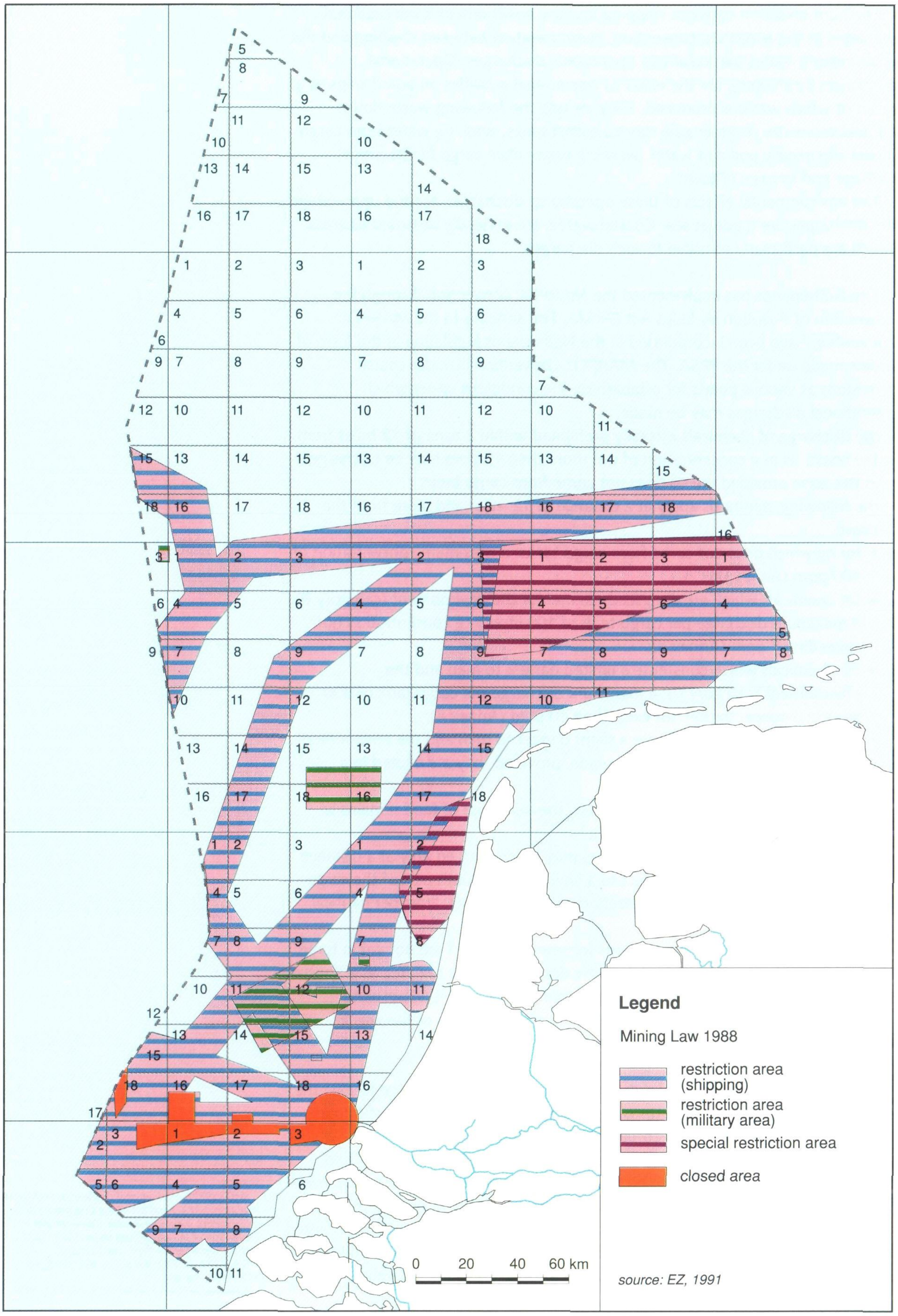
Source:

Ministry of Economic Affairs, Directorate-General for Energy, Information Directorate (EZ) (1991). Oil and gas in the Netherlands, exploration and production 1990. The Hague. ISSN: 0925-7993.

ICONA (1981). Inventarisatierapport Noordzee. Interdepartmental Co-ordinating Committee for North Sea Affairs, The Hague.

Explanatory note to the Royal Decree of 20 February 1986 containing an amendment of the Royal Decree of 6 February 1976 (Stb. 1976, no. 102), concerning the execution of article 12 of the Continental Shelf Mining Act on exploration and exploitation licences with regard to oil and gas (Stb. 1986, no. 65).

Current Mining Legislation Chart



Zoning under the MARPOL 73/78 Convention

The harmonisation between shipping and the environment is internationally regulated in the MARPOL convention. Harmonisation between shipping and the environment relates particularly to operational discharges. Operational discharges by shipping are the result of operational activities on board ships as a result of which waste is produced. They include the following waste flows: oil-polluted water (from engine rooms, ballast tanks, washing water from cargo tanks), chemically polluted water (washing water from cargo tanks), ships' garbage and sewage effluent.

The environmental effects of these operational discharges depend upon where the discharges are made at sea. Coastal waters are generally regarded as areas which are particularly sensitive to such discharges.

The Netherlands has implemented the MARPOL convention through the Prevention of Pollution by Ships Act (PPSA). The annexes to the MARPOL convention have been incorporated in the Netherlands legislation in the form of orders made under the PPSA. The MARPOL convention includes spatial provisions at various points for establishing the conditions under which operational discharges may be made:

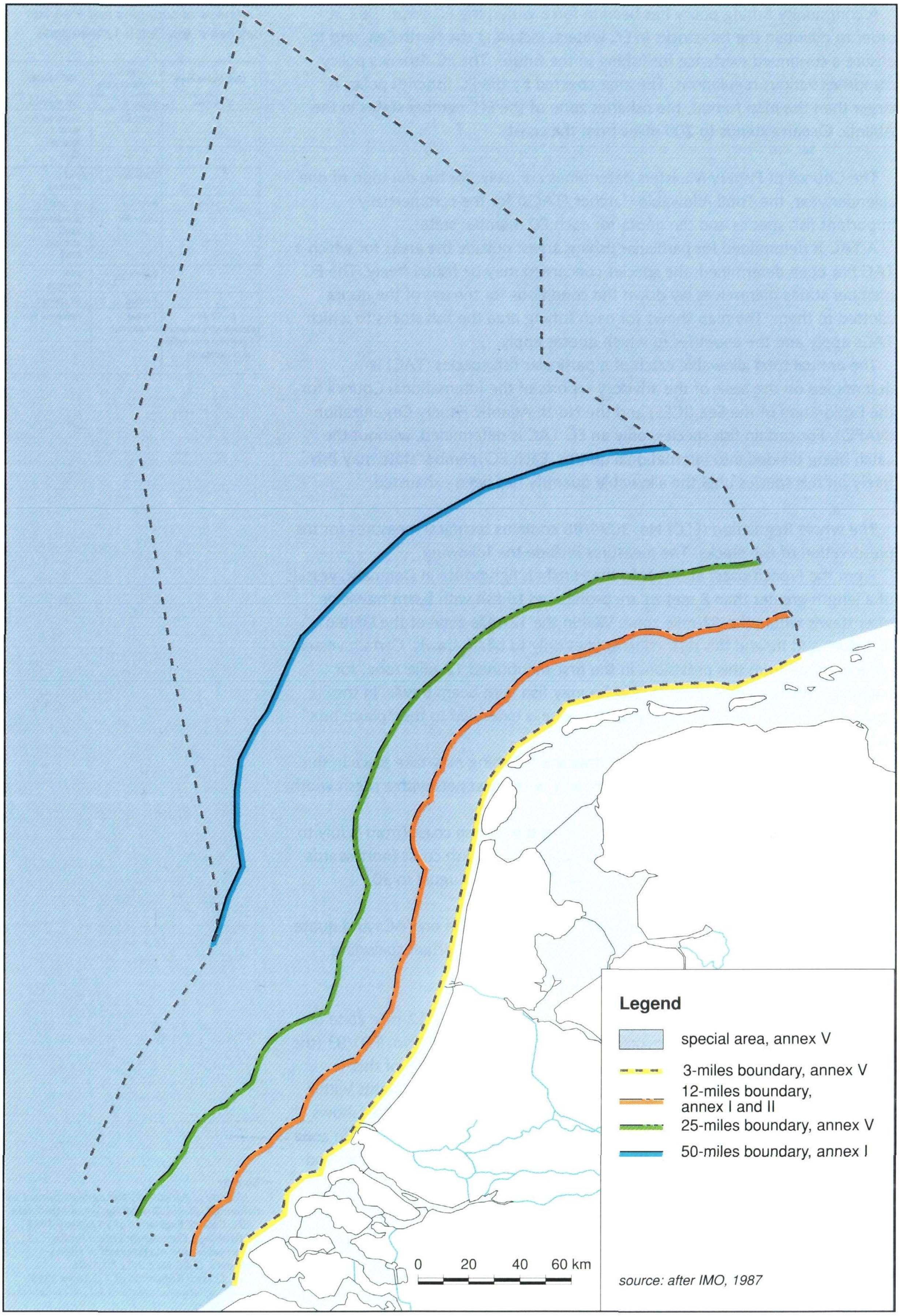
- the discharge of chemicals is totally prohibited within a zone of 12 miles from the coast; oil in a concentration of not more than 15 ppm may be discharged in this zone provided the oil does not come from cargo tanks;
- the following standards apply at a distance of 12 miles and more from the coast:
  - for oil which does not come from cargo tanks: a maximum concentration of 100 ppm (Annex I);
  - for chemicals which are dangerous to man or the environment (category B): a maximum discharge per cargo tank of 100 litres in a concentration not exceeding 1 ppm (Annex II);
  - for chemicals which constitute a limited danger to man and the environment (category C): a maximum discharge per cargo tank of 300 litres in a concentration not exceeding 10 ppm (Annex II);
  - for chemicals which constitute a slight danger to man and the environment (category D): discharges may be made, provided they are diluted in a concentration of 1:10 (Annex II).
- within a zone of 12 miles from the coast, the discharge of food remains is forbidden in a Special Area (Annex V);
- oil from the cargo section of oil tankers may be discharged only at a distance of 50 miles from any land, subject to a limit of 1/30,000th part of the cargo capacity and a maximum concentration not exceeding 60 litres per nautical mile covered (Annex I).

The internationally agreed provisions for sewage effluent are not yet in force. The MARPOL convention also permits the designation of a sea area as a Special Area for oil, chemicals or ships' garbage, which brings with it an absolute prohibition or drastic restrictions on the discharge from ships of the waste concerned.

It was decided during the Second North Sea Ministers Conference to give the whole of the North Sea the status of Special Area for the discharge of ships' garbage, with effect from 18 February 1991; this means an almost total prohibition on discharges. No agreement could be reached during the Third North Sea Ministers Conference on the designation of the North Sea as Special Area for the discharge of oil and chemicals from ships. The above zones have been implemented in Netherlands legislation. The IMO recently (1991) accepted amendments to the MARPOL convention relating to the discharges of oil from ordinary ships and tankers (15 ppm and 30 litres per mile, respectively).

Source:
IMO (1987). International conference on Marine Pollution, 1973. Final act of the Conference with attachments, including the Int. Conv. for the Prevention of Pollution from ships, 1973. 1977 edition, reprinted in 1987. IMO London.
Stb. 1983 no. 683; 1986, no. 160; 1988, no. 112; 1988, no. 636.
Netherlands Treaty Series 1975, no. 147; 1978 no. 188.

Zoning under the MARPOL 73/78 Convention



Spatial implementation of the EC fisheries policy

A community fishing policy has been in force within the EC since 1983 in order to maintain the fish stocks in EC waters, including the North Sea, and to ensure a continued existence for fishing in the future. The EC fisheries policy comprises various regulations. The area covered by the EC fisheries policy is larger than the map format; the fisheries zone of the EC member states in the Atlantic Ocean extends to 200 miles from the coast.

The Council of Fishery Ministers determines annually, for the duration of one calendar year, the Total Allowable Catches (TACs) for the commercially important fish species and the quota for each EC member state.

A TAC is determined for particular fishing areas; outside the areas for which a TAC has been determined, the species concerned may be fished freely. The EC member states themselves lay down the conditions for the use of the quota allotted to them. The map shows for each fishing area the fish stocks to which TACs apply and the countries to which quotas apply.

The annual total allowable catch of a particular fish species (TAC) is determined on the basis of the advisory reports of the International Council for the Exploration of the Sea (ICES) and the North Atlantic Fishery Organization (NAFO). For certain fish species, only an EC TAC is determined, without the catch being divided into international quotas. Each EC member state may fish freely on this species until the allowable quantity has been exhausted.

The whole Regulation (EEC) No. 3094/86 contains technical measures for the preservation of fish stocks. The measures include the following.

From the French coast at 51° N to the Hirtshals lighthouse in Denmark, vessels of a length greater than 8 metres are prohibeted to fish with beam trawls or otter trawls within the 12-mile zone. Within the 12-mile zone of the United Kingdom and Ireland this restriction applies only to beam trawls. Certain vessels are exempted from this provision. In the first-mentioned 12-mile zone, for example, fishing vessels of up to 300 hp may fish with beam trawls. In the second and third quarters of the year this zone is extended to the "plaice box" in the southeastern North Sea.

In addition, a "cod box" has been established. Fishing may take place in this zone during the first and fourth quarters only with trawl nets with a mesh width greater than 10 centimetres.

There are catch restrictions for herring along the Danish coast (from 1 July to 31 October) and in the 6 to 12-mile zone along the English coast (northwards: from 15 August to 15 September; southwards: from 15 August to 30 September).

These regulations are imposed annually in the Regulation on TACs and quota. The aim of all the above measures is the protection of important spawning grounds and nurseries of the fish species concerned.

The possibilities for one EC member state to fish within the 12-mile zone of another EC member state are incorporated in Regulation (EEC) No. 170/83 (the basic regulation). The access provisions are laid down in Article 6 of this regulation. The map shows where the Netherlands enjoys fishing rights within the 12-mile zone of other EC member states. The accompanying table shows which countries may fish on which species within the Netherlands 12-mile zone (3-12 miles). It should be noted that, under the BENELUX treaty, Belgium and Luxembourg may fish in the 3-mile zone off the Netherlands coast.

The Norwegian fisheries zone extends to 200 miles and includes a large part of the North Sea and the Skagerrak. The access of EC fishing vessels to Norwegian waters is regulated in a fisheries agreement.

Overview of countries and their fish catches in the Dutch 12 mile zone

geographic aera	EC member state	fish species
3 - 6 mile	Belgium	all species
	Denmark	demersal fish sprat scandel scad
	Germany	cod shrimps
6 - 12 mile	Belgium	all species
	Denmark	demersal fish sprat scandel scad
	Germany	cod shrimps
	France	all species
6 - 12 mile (allowed only between Texel and the border with Germany)	United Kingdom	demersal fish

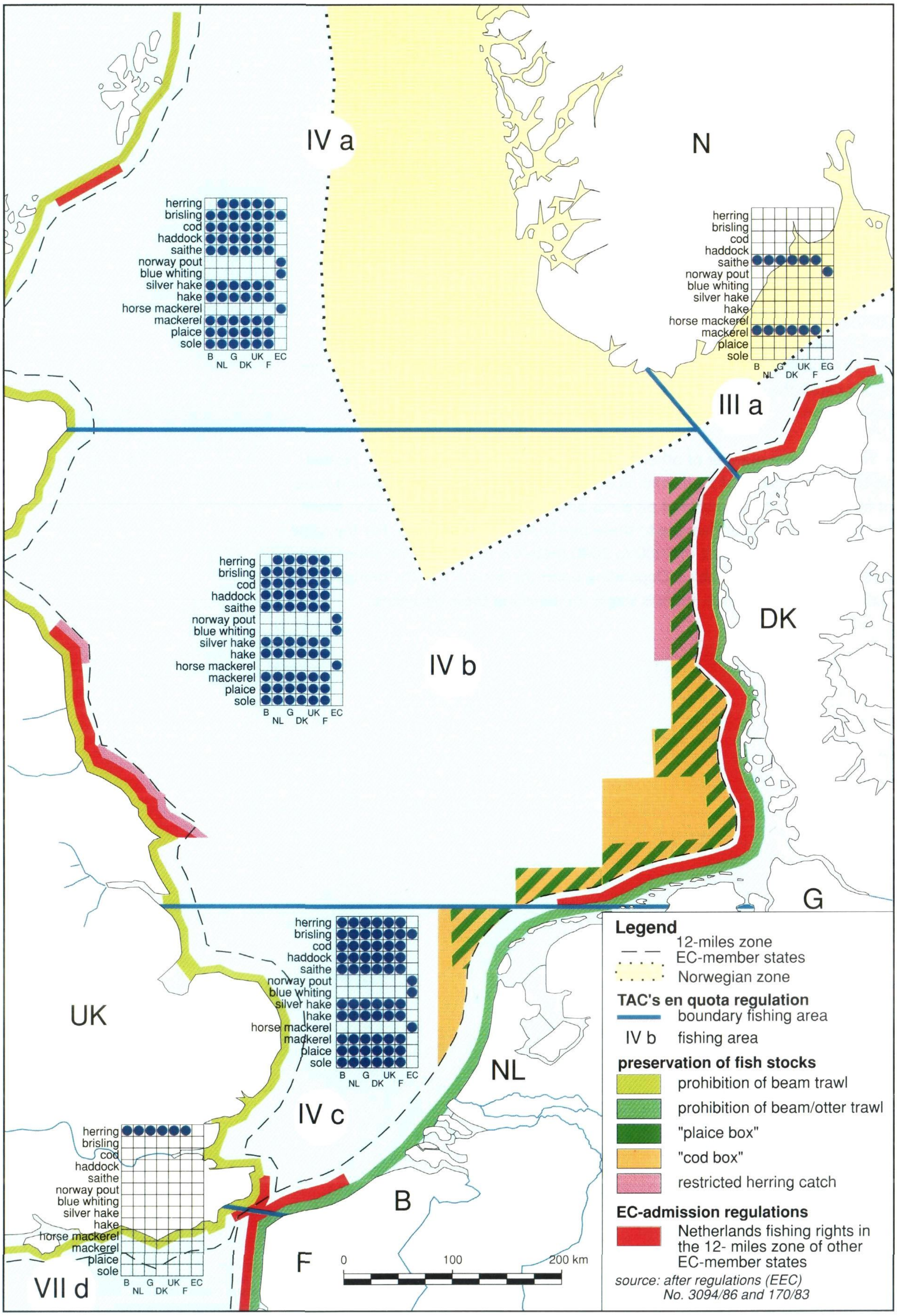
Source:

Ministry of Agriculture, Nature Management and Fisheries, Fisheries Directorate: unpublished data.

EEC Council Regulation of 25 January 1983 Establishing a Community System for the Conservation and Management of Fishery Resources, OJEC No L 24, 27.1.1983.

EEC Council Regulation of 7 October 1986 , containing technical measures for the conservation of fish stocks.

Spatial implementation of the EC fisheries policy



Closed areas for the extraction of mineral deposits

The extraction of sand, gravel or shells at sea may conflict with other uses. The policy formulated in the "Regionaal Ontgrondingenplan Noordzee" (= Regional Extraction Plan for the North Sea) tries to prevent this. The most far-reaching measure is the designation of areas where the extraction of sand, gravel or shells is excluded.

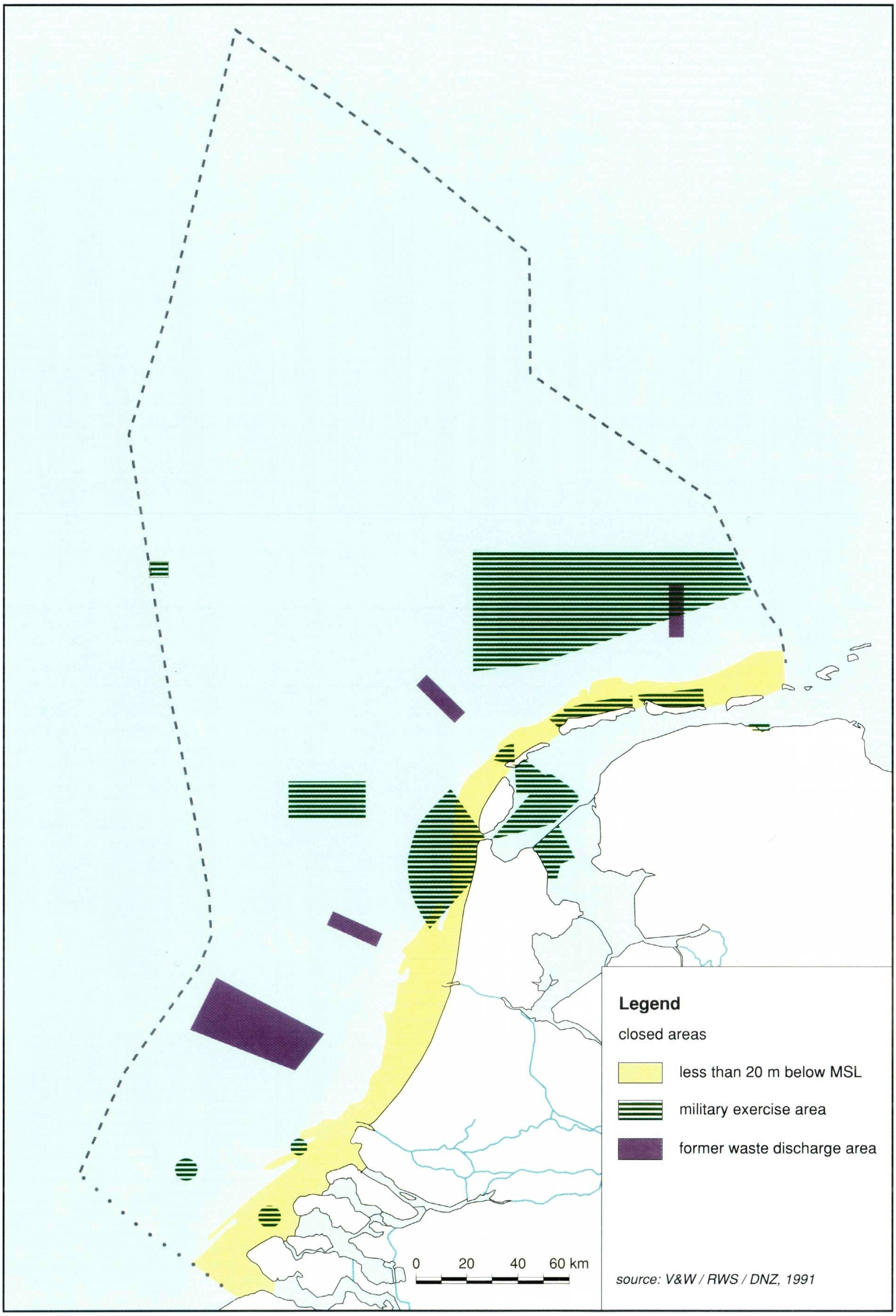
The exclusion (or closed) areas shown on the map include the area on the landward side of the line of 20 metre below MSL (excluding the nautical channels), a number of intensively used military exercise areas and former waste discharge areas. The 20 metres below MSL area has been excluded mainly to ensure the safety of the sea defences. In addition, extraction should remain prohibited in this area because of the rich variety of the benthic fauna [41, 44, 45] and the nursery function of the coastal zone.

Extraction has been excluded in the former waste discharge areas because contaminants present in the sediment may be released there. Moreover, the contaminants make the extracted material less suitable for use. Extraction has been excluded in intensively used military exercise areas because of the danger and because the extracted material may contain exploded and unexploded ammunition.

There is also a number of other exclusion areas. They have not been plotted on the map because of their small size. There is, for example, an exclusion zone of 500 metres on either side of pipelines and around drilling platforms in order to prevent breaking or damage to these pipelines and installations. For the same reason, an exclusion zone of 1000 to 2000 metres is maintained on either side of telecommunication cables. Depending upon the accuracy of the dredger's position-fixing apparatus, there is scope for adjusting these distances.

Source:
Ministry of V&W, RWS, North Sea Directorate (V&W/RWS/DNZ) (1991). Ontwerp Regionaal Ontgrondingenplan Noordzee.

Closed areas for the extraction of mineral deposits



List of abbreviations

ADW	Ash-free dry weight
ANWB	General Cyclists Association of the Netherlands
C	Carbon
CB	Chlorinated biphenyl
cm^2	square centimetre
DGSM	Directorate-General for Shipping and Maritime Affairs (The Netherlands Ministry of Transport, Public Works and Water Management)
DGW	Tidal Waters Division of RWS (The Netherlands Ministry of Transport, Public Works and Water Management)
dm	decimetre
DNZ	North Sea Directorate of RWS (The Netherlands Ministry of Transport, Public Works and Water Management)
E	East longitude
EC	European Community
EZ	The Netherlands Ministry of Economic Affairs
g	gramme
µg	microgramme
h	hour
HCB	Hexachlorobenzene
ICES	International Council for the Exploration of the Sea
ICONA	The Netherlands Interdepartmental Co-ordinating Committee for North Sea Affairs
IMO	International Maritime Organization
kg	kilogramme
km^2	square kilometre
KNMI	Royal Netherlands Meteorological Institute
l	litre
LNV	The Netherlands Ministry of Agriculture, Nature Management and Fisheries
m^2	square metre
m^3	cubic metre
µm	micrometre
MARIS	Marine Information Service (The Netherlands)
MARPOL	Maritime pollution (International Convention for the prevention of pollution from ships)
MD	Survey Department of RWS (The Netherlands Ministry of Transport, Public Works and Water Management)
MILZON	Environmental Zoning project
mg	milligramme
mm	millimetre
MSL	Mean Sea Level (in this atlas, MSL agrees with NAP (= Normaal Amsterdams Peil))
N	North latitude
NCS	Netherlands (sector of the) Continental Shelf
ng	nanogramme
NHI	Netherlands Hydrographic Institute
NIOZ	Netherlands Institute for Sea Research
nm	nanometre
NMF	Nature Conservation, Environmental Protection and Wildlife Management Department (The Netherlands Ministry of Agriculture, Nature Management and Fisheries)
NOGAT	Northerly Offshore Gastransport
OBM	Oil Based Mud
OPL	Oilfield Publications Limited
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
PEV	Pentane Extractable Fat
hp	horsepower
PPD	Provincial Physical Planning Agency (The Netherlands)
ppm	parts per million
QSR	Quality Status Report
RGD	Geological Survey of the Netherlands (The Netherlands Ministry of Economic Affairs)
RIVO	Netherlands Institute for Fishery Investigations
RIZA	Institute for Inland Water Management and Waste Water Treatment of RWS (The Netherlands Ministry of Transport, Public Works and Water Management)
RPD	National Physical Planning Agency (The Netherlands Ministry of Housing, Physical Planning and Environment)
RR	Relative Risk
RWS	Directorate-General for Public Works and Water Management (The Netherlands Ministry of Transport, Public Works and Water Management)
s	second
Stb.	Staatsblad (Statute book of the Netherlands)
Stct.	Staatscourant (State Gazette of the Netherlands)
TAC	Total Allowable Catch
UN	United Nations
V&W	The Netherlands Ministry of Transport, Public Works and Water Management
VONOVI	North Sea Traffic Research Visual Identification
VROM	The Netherlands Ministry of Housing, Physical Planning and Environment
WL	Delft Hydraulics (The Netherlands)
W	West longitude
WVC	The Netherlands Ministry of Welfare, Health and Cultural Affairs
(54)	Reference to the map where additional or more detailed information on the subject can be found

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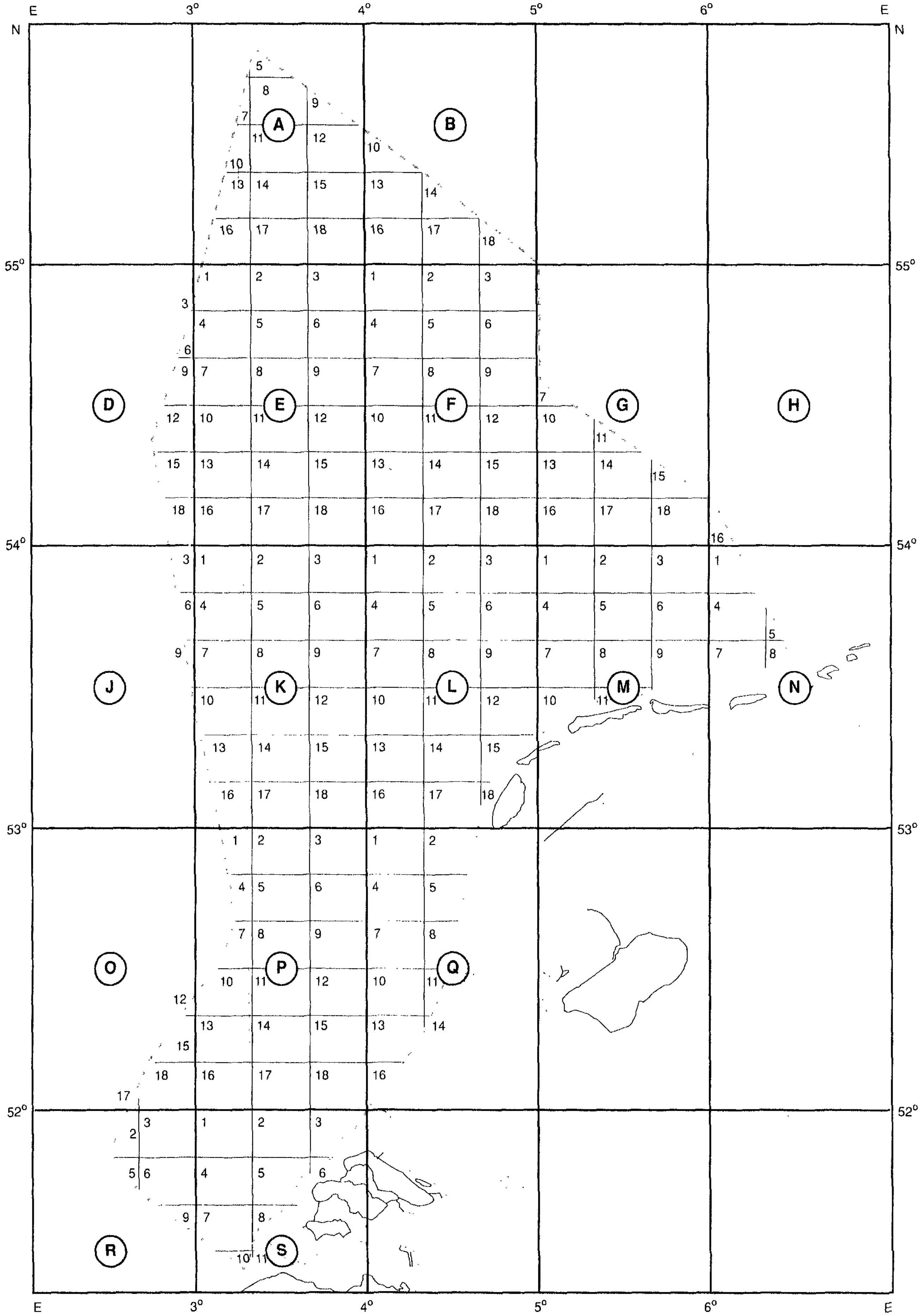
Netherlands Continental Shelf



Kaart bij
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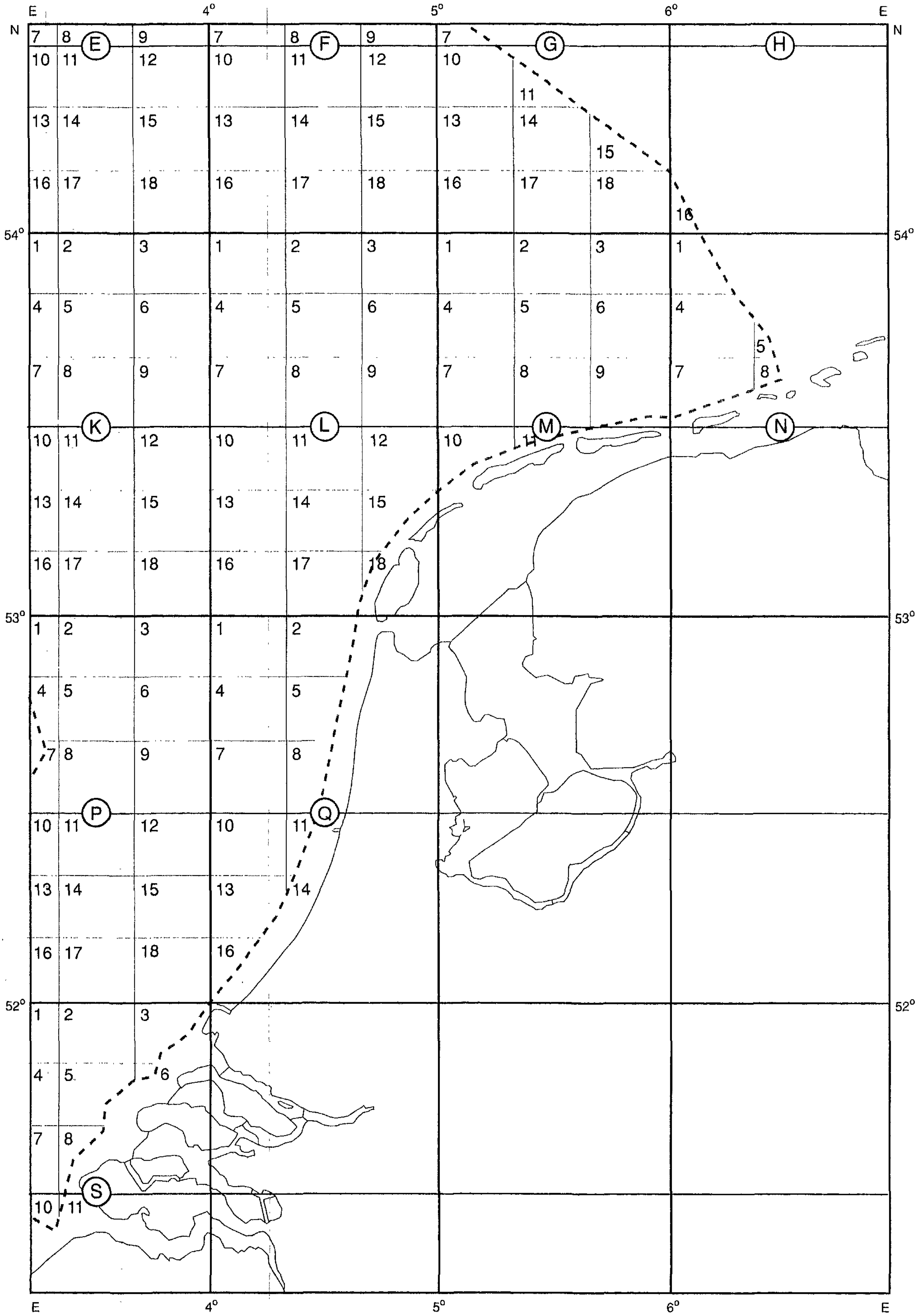
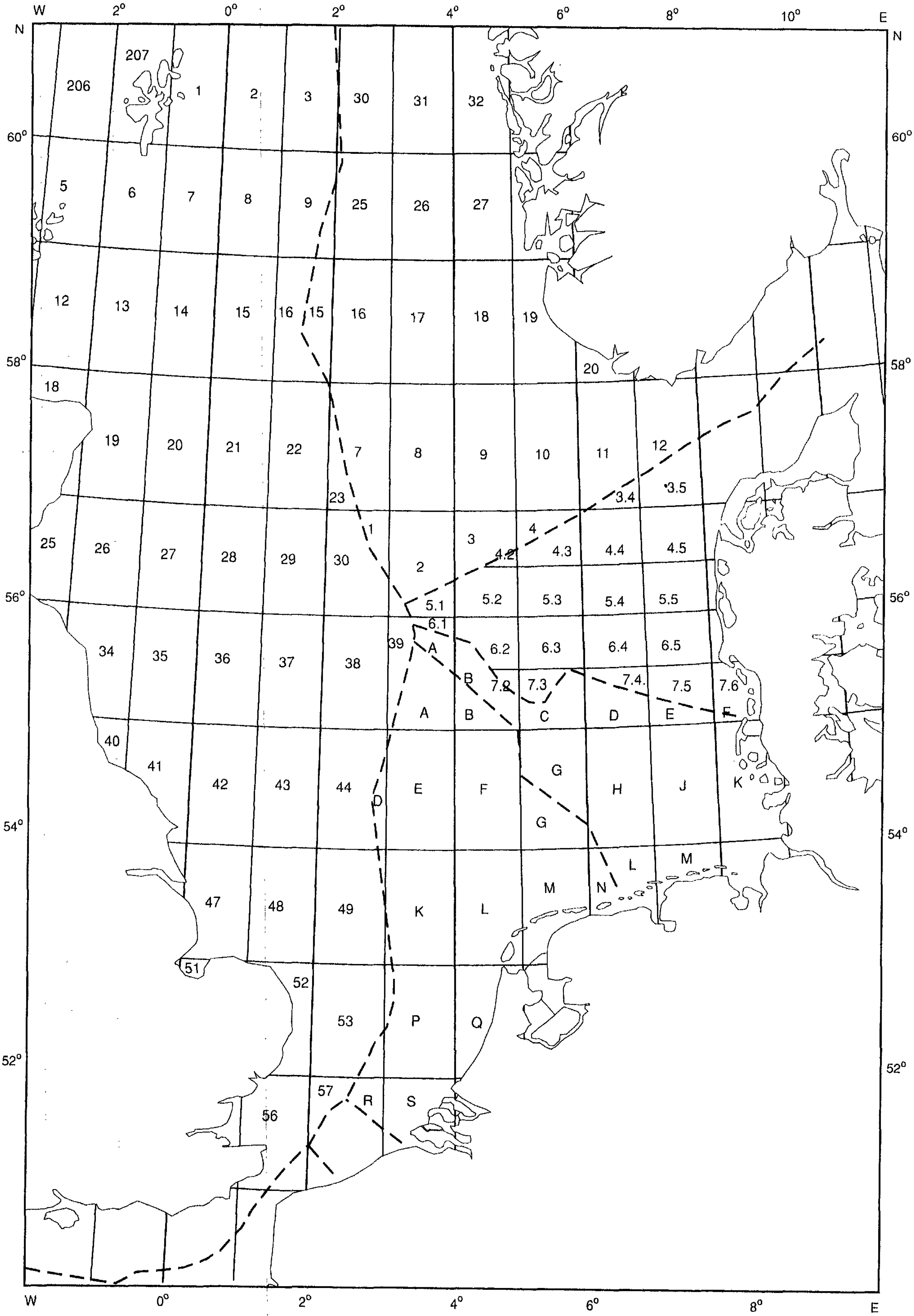
Netherlands coast



North Sea



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The North Sea is an unknown space. These are the words of Hanja Maij-Weggen, the Netherlands Minister for North Sea Affairs, in her foreword to this North Sea Atlas. The atlas itself shows how true these words are. It contains over a hundred maps; these are only a fraction of the number that could have been assembled. However they have been chosen to represent the most important uses to which the North Sea is put. Never before has such a large amount of information, from so many disciplines, been brought together in one atlas. This first North Sea Atlas contains the most recent data on a wide variety of issues from marine pollution, to maritime jurisdictional zones and fisheries. Even though the Netherlands maritime areas represent only a tenth of the total North Sea it is apparant that this sector is one of the busiest sea areas in the world. The North Sea Atlas demonstrates how we use the North Sea. For that reason alone it is a most valuable volume, but it is also intended as an important tool for the management and sustainable development of the North Sea. For obvious reasons, the information in the atlas is primarily concerned with the Netherlands sector of the North Sea, but the work as a whole is intended to be of interest and utility to everyone who is interested in the problems of the marine environment and its proper management.

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